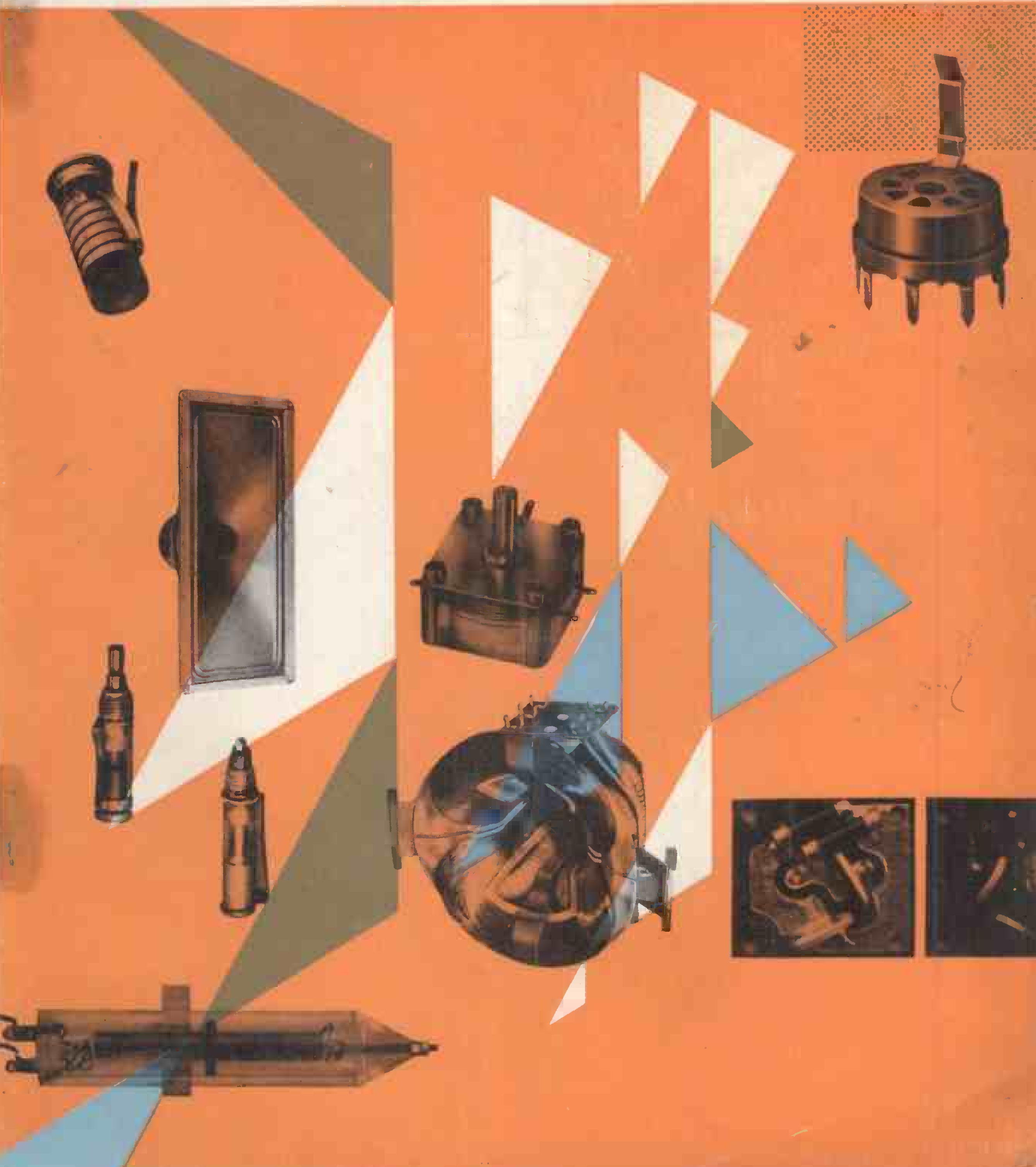
Wireless World

ELECTRONICS
RADIO
TELEVISION

JULY 1961 TWO SHILLINGS



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ELECTRONICS, RADIO, TELEVISION

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Wireless World

VOL 67 NO 7 JULY 1961

Components and Assemblies

THE emergence of the Radio and Electronic Component Manufacturers Federation's exhibition from the comparative privacy of Grosvenor House to the open halls of Olympia was regretted by many on sentimental grounds, but is nevertheless symbolic of the growth and prosperity of the root stock of the British radio and electronic industry. Formerly a sort of club where industrial and Government departmental buyers could negotiate the preliminaries of contracts with technical sales representatives of the component manufacturers, the exhibition has now opened its doors to the world, which is showing increasing interest not only in the quality of the goods, but also in the price. It is no secret that Continental equipment manufacturers often find it cheaper to buy British and to an extent which is reflected in the statistics. In 1960 exports were standing at a value of £13.5M (36.5% more than in 1959) and preliminary returns for the early part of 1960 show a further increase of the order of 20%.

By contrast the component assemblers—the manufacturers of complete equipment—have been finding things more difficult. In particular, the television receiver industry is becalmed in a sea of surplus sets. To some extent the component manufacturers must accept part of the blame, for the reliability of British television receivers has exceeded expectations, and estimates of the production necessary for replacement in a virtually saturated market have proved to be too high. German television manufacturers also have large surplus stocks, but the hold-up has been caused by vacillation over means of providing a second TV programme, and by misjudgment of the timing in the introduction of technical improvements, e.g., the "square-cornered" picture tubes. The future prospects for television sales on the Continent are bright, for it will be at least five years before the number of viewers reaches the level already achieved in the U.K.

Meanwhile the basic problem everywhere is the proper use of an excess productive capacity. This is not a new development. For many years the pattern of the industry has been formed by a number of medium- to large-sized firms each with production lines which, if working to full capacity, could have satisfied well nigh the whole of national demands. Fluctuations in demand have to be met by seasonal working and a reservoir of manufacturers' or dealers' stocks.

The possession of surplus stocks may have advantages in meeting quickly and at the right price export orders from unexpected quarters, and in this situation we find one of the strongest arguments for a change from our 405 lines to the 625-line standard. Since most of the underdeveloped countries are adopting this standard, Continental manufacturers have the advantage of being able to deliver from stock. British manufacturers are competitive in price, but not in delivering times.

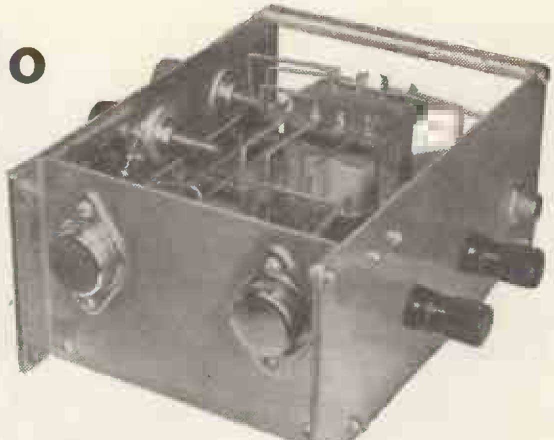
The rate of introduction of new technical developments can also have a considerable influence on the attitude of mind of the buying public. If the potential customer gains the impression that he is on the threshold of a period of fresh advancement he may well decide to stick to his old set until the situation is clear. It is unlikely to be so if manufacturers make a continuous succession of changes in design regardless of the state of the market. This aspect of the economy was underlined at a recent conference of international radio technical journalists by Herr Werner Meyer, director of the export commission of the radio and television branch of the German electrical industry (Z.V.E.I.). After pointing out the difficulties which had resulted in Germany from the successive introduction of 21-in then 19-in and 23-in tube sizes, all within a year, he reminded manufacturers that they had some responsibility for letting dealers sell existing stocks before placing new designs before the public. In his opinion the time had come when there should be intimate co-operation between the technical departments of all the important factories in Europe (and he personally hoped that these would include England and the Scandinavian countries) to secure agreement on the timing of changes and to safeguard the stability of the market.

We realize that these matters are controversial and will be stigmatized by some as restrictive practices. We prefer to describe them as planned economy which will in the long run benefit the consumer as much as the manufacturer. Recent signs and events all point to the fact that the British radio industry has decided that its future, either as a competitor with or a partner in the European Common Market, will be best assured by regrouping, consolidation and more unified control. Our own view is that it has little to lose and much to gain by collaboration with the rest of Europe in developing the markets which still remain to be served.

Transistor Audio Amplifier

By R. C. BOWES, B.Sc., A.M.I.E.E.

DESIGNS FOR 4W AND 10W OUTPUT WITH LESS THAN 0.1% DISTORTION



10-W transistor amplifier.
(Crown Copyright photograph)

POWER transistors which are suitable for audio power amplifiers have existed for some time, but most designs, up to date, cannot be classed as high quality from a distortion point of view. The currently accepted standard for total distortion is less than 0.1% at all levels up to full output (whether such a low distortion is really necessary is another matter) and the amplifier described has this performance up to maximum output which is 4 to 10 W. A transformerless class-B output stage is used to feed a 15-Ω load directly, and the distortion is kept low both by overall feedback and local feedback on the output transistors. The article describes the 4-W amplifier in detail and the modifications for a 10-W output are given at the end.

Circuit Description.—The complete 4-W amplifier circuit is shown in Fig. 1 and the logic of the design will now be considered, starting at the output stage. The current and voltage ratings of power transistors are very suitable for directly driving a 15-Ω speaker load, and the output stage is a transformerless class-B push-pull circuit with the transistors connected in series. The elimination of the output transformer has the advantage of saving a large and costly component, especially if full power is

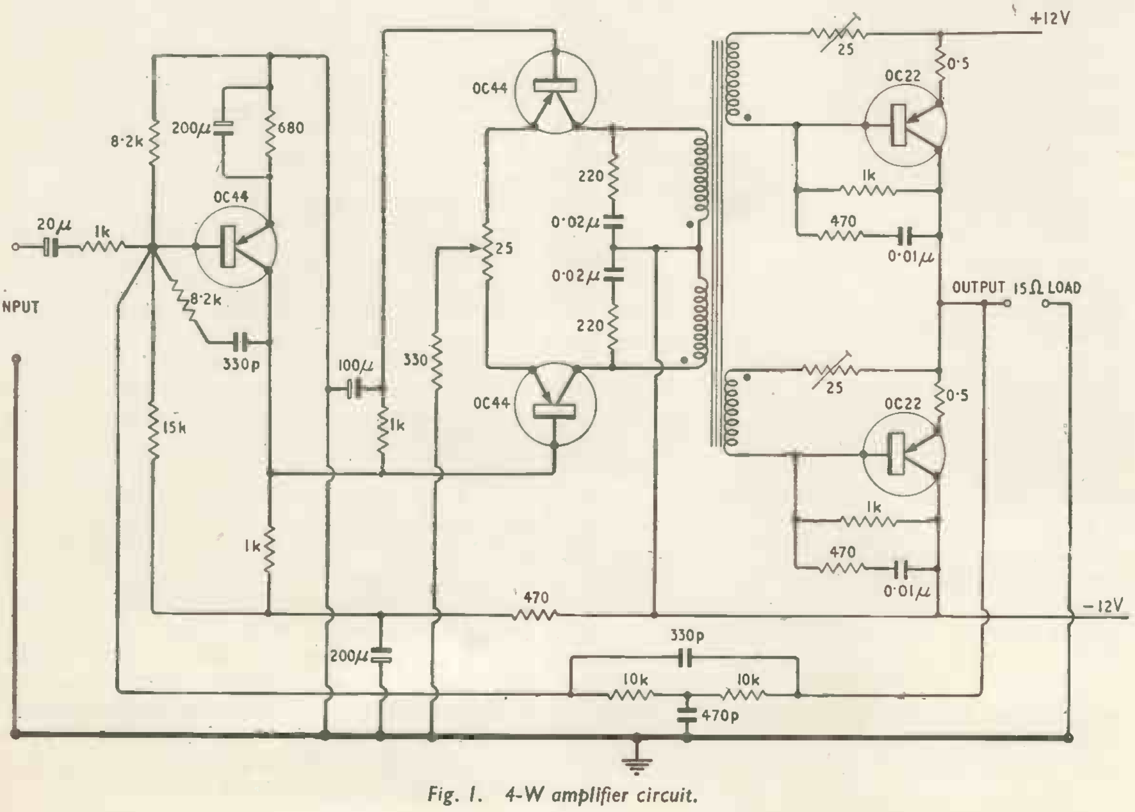


Fig. 1. 4-W amplifier circuit.

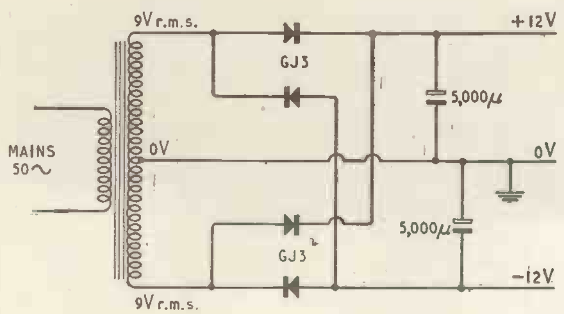


Fig. 2. Power supply for 4-W amplifier.

required at low frequencies. The use of a class-B output stage keeps the power dissipation low in the output transistors, which makes thermal run-away easier to avoid, and gives the amplifier a good overall power efficiency. The last point is usually trivial unless battery supplies are used. A symmetrical power supply of +12 and −12 V (Fig. 2) has been used because it enables the load to be connected directly between the output point and earth. (If a single supply of 24V is used two rectifiers and a large smoothing capacitor are saved, but a large capacitor is required in series with the load to earth, and if the feedback is still taken from across the load an additional low-frequency lead is introduced.)

The quiescent current (50mA) in the output transistors is determined by the 1-kΩ resistors from collector to base and the 25-Ω preset resistors in the base-emitter circuits. The output transistors are stabilized against thermal run-away both by low base-emitter resistors (about 15Ω) and the addition of 0.5-Ω resistors in the emitter circuits. This enables the amplifier (in its 4-W version only) to be safely operated in an ambient temperature of up to 40°C. This method of biasing the output transistors provides feedback at signal frequencies which reduces the current gain by about four and also decreases the distortion.

The output transistors are driven by a transformer as this is a convenient way of obtaining the floating input required by the lower output transistor. The use of a transformer has the advantage of providing a current gain of three and the resistance in the base circuit of the output transistor is kept low, which helps the d.c. stability. The transformer (details in appendix) is quite small and easy to design providing there is no d.c. polarization. The latter requirement has been met by feeding the primary, in push-pull, from the collectors of a long-tailed-pair circuit, the currents being balanced by the preset potentiometer between the emitters. At audio frequencies the primary is current driven and therefore so are the bases of the output transistors. These can be looked upon as "virtual earth" points because the input impedance of a transistor is low and the local feedback makes it even lower.

The input transistor is directly coupled to one base of the long-tailed-pair, the other base being fed through a 1-kΩ resistor with a large capacitor (100μF) to bypass signal frequencies to earth. With this circuit any d.c. drift of the collector voltage of the input transistor is fed to both bases of the long-tailed-pair circuit and so does not upset the balance of the currents in this circuit, but only slightly alters their magnitude.

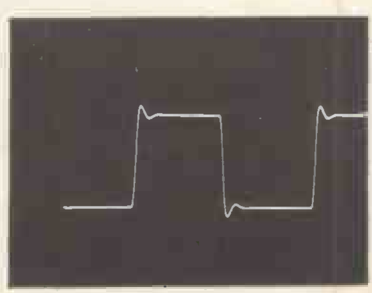
The design of the output and driver stages having been fixed, the input stage is added to increase the forward gain so that about 34dB of overall feedback can be applied while still leaving an input-output voltage gain of 20 times. The input stage is a common-emitter circuit in which the d.c. conditions are stabilized by an emitter resistor, which is decoupled, in associated with a potential divider to supply the base voltage.

The amplifier has overall feedback applied in an anode-follower manner, the base of the input transistor being the virtual earth. The input arm consists of a 20-μF capacitor and 1-kΩ resistor, and the feedback arm is a 20-kΩ resistor which is fed directly from the output point.

Loop Gain and Stability.—The loop gain at 1kc/s is 34dB, and it is 3dB down at 100c/s and 10kc/s. Taking low frequencies first, the most important phase lead is due to the driver transformer and the only additional leads are transitional ones due to the decoupling capacitors on the emitter of the input transistor and on one base of the long-tailed-pair circuit. There is no difficulty in choosing the corner frequencies of these leads so that adequate stability at low frequencies is obtained.

The high-frequency loop response is more complex. It is determined both by the transformer and the transistors, and is shaped by local feedback on the input and output transistors. The effects of resonance in the transformer are reduced by the addition of a capacitor-resistor network across the primary which changes the drive from current to voltage at high frequencies. Also, a phase advance is obtained in the feedback network by the addition of a capacitor (330pF) in parallel with the feedback resistor. The combined effect of these shaping networks is that unity loop gain is obtained at 150kc/s with a phase shift of about 120°, which is a very adequately stable system. This has been verified by feeding the complete amplifier with square waves and observing the transient response. The photograph of the small-signal response with a square wave input at 5kc/s and a load of 15Ω shows that this is very satisfactory and indicates the amplifier is adequately stable. Although OC44 type transistors (which have an average $f\alpha$ of 15Mc/s) have been used in the prototype and for the loop-gain calculations, the fitting of OC45 type transistors (average $f\alpha$=6Mc/s) still gives a satisfactory transient response.

The purpose of the 470-pF capacitor from the centre tap of the feedback resistor has been ignored up to the present. In the early design stages this capacitor was not fitted and the overall frequence response was down 1dB at 10kc/s and 3dB at



Output waveform with a 5kc/s square-wave input and 15-Ω load.

25kc/s (see Fig. 3). This was considered to be inadequate and the 470-pF capacitor was added to reduce the feedback around 25kc/s and improve the 1dB point to 45kc/s (see Fig. 3) without altering the feedback at higher frequencies.

Power Supply.—The power supply (Fig. 2) consists simply of two germanium rectifiers and a smoothing capacitor for each line. The total resistance (transformer winding and wiring) in series with the rectifiers should be about 0.4Ω in order to limit the peak current under the worst possible condition, which occurs when the mains switch is closed at peak voltage.

Distortion.—Fig. 4 shows both the harmonic distortion up to the 5th harmonic and the total distortion, for power output levels up to 4 W with a 1 kc/s signal. The total distortion with an output of 4 W is 0.031% and this low level of distortion is a result of the large amount of feedback in the amplifier. The local feedback on the output transistors reduces the gain by about 4 and the overall feedback reduces the gain by 50, so that the total feedback factor is 200 (so far as the output transistors are concerned). This means that at an output level of 4 W, if both feedback paths were made imperative, the total distortion would be about 6%, which is a typical figure for a transistor power amplifier in which no techniques are used to reduce distortion.

The push-pull output stage produces no even harmonic distortion if everything is perfectly symmetrical, and it is therefore desirable that the α's of the output transistors should be matched to better than 20%, at large currents (about ½A), so as to keep the second harmonic distortion below 0.05%. The transistors used in the prototype were matched to about 10%, and the amplifier gives just over 0.02% second harmonic distortion at an output power of 4W.

Operating Conditions.—The quiescent current of each output transistor is adjusted to about 50mA by measuring the voltage drop across the 0.5-Ω emitter resistors. This relies on the 0.5-Ω resistors being accurate, and a cross check on the equality of the quiescent currents is to measure the voltage across the load, which should be zero. If it is not zero it should be made so by readjusting the quiescent current of one of the output transistors.

The currents in the long-tailed-pair are balanced by connecting a voltmeter with a f.s.d. of the order of 1 to 5V between the two collectors, and adjusting the potentiometer in the emitter circuit for zero reading. The resistance of the transformer primary provides sufficient voltage drop for this measurement.

The input stage collector potential should be about −6V and the emitter potential about −2.6V. Variations from these voltages of up to 20% are not serious. (These voltages only apply to the 4-W amplifier.)

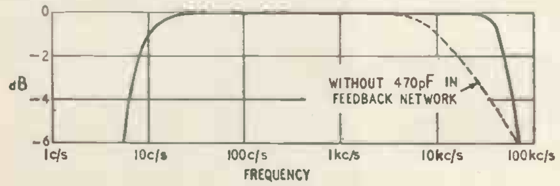


Fig. 3. Small-signal overall frequency response of 4-W amplifier.

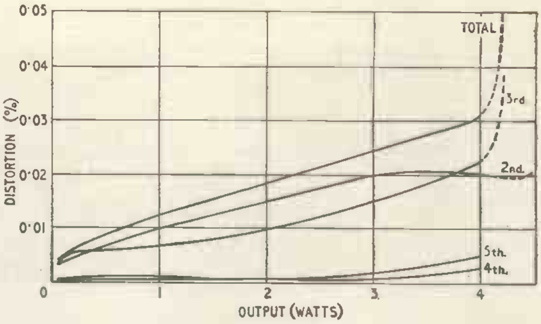


Fig. 4. Distortion at 1kc/s with a 15-Ω load (4-W amplifier)

Constructional Details.—The circuit diagram gives the output transistors as type OC22 but OC23's or OC24's are equally suitable. Each output transistor should have a heat sink of about 9 sq in and in the prototype the chassis forms the heat sink, mica washers being used to insulate the transistors. The layout is not critical but care should be taken to ensure that the feedback is taken from close to the output point, in order to avoid part of the wiring (which has finite resistance) to only *one* of the output transistors being included in series with the load. This is because each transistor only works on alternate half cycles and a second harmonic signal (which the overall feedback would not affect) would be added in series with the load.

Modifications.—The amplifier described will comfortably deliver 4 W into a 15-Ω load but this can be increased to 6 W by raising the power supply, for the output transistors, to +15 and −15 V. The only limitation on the amplifier, with this modification, is that the safe ambient temperature falls to about 35°C from 40°C. It is convenient to use the −15 V line also to supply the driver circuits. However, this requires an additional change because −15 V would cause the maximum power dissipation of the OC44 transistors in the long-tailed-pair circuit to be exceeded. The solution is either to fit a suitable dropping resistor to reduce the supply voltage to the driver circuits to −12 V, or to use XA102 transistors, which have a higher maximum power dissipation than OC44 types, in the long-tailed-pair circuit. The total distortion, with these modifications, when supplying 6 W into a 15-Ω load at 1kc/s, is under 0.05%.

More recently, the power output has been increased to 10 W by raising the power supply to +20 and −20 V. The circuit modifications required to the long-tailed-pair are the use of XA102 type transistors and the increase of the "tail" resistor from 330 to 560 Ω. Also, OC22 type output transistors cannot be used because of the increase in the supply voltages, but either OC23 or OC24 types are still suitable. The only limitation on the amplifier, with these modifications, is that the safe ambient temperature falls to about 30°C. The total distortion when supplying 10 W into a 15-Ω load, at 1kc/s, is under 0.1%.

The author would like to thank Mr. P. J. Baxandall for many helpful discussions during the design of this amplifier.

APPENDIX

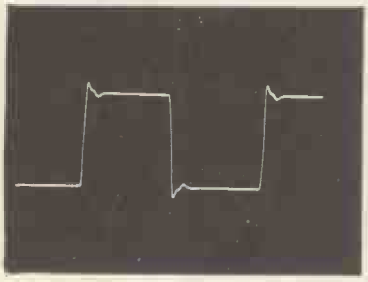
Performance of the Prototype 4-W Amplifier:—

Power Output:—The maximum power output is 4 W into a 15-Ω load and the total distortion at 1kc/s is 0.031% (see Fig. 4). Full power is available up to 10kc/s, but at low frequencies the maximum power output decreases, due to the magnetizing current in the driver transformer. Even so, over 3 W is available at 10c/s.

Overall Gain:—The overall voltage gain is approximately 20 which means that an input of about 0.4Vr.m.s. is required for full output. (For the 6- and 10-W versions 0.48 and 0.62V respectively are required.) The small-signal response is shown in Fig. 3 and is within 1dB from 10c/s to 45kc/s.

Loop Gain:—The loop gain at 1kc/s is 34dB and is 3dB down at 100c/s and 10kc/s.

Input Impedance:—The input impedance is 1kΩ and since full output is obtained with an input of 0.4V r.m.s. the maximum input current is 0.4A r.m.s.



Output waveform with a 5kc/s square wave input and a load of 15Ω and 0.05μF in parallel.

Capacitive Load:—A capacitor load of up to 0.05μF in parallel with the normal 15-Ω load does not seriously affect the stability of the amplifier. The transient response with a 5kc/s input (see photograph) differs trivially from that with a 15-Ω load only. If the amplifier is driving a speaker which is an inductive load at high frequencies, *and* there is capacitance in parallel greater than about 0.001μF (due to a very long speaker cable, perhaps) a 15-Ω resistor in series with a 1-μF capacitor should be connected across the amplifier output terminals so as to make the amplifier load still look like approximately 15Ω at high frequencies.

Hum and Noise:—Hum and noise power at the output is more than 70dB below the maximum output of 4 W.

Temperature:—The amplifier has been designed to operate safely in an ambient temperature of up to 40°C, provided that each output transistor has a heat sink of about 9 sq in.

Constructional Details of Driver Transformer:—

Core:—A square stack of 15-thou thick 39T (E's 1⅝in by 1⅛in) Radiometal laminations is used. The E's and I's are assembled with no gap and a moulded bobbin is used.

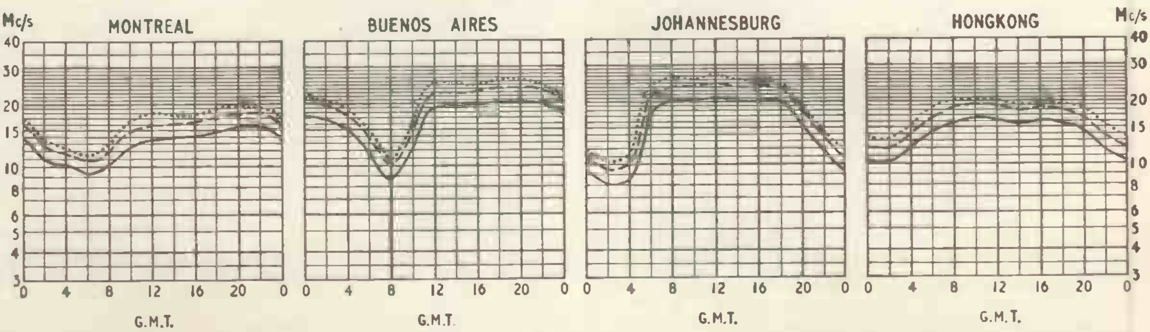
Primary:—The primary is the inner winding on the bobbin and consists of two conductors of 38 s.w.g. enamelled wire which are bifilar wound for about 630 bobbin revolutions. This took 12 layers in the prototype. (As the turns ratio of the transformer is not critical, the last layer may be completely filled.) 1-thou transformer paper is used between layers, with two turns of paper at the finish.

Secondary:—The secondary is the outer winding and consists of two conductors of 32 s.w.g. enamelled wire which are bifilar wound for about 200 bobbin revolutions. This took 8 layers in the prototype. (Again, as the turns ratio of the transformer is not critical, the last layer may be completely filled.) A 3 to 1 ratio should be aimed at. 1-thou paper is used between layers and the finish is with Empire cloth or as desired.

Measurements on Prototype Transformer:—The resistance of primary (1) was 38.6Ω, primary (2) 38.6Ω, secondary (1) 4.49Ω and secondary (2) 4.495Ω. The inductance of primary (1) was 0.57H, primary (2) 0.57H, secondary (1) 0.059H and secondary (2) 0.059H. These inductance measurements were all made under small-signal conditions at 1kc/s.

SHORT-WAVE CONDITIONS

Prediction for July



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

— — — PREDICTED MEDIAN STANDARD MAXIMUM USABLE FREQUENCY

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

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

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

WORLD OF WIRELESS

Independent Television Growth

SINCE it was established in August, 1954, the Independent Television Authority has appointed 15 programme companies to operate its stations. The recent appointment of the Wales Television Association (Teledu Cymru), which will cover west and north-west Wales, may be said to "complete the institutional structure of independent television." The I.T.A. has stated that no more programme companies can be appointed on its present allocation of channels in Band III.

Eleven companies with 13 transmitters are now operating. By the end of this year there will be 17 stations and by the end of 1962 another four. The service areas of both the Lichfield and Black Hill transmitters will be improved within the next few months by the introduction of better aerial systems and a higher mast is to be erected at Croydon next year. The Wales Television Association will initially operate two stations; one in Pembrokeshire and one on the Lleyn Peninsula.

Grampian Television, the programme contractors for North East Scotland, plan to open their two transmitters on September 30th. The main station at Durris (not Mongour as previously announced), near Aberdeen, will have a maximum e.r.p. of 400 kW and will radiate in Channel 9. The satellite station covering Inverness-shire, which is at Mounteagle (not Roskill), will radiate in Channel 12 with a maximum e.r.p. of 50 kW.

Brit. I.R.E.

ADMIRAL of the Fleet the Earl Mountbatten of Burma, K.G., who has accepted a second term of office as President of the British Institution of Radio Engineers, speaking at their 1961 Dinner, stressed the importance and responsibility of engineers in developing rapidly the scientific discoveries which were now being made at an exponential rate.

Principal speakers at the dinner included Sir Howard Florey, President of the Royal Society, H.E. the Hon. George A. Drew, Q.C., High Commissioner for Canada, and W. E. Miller, M.A., a past president of the Institution.

The Institution's seventh convention, the theme of which is to be "Radio Techniques and Space Research," opens at the University of Oxford on July 5th.

Servicing Ideas

A COMPETITION for the best ideas for improving or simplifying the servicing of sound and television receivers is being sponsored jointly by Radio Industry Exhibitions Ltd., organizers of the National Radio Show, and *Wireless & Electrical Trader*. It is open to anybody without qualification of any kind.

Entry forms, which must be returned by July 15th, are obtainable from the *Trader*, Dorset House, Stamford Street, London, S.E.1. Three prizes of £50, £25 and £10 are being offered. Prize winners' entries and those of some runners-up will be exhibited at the Radio Show (Aug. 23-Sept. 2).

Birthday Honours

AMONG the recipients of awards in the Queen's Birthday Honours List are the following:—

Knighthood

Allen G. Clark, chairman and managing director, Plessey Company.

Charles J. A. Moses, general manager, Australian Broadcasting Commission.

C.B.

A. V-M. T. U. C. Shirley, Deputy Controller of Electronics, Ministry of Aviation.

Alan Wolstencroft, Director of Radio Services, G.P.O.

C.B.E.

W. H. Penley, deputy chief scientific officer, R.R.E.

Dr. N. H. Searby, manager, Ferranti's Guided Weapons Department.

G. A. Whipple, chairman and managing director, Hilger and Watts.

Dr. F. C. Williams, F.R.S., professor of electrical engineering at Manchester University.

O.B.E.

T. W. Bearup, representative of the Australian Broadcasting Commission in the U.K.

E. A. Hamilton-Hill, director and general manager, Rediffusion (Malta), Ltd.

M.B.E.

W. E. Bell, superintendent, G.E.C. Applied Electronics Laboratory, Portsmouth.

G. Crichton, Government Communications H.Q.

J. S. Darling, communications officer, Foreign Office.

F. W. Fowler, first radio officer, m.v. *Rangitata*, N.Z. Shipping Co.

H. S. Gibbs, chief telecommunications supt. G.P.O.

R. G. Hawkins, chairman and managing director, Redcliffe Radio & Engineering Co.

I. P. Massy, Government Communications H.Q.

L. H. Rowley, senior station radio officer, Admiralty.

B.E.M.

J. M. Gardiner, R.A.F. Ground Radio Servicing Squadron, Kinloss.

S. Stallybrass, radio technician, London Airport.

Australia's v.h.f. sound broadcasting service is closing down on June 30th. Stations have been operated by the Australian Broadcasting Commission in four of the State capital cities for the past four or five years. The Australian f.m. broadcasting band (92-108 Mc/s) is to be used to increase the number of television channels. Here are the lower frequencies for each of the 7-Mc/s channels in the new 13-channel plan: 1, 45; 2, 56; 3, 63; 4, 85; 5, 94; 6, 101; 7, 137; 8, 174; 9, 181; 10, 188; 11, 195; 12, 208; 13, 215.

A Soviet Trade Fair opens at Earls Court, London, on July 7th for three weeks. Radio, television and electronic equipment (both consumer and capital goods) will be included and television receivers adapted to receive 405-line transmissions will be demonstrated. The Fair will be open on weekdays from 10.0 a.m. to 10.0 p.m. and admission will cost 3s 6d.

Telecommunications Engineering Establishment of the Ministry of Aviation, at Gatwick Airport, was officially opened on June 6th. The establishment, which incorporates what used to be known as the G.C.A. Maintenance and Inspection Unit at Blackbushe Airport, is concerned with "the field engineering of safety devices" and the installation and maintenance of telecommunications equipment.

Television Society Premiums.—The following Premiums "for outstanding papers read before the London meetings in 1959/60" have been awarded by the Television Society:—E.M.I. premium to Dr. Rolf Moller (Fernseh GmbH) for his paper "Television in Germany"; *Electronic Engineering* premium to B. Eastwood (A.E.I.), for "Deflection Techniques for 110° Picture Tubes"; Mervyn premium to S. T. Palmer (G.E.C.) for "Television Receiver Production"; *Wireless World* premium to A. J. Garratt (International Scientific Research Exhibitions) for "Science on Television"; and Mullard premium to R. N. Jackson (Mullard Research Labs.) for "Single-gun v. Three-gun Tubes".

Audio Manufacturers.—At the second annual general meeting of the Audio Manufacturers' Group of the British Radio Equipment Manufacturers' Association on May 17th, the following firms were elected members of the management committee (their representatives names are in parentheses):—A.E.I. (L. R. Metcalfe); Clarke & Smith Mfg. Co. (Major J. F. E. Clarke, vice-chairman); Decca Records (P. B. Cooper); Easco Electrical (E. L. Eastell); Electric Audio Reproducers (L. Stone); Gramophone Co. (H. F. Ford); Grampian Reproducers (J. E. Morley); Jason Motor & Electronic Co. (G. Blundell); Lowther Manufacturing Co. (D. M. Chave, chairman); Philips Electrical (F. P. P. Tielens); Standard Telephones & Cables (J. L. Goodwin); and Trix Electronics (D. A. Lyons).

T.E.M.A.—At the annual general meeting of the Telecommunication Engineering and Manufacturing Association W. F. Oakley, director of Automatic Telephone and Electric Co., was elected chairman and W. G. Patterson, M.B.E., divisional director and general manager of Associated Electrical Industries, vice-chairman.

Radar & Electronics Association.—At the fifteenth annual dinner of the association on May 12th, the president, Sir Robert Renwick, presented prizes to the "best student members of the year". The recipients were D. W. Kent, D. J. Chapman and G. B. Davies. They are all students at the Northern Polytechnic where last year a Students' Branch of the Association was formed. W. D. Day, who is a senior lecturer in radar and advanced engineering at the Polytechnic, is president of the Students' Group of the Association and is also a member of the Council of the Association.

R.I. Club.—Ernest Brown, director of Brown Bros. Ltd., who has been a member of the Radio Industries Club since its formation and was chairman in 1934, has been elected president for 1961/62. The London Club now has a membership of 948. The eight affiliated clubs in the provinces and Scotland have a total membership of 1,378.

Institution of Electronics sixteenth annual exhibition and convention is being held at the College of Science and Technology, Manchester 1, from July 6th to 12th (excluding Sunday 9th). Complimentary admission tickets, giving times of opening, are obtainable free from the general secretary, W. Birtwistle, 78 Shaw Road, Rochdale, Lancs.

A one-day symposium on "Internal Stresses in Electrolytically Produced Coatings and their Influence on the Properties of the Basis Metals" is being held at the Borough Polytechnic, London, S.E.1, on Thursday, July 6th; fee 2gn, including meals.

"**Electromagnetic Theory and Antennas**" is the title of a symposium being organized jointly by the International Scientific Radio Union (U.R.S.I.), and several Danish bodies for next year. It will be held in Copenhagen from June 25th to 30th, 1962. The U.K. correspondent is J. Brown, Department of Electrical Engineering, University College, London.

A radio telescope, which will have a steerable parabolic aerial about 80 ft in diameter, is to be built at a site near Crowthorne, Berkshire, for the Radio Research Station of the Department of Scientific and Industrial Research. It is expected to be completed and in operation towards the end of 1963 at an estimated overall cost of £250,000. The Ministry of Works, which is responsible for the construction, has invited tenders for the telescope.

Inst. P.—Phys. Soc.—In the course of the first presidential address of the amalgamated Institute of Physics and Physical Society, Sir John Cockcroft suggested that in view of the harmonious amalgamation, the separate origins of the partners could be forgotten and that they might "perhaps even change the rather clumsy title of the Institute of Physics and the Physical Society."

IBM Data Centre opened recently is equipped with IBM 1401 and 7090 data processing systems for operation by the customer. The 7090 is believed to be the most powerful computer in general service in the world—it can add more than a quarter of a million ten-digit numbers every second.

Educational Filmstrip.—"The History of Television" is the title of a new Mullard colour filmstrip which is complementary to "The History of Radio" released earlier. It deals with the history of picture transmission from the middle 19th century to the present day and its simple approach makes it suitable for use in Secondary Modern Schools or in senior classes where science is taught as a general knowledge subject rather than one for examination. The 28-frame filmstrip with teaching notes is available from the distributors, Unicorn Head Visual Aids Ltd., 42 Westminster Palace Gardens, London, S.W.1, price 25s.

"**Inside**"—a 16mm sound and colour film which runs for approximately 20 minutes—describes the research, manufacture, testing and uses of Formica industrial laminates. Copies of the film are available on free loan from Formica Public Relations Department, 84/86 Regent Street, London, W.1.

"**Computer Achievements**", a new E.M.I. 22-minute sound-colour film which shows five uses to which EMIDEC data processing computers are being put, is available for free loan on application to E.M.I. Electronics Ltd., Hayes, Middlesex.

1962 Audio Festival & Fair will be held at the Hotel Russell, London, from April 26th to 29th.

SCHOOL COMPUTER.—Some of the members of the VIth Form of the Ross-on-Wye Grammar School who, under the guidance of C. Grant Dixon, their physics master, have built the analogue computer described in our May, 1960, issue.

Personalities

Sir Bernard Lovell, O.B.E., F.R.S., Professor of Radio Astronomy at the University of Manchester and Director of the Nuffield Radio Astronomy Laboratories, Jodrell Bank, has been appointed scientific adviser to the recently formed "space" consortium, British Space Development Company. During the war, Professor Lovell was a member of the Telecommunications Research Establishment (now R.R.E.), and one of his notable contributions was to H2S, the blind bombing device, for which, with Professor P. L. Dee, he was responsible.

F. S. Mockford has relinquished his appointment as commercial manager of Marconi's W/T Company in order to undertake special duties for the managing director. Mr. Mockford joined the company as an engineer in 1930. He is succeeded as commercial manager by **F. Wheeler** who has been deputy manager of the company's Aeronautical Division since January. The new deputy commercial manager is **H. Baker** who has served the company abroad for many years, latterly as managing director of the Marconi Company in South Africa.

R. Telford, B.A., M.I.E.E., has relinquished his position as general works manager of Marconi's W/T Company and is appointed general manager responsible to the managing director for the overall co-ordination of the commercial, engineering, and manufacturing activities of the company, which he joined in 1946. **H. J. H. Wassell**, who joined the company in 1929, is appointed works manager, Chelmsford. He was appointed head of the radar development group in 1949 and was subsequently chief radar engineer and manager, Test Department. **E. Eastwood**, Ph.D., M.Sc., M.I.E.E., chief of research at Marconi's research establishment at Great Baddow since 1954, is appointed director of research. Dr. Eastwood joined the company in 1948 after two years with English Electric in charge of the radiation laboratory. He is to receive this year's Wakefield Gold Medal of the Royal Aeronautical Society for his contributions towards safety in the air. **E. N. Elford**, O.B.E., A.M.I.E.E., has relinquished his position as manager of the radar division in order to undertake special duties for the managing director, particularly in connection with the company's activities in the defence field. Lt. Col. Elford joined the company in 1946 after a career in the regular army. The new manager of the radar division is **T. W. Straker**, M.Sc., Ph.D., who was appointed deputy manager last September.

C. O. Stanley.—The City and Guilds of London Institute has conferred upon C. O. Stanley, C.B.E., chairman of the Pye Group, the Fellowship of the Institute (F.C.G.I.) in recognition of his "professional status and achievements." He qualified at the City and Guilds of London Institute in 1922.

Charles A. Marshall, B.Sc., A.M.I.E.E., editor of *British Communications & Electronics*, has been elected honorary secretary of the Television Society, in succession to Geoffrey Parr whose death we record with regret on page 349. Mr. Marshall, who graduated from Manchester University in 1944, was for three years with Philips and six years in electronic research and development at the Mullard Research Laboratories, before going into technical journalism in 1954.

R. A. Smith, C.B.E., M.A., Ph.D., A.M.I.E.E., who is at present head of the Physics Department of R.R.E., Malvern, has been appointed Professor of Physics at Sheffield University. Dr. Smith will take up his duties on October 1st and will succeed **Professor W. Sucksmith, F.R.S.**, as head of the department when he retires in September next year.

Air Commodore H. G. Leonard-Williams, C.B.E., who is 50 and was until recently commanding the R.A.F. apprentices' radio school at Locking, Somerset, has been appointed Chief Signals Officer, Fighter Command Headquarters. He entered the R.A.F. from the R.A.F. College, Cranwell, in 1932. He was at one time chairman of the British Joint Communications Board and in 1953 was a deputy director of signals, Air Ministry.

Edwin Dunne, A.M.I.E.E., has become chief inspector of the Farnborough Plant of the Solartron Electronic Group. He joined Solartron in January, having previously held the posts of deputy chief inspector with de Havilland Propellers and chief inspector with A. C. Cossor and Cossor Radar & Electronics.

E. Dunne

L. A. Thomas

L. A. Thomas, B.Sc., F.Inst.P., A.M.I.E.E., has been appointed chief physicist of the Hirst Research Centre of the General Electric Company, Wembley. Mr. Thomas, who is 44, joined the Research Laboratories of the G.E.C. in 1935. He was appointed head of the Materials and Components Division in 1960 and will retain his responsibilities in this field.

W. W. Shaw-Zambra, C.V.O., C.B.E., T.D., retired at the end of March from the post of secretary-general of the Commonwealth Telecommunications Board, which he has held since the establishment of the Board in 1949. He was secretary of its predecessors, the Imperial Communications Advisory Committee (1938-1944), and the Commonwealth Communications Council (1944-1949). He was joint secretary of the Imperial Communications Committee of the War Cabinet (1940-1944) with the military rank of Colonel. He is succeeded at the C.T.B. by **W. Stubbs**, C.B.E., M.C., M.I.E.E., M.Brit.I.R.E., who is 49, and was formerly Director-General of Telecommunications for the Federation of Malaya and State of Singapore.

F. D. Bolt, B.Sc. (Eng.), M.I.E.E., has been appointed by the B.B.C. head of the transmitter equipment section of the Planning and Installation Department, in succession to **D. B. Weigall**, M.A., M.I.E.E., who has been transferred to the staff of the senior superintendent engineer, external broadcasting for special duties. Mr. Bolt joined the B.B.C. in 1934 and was appointed to the Daventry station. In 1951 he was made head of the aerial unit in the Planning and Installation Department.

S. W. Thompson, A.M.I.E.E., who joined the B.B.C. in 1941 as a maintenance engineer, has been appointed head of the technical services section in the Department of the Superintendent Engineer, Transmitters.

C. W. Sowton, O.B.E., assistant staff engineer at the Post Office, is to be the U.K. representative on the Panel of Experts which is to meet in Geneva in September "for the purpose of devising ways and means of relieving the pressure on the bands between 4 and 27.5 Mc/s." This investigation was called for at the Geneva I.T.U. conference in 1959. Mr. Sowton is chairman of the C.C.I.R. national study group VIII concerned with monitoring and is secretary of the technical sub-committee of the Television Advisory Committee.

J. F. Young, A.M.I.E.E., A.M.Brit.I.R.E., who is manager of the Electronics Division of Donovan Electrical Company, of Birmingham, has received the Insignia Award in Technology (C.G.I.A.) from the City and Guilds of London Institute. He served his apprenticeship with G.E.C. and then spent some time with W. & T. Avery and Lancashire Dynamo Electronic Products on industrial electronic development, later returning to the G.E.C. where, until recently, he was in charge of the Electronic Development Group at Witton. He has contributed several articles to *Wireless World.*

R. S. Gilling, B.Sc., A.M.I.E.E., has been appointed manager of the A.E.I. Military and Marine Radar Works at Leicester, which form part of the company's Electronic Apparatus Division. He served an engineering and graduate apprenticeship from 1927 to 1934 with the British Thomson-Houston Company, now A.E.I. (Rugby) and in 1940 went into the electrical measurements section of the Research Laboratory, where he played an important part in the development of military radar. In 1946 he was appointed a section leader of the Electronic Engineering Department and since 1955 has been superintendent of the Military and Marine Radar Works.

Major J. F. E. Clarke, chairman of Clarke & Smith Manufacturing Co., of Wallington, has also become chairman of Specto Ltd., manufacturers of cine, photographic and tape-recording equipment, of Vale Road, Windsor, and of Lentar Ltd., the associated company in the optical field. The following executive directors have also been appointed to Specto, **E. M. Eldred,** M.I.E.E., M.Brit.I.R.E. (managing); **L. C. Crook** (deputy managing) and **D. J. Frost** (sales).

Brian A. Curtis has recently joined **P. C. Robinson,** A.M.I.E.E., on the board of Startronic Ltd., manufacturers of laboratory equipment and regulated power supplies, of New Malden, Surrey. Mr. Curtis, like his co-director, was until recently on the staff of Solartron which he joined in 1953. In 1955 he was appointed chief test engineer of Solartron Laboratory Instruments where he was subsequently chief standards engineer.

OUR AUTHORS

R. J. Hitchcock, M.A., A.M.I.E.E., who with **P. A. C. Morris** writes in this issue on possible techniques for further reducing interference in h.f. communications, represented Cable & Wireless Ltd. on the Provisional Frequency Board in 1949/50. During the next 10 years he attended most of the important international radio-frequency conferences on behalf of the Company. He joined C. & W. in 1948 and until 1959 was in charge of the section of the engineer-in-chief's department responsible for the design of aerials, radio propagation, prediction of optimum usable frequencies and other radio-frequency matters such as interference. He is still associated with Cable & Wireless and is a member of the U.K. study group of the C.C.I.R. dealing with ionospheric propagation and satellite communications.

P. A. C. Morris, B.Sc., A.M.I.E.E., joint author of the article on p. 375, joined Cable & Wireless in 1957 and took over the radio propagation section of the engineer-in-chief's department in 1959. He represents the company on the U.K. study groups of the C.C.I.R. concerned with ionospheric and tropospheric propagation.

R. C. Bowes, B.Sc., A.M.I.E.E., author of the article describing a low-distortion transistor amplifier, has been at the R.R.E., Malvern, since graduating at King's College, Newcastle, in 1950. He is a principal scientific officer in the Circuit Research Division and for the last five years has been concerned primarily with transistor circuitry. He is 35.

OBITUARY

Geoffrey Parr, M.I.E.E., who on May 15th retired from the honorary secretaryship of the Television Society, died on May 30th. He had served the society for 25 years, first as its lecture secretary and since 1945 as honorary secretary. Born in 1899, he entered the radio industry in 1926 when he joined Edison Swan as a valve development engineer, having previously been a lecturer and demonstrator at the City and Guilds Technical College. From 1932 until 1940 he was head of technical service in the company's Radio Division. He was appointed editor of *Electronic Engineering* in 1941 and since 1949 has been technical director of Chapman & Hall. He had a deep-rooted interest in the subject of technical writing on which he frequently lectured and produced a book—"The Technical Writer."

John Walter Ryde, F.R.S., F.Inst.P., the chief scientist of the Hirst Research Centre of the G.E.C., at Wembley, died on May 15th, at the age of 63. He joined the company as a physicist in 1919. His work on the scattering of light, first applied in the '20s to optical diffusing media in glasses, was developed by him during World War II to classic studies of the attenuation and the radar echoes produced by meteorological phenomena at centimetre wavelengths. His researches in World War II included velocity modulation tubes and crystal valves for microwave mixer devices. He had been chairman of the Davy-Faraday Laboratory Committee of the Royal Institution since 1951.

H. Anthony Hankey, who died on May 12th, aged 74, can be numbered among the pioneers of wireless for he was in charge of the Cullercoats station in 1907. He joined the Royal Navy in 1914 and was later posted to Hong Kong as Port Wireless Officer. After the war he joined Marconi's. He was in charge of the 100-watt 2LO transmitter at Marconi House at the time of the first broadcast. In 1928 he went on a world tour to further "Empire Broadcasting" and the following year joined the Baird Company. During the last war, he was a radio officer in the Royal Navy.

Dr. Eugen Nesper, "the last of the grand old men of German wireless," died on May 3rd in his 82nd year. He assisted Professor Slaby in his early experiments at Potsdam in 1897. In 1904 he joined the Telefunken company, but two years later went to C. Lorenz A.G., where he worked on the Poulsen arc continuous wave system. He became director of the Lorenz factory in Vienna. Dr. Nesper, who campaigned for the introduction of broadcasting in Germany in the early 1920s, published 35 books on wireless and in 1943, a "society for the exploitation of Dr. Nesper's inventions" was founded in Berlin. His published memoirs are called "A Life with Ratio."

William G. J. Edwardes, who died recently in his 80th year, had been general secretary of the I.P.R.E. since its formation as the Institute of Practical Radio Engineers in 1936. He spent some years in North America, where he was associated with Lee de Forest in the development of the triode valve, and for ten years before returning to his native England in 1934 was working in Australasia.

Derek M. Hall, B.A., manager of the Home Trade Sales Division of Mullard Ltd., which he joined in 1948, died on May 21st, aged 49. He was this year's president of the Incorporated Practitioners in Radio and Electronics (I.P.R.E.).

News from Industry

Ultra's domestic radio and television interests, which were concentrated in Ultra Radio and Television Ltd., Pilot Radio and Television Ltd., and their subsidiaries have been sold to Thorn Electrical Industries for £2.4M. The cash transaction includes Ultra's factory at Gosport, Hants, and other premises at Ruislip, Eastcote and Park Royal. Thorns, who already use the trade names Ferguson, Philco, Champion, Avantic and, under licence from E.M.I., Marconiphone and His Master's Voice, state that they intend to preserve the separate identities of Ultra and Pilot. Trevor C. Standeven, formerly general manager and director of Ultra Radio and Television, becomes managing director. The head office will remain at Eastcote. It was announced last month that Ultra Electric (Holdings), the parent company, had entered into two financial agreements with companies in and Western Hemisphere regarding its electronics subsidiary—Ultra Electronics Ltd.

Ultra Electronics Ltd. has acquired Trix Electronics Ltd., which since incorporation on 1st May has been a subsidiary of the Trix Electrical Company. Trix Electronics will continue to manufacture and install sound amplification equipment for public address and aircraft work.

Plessey-Regentone.—It has been confirmed that the Plessey Company has acquired the Eastern Avenue, Romford, factory of Regentone Products Ltd. for £507,000. Plessey has also entered into an agreement with the company whereby Regentone and R.G.D. television and sound receivers will be manufactured by Plessey to Regentone specifications. The sets will continue to be marketed by Regentone.

Sound Reinforcement :—Some of the loudspeakers for the sound reinforcement system in the recently consecrated Guildford Cathedral are embodied in the lighting fittings. In the nave there are also line source loudspeakers. As the plaster finish to the upper faces of the columns and vaultings of the roof absorb the high frequencies, the system, planned by Standard Telephones and Cables, is operated with high-frequency lift to obtain good speech intelligibility.

Relay Exchanges Ltd., which in addition to its numerous sound and television relay companies owns Goodmans Industries and operates a rental service under the name Rentaset, reports a surplus on trading in 1960 of £3,949,892 compared with £3,350,640 the year before. From this figure must be deducted £2,747,397 for depreciation of installations and £177,670 for taxation, which leaves a net group profit of £1,024,825. The group's fixed assets have recently been increased by over £4M to £21.6M.

Philips.—The annual report of N. V. Philips' Gloeilampenfabrieken, of Eindhoven, shows the following territorial distribution of the company's assets—Netherlands fl. 1,893M, other European countries fl. 2,575M, Western Hemisphere fl. 726M and other countries fl. 301M. Trading profit rose from fl. 740M in 1959 to fl. 862M last year and the net profit from fl. 351M to fl. 397M.

"House of Siemens."—The 1959-1960 report of Siemens & Halske AG, of West Germany, records that the group has its own distributing companies in every country in Europe excepting the U.K., Austria, and the Eastern bloc. The German company's turnover reached a total of DM 3,556M compared with DM 697M ten years ago. Just over 25% of last year's total turnover was exported.

Wayne Kerr—Gertsch Agreement.—A reciprocal sales and manufacturing agreement has been made between Wayne Kerr Laboratories Ltd. and Gertsch Products Inc., of Los Angeles. It provides for the manufacture and marketing of a wide range of Gertsch instruments in the U.K. solely by Wayne Kerr and also for the sale of Wayne Kerr instruments by Gertsch in California, Nevada and Arizona.

Belling & Lee are making a range of interference suppression filters, introduced by Filtron Co. Inc., of America, to be known as "Belling-Lee Filtron" filters. They are hermetically sealed and suitable for operation in the temperature range −55°C to +85°C (some types up to +125°C).

Solartron's portable double-beam oscilloscope and the rack-mounted version of the same instrument are to be manufactured in the United States by Packard Bell Electronics Corporation.

Ericsson.—A trading profit of £1,086,650 for 1960 compared with the 1959 figure of £653,160 (which included £100,000 transferred from the company's research and development reserve) is recorded in the annual report of Ericsson Telephones Ltd. The company, together with English Electric and A.T.E., jointly own Associated Transistors Ltd.

Vickers.—Reference is made in the 1960 review of Vickers Ltd. to the handling of tellurometers, the radio survey instrument, by its subsidiary Cooke, Troughton & Simms who are managing agents for Tellurometer (U.K.) Ltd. The Vickers Group's net profit of £6,252,000 last year compares with £4,934,000 in 1959. The tax payable on the 1960 gross profit was £5,381,000.

Murphy Radio.—A 30% increase in exports is recorded in Murphy's annual report but during 1960 the group incurred a loss of £76,039 compared with the previous year's profit of £668,085.

BASF recording tape and some BASF chemicals are now being marketed in this country by the recently formed BASF Chemicals Limited, of 5A Gillespie Road, London, N.5 (Tel.: Canonbury 2011). F. A. Hughes & Co. are no longer U.K. agents for BASF.

Banana-Tube Colour-Television Display

USE OF OPTICAL-MECHANICAL FIELD-SCAN SYSTEM

NONE of the colour television display devices so far developed is without disadvantages and only one—the shadow-mask tube, in which the picture is built up from triads of colour-luminescent material activated by three electron guns carefully aligned to "fire" through holes in a metal plate behind the screen, each gun lighting only one of the three phosphors—has achieved any significant commercial use. Research for a better device continues and one of the fruits of this search is the "banana" tube and system, so named not only because of the shape of the c.r.t. but also after the fashion of American Philco's code name "apple", for their beam-indexing tube.

Simple Construction of Tube

Two drawbacks of existing direct-viewing displays are the need for application to the tube screen of a complex pattern of phosphor dots and the use of complicated structures inside the tubes. The first was removed in the banana tube by the use of three contiguous lines of phosphor in the primary colours red, green and blue parallel to and scanned in the line, or horizontal, direction (Fig. 1). The beam from the single gun is made to light up the appropriate phosphor bands by vertical "spot wobble." The display thus has all lines of the picture superimposed and to expand these vertically into a "viewable" picture, an optical frame-scan system is used.

If projection onto the usual diffusing light-reflecting screen were to be employed then the banana tube display would suffer from a serious shortcoming similar to that of normal direct-viewing c.r.t.s in which the phosphors are light-coloured and reflect incident ambient light. This is a double disadvantage for colour TV because not only contrast but also saturation is reduced (the white reflected light "dilutes" the colours).

Instead a virtual-image viewing technique is used, resulting in a picture presented against a dark ground provided by the scanning system and having brightness of the c.r.t. screen reduced only by the inevitable losses in the optical components, and not by scattering at a screen.

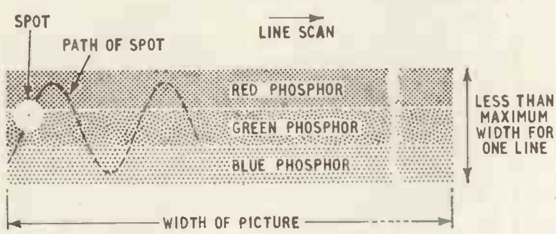


Fig. 1. Construction of tricolour "screen" of phosphor stripes for banana-tube display system. Three-stripe line is about ¼in wide and 16in (the width of the picture) long.

Mechanical-optical Field-scan

A cylindrical lens—a rod of glass—has the property of rendering visible a line behind and parallel to it over a range of positions at right angles to its major axis. Now, if this rod were placed appropriately with reference to the banana-tube line display, movement of the rod round the phosphor stripes would enable the viewer to see the displayed superimposed lines separated and thus a picture would be built up in space.

To avoid the difficulty of making the one rod

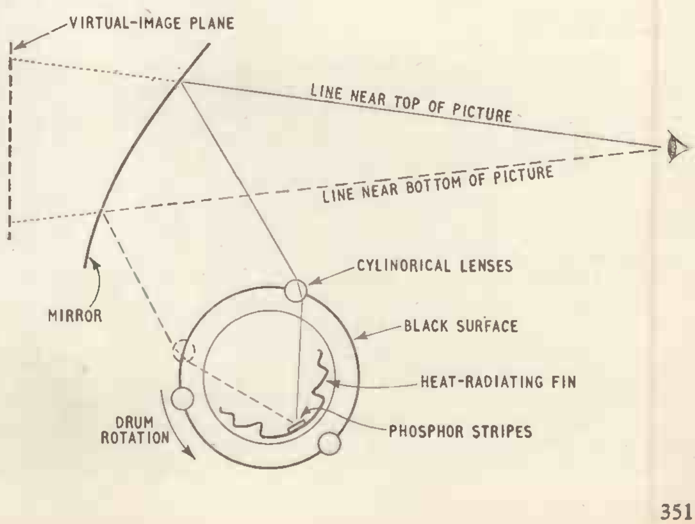


Fig. 2. Simplified "end-on" view of display system, showing light paths to viewer for lines near top and bottom of picture. To clarify details scale is distorted: diameter of banana tube itself is about 4in and height of virtual image is about 12in.

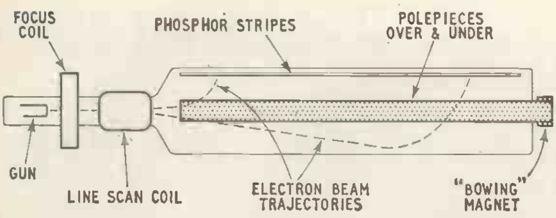


Fig. 3. Plan view of tube and some ancillaries. Line scan is provided by slightly-modified 90° coils and graded magnetic field produces " bowing " of beam to improve angle of " strike " of beam on phosphor. Spot-wobble is achieved magnetically (coils not shown).

fly back to the top of the picture during the field-blanking period, a rotating drum encircling the tube and carrying three equi-spaced rods is used: as one rod finishes its operation at the bottom of the picture (one field or frame scan) another starts work at the top. Fig. 2 shows an end-on representation of the system together with a curved viewing mirror that magnifies the picture to its correct height and corrects the curvature of the image.

To provide a dark background for display of the picture the spaces between the rod lenses are covered with a matt black material.

Field Synchronization

Frame-sync depends on the correct speed and phase of the lens drum, which is rotated at about 1,000 r.p.m. by an induction motor and which, in the absence of control, runs slightly fast. An eddy-current brake is used and the current through the magnet, and thus the speed of rotation, is controlled by a comparator basically not unlike the well-known flywheel line sync system. To detect the speed and position of the lens rods a small lamp is mounted outside the drum opposite a phototransistor on the inside.

Interlace should be better than that obtained from an electronic timebase as the inertia of the drum is far too great to allow line pulses (one of the major causes of loss of interlace) to have any effect. The major disadvantages are the extra control equipment required and the effect of mechanical shortcomings—which can give rise to bounce, jitter and line crawl.

C.R.T. Details

The banana tube has its gun at one end so that it may be inserted into the lens drum and a diametric magnetic field, graded along the length of the tube, is used to cause the beam to curve out so that it strikes the phosphors normally (Fig. 3). As has been mentioned previously, the c.r.t. uses a single gun and the spot is "wobbled" across the phosphor stripes to provide, in conjunction with variations of beam current, the required mixtures of primary colours. Each line is laid down on top of the preceding line, so the afterglow of the phosphors must have decayed, not in several fields, as can be allowed with a conventional c.r.t., but by the time that the next line is drawn, otherwise loss of vertical resolution and streaking will result. Sulphide-type phosphors with a suitable afterglow have been developed and it is fortunate that there are also some of the most efficient, so aiding the production of a bright picture. The green is not of the best colour for full coverage of the colour triangle, but with appropriate correction in the video circuits good colour rendering can be achieved over a large area of the triangle, encompassing natural objects.

E.h.t. required is about 25kV at beam currents up to 3mA. Naturally, this represents a fairly high loading on the "screen," which is thus deposited on a metal radiating fin inside the tube so that phosphor efficiency is not seriously reduced by a rise in temperature. The maximum instantaneous peak current density, though, is only about twice that for an ordinary direct-viewing black-and-white tube.

Demonstration

During a demonstration recently given at the Institution of Electrical Engineers, N.T.S.C.-type signals were provided by the B.B.C. and were displayed on two experimental "receivers" using the banana system, giving acceptable results when the video processing appropriate to the type of display was used. The vertical angle of view is slightly restricted compared with a direct-view tube, but it was a pleasant change to see the whole of the picture with truly square corners. The virtual image "hanging in space" behind the mirror seems a little odd at first; but this has the advantage that the viewer's eyes are focused on the picture and not on imperfections in the mirror surface. Important advantages are the very high brightness—about 40 foot-lambers—and the absence of adverse effects from quite high ambient light levels.

Which of the "fruit machines" (or the less exotically named devices) hits the three-lemon jackpot of commercial success remains to be seen. Mullard, developers of the "banana", freely admit that further work is necessary before this display system can be admitted to the set manufacturers' stakes. There is no doubt, though, that the work of Dr. Schagen, his team at Mullard Research Laboratories, and Dutch Philips (who carried out part of the investigation and made the phosphors) has added a most interesting and original device to the known colour display systems.

Further details will be given in I.E.E. papers (Nos. 3561 to 3566 inclusive: to be published in Vol. 108, Part B, *Proc.I.E.E.*) by Dr. P. Schagen, B. A. Eastwell, K. G. Freeman, H. Howden, R. N. Jackson and B. R. Overton.

RADIO VALVE DATA

Seventh Edition

COMPLETELY revised and enlarged, the seventh edition of "Radio Valve Data" (which is compiled by the staff of *Wireless World*) contains in its 156 pages, data on nearly 5,000 semiconductor devices, valves and cathode-ray tubes.

In particular the junction-transistor section occupies five times the space taken in the previous edition and includes many "American" listings. Other additions to the data on semiconductors include sections dealing with power rectifiers and zener diodes.

New valves and cathode-ray tubes have been added and features found useful in previous editions—the listing of valve-base connections and equivalents in the index, for instance—have been continued.

The seventh edition of *Wireless World* "Radio Valve Data," published by Iliffe Books Ltd., costs 6s. or 6s. 10d. by post.

Gramophone Record Deformation

RELATIONS BETWEEN STYLUS RADIUS AND TRACKING WEIGHT FOR CONSTANT DEFORMATION

By J. WALTON*

DUE to the efforts of Dr. Peter Lord of Salford Technical College with the Taylor-Hobson "Talysurf" in making roughness graphs of indented record surfaces at 50,000 times magnification (see Fig. 1) and to the ingenuity of Dr. P. Chippindale of the same college in devising a means of examining and photographing the contours of the record groove under the electron microscope, it has been possible to re-examine the question of record deformation and the relations between stylus radius and tracking weight.

Now it is apparently generally assumed that, for constant record deformation, the tracking weight varies as the square of the stylus tip radius. This seems to be based upon the classical Hertzian equation for *elastic* deformation:—

$$w = \left[\tfrac{3}{4}Wgr\left(\frac{1-\sigma_1^2}{E_1} + \frac{1-\sigma_2^2}{E_2}\right)\right]^{\frac{1}{3}} \quad .. \quad (1)$$

where w is the radius of the indent, W the load, g the acceleration due to gravity, r the radius of the indenter tip, σ_1, σ_2 the Poisson ratios of the ball and material respectively, and E_1, E_2 the corresponding Young's moduli for the two materials.

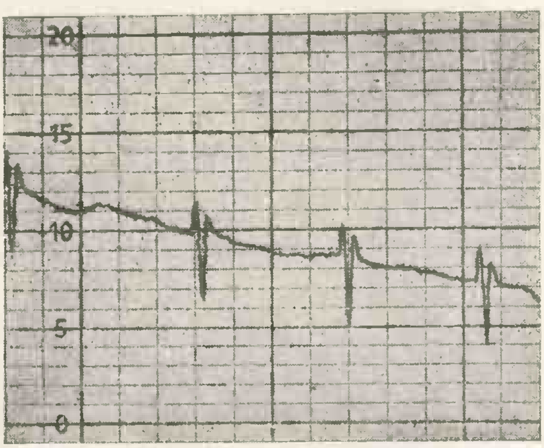


Fig. 1. Cross-section of indented record surface at 50,000 times vertical magnification and 100 times lateral. Four indents may be seen.

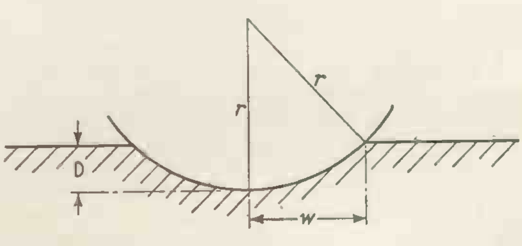


Fig. 2. Fixed indenter of radius r producing an indent of depth D and radius w.

From equation (1) it is deduced that the area of the indent for the case when the flat material is much softer than the spherical one is given by:—

$$A = \pi\left[\tfrac{3}{4}Wgr\left(\frac{1-\sigma_2^2}{E_2}\right)\right]^{\frac{2}{3}} \quad .. \quad (2)$$

and therefore the mean pressure

$$P_m = \frac{Wg}{\pi\left[\tfrac{3}{4}Wgr\left(\frac{1-\sigma_2^2}{E_2}\right)\right]^{\frac{2}{3}}} \quad .. \quad (3)$$

and for constant pressure P_m we can write $k_1 = W^{\frac{1}{3}}/r^{\frac{2}{3}}$

where, as elsewhere, the ks are constants.

$$\text{i.e. } W : r^2 \quad .. \quad .. \quad (4)$$

which is for constant mean pressure under the indenter.

If we take either the area of indent or its width as the criterion for constant deformation, then from equations (1) or (2) we get

$$W : 1/r \quad .. \quad .. \quad .. \quad (5)$$

However, it is obvious that an inverse relationship between W and r is at variance with our purpose of reducing deformation.

Moreover, when considering record groove deformation, the type of deformation with which we are concerned is that which affects the output of the pickup. Thus, whether this is mono or stereo, we are primarily concerned with deformation which gives rise to or eliminates any undulations in a plane at right-angles to the normal plane of the record wall, i.e. we are concerned with the *depth* of any deformation.

If we start from Hertz's equation again under the same condition of an inelastic sphere on an elastic plane, we can reduce it to

$$w = k_2(Wr)^{\frac{1}{3}} \quad .. \quad .. \quad (6)$$

$$\text{Now } w = \sqrt{2rD - D^2}$$

where D is the depth of the indent (see Fig. 2).

$$\therefore \sqrt{2rD - D^2} = k_2(Wr)^{\frac{1}{3}}$$

If D/r is small (as in our practical case) we can write

$$\sqrt{2rD} = k_2(Wr)^{\frac{1}{3}}$$
$$\text{or } D = k_3W^{\frac{2}{3}}r^{-\frac{1}{3}} \quad .. \quad .. \quad (7)$$

And for constant depth of penetration D we get

$$W : r^{\frac{1}{2}} \quad .. \quad .. \quad .. \quad (8)$$

and not $W : r^2$ as results from considering constant pressure under the stylus.

This of course refers to the elastic region of

*Decca Record Co.

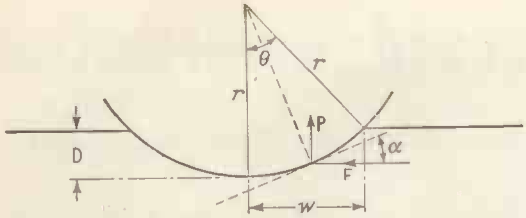


Fig. 3. Moving indenter acted on by a frictional force F.

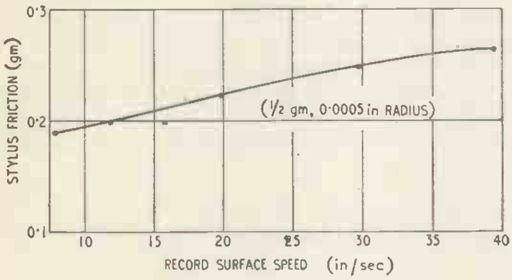


Fig. 4. Elastic region stylus frictional force plotted against record surface speed (for ½gm tracking weight and 0.0005-in radius stylus). Here, as elsewhere, the measurements were made with blank discs.

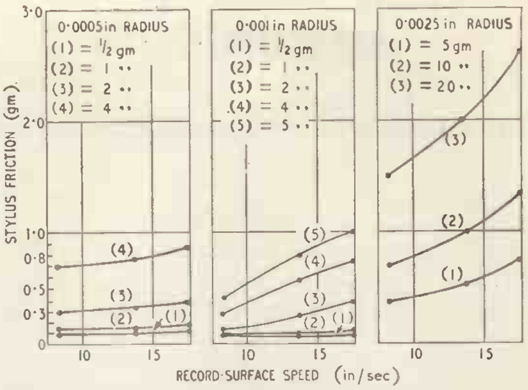


Fig. 5. Stylus friction plotted against record surface speed for various tracking weights and stylus radii.

deformation and I have not so far been able to find a suitable direct means of measuring this. The results of an indirect approach to this measurement are presented farther on in this article.

However, we are not concerned with static indents on a gramophone record, but with gliding ones, and it was found that a considerable difference exists between the indent dimensions in the two cases.

The following is an attempt to explain this in terms of a "surf board" action which causes the stylus to ride more on the surface of the medium upon reaching a certain critical speed below which there is a tendency for the stylus to sink by a greater proportion than that of the speed reduction until equilibrium is once again obtained.

Consider a stylus under a tracking weight W moving along the surface of a blank disc so that F is the frictional (drag) force experienced. *To the extent that* this force acts against the stylus at a mean angle α and produces a reaction along the radius of the indenter, then, from Fig. 3

$$P = F\cot\alpha$$

where P is the vertical component upthrust produced by F.

$$\text{Now } \alpha = \theta/2$$

$$\therefore P = F(2r - D)/w$$

$$\text{But } w = \sqrt{2rD - D^2}$$

$$\therefore P = \frac{F(2r - D)}{\sqrt{2rD - D^2}}$$

Since D/r is small in our case

$$P = 2Fr/\sqrt{2rD}$$

$$= Fr\sqrt{2}/\sqrt{rD} \quad .. \quad (9)$$

It is found by experiment that F *almost* is independent (see Figs. 4 and 5) of velocity in the elastic cases, and so we may therefore write

$$P = k_4\sqrt{r/D} \quad .. \quad .. \quad (10)$$

Equation (7) must now be readjusted to allow for this upthrust P, i.e. W must be replaced by W–P and we get

$$D = k_3(W - P)^{\frac{2}{3}}r^{-\frac{1}{3}} \quad .. \quad (11)$$

and from equation (10)

$$D = k_3(W - k_4\sqrt{r/D})^{\frac{2}{3}}r^{-\frac{1}{3}} \quad (12)$$

$$\therefore r^{\frac{1}{3}}D = k_3(W - k_4\sqrt{r/D})^{\frac{2}{3}}$$

and for constant D

$$r^{\frac{1}{2}}k_5 = W - k_6r^{\frac{1}{2}}$$

$$\therefore W = k_7r^{\frac{1}{2}}$$

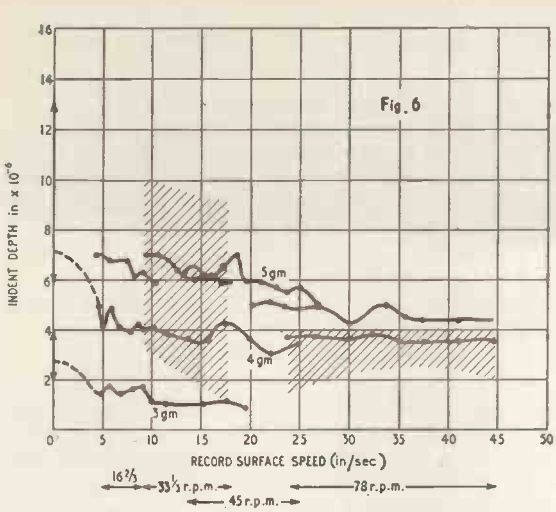
$$\text{i.e. } W : r^{\frac{1}{2}} \quad .. \quad .. \quad (13)$$

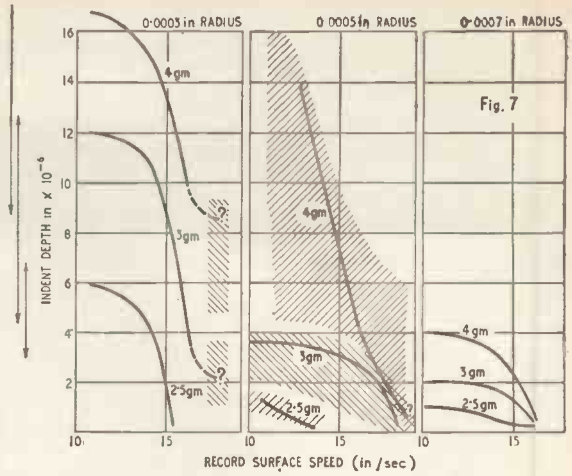
i.e. the movement of the indenter does not affect the basic relationship between W and r in the elastic region, although of course the *magnitudes* are affected, as will be shown. It will also be noted that as D (the depth of penetration) is decreased, the upthrust due to sliding is further increased, so that a region of rapid change may be expected.

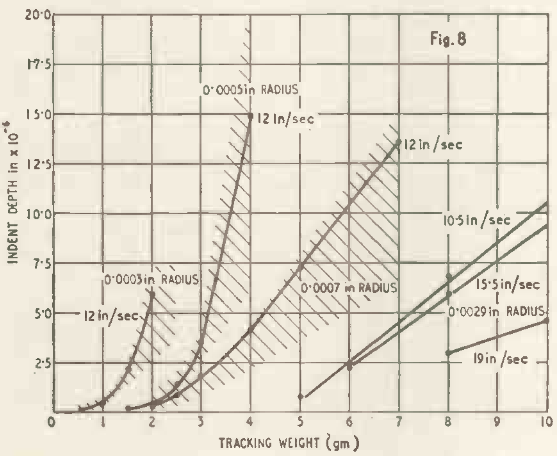
Now the foregoing theories relate to elastic deformation whereas, since I have not yet been able to devise a method of measuring such deformation, the measurements relate to *plastic* deformation. I excuse this anomaly on the grounds that the practical considerations of record wear are primarily those of plastic deformation, and also I felt it necessary first of all to attack the inappropriateness of the "W varies as r^2" elastic-region theory, since this has been used as a basis for choosing the stylus radius.

The experimental measurements gave the results shown in Figs. 6, 7, 8 and 9. These show the most consistent single sets of readings as well as the extent of the scatter between different sets of readings (the reason for which is still obscure to me). Whilst these cannot be considered to be very useful quantitatively, one can detect qualitative trends in the shape of the curves, since the two other (not shown) sets of readings which were taken follow similar, if displaced, curves. (It should be remembered that these measurements are of a very

(*continued on page 355*)







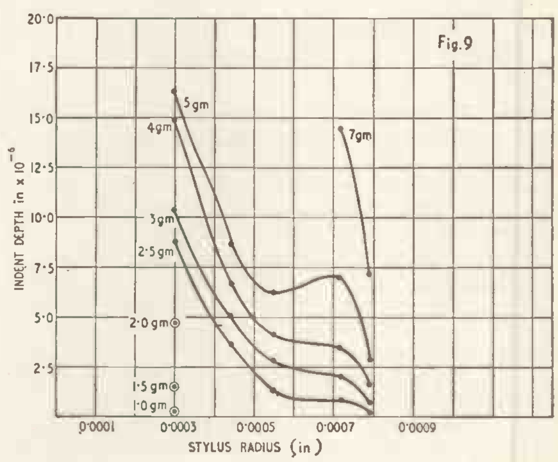


Fig. 6. Indent depth plotted against record surface speed for various tracking weights (0.0005-in radius stylus). As also in other graphs, the curves show the most consistent set of measurements and the shaded areas and arrowed lines the spread over the three sets of measurement which were taken.

Fig. 7. Indent depth plotted against record surface speed for various stylus radii and tracking weights. The arrowed lines show the spread of the measurements in the static case.

Fig. 8. Indent depth plotted against tracking weight for various stylus radii.

Fig. 9. Indent depth plotted against stylus radius for various tracking weights (record surface speed ≈ 13.5in/sec).

few microinches.) Here, as elsewhere, the measurements were made using blank discs.

It would appear from Fig. 7 that below a certain critical speed there is little appreciable increase in deformation as the indent approaches a static value and also that the elastic limit can be effectively raised by an increase in groove speed for certain ranges of stylus radii and tracking weights.

On the " surf board " theory the groove speed would tend to be either sufficient to keep the stylus " afloat " or low enough to let it " sink " and from Fig. 7 the working region of most pickups would seem to be on the critical " float/sink " part of the curves. This may have something to do with the difficulty of getting consistent results between one set of experiments and another. Further work is being attempted with closer control of temperature, stylus radius and disc hardness.

Fig. 9 shows that at higher groove speeds there may be little difference in indentation between a 0.0005in and a 0.0007in radius stylus. The reason for the " knee " in the curves is still obscure.

Fig. 10 shows that the relation between tracking weight and stylus radius for constant indent depth under practical gramophone reproducing conditions is certainly nearer to a linear than to a square law.

Before drawing any conclusions from the above direct measurements of indentation let us consider another approach to the assessment of record wear which should also have meaning in the purely elastic region of deformation.

To the extent that any deformation is purely

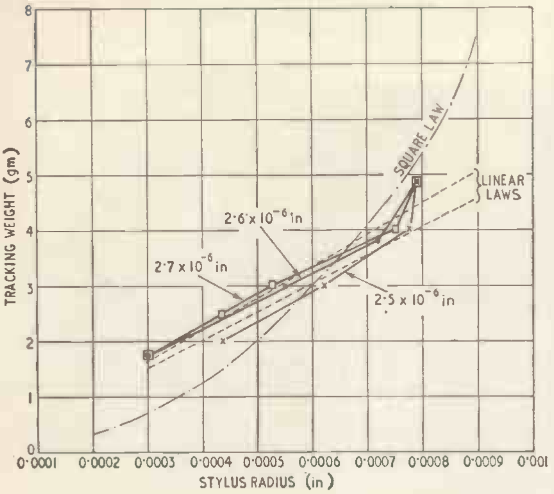


Fig. 10. Tracking weight plotted against stylus radius for various indent depths (record surface speed≈13.5in/sec).

elastic, the energy used temporarily to displace the record material should mainly be returned to the stylus. I say mainly, because there would be some mechanical hysteresis loss. To the extent, however, that there is *plastic* deformation, the energy will be dissipated in moving some of the record material. This energy should be measurable as a reaction on the pickup, i.e. as the *plastic* deformation increases so should the frictional drag of the pickup. This drag was measured, with the results shown in Figs. 11 and 12.

The methods of measurements were as shown diagrammatically in Figs. 13(a) and (b). In Fig. 13(a) in which the pickup head H is at right angles, rather than tangential, to the record motion, for small horizontal deflections x of the hanging weight W

$$F = Wx/l$$

where l is the length of the vertical thread. This method was found cumbersome because the base of the pickup had to be continually moved to track different disc radii as well as to keep the angle between the pickup head and the horizontal thread to a right angle. In Fig. 13(b), again for small deflections x,

$$S = Wx/l$$

where S is the side thrust. Taking moments about the pivot P

$$nS = Fm$$
$$\therefore F = Wxn/lm$$

Here the motor board must be orientated to keep the angle between the side thrust S and horizontal thread to a right angle, but this is easier than the alterations required by the first method. It should be pointed out that if l is 75in, and W 1gm, a deflection of 1in corresponds to a force of 0.013gm.

From Fig. 11 one can see that approximately at the point coinciding with the elastic limit as determined previously, there is a change in slope showing a lower frictional loss per gm below the elastic limit to above it.

Fig. 12 shows considerable linearity in the relation between tracking weight and stylus radius for constant frictional (destructive) force in both the elastic and plastic regions.

There appears to be considerably more consistency in the results obtained by measuring the frictional force, and this may be due to the method of measuring in serial fashion, with one measurement following directly after the other as the indent proceeds to form. The direct measurements of indent depth involved a discontinuity between formation and measurement and also between one indentation and another: these are discontinuities that were not necessary in the friction method. It is nevertheless interesting to compare the results of the two methods (see Figs. 8 and 11).

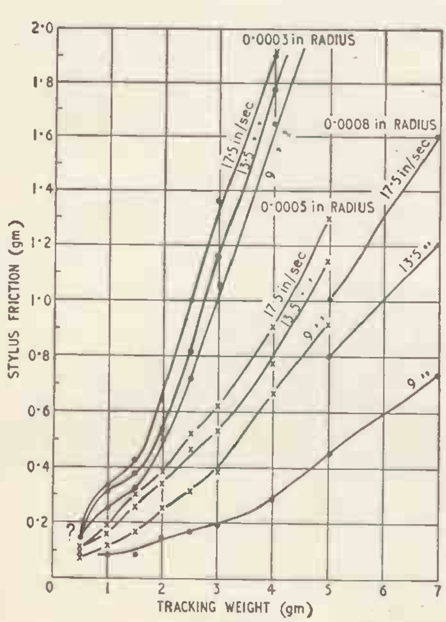


Fig. 11. Stylus friction plotted against tracking weight for various stylus radii and record surface speeds.

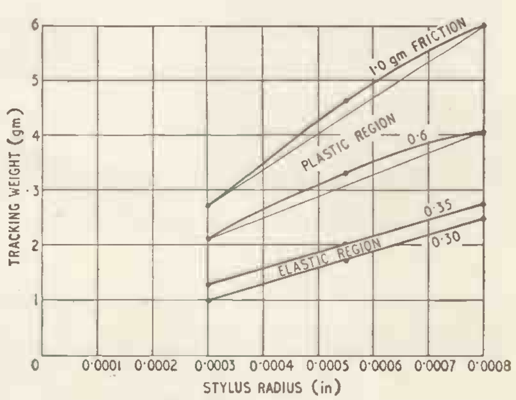


Fig. 12. Tracking weight plotted against stylus radius for constant stylus friction (record surface speed 13.5in/sec).

General conclusions we draw are:—

(1) The experimentally determined linear relation between stylus radius and tracking weight for constant record wear does *not* confirm either the existing theoretical conceptions or the theoretical conceptions presented here, and further work is necessary for its understanding.

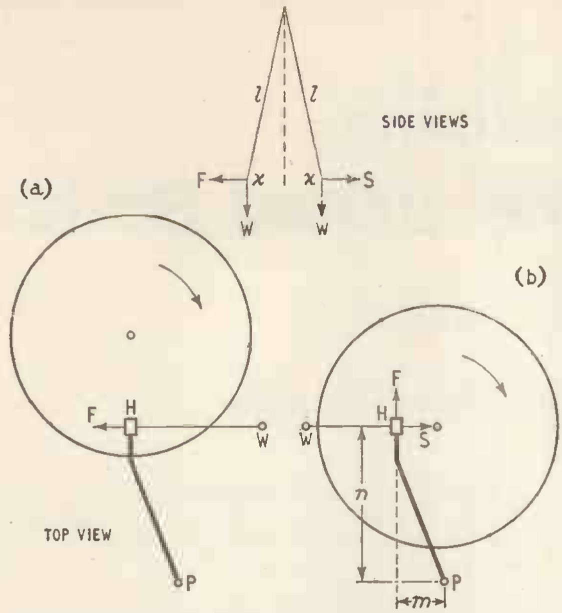


Fig. 13. Two methods of measuring stylus friction on a blank disc.

(2) The conception that, for constant deformation, the tracking weight varies as the square of the stylus radius seems inappropriate, and a better approximation is that it varies directly as the radius (unsquared).

(3) The elastic limit seems to be appreciably raised for a moving indenter as compared with the static case. Recourse to lower groove speeds (such as with 16⅔ r.p.m. records) would entail a lowering of the effective elastic limit of the record material and has serious implications for pickup design. This is made extremely undesirable when one considers that the recorded wave-lengths would be shortened to such a degree that, either excessive tracing distortion would occur, or the ensuing necessary small stylus radii would increase the record wear problem to degenerate proportions. Other ways of increasing the playing time of l.p. records should be considered.

While the relations between the mechanical impedance of the stylus tip and the tracking weight required are well known, the effect of stylus tip radius has usually been considered partly on the basis of record wear and the "W varies as r^2" relation. It should be realised that an increase in tip radius can also increase the acceleration required of the stylus in conditions of tracing short wavelengths and that large tip radii may not save the record, therefore, as much as might be hoped.

Although the above measurements have considerable spread, they were nevertheless used as the basis for the design of a stereo pickup that will track the whole frequency range of a modern l.p. disc within the elastic limit of the material. It was calculated that while this entails a tip mass in the region of 1mgm, the tracking weight could be raised to about 3gm for a ½-thou stylus rather than the somewhat lower weights required on the basis of Hunt's or Barlow's† static measurements. Tests were carried out on this and other pickups and photographic evidence gave ample vindication on the general programme of work.

While it is not considered that the above work is anything but a beginning of an attempt to understand record wear in reproduction, publication of these first results has been considered to be useful as both a corrective and a pointer for further work in the sphere of both recording and reproduction of gramophone records.

This information, work and graphs are published by courtesy of the Decca Record Co., Ltd.

†F. V. Hunt, *J.A.E.S.*, Jan. 1955, D. A. Barlow, *J.A.E.S.*, Oct. 1958.

BOOKS RECEIVED

An Introduction To Machine Translation, by Emile Delavenay. A survey of the present state of the art. An opening chapter discusses the justifications and implications, and is followed by a discourse on the possible use of computers in translation. An analysis of the problems of machine translation related to differing grammatical forms and idioms takes up the major part of the book, and the final chapter propounds possible developments in the translation of literary and poetic works. Appended is an actual translation made by an I.B.M. 704 computer. Pp. 144; Figs. 5. Thames and Hudson, Ltd., 30, Bloomsbury Street, W.C.1. Price 25s.

Principles of Semiconductors, by M. G. Scroggie. A grounding in semiconductor theory, by way of atomic physics. The first few chapters describe the mechanism of semiconduction, as an introduction to the action of devices such as diodes and transistors. Further chapters are concerned with photoelectricity and a variety of semiconducting devices and their applications. The book is written in a down-to-earth style, and is intended to provide a basis for more advanced works on the subject. The book was first published in an Americanized edition by the Gernsback Library, and this new version has been re-written with new illustrations. Pp. 156; figs. 115. Iliffe Books, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 21s.

Elsevier's Dictionary of Amplification, Modulation, Reception and Transmission, compiled by W. E. Clason. A list of nearly three thousand terms is given, with a precise definition, in English, of each. On facing pages are set out the equivalents in Dutch, French, German, Italian and Spanish. Following the list are indexes in these five languages, linked to the dictionary by reference numbers. Pp. 804. D. Van Nostrand Co., Ltd., 358, Kensington High Street, London, W.14. Price £6.

Introduction To Hi-Fi, by Clement Brown. Offers advice to the music-loving layman on the approach to domestic sound reproduction. The treatment is well suited to the potential readership, and the author does not assume either a living room the size of the Festival Hall, or an unlimited bank balance. An appendix contains a list of recommended tape and disc recordings. Pp. 198; Figs. 84. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 21s.

Radio Transmitters, by Laurence F. Gray and Richard Graham. Intended for the maintenance engineer and operator, the book deals in an essentially practical manner with design principles and operation of amplitude, frequency, phase and pulse modulated transmitters. Pp. 462; Figs. 398. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 97s.

Colour Television in the United States

By JACK DARR*

PROGRESS REPORT: THE PRESENT STATUS

THE Editor has requested that I hold forth somewhat upon the subject of colour television as we know it in the United States. Knowing that I had been associated with it for several years, and had already expressed views on the subject,† he asked for a report straight from the horse's mouth, as it were. And, while I bridled a bit, I found myself saddled with the task! (Oh, *dear!* I *am* sorry. Shan't do it again.)

We have had colour TV broadcasting for quite a while now. To run over the system as quickly as possible, we use a 525-line, dot-sequential system, entirely compatible with present B/W standards. Colour information is in the form of phase modulation of a completely suppressed "sub-carrier" of roughly 33.597545 Mc/s. This carrier is removed at the transmitter, probably to save postage! It is restored by a crystal-controlled oscillator in the receivers. Three basic colours are transmitted, red, green and blue, and the "shadow-mask" RCA three-gun tube is still the standard. Other types of colour tubes have been tried, but so far none of them has made the jump, commercially.

In the very beginning, in 1950, the F.C.C. authorized colour broadcasting using the C.B.S. system, a field-sequential arrangement. At the receiver, a "colour-wheel" was set up in front of the screen; it had slides of the three colours, and was (theoretically) rotated in synchronism with the transmitted "fields," each of which contained all the picture information for that particular colour.

Theoretically, this was all right, and the results obtained in lab. tests were very good. I have heard that this device produced colour pictures of amazing quality! However, when one contemplates the spectacle of a 4-foot colour wheel spinning at something like 440 r.p.s., sitting atop one's TV receiver in the living room, it is rather frightening. So, after four years, this was abandoned in favour of the present all-electronic system.

Of course, when it all began, quite a few manufacturers leaped on the bandwagon, and there were several makes of colour sets on the market. Most were quite expensive: I can remember one model, using a 15-inch tube, which sold for over $1,500! According to the grapevine, this set cost the maker over $1,450 to produce! Unkindest cut of all, just as they finished the first production run of 1,000 sets, the 21-inch tube was introduced! When last heard of, this poor soul was tearfully trying to dispose of the sets at about $800 apiece!

At first, no significant numbers of colour sets were sold. Those which were went to bars, restaurants, and "status-seekers," to dip into the latest jargon: ownership of a colour TV was roughly equivalent to owning a Rolls or Bentley. Prices were far above the average pocketbook, and programming was quite scarce. So, for purely economic reasons, all of the colour-set makers except RCA faded out of the picture. RCA, having a vested interest in colour, and a fat investment to boot, gritted its corporate teeth and stayed with it. Through the past years, this firm has carried colour TV on its back like a polychromatic Old Man of the Sea, doing nothing at all for its financial structure in the process! Although at first both N.B.C. and C.B.S. networks carried colour programmes, C.B.S. gradually withdrew, and N.B.C. sailed on alone.

Sales of colour TV to the public remained at an extremely disappointing level (to RCA's comptroller, at least) for many years. RCA, by all reports, went deep in the red each year on its colour (that's only a very mild pun; may I be forgiven?). However, they kept on grimly, holding many service meetings for technicians, advertising, issuing a complete colour-TV training course through RCA Institutes, and even selling colour-TV sets to interested technicians on hire-purchase, at a liberal discount.

Turn of the Tide

Engineers in the meanwhile kept digging into the "innards" of the colour set, excising parts here and there and developing a new all-glass colour c.r.t., 21CYP22, to replace the original metal-coned 21AXP22. The number of valves was reduced drastically: from 44 in the first models to 26 in 1956, and a few less in current models! After years of waiting, 1960 was *das Jahr* for R.C.A. colour TV set sales went into the black for the first time! According to "informed sources" they sold something like 200,000 sets, and predicted that the total number in use by the end of 1961 would be over 750,000 sets! Other set makers began to prick up their ears. They dusted off some designs that had been lying fallow for quite a while, and Admiral, Westinghouse, G.E., and others

* Ouachita Radio-TV Service, Mena, Arkansas.
† See for example "Rainbow Round my Shoulders," *Wireless World*, Aug., 1957.

announced the production of colour chassis. Even the conservative Zenith corporation announced that they would bring out a colour TV chassis in 1961.

Prices fell: from the original $1,500, colour sets now selling for about $495. RCA, and, from what I can discover, all others, make only a single chassis: the price differential lies solely in the cabinetry. Even we in our small town in the Hills felt the impact: our colour-TV population increased by a whopping 300%! (Instead of *one* set, we now have four!)

Programme Hours

Colour TV programming has steadily increased, although still concentrated on the lone network, N.B.C. C.B.S. still has no colour shows at this time, although they may still have the camera equipment squirreled away somewhere: they did broadcast some excellent colour. Another network, A.B.C., has publicly announced that it has no plans for getting its feet wet with colour, although this may be changed by the time this is printed. For an example, the N.B.C. colour programme for May, 1961, lists 4 hours and 15 minutes of regular colour shows every weekday in half-hour "segments." This plus an average of one full hour each week-night, two hours on Saturday and 2½ hours on Sunday, gave me a total of 121 *hours* of colour programmes for the month. Besides these, there are "specials" which pop up from time to time, usually in colour; these are full hour shows. There are several daytime shows in colour, put on so that the TV dealers can demonstrate their wares, but a significant percentage is scheduled in what the advertising agency boys call "prime-time," between 7 and 10 p.m., especially on Sundays, when there is colour from 7 p.m. to 9 p.m. every week.

Once each year, NBC puts on a special "Colour-TV Day"; colour programming begins at 6.30 a.m. and continues until midnight, with only a five-minute news-break at 11.55 and a 4.00 to 6.00 p.m. B/W break for "kiddie shows." Even the evening news report is in full colour! A total of 18 different colour shows are given on this day, the first being a part of the daily programming, an educational show called "Continental Classroom": college lecturers give talks and demonstrations in their specialties, and I understand that there is a regular course of study which may be undertaken, with credits, etc. The colour enables them to demonstrate chemical reactions, etc., with ease, although the whole course is in colour. Calculus in colour must be seen to be believed!

The other side of the coin, after the sets have been built and the programmes broadcast, is service. There is no doubt about it: colour TV sets do require more service attention *on the initial installation* than B/W sets. Colour TV sets must be set up by a competent technician with proper test equipment. However, simplification of design has brought the set-up time down from the original four hours by two men with a lorry load of equipment, to about a half-hour by one man with a cross-hatch generator; and at least half of that is usually taken up in showing the customer how to run the thing!

In early sets, convergence, colour-temperature, and signal strength had to be checked and, in many cases, completely readjusted upon installation. This was a long process. Nowadays, any number of sets operate correctly "right out of the box"! I hauled my own set more than 100 miles, lugged it into the living room, set it up, turned it on, and made only one or two minor adjustments! It didn't need convergence at all, aside from a touch-up at one or two places. Convergence was the big bugaboo; manuals told you that the set must never be moved, for fear of magnetizing the tube from the earth's magnetic fields! (This results in the gathering of much lint behind colour TV sets!) Also, in some technician's heads!

As to service required, I firmly believe that the average well-built colour TV set requires no more service attention per tube than any equivalent B/W set! I base this opinion on five years of colour-TV work, plus experience with my own set, which was secondhand when I got it. So far my only troubles have been such relatively straightforward things as a shorted audio output valve, which took a resistor with it: a weak line-scan output valve, which merely drew the picture in from the sides, and a shorted B-Y (blue) amplifier tube, a 12BH7, which caused the screen and the owner's face to turn a livid green. (Owner was thinking of the phrase in the service manual, "Bright green screen; no picture—defective picture tube"!)

There is another two-sided coin in the service end, too. Training, for one (this would be "heads," I'd think) and test equipment. Training began quite early. All major setmakers had (and still have) training courses on colour TV fundamentals; all leading magazines ran stories on colour, and there were a number of excellent books written. So, if the average U.S. TV technician hasn't a full knowledge of colour, it is definitely not because of a lack of opportunity! Quite a bit of this material was given away by setmakers, who also conducted service meetings in every major city at regular intervals, and many of the smaller towns to boot. They are still doing this, by the way.

Theory and Practice

Now, may I bring forth a long-cherished personal opinion? Like everyone else, I dived headlong into the fascinating study of colour TV at first. Reading all the material I could, I found myself enmeshed in a maze of college-level maths! Vectors, colorimetry diagrams, chromaticity diagrams, percentages of each colour at the camera, calculus, trig., etc., etc. After about a year of this, I discovered that I was almost completely befuddled! I had done, perforce, a lot of brushing-up on my long-forgotten maths, never one of my better subjects, but I *still* didn't know beans about how a colour-TV set worked!

Frankly speaking, and this is the result of much inquiry among my brethren over the past few years, this approach scared the pants off the average TV serviceman! He apparently thought, "Well! If it's going to take *this* kind of stuff to work on colour TV, the heck with it!" The actual language used, of course, has been greatly edited! As a result, he developed an unconscious *resentment* of colour TV! Aside from a hard core of devoted grinds who studied from the sheer love of it, most of the boys sheered off, and wound up with an active opposition to colour. This came out in their discussions with customers, who were also prospective colour TV buyers! When asked, "What do you think about colour?" they generally replied, "It's not ready yet!" So, quite naturally, buyer is not ready to take the financial plunge on something their pet expert has just disparaged! This is an actual quotation from any one of several technicians of my acquaintance, as of a few years back. Personally, I have been doing colour TV service work for quite a while, and have never found the occasion to use the knowledge as to "What angle is green?"! (It's rather like the chap who learned the Swahili word for "thunderstorm,": he said, "It's nice to know, but somehow it's hard to work into a conversation!)

So, of late, our periodicals and books have taken more to the "simplifying" approach; I can plead guilty to having done a few of these myself. We're trying manfully to get the U.S. technician over his fear of the complexity of colour TV sets.

Now, as to test equipment: in the early days, we were told that we'd have to have colour-bar generators, extremely wide-band oscilloscopes, and a host of other expensive test equipment. I can say from personal experience that the average well-equipped TV shop will have to have only *one* new piece of test equipment, and that is a cross-hatch bar or dot generator, for convergence work! These are available in U.S. from $15-$20 on upward, and will soon be in the U.K., if they are not already. You do not have to have a colour-bar generator to service colour, nor yet a wide-band 'scope; to *design* it, yes, but not to service it. A standard, good-grade 'scope will, in the hands of a capable technician, produce just as good results in *everyday* service work as the finest laboratory 'scope on the market! My own two 'scopes are far from broadband, being good-grade average equipment, and I've never found anything that I wanted to know that they didn't tell me, quite accurately!

The most helpful thing, of course, just as in B/W TV, has been the simply tremendous simplification of circuitry since the beginning. This is most apparent in the latest colour sets. In the original chassis, something like 30 adjustments were necessary; in the last model, this has been reduced to a *maximum* of 15, of which only 3 or 4 customarily need adjustment on installation. Time has been reduced from four to five hours to about 15 minutes!

Just as an experiment, I checked the time on the last installation I made; I was finished and talking to the customer in less than 20 minutes!

All of the convergence controls except the "statics" (the small magnets on the neck of the picture tube, for getting the beams centred at the beginning) have now been concentrated on one small PC board about 4 inches square. This is mounted on the back of the cabinet, and can be loosened and set up above the top of the cabinet facing the front. Now, the technician can make all convergence adjustments from the front of the set, without the need for mirrors. Combination adjustments are now used on the controls: "R-G," for instance, moves *both* red and green beams for vertical convergence at the *right side* only. One control is provided for each side of the tube! Using this system, almost 100% perfect convergence can be obtained on the new sets; a far cry from older sets like mine. I blush to admit that mine own is slightly off at the bottom of the screen, but you've all heard the old saw about the shoemaker's barefoot children.

The "colour temperature" adjustments have also been simplified. This was always one of the worst headaches, at least to me; getting the screen so that it was really *a black and white* picture, without colour-tinting in either highlights or "lowlights." Older sets, set up under incandescent light, look greenish in daylight. These new sets, using the new picture tube, can be set up so that one cannot distinguish between colour and B/W screens at a distance of ten feet! I've seen this done! Daylight washed out the pictures on old colour tubes; the latest tube can be viewed in light as bright as that possible with any B/W tube.

So, in conclusion, I can say that my truthful opinion, for whatever it's worth, is that colour is no harder to service than B/W TV; that it can be serviced with ordinary TV test equipment, and that a minimum of theory, aside from a thorough knowledge of B/W TV theory, is needed. Colour, from the viewing standpoint, is wonderful: many of our most colourful events are breathtaking when broadcast in colour: the Parade of Roses on New Year's Day, the World's Series (baseball, that is), and the many "specials" which are usually lavishly produced musical comedies, with gorgeous costumes, etc. And, I might add, for "Free Grid's" benefit, that he simply hasn't lived at all until he sees one of his favourite blondes in "Living Colour." (P.S. He can, by manipulating the hue control, change her to any shade of hair he wants! Green, purple, etc.—spectacular, if properly done!)

"Bibliography"

All opinions given herein are strictly those of the writer, as gained from talking to people, reading articles and books on the subject, and from practical experience. All definite figures quoted are taken from "reliable sources," which are at least as reliable as those quotations from political equivalents.

Industrial Colour Television

THE equipment shown in the photograph is part of an industrial colour-television system developed recently by E.M.I. Electronics Ltd. The camera is designed for use in hazardous situations and can be controlled from a point 1,000 feet away. As shown here, the operator is looking at a 21-in tube colour display; but a large-screen display using a projection system can produce picture up to 12 feet high and 18 feet wide. The ancillary equipment can be rack-mounted (not shown).

Radio Components Show

NEW EQUIPMENT AND DEVELOPMENTS

ALTHOUGH the change in venue from Grosvenor House to Olympia has given the advantage of extra space, the exhibition has taken on a more impersonal aspect, and exhibitors seem to be a little wary of showing equipment which is not immediately available in large quantities. As the purpose of the show is primarily to sell components, this is understandable. However, it is a pity that more prototypes could not be shown, if only because the new ideas which are our "bread and butter" seem to show up better in their original form.

Fixed Resistors.—In the main, major changes in fixed resistor design were noted only in the high-stability types, where unusual encapsulating materials were being used. For instance, Dubilier employ a p.v.c. sleeve, whilst Plessey use an epoxy-resin moulding as do Rivlin and Welwyn. Ashburton employ nylon moulded round the resistor.

Generally the use of fine wires seems to have reduced sizes and increased resistance values, for instance, Erg had on show their Type MPRB22, with a maximum value of 1MΩ on a $\frac{5}{8}$-in long by $\frac{3}{16}$-in diameter bobbin, rated at $\frac{1}{4}$W.

A novel form of wire-wound power resistor was seen on the Elcom stand. A flexible glass-fibre core supports the wire, rather after the nature of a short length of linecord, and the terminations are mild steel lugs.

Variable Resistors.—Once more miniaturization has resulted in further reduction of the size of potentiometers and a common style this year seems to be about $\frac{1}{2}$-in diameter with a $\frac{3}{16}$-in spindle.

The A.B. Metal Products version can be supplied for fixing without a spindle bush for a compact edge-control assembly and the Egen Types 365 and 363 both employ die-cast bodies and nylon spindles. Morganite's Type K has up to three tapping points for the fitting of a.f. response correction networks.

In the field of precision variable resistors the multi-turn helical potentiometer seems to be gaining ground on account of its high resolution. However, another method of achieving high resolution was shown by Colvern: their Type CLR 85/00 potentiometer has a single turn action and employs three parallel, concentric windings so that movement of one wiper from turn to turn is masked by the other parallel wipers.

Fox are using alloys of noble metals and noble-metal wipers in their potentiometers—this, they claim, improves life and reduces noise.

Continuous elements, of course, avoid resolution troubles: for instance the moulded-track type (Plessey) which, made in a square shape, is particularly convenient for a sine/cosine potentiometer. On the Ministry of Aviation stand another infinite-resolution element was seen; this was a 400-angstrom-thick layer of chromium deposited on a Pyrex rod.

Fixed Capacitors show generally development to meet transistor requirements—working voltages have been reduced by the use of thinner dielectric films so reducing the overall bulk also.

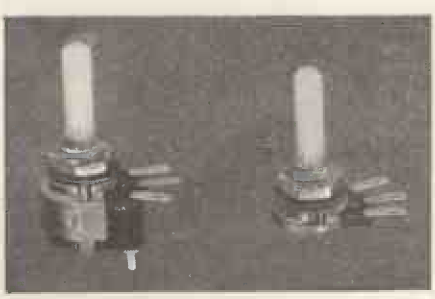
Ratings of 20 (Lemco), 30 (Mullard), and 50 (TMC) V were found in "plastics" types, typical dimensions being 12×11×5 mm for 0·1 μF (Mullard), 5mm long by 2mm diameter, 100 to 300 pF (Lemco); $\frac{15}{32} \times \frac{3}{16}$in for 0·5μF (TMC).

On the Ministry of Aviation stand the production of stacked barium-titanate capacitors by a slip casting process was shown. Barium titanate is spread in 0·001-in thick layers in the form of a slip or "mud." On top of this electrodes are printed with nickel oxide, being covered by another layer of dielectric, and so on, until the desired number of layers has been applied. Then the whole is cut up and fired in a reducing atmosphere to produce nickel electrodes and leadout wires are fitted. Capacitances of the order of 100μF/in^3 at 50V working are achievable.

For valve circuitry a trend appears to be the offering of synthetic-dielectric capacitors for ordinary coupling purposes (Suflex "Polycaps").

Another alternative to the paper type is ceramic—Erie were showing ceramic disc capacitors in ratings up to 0·1μF at 500V d.c.

Electrolytic Capacitors, like the paper and plastics-dielectric types were presented in various new forms of covering: Hunts, Plessey and T.C.C. were all using various types of plastics moulding. The T.C.C. "Elkomold" series is designed for operation at 75° C without de-rating



Left: Egen potentiometers with die-cast bodies ½-in diameter. Switch-on Type 365 is rated at 50V, 150mA.

Right: Jackson Brothers Type S.D.1 miniature tuning capacitor.

and Plessey were rating capacitors in polypropylene cases at 85° C.

C.C.L. were showing a new range of electrolytic capacitors designed for printed-wiring use in transistor circuits. A typical size was 35μF, 6V working and the transistor-like appearance was brought about by the aluminium can with the leads, sealed in epoxy resin, emerging from one end.

Variable Capacitors.—Most noticeable on the majority of stands of variable-capacitor manufacturers were small, solid-dielectric two-gang tuning capacitors of roughly similar dimensions (about 1-in square and $\frac{1}{2}$-in deep). Mullard and Jackson use "tracked" vanes, so that an additional oscillator padder is not required (maximum capacitances about 180pF and 80pF) whilst the Plessey unit has a switch fitted which earths two contacts when the 180° rotation point is passed. These contacts are used to add parallel capacitors for reception of the l.w. Light Programme with m.w. coils, the extra rotation of the capacitor providing a fine tuning function.

Also using a solid dielectric was a capacitor from Suflex, covering the range 0·035 to 0·1μF. This consists of a specially-wound tubular polystyrene capacitor which is "squashed" to provide the capacitance variation. Other values are 0·45 to 0·5μF and 1μF$\pm$3% and the long term stability claimed is better than 0·1%.

L.F. Transformers.—A new range of sub-miniature ($\approx$1in^3) transformers shown by Ferranti used a new type of epoxy resin which sets at least ten times as fast as normal resins and so allows a much greater rate of transformer production.

Haddon showed a three-phase saturable reactor in which a single control winding is used to produce more nearly equal powers in each phase than is obtained with the normal three control windings (one in each phase).

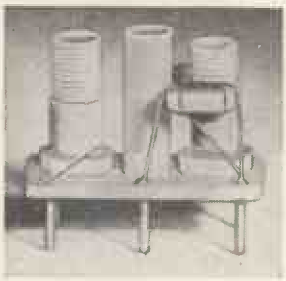
A range of small transformers shown by Andec are, for convenience in use, built around the mains plug. One of these also incorporates a rectifier to produce a 1-A, 12-V battery charger.

Aveley showed a range of toroidal variable-ratio transformers tapped in three decades to an accuracy of 1 part in 10^6. Similar accuracies are available for some units of the Gertsch range of multi-decade ratio transformers shown by Wayne Kerr.

R.F. and I.F. Transformers.—A range of transformers for f.m. receivers shown by the Wireless Telephone Company has the useful facility that the coupling can be varied without altering the tuning of the individual coils. The two coils (with their ferrite tuning cores) are placed side-by-side with their axes parallel. To vary the coupling a third parallel ferrite core is screwed in between the coils.

As coils are increasingly miniaturized it becomes more difficult to form threads on ferrite cores for them. This difficulty has been avoided by the Wireless Telephone Company and by Weymouth by using a non-threaded core attached to a larger threaded polystyrene plug. The Wireless Telephone Company used the normal movable internal core, but Weymouth used a fixed inner core and varied the inductance by means of an external parallel movable rod. Another approach adopted by Weymouth in their P80 series was to use a comparatively large hollowed-out threaded core which is screwed down over the coil and internal fixed core.

To avoid radiation at the i.f. or its harmonics several companies have in the past mounted the detector and its filter capacitor inside the screening can of the last i.f. transformer. This idea was carried still further this year by Brayhead, who also included the last i.f. transistor and its d.c. biasing components inside the screening can.



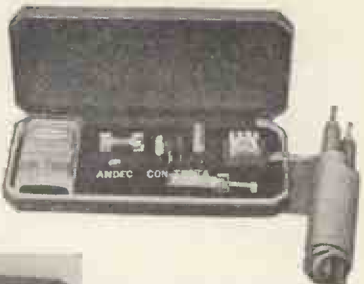
Plessey first i.f. 10.7 Mc/s f.m. transformer in which the coupling can be varied (by moving the core in the centre former) without altering the tuning of the two outer cores.

Left: Voltage proof testing equipment shown by Lemco, which simulates 2 kV d.c. for 1 min. by means of high-voltage pulses.

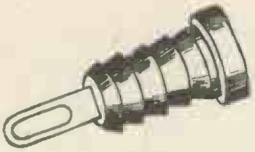
Component Testing.—Rapid voltage proof testing is provided by the Lemco equipment. The normal test —the required direct-voltage of one minute's duration—is replaced by a high-voltage pulse applied for a matter of milliseconds, front-panel lamps indicating pass or fail. Connections are provided for the operation of automatic equipment, when the rate of test can be up to 100 components per minute. Voltage is continuously variable up to an equivalent 2kV d.c.

Resistance Measurement. — Continuity-checking is simplified by the use of the Andec Con-Test. This consists of a transistor oscillator working in the audio range, with the output feeding a small speaker. Probes are applied to the measuring point, and the resistance encountered between them, being in series with the oscillator supply voltage, varies the frequency in linear proportion. The current applied to the external circuit is of the order of microamperes and the instrument may be used on live circuits up to 50V. Sensitivity is sufficient to discriminate between a short-circuit and a dry joint.

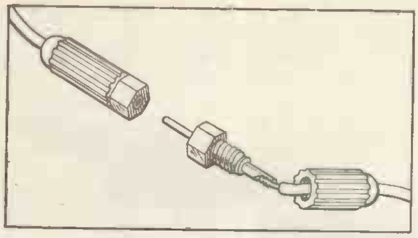
Extremely low loading of the resistor under test is afforded by the B.P.L. RM196 Wheatstone Bridge. The maximum dissipation demanded is 15mW, over the range 0.001Ω to 10MΩ. Null indication is by centre-zero meter, fed by the output of a chopped d.c. amplifier. Switch indications are by neon in-line indicators, with a decimal point. Accuracy is within 0.1%.



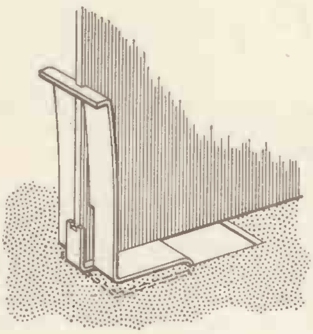
The Andec Con-Test continuity tester.



Quick-fixing chassis socket—the Fasfit—by Spear Engineering. The socket is simply pushed into place and is held by the moulded serrations.



Miniature plug and socket shown by Harwin. Either half can be male or female, and a very positive connection is achieved.



Salter retaining springs for printed boards. A slot in the board edge prevents accidental withdrawal.

Contained in a 1-in cube, this blower by A. K. Fans will move 2.2 ft^3/min.

Switches.—A.B. Metal Products showed a new range of push-button switches built on a single-piece frame which is bent into the shape of a trough. This is claimed to be more robust than the normal four-plate frame.

Ardente showed a miniature ($\approx\frac{1}{2}$-in diameter) 2-pole 3-way rotary switch with the unusual facility of spring return. This is designed to replace the normal lever key switch.

Printed circuit switches were shown by Plessey and Harrison.

Relays.—S.R.D.E. showed a number of relays made up from single-changeover cylindrical capsules only $\frac{1}{8}$-in in diameter and 1-in long. Each capsule contains a spring-loaded armature plunger which in operation is attracted (by the field of the exciting current in an external coil) away from the non-magnetic contact at one end of the cylinder towards the magnetic contact at the other.

Plessey showed a relay in the unusual shape of a cylinder in which a disc armature moves an axial rod at right angles to the disc plane. This relay is also unusual in that it is the outer rather than the inner contacts which move.

Chassis Fittings.—Miniature lamps were shown by Thorn Electrical. The Mite-T-Lite is only 0.055-in in diameter and 0.175-in long. It requires 1-1.5V at a maximum current of 35mA. Output is 35 millilumens. The Micro-Lite can be operated from an 0.8V supply at 6mA.

Transistor retainers were shown by Rendar and Lewis Springs. The Rendar fitting is single-screw fitting and moulded from polypropylene. A beryllium-copper spring retains the transistor. The Lewis retainer is a beryllium-copper spring and assists in heat dissipation; fixing is by clipping into a hole in the chassis or p.c. board.

Valve retainers shown by Electrothermal are made from heat-resisting rubber and are designed to fit any size of valve. The VRE retainer ends are serrated and are simply pulled through holes in the chassis until the correct tension is obtained.

For the mounting and locking of potentiometers and trimmers, General Controls have introduced the Flush Lock. The potentiometer is set back from the panel, and all that protrudes is a $\frac{1}{32}$in surround. The spindle is locked by a grub-screw pressing on a ball arrangement.

Plugs, Sockets and Connectors.—For use in circumstances where longitudinal strain is applied to the centre contact, Transradio have introduced a modified contact pin with a shoulder. The coaxial plugs fitted with the new pin are the Types "BNC," "C" and "N."

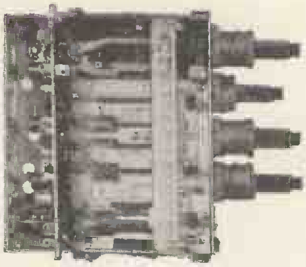
"Collecon" and "Camlecon" are the names of multiway plugs and sockets made by Belling and Lee. After insertion, which requires very little force, contact is made by compressing the socket round the plug-pin, by means of a cam action.

Designed for use on remotely controlled television receivers, the Pressac 8-way shuttered plug and socket contains an independent pin-holding plate which may be removed for easy connection of wires. The units are moulded from high-impact polystyrene.

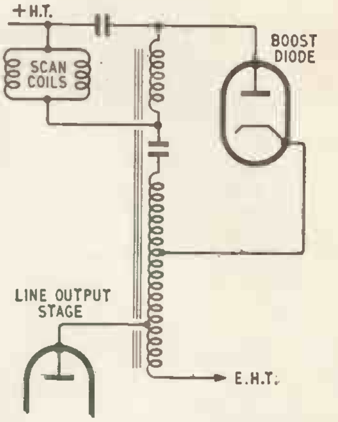
Sub-Assemblies.—Transistor power supplies may conveniently be assembled using the Mullard sub-assemblies. Two basic unstabilized supplies giving 1A or 5A at voltages from 1-39 may be combined with a stabilizer reference circuit to give 1-30V at 250mA, while for heavier currents a series regulator is added, giving up to 0.5A. More current is obtained by the addition of further series regulators. Stability with mains variations is 200:1 for +10% −15%.

What must surely be the ultimate in compactness was shown on the stand of A.K. Fans—the makers of Airmax blowers. This is a blower contained in a 1in cube and moving up to 2.2 cubic feet per min, depending on the pressure. The hysteresis motor consumes only 3W at a variety of a.c. voltages and is guaranteed for a continuous running life of 1,000 hours at normal ambient temperatures. The blower is made by the American firm of Sanders.

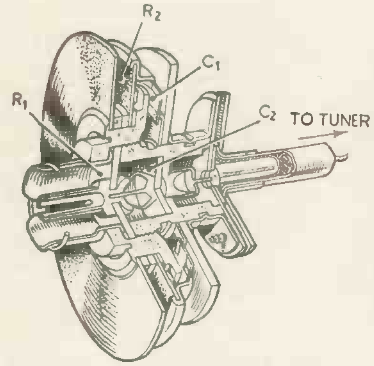
Television Components.—In the Cyldon Type PC80 tuner, the mechanism allows selection of any of the thirteen channels on any push-button. The tuner is of the incremental type, using a flat, printed "coil-board" across which a shorting slider moves, positioned by a 13-step cam on each button (the button is turned to pre-select channels) and the manufacturers claim a reset accuracy of 50 kc/s. Several versions of this tuner are available, one of which uses three Type AF102 transistors in the grounded-base mode. This company were also showing a u.h.f. tuner using two triodes. Resonant lines form the tuned circuits and are coupled together by slots in the screening partition. Primarily (at the moment) for the export market, this tuner com-



A. B. Metal Products new transistor TV tuner (left) and (below) 13-step cam channel-selector button.



Circuit used by Plessey and Elac for cancelling flow of d.c. through line-output transformer windings.



Aerial isolator for a.c./d.c. television receivers (Egen).

Integral-safety-shield television c.r.t. by Cathode Ray Tubes Ltd. "Ears" at corners ease mounting problems.

plies with the German radiation specifications.

A.B. Metal Products were also showing a transistor tuner, but this was of more conventional turret design. What is unusual is that the three transistors (Semiconductors types) are operated in the earthed-emitter connection. The noise performance compares well with valve tuners, but the minimum-gain specifications (Band III, 19dB) look disappointing until it is realized that these figures are *power* gains, and not voltage gains between unrelated impedances, as are usually quoted for valve tuners.

Brayhead's BT 19 series of tuners uses printed-coil aerial and r.f. biscuits as well as including a range of variations, two of which are the use of a tetrode r.f. amplifier and a back-biased junction diode for the fine tuner.

For transistor television, Elac, working on the basis of a 90° c.r.t. at 12kV e.h.t., have adopted wave-winding for the e.h.t. coil to reduce the self-capacitance of the overwind which employs a greater step-up ratio than is usual today for valve working. The scan coils look conventional except for round correction magnets with long pole pieces extending round the coil: these provide a slight amount of scan magnification. Some of Plessey's components had been developed along the same lines; but in addition they had an experimental design for a 110° c.r.t. at 16kV.

With valves, "desaturation" of the line-output transformer for 110° c.r.ts. usually employed an isolating choke; but both Elac and Plessey were showing an arrangement which uses instead the scan coils (see circuit). The cancellation of d.c. flow has, too, allowed a smaller core to be used—tighter coupling of the e.h.t. winding is thus possible and an e.h.t. series impedance of about 7.5MΩ (compared with 12MΩ) has been achieved. A new component from Egen, the aerial isolator Type 364, is completely coaxial in its construction. The drawing shows the main features; R_1, the "static discharge path between inner and outer of the aerial cable, is completed by a resistive sprayed carbon-composition coating on the insulating washer. The r.f. circuit is made by C_1, formed by a metallized mica annulus between the aerial and tuner-lead sections, and C_2, a ceramic disc capacitor. The leak resistor from chassis to aerial is again constituted by a composition coating, R_2. Features are a very small insertion loss and an s.w.r. at u.h.f. of only 1.56.

Cathode-Ray Tubes.—The quest for the slim television set has forced matters even further than the 110° tube; the safety-glass and mask have now been eliminated! Brimar were showing tubes with both Diakon and toughened-glass shields cemented to the tube-faceplate, the corners of these shields carrying ears for clamping the c.r.t. to the cabinet, and Cathode-Ray Tubes Ltd. had on show tubes with shields in Perspex and Diakon. When imploded, the glass of the tube face-plate, although broken, remains "glued" to the protective panel.

For transistorized television sets Mullard were exhibiting a 14-in 90° c.r.t. with a heater rated at 11.5V, 165mA, to suit a nominal 12-V battery on discharge.

Oscilloscopes.—The pattern of plug-in amplifiers to the basic instrument is adopted in the Serviscope D33. This is a dual-channel instrument, using a double-gun G.E.C. tube with P.D.A.. Three types of amplifier are available—a wide-band unit 0-6Mc/s at 100mV/cm., a differential amplifier 0-200kc/s at 1mV/cm., and a high gain a.c. unit 5c/s-150kc/s at a sensitivity of 100μV/cm. The wide-band amplifier may be switched to increase gain 10 times at reduced bandwidth.

Frequency Measurement. — Examples of the integrating discriminator frequency meter were shown by Greencoat Industries, and have been developed for the measurement of shaft rotational speed. Two types were shown, a hand-held and a bench instrument. The hand-held device will measure speeds in the

(*Continued on page* 365)

range of 10 r.p.m. to 20,000 r.p.m. in four ranges at an accuracy of 2 in 10^4, and will indicate changes of 2 r.p.m. at 10,000 r.p.m.

A frequency-divider unit developed by Greencoat will deliver outputs from 100kc/s to 10c/s, from either an internal Xtal oscillator or an externally applied signal. The unit may be employed as a digitally preset square-wave generator, delay pulse generator, frequency divider with divisor 2-200,000 or as a crystal calibrator.

Voltage Measurement.—A small high-sensitivity test meter—the Minitest—was exhibited by Salford. On d.c. volts the resistance is 20,000 Ω/V, and 2,000 Ω/V when measuring a.c. volts. D.c. and a.c. voltage measurement from 2.5V to 1,000V full-scale is offered while d.c. current from 50μA f.s.d. and resistance up to 20MΩ may be determined.

Meters.—A very neat little panel-mounting meter is the edge-wise reading Pullin Series 10. The front measurements are $1\frac{1}{2}$in and $1\frac{1}{4}$in, and the 1-in scale may be either horizontal or vertical. Full scale deflections from 20μA to 500mA are available, and a self-contained a.c. unit is produced.

Metal Rectifiers. — Developments made by Salford Electrical Instruments include a range of "economy-class" contact-cooled rectifiers of simple construction, "semi-contact-cooled" types and increases in the p.i.v. ratings of selenium elements.

The "semi-contact-cooled" types are primarily for low-voltage-rectification: in appearance they resemble ordinary air-cooled types except that the plates are very much closer together and a large insulated metal bush is fitted at one end. When bolted to a reasonable area of chassis the bush transfers heat from the plates to the chassis. S.E.I. make their plates by a vacuum deposition process and improvements in this are raising constantly the peak-inverse maximum rating of the elements from about 27 to, at the present stage of development, 32 to 40.

Semiconductor Diodes.—The remarks made about transistors could be applied, with appropriate modifications, to diodes. Ranges on show have been very widely extended both in voltage and current rating and switching speeds have been increased, in some cases to a startling extent. Recovery times of the order of 1 nanosec are achieved by several manufacturers: stored charges are 20 to 50 picocoulombs.

Television h.t. rectifiers are now available from many manufacturers and single 800-V units are available. The major difficulty in this type of application is caused by the presence of high-voltage spikes on the mains supplies: most rectifiers are rated at, say, 800 p.i.v. but 1.25kV for occasional periods of less than 10msec.

Voltage-variable capacitors (back-biased diodes) are becoming available in a variety of shapes and sizes for most applications. G. & E. Bradley (Lucas) were demonstrating two reverse-biased 750-mA rectifiers in use for the tuning of an ordinary a.m. superhet. A capacitance swing of about 75 to 550 pF was achieved with a voltage variation of about 150.

Tunnel and parametric diodes continue to be presented in experimental forms but do not seem yet to have achieved any major use. The latest type of tunnel diode from S.T.C. (JK30A) is contained within a very short ceramic tube fitted with tag contacts.

Zener Diodes, too were found in great profusion. Perhaps the most interesting ideas in this field come from Brush and Ferranti. Brush has a metal block (called Statavolt) containing holes into which Zener diodes are inserted: by the correct choice of characteristics and the use of reversed devices a reference independent of temperature variations is produced. Ferranti combine Zener diodes and an ordinary junction in one tube with the same aim.

Brush " space-saver " design for medium-power transistor packages.

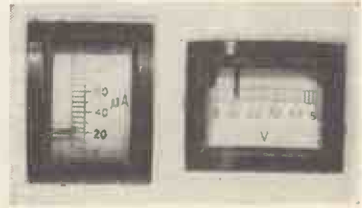
Photo-electric Devices.—As is well known, the efficiency of the silicon photo-electric device can be as high as 10%. International Rectifier were showing what they describe as "ruggedized" cells in which an alloying technique is used to attach the contact strips to the silicon wafer. Ferranti have fitted experimental hemispherical wide-angle lenses of epoxy resin to their cells, to avoid the necessity for "tracking" the cell on to the source of energy.

Transistors.—A high rate of development continues in this field and many new types were on show at the exhibition; for instance Newmarket introduced completely new ranges (type numbers NKT) covering both industrial and entertainment devices. There seems to be a general movement towards the use of the American JEDEC standard cases for transistors—in fact the only noticeable "rebel" was Brush with their "space-saver" design which is about $\frac{3}{8}\times1\frac{1}{2}$in and can be used for devices up to about 10-W dissipation, with, of course, a suitable cooling fin.

Notable in the new Mullard range for radio and television are the AF102 and AF118; both of which are intended for transistor receivers. The AF102 provides a minimum current gain of 20 times at 25°C and has a noise factor (typical) of 6dB at 200Mc/s. The AF118 has an α of 200 and maximum collector ratings of 50V and 30mA; these ratings, together with a f_1 of 174Mc/s render it most suitable for use as a video amplifier. Semiconductors (Plessey group) too have a range of transistors suitable for the receiving circuits of transistor TV and the agreement made recently with the American Bendix organization should result in suitable timebase types being available. The alloy-diffused and micro-alloy-diffused types are now well established and make up the great majority of the h.f. ranges and devices made by the epitaxial technique show promise of fulfilling the higher power r.f. applications.

An illustrative example of thermo-

Solar cell by Ferranti with wide-angle lens for light-gathering.



Pullin Series 10 miniature meter.

electric cooling applied to a transistor was given by M.C.P. Electronics. Bismuth telluride cooling "cells" consuming 2½ to 3W were used to double the rating of a transistor rated at 2½W on a 10×10cm fin.

Microminiature Semiconductor components made by Hughes have been given the name "Microseal." We noted the "dot" diode a short time ago* and this and its companion transistor was on show. The transistor is pear-shaped in plan (0·7×0·062in) and 0·030 in thick. The collector "cap," which forms one end of the ceramic housing, is magnetic and coloured for identification. The other cap is split across and forms emitter and base connections. These devices can be wired-up by a "swiss-cheese" printed-circuit board which is of the same thickness as the units and bears conductors contacting the inserted microseals as if they were feed-through components.

Receiving Valves.—New valves for television "front-ends," are a "beam triode" (PC97) and a v.h.f. tetrode (Mazda 30F27), which use simpler circuitry than the cascode stage.

In a frame-grid triode the major part of the anode-to-grid capacitance is associated with the grid supports. Mullard have, therefore, enclosed the "ends" of the grid assembly of the PC97 in a shield like the beam-plates of a tetrode, and have shaped the anode so that C_{ag} is reduced to about a third of the normal value. Neutralization is still required and the gain is slightly less than that of the cascode stage, but the noise performance is unimpaired.

The tetrode, on the other hand, has a slightly worse noise factor than the cascode, due to partition noise, but Mazda have kept this and, at the same time, C_{ag} to a minimum by lining up the grid and screen-grid so that the latter is shadowed to some extent by the former.

Another Mazda development is a frequency changer triode-pentode (Type 30C17) to which a.g.c. can be applied so that cross-modulation is reduced. Normally a.g.c. would lead to excessive changes of input capacitance, but, by using a high-slope variable-μ pentode and good internal screening, the effect has been reduced to acceptable proportions.

Industrial and Transmitting Valves.—The largest valve on show was the English Electric Type 4KM5000LA four-cavity power klystron primarily designed for u.h.f. television transmission. Rated to give 10kW output this device has a gain of 57 dB and is tunable over Band IV.

For transmission on a smaller scale—from mobile sets—Mullard have produced a series of valves which have a warm-up time of less than one second. This is achieved by the use of either coated-ribbon or multiple parallel fine-wire filaments.

G.E.C. have in their Type A2900 a reliable version of the 12AT7, with a stated average life expectancy of 10,000 hours. Produced for computer and instrumentation applications, this long life is achieved by observance of close manufacturing tolerances and a redesigned heater and cathode assembly.

Brimar were showing a new double valve (ECF804) combining triode and pentode sections of high slope (7·2 and 11μA/V respectively, both at 150V h.t.). This should prove useful where the triode section of the television frequency-changer type limits the performance available from its companion pentode.

Frame-grid construction continues to show its advantages. Two valves from Mullard using this form of construction have very high figures of merit: E810F, 238Mc/s (slope 50mA/V); E55L, 194Mc/s (45mA/V, anode-dissipation 10w).

Microwave Valves.—An X-band t.w.t. amplifier shown by Ferranti is unusual in that it can be modulated by means of a grid incorporated in the electron gun. This enables the modulation power to be reduced at about a thousandfold below that required for cathode modulation.

Microwave Components. — Elliott showed how strip lines between two ground planes spaced only about 0·1-in apart could be used to produce a range of relatively-compact coaxial components.

A coaxial three-port circulator shown by Marconi for frequencies as low as 400Mc/s consists simply of a flat circular cavity containing a sandwich made up of a conducting plate (attached to the three equally-spaced coaxial inners) between two magnetically-biased ferrite discs.

In a three-port X-band switch shown by Sanders an isolation as high as 110 dB is achieved simply by loading the edges of the rotor with a suitable lossy material.

A range of waveguide components for wavelengths as short as 2mm was shown by Elliott.

Materials.—A new method of cabinet construction, based on the Imlok principle but much smaller, was shown on the stand of Alfred Imhof. Units as small as 4¼in cube may be constructed, although the material is also well-suited to much larger structures. A complete range of extrusions, screws, corners, panels, etc., is available.

Among the range of new alloys developed by Telcon are Telconstan and C.P. Alloy. The former is a resistance material used in wire, tape or foil form, and features a sensibly constant specific resistance over the range 20-100°C. Temperature coefficient of resistance is 0.000014/°C. over this range. C.P. (Constant Permeability) Alloy is also designed to be temperature stable, the parameter in question being its permeability, which is between 31,000 and 34,000 over the range −20 to +100°C. Otherwise it resembles Mumetal.

Calculated to reduce the incidence of high blood pressure among electronic engineers is Denamel, a substance produced by Hellermann for the easy removal of enamel from wire. Immersion in the liquid for one minute swells and softens the enamel and a wipe with a rag brings it off. Also from the Hellermann stable is CRC2.26 — a moisture-dispellant. This may be used to remove all moisture from equipment which has failed due to ingress of moisture or even immersion in water. It is available in either aerosol or bulk form and is completely inert.

Suflex exhibited a PVC-coated glass sleeving which will work continuously at 130°C. Dielectric strength is 5kV and bore sizes are from 1mm to 5mm. Material made by Symons is broadly similar and is stated not to exhibit pull back when in proximity to soldering operations. It is resistant to chemicals and oil.

Spirex is a new product of Langley London, offering a low-cost, precision insulating tube of many shapes and sizes. The tube may be rectangular or round, and is spirally wound from a variety of papers and plastics with coverings designed for many different applications.

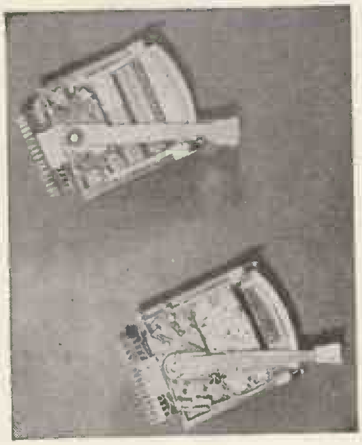
Loudspeakers.—In a new Plessey range the leads are taken directly to the voice coil, rather than *via* two terminals in the speaker cone. This avoids asymmetries in the high-frequency nodal pattern produced by the extra mass of the cone terminals, and also avoids distortions of the cone shape which can occur round these terminals as the cone expands and shrinks with atmospheric moisture changes.

For miniature speakers it may be-

**Wireless World*, p. 280, May, 1961.

Right: Gramophone Company simple speed-change mechanism for record players.

Below: Electronic Components transistorized continuously-variable constant-impedance audio fader (below) designed as a plug-in replacement for their resistive network step fader (top).



Right: Sanders 7-in $33\frac{1}{3}$/45 r.p.m. autochanger with view of underside in mirror.

come economical to machine-out a suitably shaped pot and to use a single-piece cylindrical centre-pole i.e. to do without a separate pot front plate and pole piece. This decrease in the number of separate parts results in an increase in the magnetic and acoustic efficiency. This principle was adopted by Fane, Goodmans and Plessey.

A new waterproof 1-watt pressure unit for underwater entertainment purposes was shown by Goodmans.

Microphones. — The plane-wave noise concellation produced when a microphone diaphragm is exposed to the air on both sides is used by Lustraphone to avoid handling noise in their new "Contadyne" miniature contact microphone for vibration measurements in medical and other fields.

Audio Amplifying Equipment.—Electronic Components showed a continuously-variable constant-impedance (within 1%) transistorized electronic fader designed as a plug-in replacement for their normal resistive-network stepped attenuator. Advantages of the new attenuator are, of course, the facility of continuous variation, as well as the avoidance both of the possibilities of noise due to multiple contact paths or sudden switching-voltage changes, and of high-frequency response correction difficulties.

Record Turntables.—Several new record turntables were introduced. In an unusual battery autochanger shown by W. H. Sanders for 45 or $33\frac{1}{3}$ r.p.m., 7-in records, the pickup arm is raised and lowered by mounting it on a ball which is partly rotated by contact with a vertical wheel driven from the turntable.

A new Greencoat battery record player has a number of unusual features. For example, the pickup arm rest is movable so that when not in use the pickup may be stowed for compactness half way across the turntable. The centrifugal governor contactor is in series with only one rather than all of the armature windings and the speed-change control moves the motor and spindle rather than the idler-wheel.

In a very simple speed-change mechanism introduced by the Gramophone Company the idler is moved by attachment to a spring-loaded pillar which bears in a groove of variable depth in the underside of the speed-change knob. Protuberances in the knob spindle move the connecting rod between the spring-loaded pillar and idler spindle so as to automatically disengage the idler as the speed is changed.

Tape Recording Equipment.—Battery motors suitable for tape recorders were shown by the Gramophone Company and also on the B.S.R. stand by Marriott.

An unusual feature of a range of magnetic tape heads shown by Thermionic Products is that only a single lamination (twisted to form the pole pieces) is used for each head. This, it is claimed, avoids harmful effects caused by the magnetic field not directly crossing the gap near the laminations, effects which will be accentuated if the laminations on the two sides of the gap are not aligned.

In the "X" range of heads introduced by Marriott a gap width of only 8×10^{-5}in has been achieved. This company also showed an erase head requiring only 34mW for a 4-track operation (52mW for 2 track).

A set of transistorized replay, record and bias plug-in units was introduced by Thermionic Products.

Data Processing Equipment.—Gresham Lion Electronics have combined digital read and write magnetic tape head gaps into a single double-gap head, thus reducing the separation between the read and write elements and also obviating the need for alignment between separate read and write heads.

Thermionic Products showed a time injection unit which provides an output in International shortened morse code 1,000c/s bursts for recording on magnetic tape.

Computer Bricks.—A range of plug-in modules designed by Bailey Meters and Controls is marketed by T.M.C. The units comprise a chopper, demodulator, oscillator and amplifier and are intended to comprise a d.c. amplifying system for use in instrumentation. The modules use solid-state circuitry throughout and are resin-encapsulated; the bases will fit a B.9A socket. The chopper is capable of handling an input of 1μV to 250mV d.c.

In the hope of converting the designers of industrial control equipment such as lift controls, weighing equipment, etc., from electromagnetic relays to electronic circuitry Panellit have introduced a system of logic—Minilog—using small encapsulated elements. A whole equipment may be designed using only one basic logic element and one or two driver units. The basic unit is "AND/OR" gate, providing a 6-way "inverted and" function. The output will drive up to 25 other units. Two more units serve as power amplifiers to drive relays, etc.

LETTERS TO THE EDITOR

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

Sound Reinforcement at the I.E.E.

I FEEL bound to comment on the last paragraph of the report entitled "Television and Film Techniques" appearing on pages 321 and 322 of your June 1961 issue.

Why, you ask, should the cobbler always be the worst shod of men? But it is not the cobbler's fault if those to whom he lends his shoes get the laces inextricably tangled up! The cobbler much regrets the unusual limping that resulted on the evening in question but it has led him to formulate new conditions for the lending of shoes.

The foregoing parable refers in particular to the behaviour of the sound reinforcement system. So far as the slide-projection arrangements were concerned, the meeting in question was lucky to get any slides shown at all; owing to the badly constructed frames of the slides with which the projectionist was provided, they jammed as often as the old-fashioned Gatling—necessitating, incidentally, a repair job on the slide carrier.

London, W.C.2. W. K. BRASHER,
Secretary,
The Institution of Electrical Engineers.

The Jigger

"FREE GRID'S" theory of the origin of "jigger" as far as wireless is concerned is hardly right if what I heard very early in the game was true.

Marconi, I think, devised these r.f. transformers probably at the Haven, and their action was described to Kemp.

Kemp was his well-known ex-naval assistant who, it will be remembered, was one of the two assistants Marconi had with him on the first Newfoundland tests.

Kemp immediately remembering his life on board ship said "Oh, that's a jigger", which seems to be a general expression for a lever, and the name stuck.

Two early wireless nicknames which, however, haven't been perpetuated were "sea serpent" for h.f. power cable (used on the giant transmitting jigger at Clifden) and "Crippens" for the large l.f. chokes which were hung by ropes from the roofs. Clifden stock lists containing these names were seriously questioned by the London Office.

London, E.C.1. H. J. ROUND.

Stereophonic Broadcasting

I HAVE followed with interest the correspondence in your columns on the subject of stereophonic broadcasting.

I think, sir, we must face the brutal facts. There are no real *technical* problems against the introduction of compatible stereo broadcasts that cannot be solved by skill and acceptance of compromise. The pure and simple truth of the matter is that of the vast millions of radio listeners in this country, those that would actively agitate for the introduction of such a service would be very minute indeed. If it were otherwise the future outlook would be very different.

I have arrived at this conclusion with some regret since for me, at least, stereophonic reproduction has no attraction at all unless it is of a live broadcast concert (or at second best, a tape). Commercial recordings in their present form only serve to emphasize the synthetic origins of their programme content. That there are technical problems to be solved has to be admitted, but I would remind you, sir, of the controversy that raged in your columns in pre-f.m. days—the gloomy prophecies on the cost of suitable receivers, difficulties of alignment, etc., etc. I suspect the main difficulty is the relatively low standard of the land lines linking studio centres and transmitters. Even in my part of the country, fairly close to London where the experimental broadcasts originate, one has only to listen to the poor quality of the "sum" signal to appreciate the degradation that can result from land lines with unmatched phase shift. But this *could* be solved, and extension of the audio bandwidth to realize the full potentialities of the f.m. service is long overdue. As witness recent events, it would seem no effort can be spared to provide a communication link a few *megacycles* wide over thousands of miles—yet all the reasons in the world are advanced for not providing an extra half an octave on the audio bandwidth of my local f.m. transmitter.

So, sir, I fear the conclusion is inescapable and we, who still enjoy steam radio more than the almighty "goggle-box," might reflect on it. We are unlikely to have a regular stereo broadcast service in ten years—or ever for that matter. I, for one, will have to content myself with an occasional tape from more fortunate enthusiasts in the U.S.A.

Furthermore, I suggest the B.B.C. cease the experimental broadcasts altogether. It's like having a carrot dangled in front of one's nose without the likelihood of ever eating it.

Norwich. R. WILLIAMSON.

Television Standards

MANY readers will commend Mr. Heightman's wish to improve our definition standard (May, 1961), if only because they would like to enjoy the superior picture which the larger screens should offer. As he says, attempts to fill the gaps between the lines by elongating or "wobbling" the spot are no substitute for balanced definition.

Our present scanning analysis is optically unbalanced, being continuous along the lines and discontinuous in the "frame" direction. It is, in fact, *unidirectional*, for there is no scanning vertically, merely chopping into 377 parallel strips. The definition *along* the lines is excellent—but they do not touch! If our scanning were balanced Test Card C could be turned through any angle without loss of definition. For that perfection the lines would have to touch, whatever their total number, leaving no cracks for omission and distortion of details and for spurious patterning.

Mr. Heightman may not be aware that many of us "realise that vertical picture resolution is not equal to the number of picture lines." After considerable experiment a Kell factor of about 0.6 was accepted, from which it is safe to say that vertical definition is down about a third. I have my own way of proving this, and have demonstrated the simple test on several receivers. With focus adjusted for sharpest definition, reduce the picture height until the traced lines touch. The resulting Cinemascope-shaped picture will be much clearer and brighter, and will leave about one-third of the screen dark, part above and part below. This tells us that one-third of our picture is missing, surely of some importance in technical circles also?

Some years ago several workers found that the focused scanning point diameter never exceeds 0.7 elemental line-pitch, even in bright areas of the screen. It surprises me that these investigators did not realize that the spot area is therefore only 0.49 elemental. To discover that our scanning point is only a half-element in size should have shaken those who adhere to the unreal formula for f_{max} which fixes our line total and scanning pitch. Conventional equations assume the spot to be elemental, based on Nipkow's idea that an element-size scanning aperture can sweep along a row of pictorial elements, analysing and reproducing them individually. This fallacy was quietly discarded when the c.r. tube took over from the mechanical systems, and the scanning point was reduced well below element size to obtain horizontal resolution. The lines contracted and separated, but Nipkow's second fallacy of elemental pitch was not recognized, so never remedied. The scanning point was too small for the line total, but the dark grid did not matter much on 12-inch screens. Now our largest screens are nearly four times as large!

Since aspect ratio is universally 4:3, the revised line-standard formula for balanced definition, in which the practical half-element point scans at $\frac{2}{3}$ elemental pitch, closing up its lines, simplifies to $f_{max}=(\frac{2}{3}l)^2 f_p$. For 625-line definition each vision channel requires less than 4⅓ Mc/s.

We should be unwise to copy "Continental" 625-line channel planning, where guesswork allows 4½, 5 and 6 Mc/s per channel. Our Television Advisory Committee finally reduced their interim recommendation of 6 Mc/s to 5½ Mc/s, which would still waste over 1 Mc/s per channel by encouraging engineers to reduce the scanning point still further—again separating the lines and spoiling vertical definition.

Worthing. A. O. HOPKINS.

Colour Tube Costs

IN the past months colour television has been discussed in Parliament and has been the subject for conflicting statements by various bodies. The colour tube in particular has been singled out for criticism on account of its cost. The facts on the price are as follows.

Until recently RCA Great Britain, Limited, offered the 21CYP22A colour picture tube in small quantities in this country at a price of approximately £48 net ex New York, adding shipping charges of approximately £5 per tube, making £53 in all. This became the price to the United Kingdom user. Following a recent reduction in the U.S. the price for this tube is now £44, making a landed cost of approximately £49.

A few weeks ago RCA announced a new colour picture tube—type 21FBP22—which offers an increase of 50 per cent in brightness due to the new sulphide phosphors used. The price of this tube is approximately £46 ex. U.S. (landed cost £51). In all cases these prices are for small quantities only, so that freight and insurance is a rather expensive factor.

The price for the new 21FBP22 tube in large quantities, say in excess of 500 tubes, is expected to be certainly less than £40 landed United Kingdom. Customs duty has not been called for as there is no equivalent product in manufacture in the United Kingdom. If this position is changed duty would be payable at an appropriate rate.

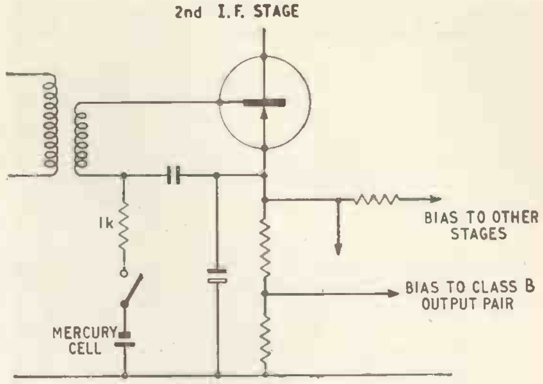
It is hoped that future statements will bear these figures in mind.

Sunbury-on-Thames DONALD MACPHAIL
RCA Great Britain, Ltd.

Transistor Bias Supplies

I AM not aware of any commercial transistor receivers which use a base bias supply for all stages separate from the main battery, although there seem to be worth-while advantages in doing so.

In the circuit suggested, the current drawn from the



single bias cell is so low (say 50 microamps) that a mercury cell might well be installed as a semi-permanent component. Actually the cell biases the 2nd i.f. transistor only, but in doing so controls the bias for all the other stages. With this steady bias it is possible for the output transistors to have the minimum required quiescent current even with a new main battery while still giving reasonable quality right down to half voltage, with the added saving of no wasted battery power in potentiometer networks.

Also, design is made very simple, emitter resistors being chosen for the required working currents at the constant base bias available. Incidentally, several resistors are saved, and none needs to be very accurate apart from ensuring the correct ratio between the two emitter resistors.

It has been found to be stable and reliable in practice.

Dunstable E. JACKSON

"Suppressed Carrier Double-Sideband Systems"

MR. G. W. SHORT has done a most useful service in drawing attention (May, 1961) to the ingenuity of the synchronous detector developed by Dr. J. P. Costas, W2CRR, for suppressed carrier double-sideband reception. But on a few points his article calls for comment.

The statement that the d.s.b. system is "almost unknown" in Britain does less than justice to the amateur radio enthusiasts who have shown a lively awareness of this system for several years, as innumerable references in the amateur radio journals show. This interest was, incidentally, commented upon in my article "Amateur Radio Progress" in your November, 1960, issue.

Then Mr. Short, quoting classic radio theory on the subject, may give readers the impression that d.s.b. signals cannot be successfully received unless the locally generated carrier is exactly equal in frequency and phase to the original (suppressed) carrier frequency. This will bring a wry smile to the many amateur operators who regularly listen to d.s.b. transmissions on conventional (though selective) receivers. The answer—as I tried to indicate in the article already referred to—is simply to listen to only one set of sidebands and to filter out the other set of sidebands *in the receiver*. Admittedly, the synchronous detector is a much more elegant system and permits an improvement in signal-to-noise ratio, but surely it is time we buried the classic theory of the difficulty of d.s.b. reception along with that other famous theory exploded by the radio amateurs of the 'twenties—"the uselessness of short waves."

It may also be of more than academic interest to draw attention to Costas's later article in *Proc. I.R.E.* (December, 1959) in which he set out to show that, in a congested band, broader bandwidths and many channels (as possible with d.s.b.) can be expected to provide better communication reliability than s.s.b. He suggested that for certain applications (including military), narrow band techniques (for example, s.s.b.) lead progressively to more expensive communications systems and less expensive jammers.

Finally, can I suggest that we avoid introducing yet another abbreviation "d.s.b.s.c." since the shorter "d.s.b."—although illogical in some respects—has already firmly established itself, and is in line with s.s.b. for single-sideband suppressed carrier systems and i.s.b. for independent sideband suppressed carrier systems.

London, S.E.22. J. P. HAWKER.

The author replies:

I have been expecting some reader to send in the cryptic message, "1961 – 1956>4." Mr. Hawker's letter gives me the opportunity to correct an error in my article, caused by the ravages of time, and, I hope, to save a little face into the bargain. When I wrote that details of the d.s.b. system were published "nearly four years ago" (in 1956) this was correct. My article was actually sent in *before* Mr. Hawker's interesting review of amateur progress appeared. For the rest, I can only plead ignorance, apologize to the "hams" and alter my statement to "almost unknown *outside amateur circles.*" This, I think, is true.

The method of receiving d.s.b. described by Mr. Hawker requires a very selective and stable receiver, and considerable operating skill. It is definitely not the thing for Aunt Jemima. Costas' synchronous receiver, on the other hand, should be easy to tune and, once tuned, the a.f.c. (or, rather, a.p.c.) should keep it tuned. The synchronous d.s.b. receiver, therefore, has possibilities as a broadcast receiver for a.m. signals in general, whether s.s.b., d.s.b.., with carrier, or without it. G. W. SHORT.

Museum Pieces

"FREE GRID" wonders why a wireless museum has not been established and advances a few possible reasons for its non-existence. He omits to mention one important fact, that it would not be in the interests of present-day receiver manufacturers to have such a museum. Why?—read on.

Up until about twenty-two years ago, when the Corporal started getting involved with this country, wireless receivers were steadily improving in every way, and models were available ranging from a simple three-valve "straight" up to superhets containing nine or more valves. Automatic tuning; "magic eyes"; push-button tuning; several wavebands; large speakers and beautiful polished wooden cabinets were the order of the day. Also large detailed glass dials, which were calibrated with a useful degree of accuracy were fitted. Dual-speed tuning was another asset. All the big names in receivers produced such sets and older hands will recall the beautiful range of models produced by leading firms.

Since the war, a generation has grown up which, on the whole, to judge by what it eats, wears, is entertained by and generally appreciates, has no conception of quality. Manufacturers have been quick to seize upon this fact, and on the principle of "any old muck will fill a bin" have in most cases reaped a rich reward.

Wireless has probably been hit harder than most things, with the result that it is almost impossible to find in the average shop anything better than a midget, five-inch speaker, ferrite aerial four-valve plus nothing superhet (does the public think "super" means good or best?). This thing gets about two local stations reasonably clearly and sometimes a succession of regionals accompanied by a loud hiss. No one puts up an aerial today: the sets would be a bag of whistles if they did since screening is almost unknown and all design is cut to the bone. These atrocities cost between about ten to thirty guineas, probably not far removed from the pre-war prices.

We know that greed and national pride have ruined the medium wavebands, but we had "whistles" in the early 'thirties I believe, and if one takes the trouble to put up a useful aerial and earth and knocks up a simple reacting 1-v-1 with decent inductors, one will be amazed how much can be obtained than can be heard on the *standard* superhet.

Had wireless progressed since 1939, we should by now have had a *standard* receiver which, taking into account modern production technique, should retail for about thirty pounds (plus tax) and contain the following features: r.f.; mixer; oscillator; two i.f.s; det.; a.f.; push-pull output; rectifier. A dozen wavebands (nine band-spread); 10-inch speaker; push buttons; a.f.c.; continuously variable selectivity; a *real* dial that means something; bass and treble controls; r.f. gain control as well as the usual controls; full range of sockets for pickup; extended speaker; aerial *and* earth and some form of aerial tuning.

The box would be no bigger than most television sets. Also remember how the manufacturers cried down the r.f. stage on the grounds of putting an extra pound on the price? I don't remember hearing much screaming when the f.m./a.m. set hit the market. We might just as well put the clock back to P. P. Eckersley and his wired wireless; we shall soon reach it if present-day retrogressive progress is a pointer. He must have been able to see into the future!

I recently handled a "communication" receiver which was made by a well-known firm. This set, *in my opinion*, is not as good as some of those pre-war "domestic" receivers mentioned above. From a circuit point of view there was less in it.

Pershore, Worcs. JOHN A. MUNNING.

TV Afloat.—In addition to being able to receive broadcast television programmes regardless of the standards employed (405, 525, or 625 lines), the Marconi installation in the liner Canberra provides for closed-circuit TV for interviews and the relaying of ship's concerts, etc. Initially the vessel, which is on her maiden voyage, is equipped with forty receivers but provision is made for up to 350.

Transistor Measurements

1.—PRACTICE AND THEORY

By C. BAYLEY

MAKING transistor measurements is quite different from measuring the characteristics of any other sort of electronic component. The method of measurement is, in principle, very simple and as we will see, almost elementary measuring arrangements are involved; but the real difficulty arises in defining parameters themselves and in " translating " their implications in circuitry.

In recent years a tremendous amount of theoretical literature on transistors has appeared. Unfortunately there is much less information available on the practical side of this business—speaking more precisely—how to link transistor-characteristic data with the requirements of electronic circuits. This could be result of the fact that there are many interpretations of transistor parameters. There are " four pole " parameters, r parameters, hybrid parameters—and most of these can be expressed differently, depending on the transistor circuit configuration.

In view of this state of affairs it is no wonder that there is confusion among engineers, let alone the unfortunate beginner.

The writer considers that one of the best ways to understand the fundamentals of transistor parameters is to gain practical knowledge of transistor behaviour in circuits in the first instance. Then the meaning of transistor parameters emerges and, in later stages, theoretical deduction is easier to follow as the user should then be able to attach a real, physical meaning to parameters.

In this article the writer hopes that, apart from outlining the basis of transistor measurements, he has made a link between the physical behaviour of the transistor in a circuit and the transistor's theoretical parameters. Although junction transistors are considered, many of the measuring methods are also applicable to point-contact devices.

Transistor as Two Diodes

The transistor, as it replaces in function a thermionic valve, is often compared in its behaviour with the latter. However this can be misleading and a much more logical comparison would be with two diodes (see Fig. 1). From semiconductor construction, the transistor can in fact be considered as two diodes connected in series, back-to-back.

Biasing arrangements become quite clear from such a representation as the input " diode "—which is in fact the emitter circuit—has to conduct and therefore is forward-biased. The collector circuit is biased in the reverse direction and the presence of collector current results from emitter-current multiplication in the junction.

To complete our short analogy, it must be emphasized that the paramount feature of the transistor is that collector current caused by the presence of emitter current is only slightly smaller than the emitter current itself (in point-contact devices it is larger), in spite of the much higher resistance of collector as a " diode ": hence the amplifying property of the transistor junction.

Basic "T" Parameters

It is quite important to realise that, whatever transistor configuration is being used in an electronic circuit, there are only five basic parameters which can characterize the device. Fig. 2(a) shows the well-known T representation of transistor, where resistances r_e r_b and r_c represent emitter, base and collector resistances respectively. The fourth parameter is the current gain, α which, generally speaking, is the ratio of the alternating currents in the collector and emitter arms, assuming that the external load of the collector circuit is several times lower than r_c (r_c is usually high—hundreds of kΩ). It is significant that first three parameters could be expressed without mentioning any particular loading conditions. α, however, as defined as a

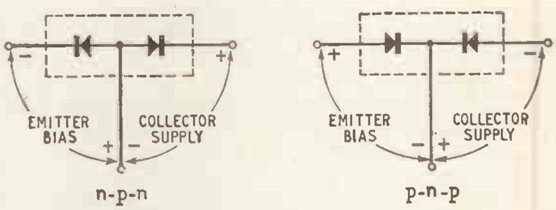


Fig. 1. Twin-diode analogy for (a) n-p-n and (b) p-n-p transistors.

function of currents, cannot be considered without closing both collector and emitter circuits.

As the values of r_e and r_c are very simply related to the input and output resistances of transistor working as an amplifying device, initial biasing conditions for emitter and collector circuits cannot be disregarded. r_b could be defined as the common part of both input and output circuits and thus have smaller significance when the transistor is employed as a l.f. amplifier. So we can see that four parameters, as outlined above, are sufficient to define the characteristics of a transistor, assuming that the frequency is sufficiently low to avoid any departure from d.c. conditions. With a rise of frequency, internal capacitances have shunting effect across r_e and r_c: consequently the value of α is affected.

Therefore the so-called α-cut-off frequency $f_{c\alpha}$ is usually quoted in transistor data and this would be fifth important parameter. The exact definition of $f_{c\alpha}$ is the frequency at which α is lower by 3dB than its value measured at a low frequency, say, 1kc/s.

To remind our reader of the order of typical

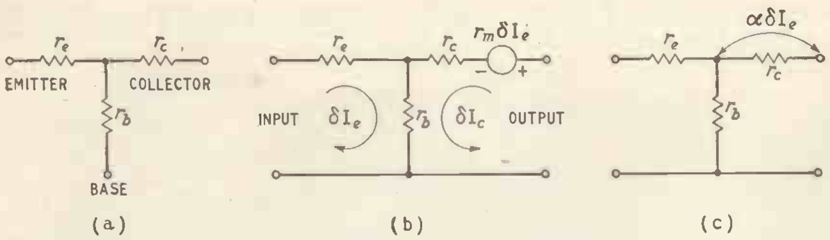


Fig. 2. (a) General "T" network representation of transistor and (b) its form in earthed-base mode where amplified power in the collector circuit is represented by constant - voltage generator $r_m\delta I_e$ or (c) where collector signal is $\alpha\delta I_e$ flowing in r_c.

values of internal resistances, an average r_e would be a few hundred ohms, r_b a few tens of ohms and r_c a few hundred kilohms. α usually ranges between 0.9 and 0.98. In talking about essential transistor parameters, we must mention another useful parameter, α' or β which is the current amplification when the transistor is connected in the common emitter (c.e.) configuration shown in Fig. 3.

In such a configuration, small changes of base current cause much larger variations of collector current and average values for β are from 10 up to 60.

"Four-Pole" Parameters

Fig. 2(c) represents a transistor as an amplifying network. In this case input and output terminals are chosen and the presence of amplified alternating power (caused by emitter a.c.) in the collector circuit is expressed by $\alpha\delta I_e$ flowing through r_c.

Fig. 2(b) gives another interpretation of the amplified power in the collector circuit expressed this time by a constant-voltage generator $r_m\delta I_e$ connected in series with r_c. As we will see in a later section, the value of r_m is helpful in measurements; for the time being it is sufficient to imagine r_m as an internal resistance.

The so-called "four-pole" parameters are values of resistances which can be measured related to the transistor T-network. It must be realized, that direct measurement of r_e r_b r_c is physically impossible because the position of the junction between them is not clear and in any case is not accessible from the outside.

Four-pole representation of the transistor (Fig. 4) is useful as a basis for all transistor measurements. With fixed loads on the input and output of such a network, values of I_1 I_2 v_1 v_2 can be measured by external means. To analyse the relation between these quantities (expressed by d.c. values), it is necessary to fix the value of at least one of them, then the other three would be related by two functions. For instance, having decided that the transistor will be used in the common-base configuration and changing the notations appropriately (e for 1 and c for 2) we may fix the value for v_c as constant and make v_e a function of I_c and I_e as follows:

$$v_e = f_1(I_c I_e) \quad \ldots \quad (1)$$

By making the value for v_e constant, v_c could be expressed as another function of I_c and I_e :—

$$v_c = f_2(I_e I_c) \quad \ldots \quad (2)$$

Each of these functions has two independent variables I_c and I_e. By fixing in turn I_c and I_e it is possible to derive four functions each with one independent variable, namely:

$$v_e = f_1(I_e) \ \ldots \text{ with } v_c \text{ and } I_c \text{ constant} \quad (3)$$
$$v_e = f_2(I_c) \ \ldots \text{ with } v_c \text{ and } I_e \text{ constant} \quad (4)$$
$$v_c = f_3(I_e) \ \ldots \text{ with } v_e \text{ and } I_c \text{ constant} \quad (5)$$
$$v_c = f_4(I_c) \ \ldots \text{ with } v_e \text{ and } I_e \text{ constant} \quad (6)$$

These four equations (3 to 6 inclusive) express four sets of static transistor characteristics.

As we are chiefly interested in establishing relations between r_b r_c r_e and measureable values v_e v_c I_e I_c or their increments δv_e δv_c δI_e δI_c it is not worth analyzing any more similar characteristics.

The two previous expressions (Eqns. 1 and 2) for v_e and v_c could be rewritten as :

$$v_e = r_1(I_e I_c) \quad \ldots \quad (7)$$
$$v_c = r_2(I_e I_c) \quad \ldots \quad (8)$$

where voltages v_e and v_c could be expressed as function of various products of resistances and currents. Assuming that we are operating in small increments of v_e v_c I_b I_c δv_e and δv_c can be expressed by a Taylor series:

$$\delta v_e = \frac{\partial v_e}{\partial I_e}\delta I_e + \frac{\partial v_e}{\partial I_c}\delta I_c + \quad \ldots$$
$$\delta v_c = \frac{\partial v_c}{\partial I_e}\delta I_e + \frac{\partial v_c}{\partial I_c}\delta I_c + \quad \ldots$$

where terms of higher order can be neglected.

As we have just said, $\partial v/\partial I$ will be expressed as particular resistances which are:

$$r_{11} = \frac{\partial v_e}{\partial I_e} \ \ldots \text{ with } I_c \text{ constant} \quad (9)$$
$$r_{12} = \frac{\partial v_e}{\partial I_c} \ \ldots \text{ with } I_e \text{ constant} \quad (10)$$
$$r_{21} = \frac{\partial v_c}{\partial I_e} \ \ldots \text{ with } I_c \text{ constant} \quad (11)$$
$$r_{22} = \frac{\partial v_c}{\partial I_c} \ \ldots \text{ with } I_e \text{ constant} \quad (12)$$

r_{11} and r_{22} correspond with input and output resistances of the transistor; the coefficient r_{12} (from the definition above) represents the change of collector current that would change the emitter voltage whilst keeping current of the latter constant. As amplification is basically forward, that is, from the emitter to the collector, such an effect is in the opposite

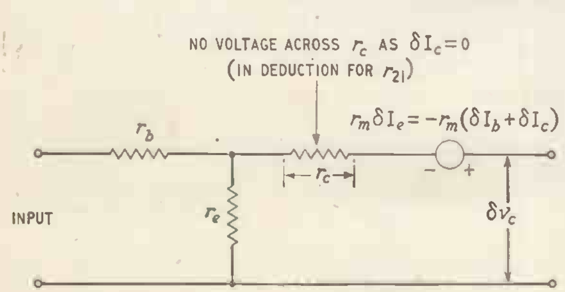


Fig. 3. Common (earthed) emitter connection of transistor represented by T-network parameters. Generator $r_m\delta I_e$ becomes $-r_m(\delta I_b + \delta I_c)$, the change in sign representing the waveform inversion.

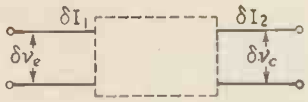


Fig. 4. Four-pole-parameter representation of transistor. Here measurable quantities are labelled generally 1 (input) and 2 (output) and replaced by notation appropriate to mode of connection. For instance, mode: common base, then 1 becomes e and 2 becomes c.

direction to amplification and therefore indicates feedback action. r_{12} is usually called the feedback resistance and has no analogue in thermionic valve techniques.

Parameter r_{21} represents the way in which collector voltage changes with a change in emitter current (collector current constant) and is of great importance. Some analogy with the valve could be made here, as the function r_{21} is similar to the slope of I_a/v_g characteristic, assuming that voltages are replaced by currents and *vice versa*. r_{21} can be regarded as the slope of the transistor forward characteristic.

As far as amplification in the transistor circuit is concerned, r_{12} is in opposition to r_{21} and we will see in the next section that the coefficient r_m representing current multiplication in the collector circuit, is equal to $r_{21} - r_{12}$.

Before deducing relations between r_{11} r_{12} r_{21} r_{22} and r_b r_e r_c r_m we should underline again that :—

(a) All "four-pole" parameters should be defined under strict loading conditions, that is, with emitter or collector currents held constant (open-circuit conditions).

(b) "Four-pole" parameters can be expressed in the common-emitter configuration and will be different from those of the common-base configuration.

Transistor and "Four-Pole" Parameter Relationship

Common-base and common-emitter configurations are often used : therefore the relationships for both cases will be deduced.

Common Base.—Looking again at Fig. 2(c), values for r_{11} can be defined immediately as :

$$r_{11} = r_e + r_b \qquad \ldots \ldots \ldots \ldots (13)$$

The collector leg of the circuit does not affect r_{11} as I_c is assumed to be constant: that is, the collector circuit is open ($I_c = 0$).

In practice open-circuit conditions for the collector circuit are realized by the insertion of large resistor and the use of a fairly high voltage battery as a supply (to obtain initial collector current).

A similar relation can be deduced for r_{22}

$$r_{22} = r_c + r_b \qquad \ldots \ldots \ldots \ldots (14)$$

The situation here is reversed with the emitter circuit open: r_e is not included in the r_{22} value.

The expression for r_{12} can be deduced as :

$$r_{12} = r_b \qquad \ldots \ldots \ldots \ldots \ldots (15)$$

from the following analysis:

r_{12} is defined as the ratio of small increments of emitter voltage δv_e to the collector current δI_c assuming that the current of the former is constant (see Fig. 5(a)). This last condition implies that there is no voltage increment across r_e and the full voltage v_e appears across r_b. As only current δI_c is flowing through r_b:—

$$r_b = \frac{\delta v_e}{\delta I_c} = r_{12}$$

The relation between r_{21} and transistor parameters can be established in the following manner : (see Fig. 5(b)).

From the original definition r_{21} is equal to the ratio of increments of collector voltage and emitter current, assuming that collector current does not change (Eqn. 11). Therefore the voltage increment across r_c should be equal to zero and the following voltages would appear in the collector circuit :

across C-D — $\delta I_e r_b$
across A-B — voltage generator $r_m \delta I_e$
across B-C — increment δv_c

The generator $r_m \delta I_e$ which is the source of e.m.f. in the collector circuit, is easier to express physically by a current generator $\alpha \delta I_e$ connected across r_c (Fig. 2(c)): that is, a generator of current $\alpha \delta I_e$ having internal resistance r_c. But for the writing of Kirchhoff equations for the collector circuit voltages have to be used and therefore it is necessary to introduce symbol r_m. From these equations the p.d. between A-B ($r_m \delta I_e$) should be equal to the sum of the voltage drops B-E and B-D :—

$$r_m \delta I_e = \delta v_c + (-\delta I_e r_b) = \delta v_c - \delta I_e r_b$$

It should be noted that δI_e has a minus sign as $r_m \delta I_e$ has the opposite sign to the voltage drop $\delta I_e r_b$.

From the last equation the value of $\delta v_c / \delta I_e$ can be easily defined as:—

$$\frac{\delta v_c}{\delta I_e} = r_m + r_b = r_{21} \qquad \ldots \ldots \ldots (16)$$

From the four relations deduced above (Eqns. 13-16 inclusive) transistor parameters can be easily calculated as :

$$r_e = r_{11} - r_{12} \qquad \ldots \ldots \ldots \ldots (17)$$
$$r_b = r_{12} \qquad \ldots \ldots \ldots \ldots \ldots (18)$$
$$r_c = r_{22} - r_{12} \qquad \ldots \ldots \ldots \ldots (19)$$
$$r_m = r_{21} - r_{12} \qquad \ldots \ldots \ldots \ldots (20)$$

Common-emitter Mode.—Returning to Fig. 3 it should be noticed that the input impedance r_{11} will be expressed by the same formula as in common-base configuration :—

$$r_{11} = r_b + r_e \qquad \ldots \ldots (13) \text{ (repeated)}$$

as the open collector circuit does not contribute to any voltage increment across r_e. However the relation for r_{22} will be different from that of the common-base configuration.

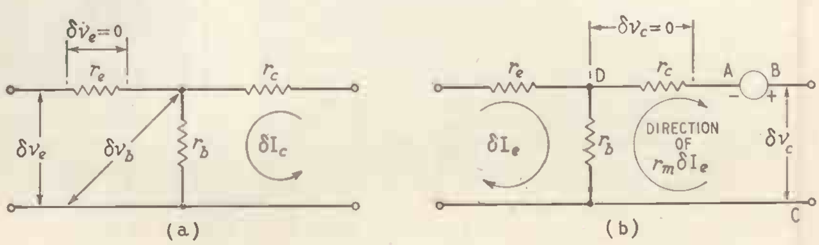


Fig. 5. Deduction of relationship of transistor to four-pole parameters. (a) With emitter current constant there is no increment of emitter voltage across r_e. (b) With collector current constant no increment of collector voltage can appear across r_e.

Irrespective of configuration, the e.m.f. in collector circuit is equal to $r_m\delta I_e$.

Comparison of the expressions for r_{22} in the common-base set up with that for common-emitter mode (that is, Eqn. 12).

$$r_{22} = \frac{\delta v_c}{\delta I_e} \text{ where } \delta I_b = 0 \quad \ldots \quad (21)$$

shows that the former has the condition of I_e constant (increment $\delta I_e = 0$) instead of the condition for common-emitter, which is $\delta I_b = 0$.

Therefore the term $r_m\delta I_e$ cannot be disregarded when measuring the impedance r_{22}. Consider

$$r_m\delta I_e = -r_m(\delta I_c + \delta I_b)$$
$$= -r_m\delta I_c - r_m\delta I_b$$

(compare with the deduction for r_{21} in the common base configuration, Eqn. 11), $-r_m\delta I_b$ would disappear leaving only $r_c - r_m$ in the collector circuit.

Therefore the total output resistance in the common-emitter configuration will be:

$$r_{22} = r_e + r_c - r_m \quad \ldots \quad (22)$$

Making a similar deduction to that for r_{12} in the common-base case:

$$r_{12} = r_e \quad \ldots \quad (23)$$

Finally, the forward resistance r_{21} can be deduced the same way as in the common-base state by replacing the e.m.f. $r_m\delta I_e$ by $r_m(\delta I_b + \delta I_c)$. Then the Kirchhoff equation will be:

$$\text{e.m.f.} = -r_m(\delta I_b + \delta I_c) = \delta v_c + (-\delta I_b r_e) + r_c\delta I_c$$

As $\delta I_c = 0$

$$-r_m\delta I_b = \delta v_c - \delta I_b r_e$$

$$\frac{\delta v_c}{\delta I_b} = r_{21} = r_e - r_m \quad \ldots \quad (24)$$

(See Fig. 3).

From the above four relationships for the common-emitter case, the transistor parameters can be calculated as:

$$r_b = r_{11} - r_{12} \quad \ldots \quad (25)$$
$$r_e = r_{12} \quad \ldots \quad (26)$$
$$r_c = r_{22} - r_{21} \quad \ldots \quad (27)$$
$$r_m = r_{21} - r_{12} \quad \ldots \quad (28)$$

Next month we shall start by considering conductance and hybrid-parameter terms with their relation to basic parameters and deal with some of the ways in which measurements can be made.

(To be concluded).

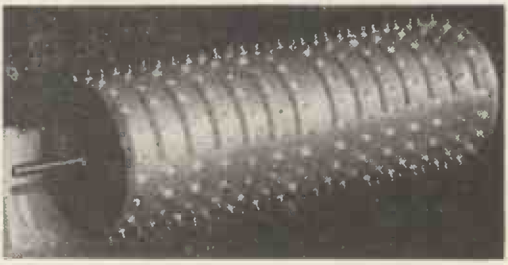
Communications Satellites

AN INTERNATIONAL symposium on communications satellites was held in London on May 12th by the British Interplanetary Society. It is to the credit of the Society that it, rather than other organizations more usually associated with telecommunications, should be the first to present here, in London, such a variety of authors from both sides of the Atlantic, on this most important of subjects. It has of course the example of its past chairman A. C. Clarke, whose article on "Extra Terrestial Relays" appeared in *Wireless World* 16 years ago and whose suggestion of 24-hour or synchronous communications satellites was so much a point of discussion at this symposium. Inevitably one thought back to the time when scatter propagation was novel and when at meetings and symposia, speakers from this country had, in presenting their papers, little or no practical experience to draw on. The same handicap applied at this meeting. Whereas speakers from the United States could refer to the results of experiments with projects Echo and Courier, those from the U.K. could only talk in hope, for whether this country or the Commonwealth ever produces the rocket capability to initiate a system of its own has yet to be decided. Enthusiasm, however, was the keynote and it was interesting that the only hint of caution came from J. R. Pierce, of Bell Telephone Laboratories, the speaker with perhaps the most practical experience.

The papers were catholic in content. The first from G. K. C. Pardoe, of the de Havilland Aircraft Company, considered what might be called the logistics of putting a communications satellite in orbit whereas the second, by E. K. Sandeman, of English Electric Aviation, dealt more with the radio aspect, channel arrangements, modulation systems and power requirements. With all speakers in favour of active rather than passive satellites interest tended to centre on whether a communications system should be the low-level type calling for 30 or more satellites for global communication or of the 24-hour "stationary" type where only three would be required. The latter has obvious problems in altitude and attitude stabilization but there is also the question of the tolerability of the unavoidable time delay. A demonstration telephone circuit, incorporating the delay (0.28 secs) enabled participants to judge the effect for themselves, many appeared agreeably surprised. Speakers favouring the synchronous system included R. P. Havilland of the General Electric Company of America, E. K. Sandeman and H. R. L. Lamont who read a paper by E. A. Laport of the R.C.A. J. R. Pierce on the other hand preferred to make the first step the low-level system. W. F. Hilton, of Hawker Siddeley Aviation, emphasized the aspect of Commonwealth communications and concluded that a minimum of eight active satellites in six-hour elliptical orbits would suffice and that if the go ahead were given now such a system could be in service before the completion of the Commonwealth telephone cable in 1967. He thought the latter might then be uneconomic but J. R. Pierce was of the opinion that the two forms of communication would be complementary.

Further papers were presented by G. E. Mueller, of Space Technology Laboratories Inc., and by Lt. Col. J. T. Newman, of the U.S. Army, who read a paper on the Courier satellite by G. F. Senn and P. W. Siglin, of the U.S. Army Signal Research and Development Lab. A lively discussion followed both the morning and afternoon sessions.

Multi-gang Potentiometer



This 14-gang potentiometer with no fewer than 294 tapping points, was made for computer use; each of the fourteen sections has 21 tapping points, each welded to a selected turn on the winding. The operating torque necessary is only 2oz-in. (General Controls Ltd., Bowlers Croft, Honywood Road, Basildon, Essex).

The H.F. Band: Is a New Look Required?

POSSIBLE TECHNIQUES FOR FURTHER REDUCING INTERFERENCE

By R. J. HITCHCOCK,* M.A., A.M.I.E.E. and P. A. C. MORRIS,* B.Sc., A.M.I.E.E.

IN 1948, as a result of the radio conference held in Atlantic City the previous year, there was set up in Geneva two bodies—the International Frequency Registration Board (I.F.R.B.) as a permanent technical executive and the Provisional Frequency Board (P.F.B.) whose particular task it was to plan, on a logical basis, actual frequency assignments for all the fixed and mobile services in the h.f. band between 4 and 27.5 Mc/s. Although the P.F.B. worked conscientiously for two years, so far as the fixed services were concerned the attempt failed because, even when the most severe theoretical sharing conditions were applied, the requirements greatly exceeded the available spectrum space.

Since those days, however, the situation has worsened, for the decisions of the Atlantic City Conference to reduce the bandwidth allocated to the fixed services in this part of the spectrum by 678 kc/s (5% of the whole) have been implemented, and the frequency requirements, as indicated by the International Frequency List, have roughly doubled. The difficulties in obtaining frequency allocations for new or extended services and the possibility of such allocations adding to the general level of interference are well illustrated by the typical spectrum scan in Fig. 1. This shows the "frequency occupancy" at a particular receiving station for that portion of the fixed service band between 7.3 and 8 Mc/s.

As an example of the interference problems in the fixed service bands an analysis of four important transmitting stations, all well separated geographically, showed that out of a total of 142 allocations, 18, or 13%, were unusable or seriously affected by persistent interference and a further 69, or 49%, were of reduced value because of occasional interference. This analysis was made before the onset of the approaching sunspot minimum when a reduction in the reflecting properties of the ionosphere at higher frequencies will still further increase the congestion in the lower part of the h.f. band. Thus, while a decade ago it was agreed that the h.f. band was congested and in need of treatment, it is now generally agreed that today it is saturated and the necessity for such treatment has become a matter of urgency.

At the Administrative Radio Conference of the I.T.U. held in Geneva in 1959 a resolution was adopted which all users of the h.f. portion of the

* Cable & Wireless Ltd.

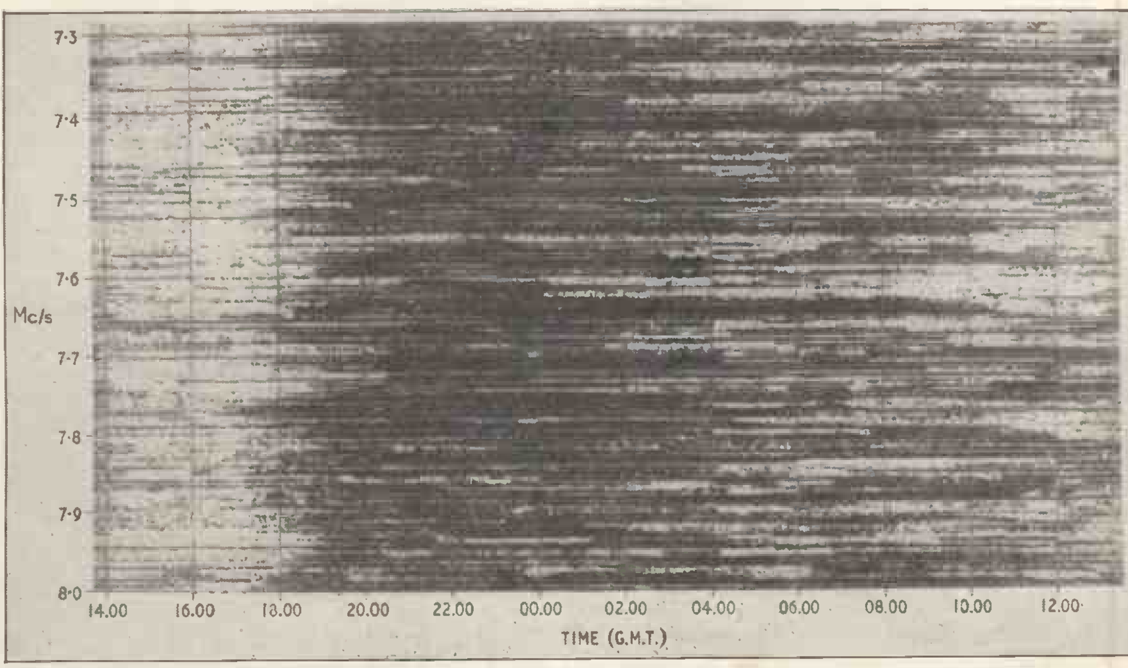


Fig. 1. Occupancy of a section of the h.f. band as recorded at a receiving station over a period of 24 hours.

radio spectrum must have welcomed. It read in part: "The Conference, considering the trend towards congestion and saturation in the bands between 4 and 27.5 Mc/s; realising that if this trend continues this portion of the radio frequency spectrum will become progressively less useful to administrations for purposes for which it is indispensable; . . . resolves that a Panel of Experts should be convened for the purpose of devising ways and means of relieving the pressure on the bands between 4 and 27.5 Mc/s." Thus the Conference voiced the deep concern of many radio engineers at the rapid increase in usage of this section of the spectrum, particularly at a time when decreasing sunspot activity is reducing the overall available bandwidth.

Although the panel of experts* is not due to meet until the autumn of this year preliminary investigations into frequency usage and habits are being made by the I.F.R.B. These preliminary investigations suggest that the panel may well be inclined to follow traditional and somewhat obvious lines in their approach to the problems confronting them. It would be a great pity if the opportunities that this study affords were to be wasted by adhering too closely to the conventional and to the expected. For example there are strong indications that administrations and operating organizations will be exhorted to follow certain lines, most if not all of which are no more than good engineering practice and good common sense and which in nearly every case *are already being followed.*

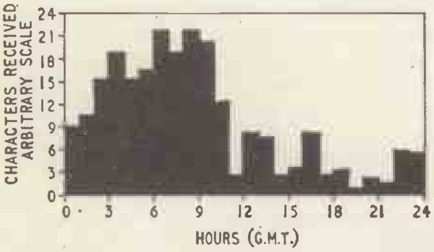


Fig. 2. Traffic utilization of a Singapore-Aden-London circuit.

It does not take an expert to realize that the most obvious way of reducing congestion is to thin out the requirements and, if the capital resources are available, to replace h.f. systems by other services using either a less crowded part of the radio spectrum or a different communications technique. An approach such as this must be in the mind of almost every user of the h.f. band and there can be few forward looking administrations or organizations who are not constantly increasing their v.h.f. systems at the expense of their h.f. systems, converting their radio-telephony circuits from d.s.b. to s.s.b. and in the broadcasting field changing their national short-range h.f. services to v.h.f. Thus any policy based on these and similar lines of thought is doing little more than running alongside the normal movement of events.

All communications engineers appreciate that one day, repeatered cables, satellite systems and waveguides will carry vast quantities of the world's communications traffic but experience suggests that h.f. services will be required for many years to come and it is difficult at this moment to see any immediate relief occurring in these bands unless more fundamental ideas are introduced.

* The U.K. representative will be C. W. Sowton of the G.P.O.—Ed.

Understanding the H.F. Medium

Since the ionosphere is dependent upon solar radiation its properties follow a strong diurnal cycle and so it is not by any means an ideal medium for 24-hour communications.

When a radio path is entirely in daylight or entirely in darkness it is possible with a suitable choice of radiated frequency to operate a long-distance circuit with modest transmitted power. However at the transition between day and night, and particularly when one terminal is in daylight and the other not, the available range of frequencies that can be propagated over the route becomes very narrow. Ideally at this time the radiated frequency should be continuously changing because the ionospheric parameters are rapidly varying. In practice circuits are operated during transition times with far too few frequency changes: this is for two main reasons:—

(i) The difficulty in co-ordinating the change at both ends of the circuit and

(ii) Insufficient knowledge of the optimum frequency to use at any instant.

The second of these reasons will be discussed later.

Now the diurnal peak of demand for telephone and telegraph facilities is centred upon local business hours: this is very fortunate because it fits in with daylight hours during which ionization is strongest. So, for communication between places with the same local time, i.e. north-south routes, the ionosphere as a medium is well suited to carry high-capacity traffic during business hours and, perhaps, a low capacity service during the remainder of the 24 hours.

However, as far as the United Kingdom is concerned this only facilitates communication with West Africa and the Arctic Ocean: the vast majority of trunk circuits connect places with a local time difference exceeding two hours. The result, for these circuits is, first that the transition between steady day- and night-time conditions is lengthened and, secondly, that the heavy traffic demands extends into these transition periods. Fig. 2 shows the utilization of the Aden relay of a Singapore-London channel on a typical day: the peak corresponds to midday in Singapore but to the pre-dawn ionization dip at London.

This is an unfortunate fact which must be taken into account by traffic planners. There is no easy solution but it is worth mentioning that one approach is to send the traffic the other way around the world at this time; another which can apply to certain types of traffic is to store messages until each terminal is in daylight—and, incidentally, until the customers at *both* ends are awake.

The former solution is one that only a unified world-wide communications system can organize: from this point of view and also with regard to the usage of frequencies the fragmentation of international systems as new nations emerge is unfortunate.

In order to operate circuits under these transition conditions it has become necessary to provide ever higher transmitter powers. This, of course, is waste-

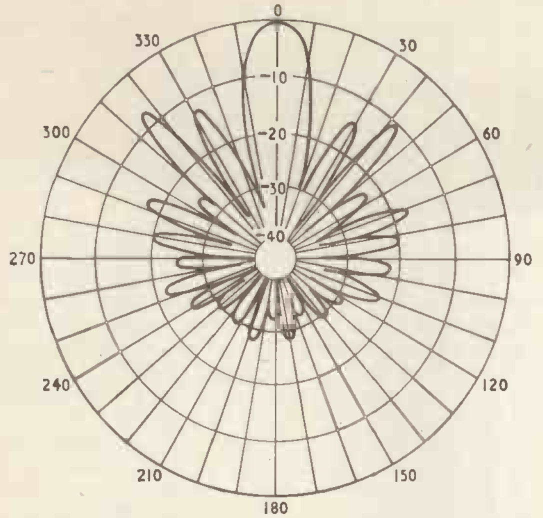


Fig. 3. Measured directivity characteristics of rhombic aerial. (From P.O.E.E.J., July 1958)

ful in itself since the required field strength at the receiver alters little and the extra energy may escape through the ionosphere or merely illuminate unwanted areas. But, much more important, the range at which other stations suffer harmful interference is thereby greater than it need be.

With the rhombic aerials commonly in use there are many side lobes which are no more than 15 to 25 dB below the main lobe (see Fig. 3). Consequently if the field strength at the receiver towards which the transmission is aimed is, say, 20-30 dB higher than necessary then the side lobes must be strong enough to cause interference at a similar range in almost any direction.

To some extent this emphasizes a basic handicap of operating at frequencies in the h.f. band. Since the wavelength is relatively so large it is impossible to produce really narrow beamwidths; although if it were it might well add to the difficulty of frequency selection.

The Power Requirement

It is a common practice for receiving station watch-keepers to insert substantial attenuation into their receiver aerial circuits during certain hours of the day. Every 6 dB of attenuation implies a 6 dB surplus of transmitter power at that time and this in turn implies that the radius exposed to interference is up to twice as great as it need be.

The planning engineer can get a very good idea of the effective radiated power required for a given circuit provided he confines his attention to the steady day or night conditions.

For an example the power required under these steady conditions for a simple telegraph channel between Nairobi and London is shown by the full line in Fig. 4. The very low power will be noted. Now if it were possible to calculate the transmission loss at the transition times the diurnal distribution of required power would appear something like the dotted line and the maximum power then has some relation to the actual powers used. In general one might suggest, therefore, that the full e.r.p. of a transmission is needed only for about one-third of the 24 hours.

So the excess power problem is very serious and it is proposed that consideration should be given to several lines of approach.

Suggested Approaches

The first is concerned with more thorough engineering control of circuit operation hours, so that whenever possible commitments are not undertaken for unfavourable times of day.

It is now common practice on teleprinter circuits to use automatic error correction (ARQ). This operates in the following way: when a received error is detected a request for repetition is automatically transmitted over the circuit to the sending end so that if one path has faded out the other path continuously repeats a group of characters until contact is restored. This is known as "cycling." Thus, on a system of this type it is necessary for the whole circuit—both the "go" and "return" directions—to be operating in order to pass traffic either way. So when conditions are only good enough for a marginal link in one direction it would not be able to clear any traffic when error-correction is in use. In practice there are times when circuits are nominally open but when the chances of both directions being open simultaneously are rather remote. Under these conditions it is often true that no increase in e.r.p., however great, can possibly maintain contact. *Everyone would gain and no one would lose if this was appreciated and the circuit was closed.*

The second approach to the problem would be to develop a system of automatic transmitter power control. The ARQ system, already mentioned, automatically controls the rate at which error-free characters are received: extending this principle one can visualize a "surplus signal/noise ratio detector" at the receiver sending impulses back over the circuit to control the transmitter power.

There might be, say, six power levels, spaced at 3-dB steps. Such a system has been worked out for application to tropospheric scatter circuits.[1]

Automatic control must surely have a beneficial

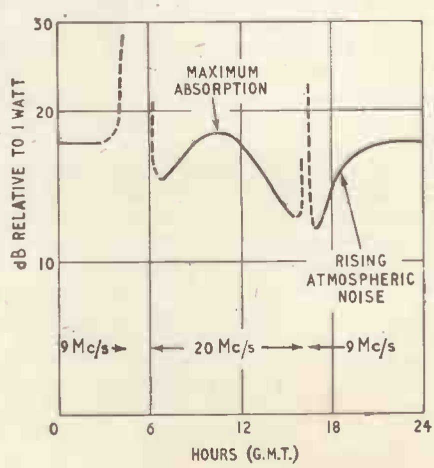


Fig. 4 Power required for 50-band telegraph channel between Nairobi and London during sunspot minimum period.

effect on the general level of interference if adopted widely; although it must cause some slight increase in "cycling" of ARQ systems under such circumstances as sudden bursts of atmospheric noise or "crashes." The development of world-wide telex would have been impossible without the benefit of ARQ, and we are approaching the time when, for further expansion, the inherent advantage of *feeding back control information* will have to be exploited to the full by operating on more rational margins.

The next approach to the conservation of spectrum space is to hasten the application of various ionospheric sounding techniques in order to reduce the proportion of total transmitting time during which incorrect frequency usage prevents the lowest-loss propagation mode being used. Such techniques will also discourage some operators from using several simultaneous transmissions to ensure reception.

At present, receiving station watch-keepers have only "long-range" monthly median predictions and their own experience to guide their hour-to-hour selection of frequencies. But by transmitting pulses at oblique incidence—i.e., directed in the same manner as the normal transmission—it is possible to examine the path and to measure the optimum frequency. The pulses may either be received by ground back-scatter at the transmitting end of the path or in the normal way at the receiving end.

The former method has the disadvantages of needing skilled interpretation of the echoes and also the difficulty of telling what strength of echo corresponds to a useful signal at the receiver but the sounding can be initiated and used by the watch-keeper without the need for the co-operation of any distant operator.

The Sweep-Frequency Technique

The alternative method in which the receiving watch-keeper observes a pulse transmission from the distant terminal may be superior, particularly if the sweep-frequency technique is used. In this system a transmitter and receiver, though separated by thousands of miles may be tuned rapidly from one frequency to another, and with accurate synchronization the time interval on each "spot" frequency may be a fraction of a second. The transmitters and receivers are rapidly step tuned with increments of the order of 100 kc/s to several hundred frequencies throughout the h.f. band and synchronization is achieved by reference to crystal clocks.

A sweep might be provided at, say, half-hour intervals during transition periods: those frequencies which are suitable for the instantaneous path conditions would be clearly indicated.

The sweep-frequency technique has been in use by research establishments for some years, e.g., by Kift of Radio Research Station, D.S.I.R.[2], on the path between Ascension Island and Slough. Suitable equipment is now available for the sweep-frequency technique: the pulse length used by one manufacturer is 10μsec and the p.r.f. 10 per second.

The harmful effect of sweep-frequency pulse transmissions upon other services appears to be a subject worthy of careful study. Even if it were in general use one would not expect to find objectionable interference to speech or music reception and the effect of such a short pulse length upon high-speed telegraphy, particularly with automatic error correction, may be tolerable. It is suggested that any harmful effects would be more than offset by the possible saving in redundant transmissions.

What is a Radio Frequency?

Finally, following the philosophy of Costas[3], the question arises, have we gone awry by our concept of *a* radio frequency? Emphasis has always been directed towards reducing the tolerances of transmitters so as to reduce the effects of mutual interference. However, instead of relying on accurate frequency division to discriminate against unwanted signals it is equally possible and it may well be more economical to use the dimension of time. No radio circuit is carrying information at every moment and all could tolerate a "controlled" amount of interference particularly when error correcting techniques are in use. By rigidly fixing tens of thousands of transmissions on individual and discrete frequencies we achieve neither an equitable distribution of interference nor any assurance as to how much any particular transmission will be interfered with, either in terms of time or severity. It would seem preferable, therefore, to accept a "controlled," randomly distributed amount of interference rather than an intolerable continuous interference to certain unfortunate operators.

A communications system can thus be visualized based on the sweep-frequency technique mentioned earlier. The step-tuning might be continuous such as that operated in France on a u.h.f. tropospheric scatter system[4] in which the transmitter and receiver are rapidly tuned across a band 500Mc/s wide ten times per second in synchronism with a long-wave-broadcast transmission. Whether an h.f. system should have step transmissions or continual sweeps need not be discussed here, but whichever were used it is envisaged that the frequency coverage would range across the usable band as dictated by propagation considerations. The frequency range could be obtained from either circuit predictions or more likely from trial sweeps at certain specified intervals of time. The final concept is one in which all-important transmissions in the h.f. bands will be ceaselessly sweeping across their individual optimum propagation spectra thereby ensuring that interference is equitably distributed amongst all users and that the maximum continuity of service is achieved.

Whilst in recent years vast improvements have been made in the performance of h.f. radio equipment, too little effort has been devoted to ways and means of conserving spectrum space. The need for international co-operation, however difficult to achieve, is inherently imperative and it is to be hoped that the I.T.U. Panel of Experts will be able to lead the way towards stabilizing the dissipation of one of the world's resources.

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[1] Axelby and Osborn, *I.R.E. Trans. on Communication Systems*, March 1960.

[2] *Wireless World*, May 1959, p. 234.

[3] Costas, *Proc. I.R.E.*, December 1959.

[4] Landauer, *I.R.E. Trans. on Antennas & Propagation*, July 1960.

CAR RADIO

By H. HOLT

—Yesterday, Today and Tomorrow

CAR radio designers are agreed in regarding 1961 as a year of great changes; it is, perhaps, not surprising that though they are reasonably in accord as to the main trend, they are at variance on detail developments. It is, of course, commercially important to be first in the field with new developments and techniques if that can be managed, but it is even more important to submit the right answer to the problem at first go, rather than be compelled to make major changes during a production run, which can be costly both in expenditure and in reputation.

Valves and Transistors

The background against which this intriguing scene is set is simple enough. After years of all-valve radio, for which the nominal 6 or 12 volts of the car's electrical system had to be turned by vibrator into a.c., stepped up in voltage and then rectified to d.c. again, came what is universally referred to as the hybrid set. This combines the advantages of valves which are capable of giving adequate radio-frequency performance on the nominal 12 volts of a car's battery, with the power transistor which handles only the audio-frequencies of the output stage, and is amply satisfied with that comparatively low voltage. This combination ensured the success of the Pye TCR 1000, first hybrid receiver on the market, introduced at the Earls Court Motor Show of autumn 1957, quickly to be followed by similar products of other manufacturers.

These, dispensing with the noisy and rather vulnerable h.t. vibrator, also brought the drain on the battery down to around 1.3 amps—less than half of what had been required by comparable all-valve sets. That is an important consideration in cars in which steadily and substantially increasing demands on the battery and generator have coincided with progressive decreases in the capacity of the battery installed. It is true that greater sophistication of the generator control system helps to improve input to the battery, but only so long as the engine is turning the generator fast enough to give the necessary output. Traffic density nowadays, however, can be such that, in town, the periods during which the battery is receiving a charge may be inadequate to balance the deficit which accumulates during the remainder of a journey. In cold, foggy weather the trouble is accentuated.

In addition to receivers with the single 2- or 3-watt transistor power stage, there are on the market output units offered as alternative equipment with a transistor driving two power transistors in push-pull, to give as much as 8 watts output to two or even more loudspeakers, yet requiring a surprisingly low current compared with the 5 or 6 amps of a comparable all-valve set.

Next stage, then, is the logical one—to use transistors, now available at an economic price, in the radio-frequency stages as a complete replacement for valves. In recent months all the major manufacturers have been testing prototype all-transistor receivers which are intended to give fully satisfactory performance both when operating in a moving car and when used as a personal portable at home or in an hotel, energized in the portable role by internal batteries. It is in this direction that in addition to meeting the rapidly developing demand for car radio, they hope to tap a potentially great new market.

Here is to be found one of the major divergences of opinion. One avenue of approach is to start with a good portable, and then modify it until it will give adequate service as a car radio; another is to design the car radio, and then arrange convenient detachment of as much of this receiver as will give satisfaction as a portable. Since the car radio application involves much more difficult conditions than are experienced in normal domestic use, it would seem logical to meet this requirement first, ensuring adequate quality, range, selectivity and freedom from fade and interference, at the same time satisfying amply the less demanding specification. However, both avenues of development are being thoroughly explored, and it may be that major success will go to the one which is first in the field with a satisfactory receiver, regardless of the technicalities. After all, few of the listening public are concerned about how the results are achieved, so long as the end product gives them what they are asking for.

Limitations of Portables

In the past two years there has been great increase in the use of domestic portables in cars. Some users have declared themselves to be quite satisfied; others, their appetite whetted but not satisfied, have then gone out and bought a conventional car radio receiver.

It is not surprising that the very good quality and performance of the transistor superhet portable at home has led many to expect equally good reception in a moving car, but usually with disappointing results unless the listener is prepared to accept lower standards.

One major snag is that the portable relies on a ferrite rod for aerial input, and because this has directional characteristics, signal strength varies considerably as the car's attitude in relation to the transmitter changes. There is serious fading, and automatic gain control to minimize this variation is not nearly so effective as in the conventional car-radio receiver.

A related difficulty is that within the steel shell of a car body the aerial is screened to some extent from the incoming signals unless the set is placed near a large area of glass—on a rear parcels shelf, for example, where it has the additional advantage of being as far as possible from the "power station" under the bonnet.

One way of overcoming these troubles is to inject signals from the normal type of exterior car aerial, and many portables now have a socket to accept the plug connector of such an aerial. This does not usually increase signal strength but it helps to keep it at a reasonably steady level.

The limited amount of sound available from a portable gives rise to another snag. In order to provide reasonable life from internal dry batteries, maximum output is kept down to around 0.3 watt, which is adequate for most domestic use, but not within a moving car, especially in traffic. One turns up the volume control to full in an effort to overcome the ambient noise—and the receiver, operating at a level where its distortion is also at maximum, loses much of its quality, while a small loudspeaker may itself be overloaded to the point of distortion. One can arrange, when such a receiver is used in a car, to drive it from the car battery, and also to feed an additional, larger loudspeaker. But so soon as the set uses power from the car's battery, says the G.P.O., it becomes necessary for it to have its own £1 radio licence just like the conventional car radio—and a surprisingly high level of sales resistance is then encountered.

Finally, portables are much more susceptible to ignition interference than is the conventional car radio which, after all, is designed specifically for its very exacting job, and the car electrical system must be fully suppressed if background noise is to be kept low.

Domestic portables as such, then, are not a fully satisfactory answer, except for occasional use by those who are not too finicky about quality of reproduction.

Car radio as we know it today is quite a remarkable achievement, for the car manufacturer normally provides a mere 7in by 2in facia space for the escutcheon and controls; most radio designers cope with this satisfactorily, and if fore-and-aft space is limited, they arrange the output stage as a separate unit which can be placed remotely from the tuner.

Loudspeaker Problems

But the loudspeaker is a more difficult proposition; in the present stage of sound reproduction, loudspeakers are like boxers—a good, big 'un will always beat a good, little 'un. Some manufacturers provide a grille in the facia, behind which a small elliptical speaker can be mounted, but no one plans accommodation for, say, a good 8in circular speaker. It is a happy stroke of fortune that current styling can provide reasonable space and environment for a large loudspeaker, notably in the large rear parcels shelf—yet singularly few manufacturers incorporate a suitable hole in the metal, which has to be trepanned. However, this provision is now taken so much for granted that when a radical styling change—as in the new Ford cars—sweeps away the rear shelf, accommodation of a loudspeaker again becomes as tricky a problem as it is in the cramped cockpit of a sports car.

In these circumstances the fitter is often driven to make use of space between inner lining and outer shell, perhaps beside the passenger's legs, but this usually directs the sound straight at a heavily carpeted gear box hump, which can affect the reproduction markedly.

In the experimental laboratories all kinds of expedients are being tried to find a more convenient replacement for the permanent magnet loudspeaker, but the ubiquitous elliptical speaker is very firmly entrenched—usually, for convenience, with its longer axis horizontal, though the purist would prefer it vertical. One ingenious idea is to modulate the incoming air stream of the ventilation system which most cars have nowadays, at some point in its ducting, so dispensing with the loudspeaker altogether—an ideal solution if it can be made efficient and not too expensive.

The Aerial

Much research is going on also into the possibility of dispensing with the conventional whip aerial, which is applied to a car as an afterthought—and from the styling point of view often looks like it! It is vulnerable to the curiosity of people who wonder how far it can be bent over, and it is apt to deteriorate in appearance and performance after a time in its very exposed position. Ferrite rod or block is a strong contender for the succession, but its directional effects are a disadvantage not yet overcome in production, though one hears of successful laboratory experiments. Fancy shapes are probably not the solution, for when they depart from the straight and narrow they impose new difficulties in winding the necessary coils upon them. The target is to devise an arrangement of ferrite material which is at least as efficient as the conventional whip aerial, costs no more, and can be built invisibly into the trim of the car, probably at the manufacturing stage. We have not yet arrived at the point where radio is as usual a fitting in a family car as a heater is at present, but the rapid increase in its use, as evidenced by official returns of car radio licences in force, shows the trend. Probably more than one in ten of cars on British roads today has radio, and the proportion is rising faster than the increase in motor vehicles. Car manufacturers are taking a greater interest in radio—two of our largest themselves market sets for accessory fitting—and the time is not far ahead when the aerial at least will be built in much as demisting ducts are now.

Unless there is a technical breakthrough which permits the current type of loudspeaker to be superseded—and this does not seem likely in the near future—the next stage will be when car designers include adequate provision at the manufacturing stage for a good, big loudspeaker.

British car radio receivers at present are of two basic types. The cheaper, manual tuning models, costing around £20 or so, cover medium and long waves, have a single output transistor mounted in a heat sink on the back of the receiver, giving up to three watts to an elliptical loudspeaker, and fed from a 3- or 4-valve superhet radio-frequency circuit. They vary in detail—some have smoother tuning than others, some pull in more long-range transmissions (and more interference), but there are very few poor ones in such a keenly competitive field, and most reach a very high standard.

Next refinement, coming into the £25 and upwards range, is the provision of press-button tuning, giving immediate selection of one long-wave and four medium-wave channels in addition to manual tuning; experience is that press buttons usually supply up to 99 per cent of one's listening. With this amenity may go tone control, variable intensity of panel lighting, and so on, and most manufacturers go on to offer choice of normal or high-power amplifying stages (up to 8 watts), and multiple loudspeaker installations with balancing controls.

No English manufacturer at present offers the American and Continental type of "self-seeker" tuning in which, after selecting a sensitivity level for, say, town or country, the receiver itself at the touch of a button tunes in turn all broadcasts reaching the preset level, automatically and accurately. Such a device puts up the price by £40 or more, and since the gamut of British broadcasting for most of us is covered by just three programmes—Light, Home and Third—we do not need such elaboration. Three medium-wave press buttons give us these, the fourth gives us one Continental (usually Luxembourg), and the Light Programme is available on 1500 metres in areas where the medium-wave transmissions are unsatisfactory.

Much greater interest is taken these days in quality, under the stimulus of good sound reproduction heard at home on the B.B.C.'s v.h.f./f.m. broadcasts. Indeed, one manufacturer is now producing a special "hi-fi" amplifier of 6 watts output, with matched high-quality 8in loudspeaker, which gives fidelity of reproduction comparable with that enjoyed in many good domestic installations.

There is no v.h.f.-tuning car receiver at present available from British manufacturers; one was offered some time ago, but was withdrawn. The difficulty is primarily one of suppression. One can spend a great deal to achieve near aircraft standards of screening to ensure satisfactory listening in one's own car, only to have the whole thing ruined by neighbouring cars in the first traffic jam. It may enjoy a resurgence, but that seems unlikely in the face of the quality now available from our conventional a.m. receivers. After all, those who wish to enjoy the highest achievable standards of reproduction are likely to want it in quiet domestic surroundings where they can devote full attention to it, rather than among the distractions and din of our crowded roads.

Road-speed Volume Control?

With good press-button tuning, then, one can drive all day with merely an instant's finger pressure to bring about a change of programme when required—except for the volume control. For anyone who must fiddle about with something or other, the volume control gives complete release, but since so many prefer to concentrate their energy on their driving, it seems odd that we have yet to see automatic control of volume as well as r.f. gain. In a small degree there is automatic audio volume control already, due to increased volts on the output stage, up to the point where the dynamo reaches its maximum voltage, but that usually occurs at less than 30 m.p.h. road speed, and the rise in audio output ceases at the point at which it would begin to have real value.

It need not be an elaborate affair, compensating for such onslaughts as a sudden change of gear of a neighbouring, noisy lorry—indeed, the combination might well be worse than the one nuisance alone. One can think of several ways, however, in which to contrive that volume could be set at a particular level by the hand control on the receiver, and thereafter augmented automatically as the speed of the car, and hence the level of ambient noise, increased. Ready to hand behind the facia, for instance, is the speedometer drive cable, the speed rotation of which is directly proportional to the speed of the car. It should not be difficult to derive from that a potential to govern gain, and so sound level, subject to the overriding control of the volume knob on the receiver itself. Nor would it be difficult to grade the ratio of sound increase—perhaps from a mere 100 per cent for the lordly Rolls to 1,000 per cent for the Whiz-bang Sports Special.

At least one manufacturer has on test a prototype embodying this refinement; one hears that its influence goes unnoticed—until it is switched out of action—that it is not expensive, that it has proved effective in a variety of cars, and that it is a simple, plug-in affair with no complications.

A final elaboration—there is on the market already a record player of high quality and great ease of operation, which plays through the car radio and is wellnigh immune to road bumps, hard cornering and similar disturbances. One just pops the record into a slot like posting a letter, and application of the pickup, starting and stopping the motor and final rejection of the record are all done automatically.

Soon we shall see an even simpler device, playing tape recordings through the car radio amplifier and loudspeaker. The tapes, in convenient cassette containers, will be threaded into the reproducing head automatically; less vulnerable than records, they will have a longer life in car use, and will be ideal for the time when suitable broadcast programmes are not available, or do not suit the listener's taste.

Commercial Literature

Thermal Relays made by G-V Controls (U.S.A.) are available from Coventry Controls Ltd. and use the longitudinal expansion of a heated stainless steel rod as the primary actuator. The movement of this rod is magnified by levers to open and close contacts. In one type—series GD—the magnification is 20 times, and neither 50g, 11msec shocks nor 20g vibration from 5 to 3,000c/s affect operation even when the contacts are within 0.001 in of closing. Leaflets from Coventry Controls Ltd., Godiva House, Allesley Old Road, Coventry.

Polystyrene Capacitors are well known for their stability under adverse climatic conditions and their good high-frequency performance. Polystyrene-dielectric capacitors made by S.T.C. range between 10pF and 0.5μF at 125V d.c. and up to 0.2μF at 350 and 500V d.c. working. Full details on Technical Data Sheet MC/106 from Standard Telephones and Cables Ltd., Connaught House, 63 Aldwych, London, W.C.2.

Minilog is the name given to a panel containing a solid-state logic unit manufactured by Panellit Ltd. These units can be used for the replacement of relays, stepping switches, contactors, etc., in control systems with a gain in reliability and performance. Leaflet from Panellit Ltd., Elstree Way, Borehamwood, Herts.

Radar Tape Recorder by Decca performs the same function for radar that is carried out by a video tape recorder for television. Description of apparatus and techniques used from Decca Radar Ltd., Albert Embankment, London, S.E.11.

"Export, Exportation, Exportacion" is the title of a four-language (English, German, French, Spanish) publication which aims to give an idea of the scope and products of the E.M.I. organization to the intending buyer from overseas. E.M.I. Electronics Ltd., Hayes, Middlesex.

Negative Feedback and Hum

By "CATHODE RAY"

THE title is one I have already used. But as that was 15 years ago and therefore in ancient history so far as many readers are concerned, and scepticism is openly expressed* about some of the conclusions I repeated recently†, I'd better go into the matter once more.

The chief point at issue is the common belief that negative feedback reduces distortion, noise, hum, etc., by the same factor as it reduces voltage amplification or gain; viz., $1/(1-AB)$, where A is the gain without feedback and B is the fraction of the output voltage fed back. If the feedback is negative, then B must be negative, cancelling the minus sign already there.

Last April we examined the distortion aspect, or at least that principal variety of it caused by non-linearity. Since non-linearity means that A varies over each cycle of signal, the familiar $1-AB$ formula as commonly used tells us how much the distortion is reduced only when there is no distortion to reduce.

By means of a more complicated analysis we found that negative feedback works according to plan so long as the amount of distortion is reasonably small without it, but if the amplifier is driven too hard the result is worse than the same output without feedback. The actual quantity of distortion may be less but its unpleasantness is greater. In short, like a certain little girl, when a negative feedback amplifier is good it is very very good but when it is bad (i.e., overloaded) it is horrid.

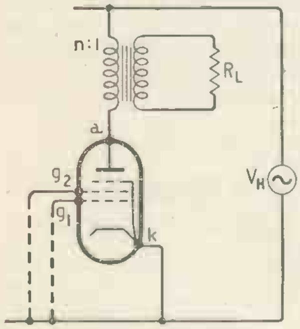

Fig. 1 By omitting everything not directly involved, we can see more clearly how much of the hum voltage V_H due to imperfect h.t. smoothing reaches the loudspeaker coil (a.c. resistance, R_L). The dotted lines indicate that in this case, so far as V_H is concerned, the grids are held at cathode potential.

Hum is quite differently involved, because it would never—we hope!—come anywhere near overloading the amplifier, and is most noticeable when the signal voltage is least. So we can regard A and B as constants, which means that the reducing factor is a constant and the complications just mentioned do not arise. There is therefore some excuse for supposing that hum is invariably reduced to the extent indicated by that factor.

It is hardly necessary to mention, perhaps, that although in ordinary speech "hum" means a particular sort of sound, in an electronic context it includes the alternating voltages and currents in an amplifier, etc., which cause that sort of sound to issue from the associated loudspeaker, if there is one, or corresponding undesirable effects to appear on the screen of a television receiver.

There are several ways in which hum can insinuate itself into circuits. The original source is the a.c. used for power supply, its frequency being (in Britain and many other places) 50 c/s. This can be picked up inductively from the mains transformer or capacitively from the wiring, but such action can be largely counteracted by screening and suitable placing of components. And, because of the insensitivity of the ear at such a low frequency, a reasonably small residue is unobjectionable.

A more important cause is the unavoidably imperfect smoothing of the rectified output, because that output necessarily flows through the valves, etc., and moreover the rectifying process creates higher and therefore more audible frequencies.

It will help to keep our inquiry within reasonable bounds if we concentrate it on the output stage, because that is always involved whenever negative feedback is used. It is also the one using by far the biggest share of rectified current, which is therefore the most difficult to smooth. Chokes to carry this large current with the loss of few volts, and at the same time to suppress the hum effectively, tend to be large, heavy and expensive, with a strong hum field surrounding them. Resistors tend to drop too many volts or not enough hum. So much is left to the capacitors to do, and they must be large. If feedback can substantially reduce hum it should enable smaller and cheaper smoothing components to be used, apart from any other benefits.

Hum arriving from the previous stage(s) comes along with the signal, so the ratio of one to the other is not improved by last-stage feedback. And because it is amplified by the last stage it must obviously be kept down to a very small amount, by extra smoothing for the other stages or by including them in the feedback loop, or both. It is usually both.

A Review of Circuits

My former article under the same title included triode valves and feedback from across parallel-fed loads. Looking at more than 50 circuits of recent sound and television receivers I notice a complete absence of either of these features in sound or vision output stages. Sound stages are invariably pentode (including, for brevity, tetrode) valves, transformer-coupled to their loudspeakers. Negative feedback is taken from either the anode or the secondary (or a tertiary) winding. Feedback is not used in video amplifiers except partially by means of a cathode

*Last month's issue, p. 311.
†April issue, p. 225, para. 2.

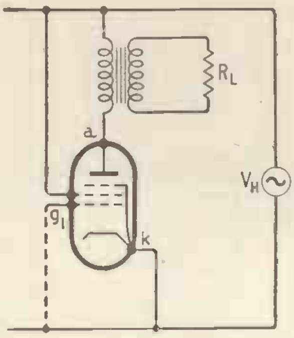

Fig. 2 This differs from Fig. 1 in that the g_2 current is not smoothed, so receives the full V_H.

resistor, and this can be considered at the end as a special case.

Fig. 1 shows as much of our output stage as concerns us for a start. D.c. and signals are ignored, and the hum current through the valve is regarded as due to a hum voltage V_H from a generator. One ought, strictly, to show a generator impedance, but as we—or some of us—saw in the November 1949 issue, the only variable that affects V_H materially is the amount of d.c. flowing, and we have no intention of altering that, even by the introduction of feedback. This is just as well, for the impedance would have to be different for each hum frequency.

The effective load resistance, R_L, is shown connected through the usual step-down transformer. We are going to be more interested in its equivalent across the primary winding, which is calculated by multiplying R_L by the square of the transformer ratio.

Let us suppose, first of all, that the potentials of the grids are kept constant relative to the cathode, which itself is kept at constant potential by means of a large capacitance across any bias resistor there may be between it and earth. Then V_H is divided between the load (primary side) and the valve, in the ratio of their impedances. The load is usually about one-eighth of the valve's r_a, so receives something like one ninth of V_H. It could receive quite a lot less, because the load resistance, n^2R_L, is shunted by the susceptance‡ of the transformer primary, which may be very appreciable, especially at frequencies as low as 50 c/s.

So far our pentode or tetrode is doing not too badly, compared with a triode, which would leave the load to take about two thirds of V_H. But the stipulation about the constancy of g_2 potential means that its current supply must be *perfectly* smoothed. In quite a number of actual sets, however, it is no more smoothed than the anode supply. The connection is then as in Fig. 2, so that the whole of V_H is applied to g_2. The result, so far as hum current through the anode circuit is concerned, is μ_2 times as much as in Fig. 1 μ_2 being my symbol for what is awkwardly if more officially denoted by μ_{g2-a}—the amplification factor of g_2. Its value, for a valve commonly used in the sound output stage of television receivers, is about 20. So use of the simple Fig. 2 connection multiplies the anode-current hum by that factor—as compared with perfect smoothing. In practice, of course, it is compared with the imperfect smoothing provided by components of economic value, but even that is enough to reduce the hum to a small fraction of what it would be without. And some valves have a much larger μ_2 than 20.

‡The reciprocal of the reactance. It is equal to $1/2\pi fL_p$.

It is now about time to see what negative feedback does to the hum. One method of applying it is to connect a path from the anode of the output valve to that of the previous one—or, what comes to the same thing, its own grid; Fig. 3. The previous stage has to provide a greater signal voltage to make up for the loss of amplification, and we don't know whether this will result in a correspondingly greater hum voltage or not. The signal/hum ratio is very unlikely to be made worse, and it might well become better. However, we are not taking hum from this source into account just now, important though it might be in practice. What about V_H?

As regards its direct assault on the anode, we saw that V_H is shared between the load and the valve in the ratio of their impedances, and, because the impedance of a pentode without negative feedback is relatively large, only about 10% of V_H reaches the load. One effect of negative feedback—at least, when applied as in Fig. 3—is a drastic reduction of the valve's r_a. In that respect the pentode virtually becomes a triode. So the proportion of V_H across the load is likely to rise to perhaps 70%, even with very moderate use of feedback.

In More Detail

Readers who — very wisely — object to blindly accepting statements such as the foregoing about feedback reducing the valve's resistance will want to trace the action in detail. Let them consider the moment at which V_H is maximum positive on the anode side. The direct result will be to make more anode current flow, but very little more, as inspection of any pentode's I_a/V_a graph will make clear. The indirect result via feedback is that the control grid (g_1) gets a share of this positive voltage, which causes an amplified increase in anode current, and therefore more hum. It is just as if a lower-r_a valve (without feedback) had been substituted. Hence the doctrine that negative feedback reduces r_a.

That is assuming perfectly smoothed current for g_2. Next, let us see what happens if the same kind of negative feedback is applied to Fig. 2, as in Fig. 4. We noted that in Fig. 2 the direct effect of V_H via the anode was many times exceeded by that via g_2. We might therefore quickly assume that hum in Fig. 4 would be the worst of the lot, since it would receive V_H on all three electrodes in the same

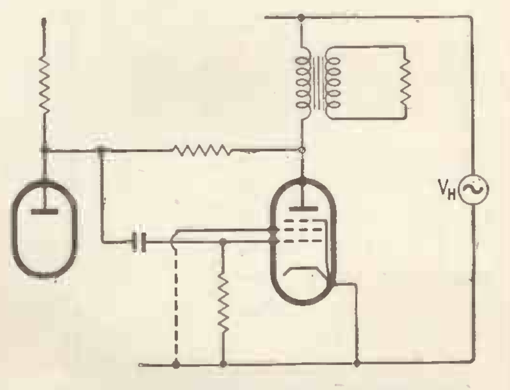

Fig. 3 Here, negative voltage feedback is applied from the anode, the conditions otherwise being as in Fig. 1.

phase, two of them amplifying it. It stands to reason that " unsmoothing " g_2 must make the hum worse! (We have already found that to be so in Fig. 2 as compared with Fig. 1).

Well, it only shows how wrong one can get by doing things in a hurry. Practical test (which was what I did for the 1946 version) shows that hum is *less* with Fig. 4 than with Fig. 2. Why?

The explanation is quite interesting. In Fig. 2, V_H, which is applied in full to g_2, is so much amplified that the hum voltage thereby developed across the load is almost certain to be greater than V_H. With typical valves it is likely to be about double. Consequently, at the moment when V_H is at its maximum positive the anode is being driven neagtive. It is this negative hum voltage that is fed back to g_1, where it opposes the positive hum voltage on g_2. If this gives us the idea that by a suitable choice of B—the feedback ratio—we can nicely balance out the hum, we are wrong again. The voltage applied to g_1 only does any balancing out so long as the hum voltage across the load *exceeds* V_H. So the best that can be done is to prevent it exceeding it much. It is hardly surprising that only three of the many models I examined make use of the Fig. 4 type of circuit, and their amount of feedback seems to be very limited. A somewhat larger number resemble Fig. 3 in having extra smoothing for g_2, or, what is perhaps rather better as regards hum, have extra smoothing for both g_2 and a.

A Popular Method

By far the commonest method of arranging negative feedback is from across the transformer secondary winding. Among these can be included some that have a special tertiary winding for feedback only. Either leaves the designer free to use a fedback voltage of either polarity, and almost invariably he takes advantage of this to apply it to the previous stage, roughly as in Fig. 5. The main idea behind this, no doubt, is to apply the distortion-reducing virtue of negative feedback to as much of the audio system as possible. But for the moment we are solely concerned with how it affects hum.

Here again we have to be rather careful how we reckon our potentials. Relative to cathode, the top end of the transformer primary is at full hum potential, V_H. Relative to that point, the anode is less positive. In Fig. 2—and Fig. 4—it is usually so much less that it is reversed in sign. Let us

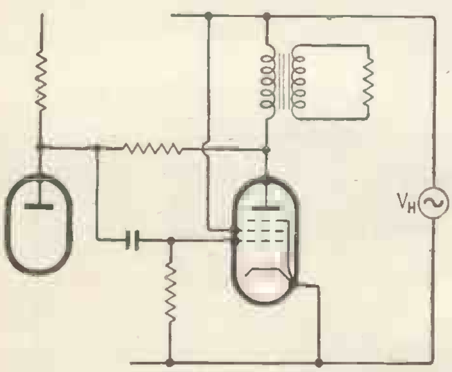

Fig. 4 This is the same as Fig. 3 except for absence of g_2 current smoothing.

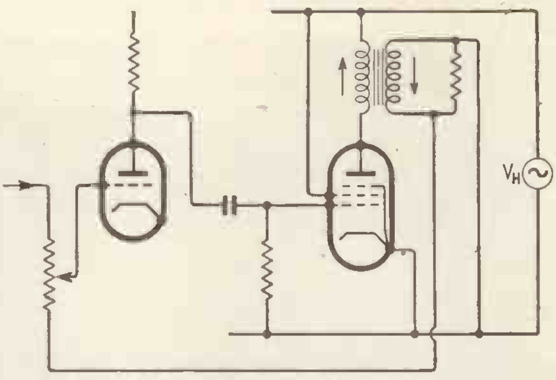

Fig. 5 This differs from Fig. 4 in the method of negative feedback, which is via the transformer secondary and the previous stage.

check that as shown in Fig. 5 the signal voltage feedback is in fact negative. The coils are shown in opposite rotation, so an increase in signal current through the valve, which would make the anode go negative-wards, would feed positive voltage to the grid of the triode and negative to g_1 of the pentode, opposing the cause and therefore correct.

The same applies to hum currents through the pentode, however caused. So far as this type of feedback circuit is concerned, then, it is true that hum is reduced in the same ratio as gain, distortion, etc. So even the potentially very bad hum situation of Fig. 2, which no amount of feedback from the anode can reduce to less than the full V_H across the transformer, can be substantially improved. Applying 20dB of feedback in a typical case would bring it down to about one fifth of V_H, or nearly as good as Fig. 1 without feedback. Applying it to Fig. 1, so that the circuit is like Fig. 5 plus effective smoothing of the g_2 current, the already relatively small Fig. 1 hum is reduced by however much feedback is used. More than half the feedback circuits examined were in fact of this type, the number without extra smoothing (Fig. 5) being relatively small. In two of the former and one of the latter the feedback was to the cathode of the pentode instead of the grid of the triode, but I don't think we need make a special study of that particular variation. There are also devices in some to increase the amount of feedback at high signal frequencies.

Another feature, appearing in nearly half the sets looked at, does perhaps deserve mention, seeing that it concerns hum—though not in relation to feedback. Instead of the h.t. current being fed in at the end of the output transformer it is tapped a little way down, as in Fig. 6. Hum current flows towards each end of the transformer winding in inverse proportion to the impedances of the paths available. As the impedance via R and C— of the order of only 1–2kΩ—is much lower than through the valve, the hum current is relatively high and only a few turns are needed to provide sufficient ampere-turns to neutralize those in the rest of the primary.

Here is yet another trap. The attentive but hasty reader may say Oh! But we are using negative feedback, so the valve impedance will be quite low! So we are, and in one way it is low, but in another it is

(*Continued on page 385*)

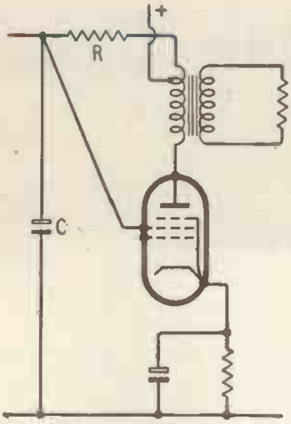

Fig. 6 A device for balancing out hum in the anode circuit is to tap the h.t. connection a little way down the transformer primary. The precise point depends on the ratio of the impedance of R (C being negligible) to that of the valve, which is usually enhanced by negative feedback.

very high. This ambiguous state of affairs can only be made clear by once again taking care how we reckon our potentials. From the point of view of the transformer (the h.t. voltage being constant) any voltage generated therein that increases current through the valve must be positive at the anode end. That feeds back negative voltage to the triode grid and positive to g_1, making the increase of current greater than it would have been without feedback. So in effect the pentode's resistance is less.

But now look from the h.t. supply's point of view. Any hum voltage that would increase the anode current would have to be positive at the supply end, which (owing to the increase in current) would be negative at the anode end—relative to + h.t., not to cathode. So voltage fed back would be opposite to that in the first case, tending to reduce the increase in anode current, just as if the valve impedance were higher than without feedback. Seeing that that is quite high, one can see why the h.t. tap need not be far down the primary.

The combined use of g_2 smoothing, negative feedback and transformer tapping should therefore add up to a satisfactorily low hum level even if the smoothing immediately following the rectifier has been planned with strict regard to economy.

Cathode Feedback

About a dozen of the audio stages surveyed, and the great majority of the v.f. output stages, departed from our assumption about constancy of cathode potential by having no effective hum-frequency bypass across the bias resistor (Fig. 7). All except two of these audio stages included other forms of negative feedback. The current passing through R_k, whether it be d.c. feed, signal or hum, biases all the other electrodes (anode, g_1 and g_2) negatively with respect to cathode, which is the reference or starting point in any valve. The effect on anode current via the anode voltage is small (say 5%) compared with that on g_2, and that in turn is usually even smaller compared with that on g_1, which by definition influences the anode current μ times as much as does the anode. So we concentrate on the g_1 bias.

By the way, just to get our terms clear, the word " bias " is usually applied only to the d.c. component of the voltage across R_k, and this component of course is there whether R_k is bypassed by a capacitor or not. But for convenience I am applying it to the hum voltage. And when I say it biases the grid (g_1) negatively I am counting as positive the half-cycles of hum voltage that add to the d.c. The negative half cycles bias the grid positively, since two negatives make a positive.

Now because this grid-biasing voltage is proportional to the current through R_k it is called current feedback. It increases the apparent resistance (r_a) of the valve, because its effect via the grid is to oppose any change in current produced by an externally applied voltage. In Fig. 1 we saw that the higher the resistance of the valve the smaller the proportion of V_H getting to the load. So cathode feedback reduces hum in that type of circuit. So far as hum voltage set up across R_k is concerned, it obviously reduces itself in the same proportion as signals—assuming there is nothing to discriminate between hum frequency and signal frequency. That is not an effect additional to the one mentioned earlier in this paragraph; it is just another way of looking at the same thing.

The argument applies also to the other circuits. For instance, in Fig. 2 the effect of V_H is magnified via g_2, but it equally magnifies the hum current through R_k and therefore the anti-hum voltage to g_1.

Like any other form of negative feedback, the cathode resistor reduces the gain and necessitates a corresponding increase in signal input. If most of the hum is coming in with the signal, the net improvement in signal/hum ratio may not be noticeable. In that case the designer's attention must be transferred to the previous stage. There, owing to the far smaller current drain, the smoothing problem is comparatively light. The main difficulty is likely to be inductive or—still more—capacitive pick-up. But screening is another story. And then there is modulation hum, due perhaps to poor smoothing in the r.f. stages.

Summing up the findings, we can say that negative feedback from the anode is not recommended, because with unsmoothed g_2 (Fig. 4) it is powerless to reduce the hum voltage across the output transformer to less than V_H, while if g_2 current is smoothed it brings back the hum so disposed of. Feedback from the secondary has the advantage—among others—of reducing hum in the same ratio as signal. To ensure very low hum, g_2 should have extra smoothing; and if even that is not good enough the dodge shown in Fig. 6 can be brought in. Cathode feedback (Fig. 7) is another that reduces hum in proportion to signal, and is cheap (its cost is minus that of a bypass capacitor) but its r_a-boosting property may not commend it to the hi-fi enthusiast. Finally, it profits little to eliminate hum in the output stage if the cure leads inevitably to more being brought in from the preceding stage, so don't overlook that source.

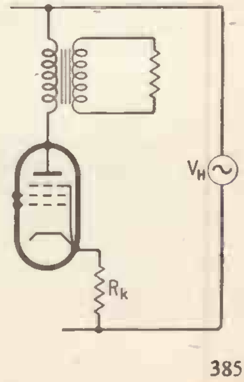

Fig. 7 The effect of a cathode resistor, R_k, when not bypassed to hum by a large capacitance, is to reduce the hum.

Elements of Electronic Circuits

27.—Pulse Modulation (2)

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

WHERE the transmitting valve either has no grid (magnetron), or where it is inconvenient to use the grid for modulation, the anode supply is switched on and off. Anode modulators can employ either "soft" valves (e.g., the thyratron) or "hard" valves, for the switching function. Soft valves can be triggered easily and can pass larger currents with less power dissipation than hard valves, but their disadvantage is that the discharge has to be extinguished, rather than the flow of electrons interrupted, at the end of the pulse. This takes time and can militate against the use of the more economical device.

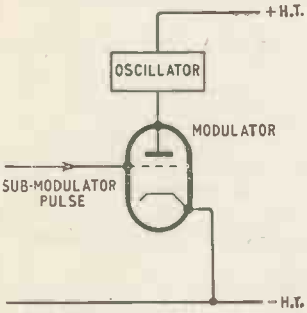

Fig. 1

The pulse-forming network is the source of supply for the oscillator and it stores and carries all energy that is to form the r.f. pulse and cover losses in the transmitter. This pulse energy is discharged into the oscillator, which is in series with the modulator valve, and we are therefore concerned with the control of the charging of the network, together with its subsequent discharge into the oscillator. If the modulator is of the hard-valve type, the control of the shape and duration of the modulator pulse is done at an earlier low-power or sub-modulator stage. The problem here is one of amplification, in other words, the provision of sufficient power to modulate the oscillator.

Anode Modulation

A hard-valve modulator requires the application of a positive pulse of large amplitude (which is produced by the sub-modulator) to make the modulator valve conduct as heavily as possible. As the action of the modulator depends on a large grid current flow with consequent low input impedance during the conducting period, the output impedance of the sub-modulator stage must also be low if the pulse shape is to be preserved and grid limiting prevented.

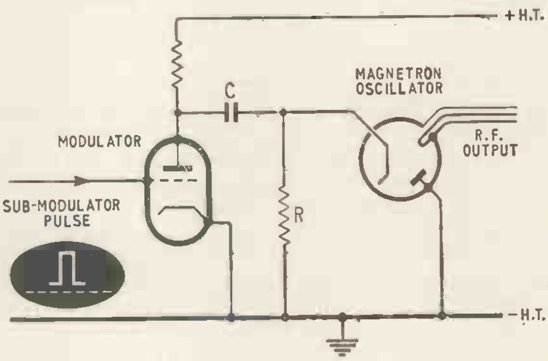

Fig. 2

Fig. 1 shows the basic simplified circuit of a hard-valve modulator and Fig. 2 its connection to a magnetron type of oscillator. It will be noted that in the latter case, owing to the construction of the magnetron, it is necessary for the magnetron anode to be at earth potential: hence a method of shunt feeding is employed.

In order that the voltage across the magnetron may remain steady during the pulse, the C-R coupling circuit is arranged to have a long time constant.

The sub-modulator pulse for a hard-valve modulator may be derived from a single-valve circuit based on the one illustrated in Fig. 3. This circuit

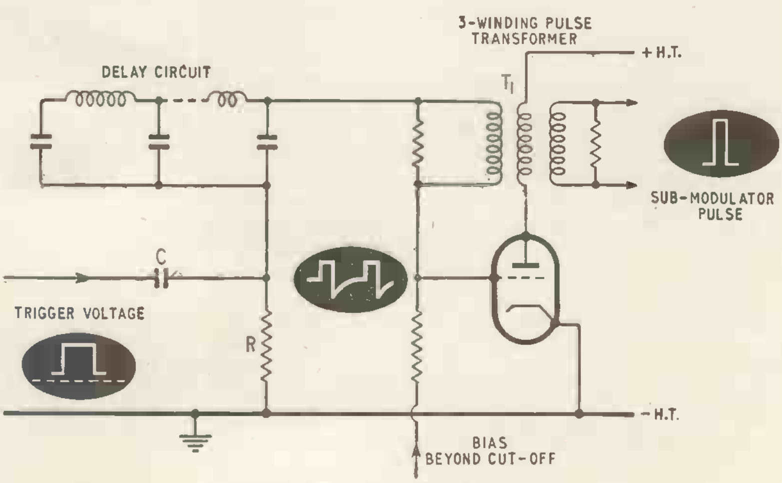

Fig. 3

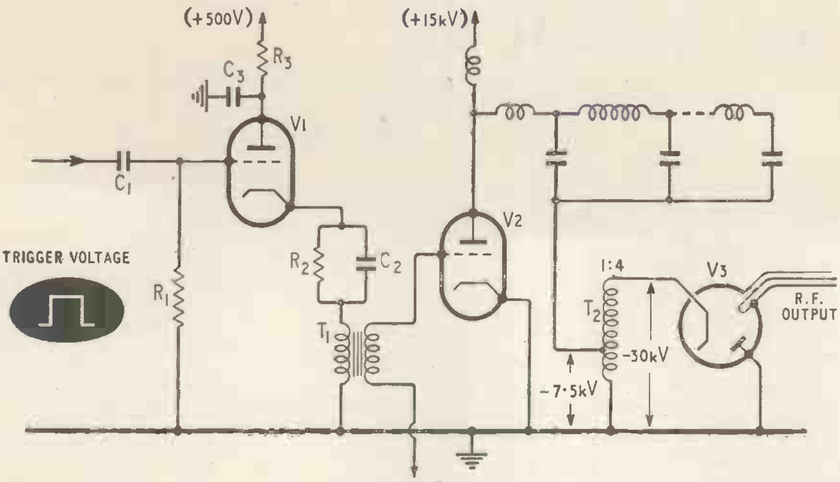

Fig. 4

consists of a triggered blocking oscillator which includes an open-ended delay network to determine the length of the pulse to be produced. A positive trigger voltage applied to the short time-constant C-R circuit results in the grid of the valve being raised above cut-off. The valve conducts heavily and produces a high voltage across the grid winding of the triple-wound pulse transformer T_1: this charges the delay circuit.

When the negative-going reflected wave reaches the input (voltage reflection at the open end without change of phase), the valve is again cut off. The duration of the output pulse depends on the double transit time of the delay circuit (see No. 25 of this series; May, 1961).

Pulse Transformers

An important component in modulator circuits is the pulse transformer which is used for:—

(i) matching of the modulator to the magnetron (via any interconnecting cables),

(ii) phase inversion of a pulse where necessary, e.g., between sub-modulator and modulator valves,

(iii) coupling between two circuits when the direct potentials are different.

In each case the pulse transformer is required to pass the pulses without appreciable distortion of their shape. The working conditions are stringent: high voltage peaks, with peak pulse current that may reach hundreds of amperes and often (in airborne equipment at any rate) the running temperature may well be high.

One interesting and almost universal "dodge" adopted for magnetron transformers is the use of bifilar secondary windings. Through the two parallel coils flows the magnetron heater current (the turns are few, so there is no great loss) and this enables the magnetron heater to be energized from a supply at earth potential although its cathode may be some tens of kilovolts below earth during the pulse.

Practical Modulator

An example of anode modulation using a pulse forming network in the modulator circuit and the employment of pulse transformers in both trigger and modulator circuits is shown in Fig. 4.

To assist in the explanation of the function of this circuit some typical voltage values have been chosen.

The positive trigger voltage is differentiated by C_1 R_1 to produce a narrow pulse on V1 grid (say 100μsec). V1 is initially cut off by the cathode bias produced by C_2 R_2 during the pulse and C_3 is charged to 500 volts. The short positive pulse on $V1_g$ causes V1 to conduct and C_3 discharges through V1, the primary of T_1 and C_2 (C_3 recharges through R_3 when V1 stops conducting). The bias voltage (say -50V) on the modulator valve V2 is overcome by the pulse from T_1 secondary and V2 consequently conducts heavily.

Prior to this the delay line had been charged to 15kV (by a separate rectified high-voltage supply). When V2 conducts, a -7.5kV discharge pulse of, say, 1μsec length appears across the primary of T_2. The turns ratio of this transformer is chosen to fulfil two main functions:—

(i) it matches the magnetron to the delay-line impedance when the magnetron conducts (e.g., magnetron 640Ω, line 40Ω),

(ii) it steps up the modulator voltage to that required by the magnetron (e.g., 30kV).

The magnetron, passing a pulse current of approximately 30A, produces a 1 megawatt pulse of r.f. of 1μsec duration at the repetition frequency imposed by the trigger circuit (say, 500 pulses/sec).

For the sake of clarity much circuitry has been eliminated. Often methods are employed for shaping the pulses at the intermediate stages. It is also necessary to introduce clamping to prevent ringing or spurious oscillations. Overswinging of voltages and large grid currents caused by high voltage swings have to be restricted. Again, in a practical circuit the single delay line may be replaced by two identical lines in parallel, as in the Blumlein modulator.

This improvement can result in the delivery of a greater voltage to the load (i.e., the magnetron) and is brought about by the addition of wavefronts, caused by multiple reflections from the ends of the lines. One line is open-circuited, the other short-circuited, by the thyratron or triggered spark-gap.

Reflections at the short-circuited end produce a reversal in polarity of the voltage, whereas at the open-cicuit end there is no change in polarity on reflection. As the initial charging voltage divides between the lines, some reflections of the voltage wave combine and some cancel out with the result that the load voltage (i.e., that delivered to the magnetron) becomes the vector sum of the reflections.

It is important that both lines should be of identical construction, low-loss, of the same Z_0 and have the same transit time.

RANDOM RADIATIONS

By "DIALLIST"

Radar Echoes from Venus

THE recent successful attempt by Russian scientists to obtain radar echoes from the planet Venus has produced some interesting results. Nothing is known of the surface of the planet, for it is always covered by dense layers of cloud which make telescopic observation of it impossible. The Russians have found that radio signals are reflected in different ways by various parts of the planet and from measurements made have calculated that Venus revolves on its axis about once in eleven days. Another interesting result of the experiment is a fresh determination of the mean distance between the Earth and the Sun, which they have found to be 92,868,000 miles. This agrees reasonably closely with the figure of 92,874,000 miles obtained by the Massachusetts Institute of Technology in 1948 and with Jodrell Bank's 92,876,000 miles in 1959. But it is a good deal less than the latest figure obtained at Jodrell Bank, which is 92,956,000 miles. All the same, I'd put my money on Jodrell Bank's being right—or, rather, more nearly right than they. . . Soon after I'd written that came news of a fresh determination of the mean solar distance by M.I.T. Their new figure is 92,954,000 miles—only 2,000 miles different from Jodrell Bank's.

'Phone via Satellite

IT'S good to know that we are to take part in experiments involving the bouncing of radio signals from artificial satellites. Our contribution is to be a transmitting and receiving station on the Goonhilly Downs, near the Lizard, in Cornwall. A similar station is to be built in the U.S.A. and the Americans will put the satellites into orbit. They're expected to be quite small, weighing only about a hundred pounds apiece, and will be shot up by Thor rockets from the Vandenberg base in California. Sir Ronald German, director general of the G.P.O., has said that if satellites can be guaranteed to remain in orbit for ten years the space method will be competitive with the cable. The station is to be equipped with an 85ft steerable paraboloid.

A British Satellite

SO we're to have a satellite of our own next year. We shan't fire it ourselves, for it will be put into orbit from Wallops Island by a four stage American Scout rocket. It's going to contain quite a lot of apparatus which will carry out tests designed by different teams of British scientists. The power for these is to come from solar batteries and it's reckoned that they will keep it at work for a year. Besides detecting cosmic radiation, it is to measure electron density in the ionosphere and analyse the gases which make up the outer parts of our atmosphere. Let's hope it will be a success and that the information which it is to send back to earth by wireless will make a useful contribution to our knowledge of conditions towards the fringe of the atmosphere.

"Backroom Boy"

THE story of the brief but very brilliant career of Eric Megaw who, when he died at the early age of 48, was Director of Physical Research, Royal Naval Scientific Service, is told in Arthur Stanley's biography, "A Backroom Boy". His hobby from the time when he was quite a small boy was wireless, in which he was later to do remarkable work. At 20 he won a Beit Research Fellowship at the Imperial College of Science and it was there that he became interested in very short radio waves, which became almost a passion for the rest of his life. In 1930 Dr. Megaw joined the staff at the G.E.C. Research Labs at Wembley, where he stayed for 16 years. I didn't know that he had anything to do with the development of the cavity magnetron, but Sir Edward Appleton is quoted in the book as saying, "Those who were in the business know how much the practical development of the cavity magnetron—the development that made it something that could go into operational use—was due to Dr. Megaw. Yet, smilingly, he let the credit go wholly elsewhere, although a large part of it was his." It was in 1946 that he left Wembley for the R.N. Scientific Service, where he was doing remarkable work up to the time of his death early in 1956. "A Backroom Boy", published by W. Erskine Mayne, of Belfast, is a little book which is really well worth reading.

Colour Television in America

A GOOD many firms of American wireless and television manufacturers believe that colour TV is about to stage a long-awaited leap into popularity in their country. It has certainly hung fire for a long while. What, I believe, hampered its progress was not the cost of receivers, for there must be plenty of Americans ready and willing to fork out the equivalent of £200-£250 (or to pay the corresponding "never-never" instalments) for something which could guarantee entertainment more pleasing than that provided by the black-and-white receiver. The main trouble in the past was the frequent knob twiddling required and the serviceman had to be called in too often. Well, manufacturers have now had plenty of time to improve things and, I understand, can now produce sets which are stable and reliable. If that's so, there's no reason why colour TV shouldn't quickly become almost as popular as the monochrome variety on the other side of the Atlantic. There are are now quite a number of colour broadcasts and if sets show signs of selling well my guess is they'll quickly increase in number and in duration.

Still π Chasing

A KIND reader who lives at Purley reminds me of some rhymed mnemonics I quoted in these notes in November, 1944, for the value of π and tells me that just for the sake of amusement he worked it out to some forty places. The chasing of π used to be a favourite hobby of mathematicians in the seventeenth and eighteenth centuries and it still goes on to-day. But two things have happened lately which are likely to bring it to an end. The first is the evolution of a proof that the value can never be worked out exactly. The second is the result produced by an Emidec electronic computer, which without turning a hair worked it out to 10,880 decimal places! I believe I am right in saying that the best human effort was that of W. Shanks. In the 1850s he reached 530 decimal places and he had another go some 20 years later and went on to 707 places. But I understand it was recently found that he had introduced an error in the neighbourhood of the 530th decimal place.

UNBIASED

By "FREE GRID"

Cure for Cacophoria

AS the years go by, my collection of *Wireless World* steadily grows and Mrs. Free Grid is—to put it mildly—getting very restless about the space they occupy, and is inclined to make sufficiently tart remarks about the matter to induce in me a feeling of cacophoria. There must be many of you suffering from similar symptoms of uxorogenic cacophoria due to the same basic cause, and I think we ought to get together and find a way out of the difficulty.

I have been wondering whether the correct procedure would be to make a tape recording of each volume or to microfilm it. Taking all things into consideration, a microfilm version of each volume would seem to be the easiest way out of the difficulty as I should find it very tedious and voice-straining to read 50-years' volumes into a microphone.

"*Books cannot always please, however good.*"

With regard to future volumes, I wonder if we could get the Editor to approach his directors with the suggestion that at the end of each volume a microfilm version would be available to those who wished to buy it rather than pay to have their issues bound.* Since *W.W.* has a very large flock of sister journals, the cost of installing the microfilming apparatus would be small if spread over them all so that microfilmed volumes of each journal could be made available to their respective readers.

*Microfilms of *W.W.* since 1950 are available from University Microfilms Ltd.—Ed.

Le Mot Juste?

I WAS interested to see that our amicable French contemporary *Toute la Radio* devoted a whole page in its May issue to congratulating *W.W.* on its *noces d'or.* But in mentioning myself among the Editor's *vaillante équipe de collaborateurs,* I am not sure whether I ought to feel complimented or otherwise at being referred to as "*l'inénarrable* Free Grid," and I wonder if any of you Francophilologists can help me out; I cannot very well lose face by appealing to the Director of *Toute la Radio* for a translation.

I have been told on good authority that the expression means "the unspeakable Free Grid," but even if that be true I am still left wondering what the writer in our French contemporary really means. After all we speak of an exceptionally beautiful girl as being of "unspeakable beauty" but we also speak of a certain type of man as being an "unspeakable cad."

An alternative translation is "screamingly funny" and if Monsieur Aisberg really means this he must possess a first-class knowledge of colloquial English to have penetrated to the point of some of my more oblique allusions.

Who Invented Wireless?

IF the proverbial man in the street were asked the question in my title, it is more than likely that he would glibly answer "Marconi;" and if he were asked who invented the steam locomotive, he would probably say "George Stephenson." In the latter case he would, of course, be hopelessly wrong, for steam trains were running at Euston in 1808, over 20 years before Stephenson's "Rocket" appeared in 1829 and six years before his first locomotive, "My Lord," was built in 1814.

If he said that Marconi invented wireless, he would, in my opinion, be far more accurate than is generally realized. Now before you all dip your pens in H_2SO_4 to write to the Editor saying, "Free Grid must go," I would beg you to pause a moment and ask yourselves who, in your view, invented wireless. Probably you will think of a list of names like Hertz, Branly, Lodge and many others, and say they all contributed something but no one person could claim to be the inventor of wireless.

To get a clearer picture of what I am driving at, I think it would be better if I said that in my opinion it was Marconi who invented wireless communication, the emphasis being on the latter word. Transmitting messages from one room in a laboratory to another, or even across a large Italian garden as Marconi did at first, was valuable groundwork but if left at that "wireless" would not have been of much use as a practical means of communication.

It was Marconi—and nobody else—who changed all that when he added the missing link by attaching to his apparatus an elevated wire which we usually call an aerial. At that moment wireless communication was truly born and it was Marconi who acted as midwife. I am perfectly well aware that the Russians have staked a claim for Popov as the inventor of the aerial. But there is no evidence that in using such a device his idea was to do anything but collect atmospherics, and even in that he was forestalled over a century earlier by Franklin.

Tapped or Taped?

A FEW years ago some of us in the U.K. were worried about our telephone conversations being tapped by the authorities and questions were asked about it in the House. Since then, however, a far greater menace to the privacy of our conversation has arisen.

In the days of the telephone tapping scare, my blonde and I were forced to seek the sanctuary of speaking in Swahili in order to preserve the privacy of what we said to each other. But, as I foresaw at the time and mentioned in these columns (Aug., 1957), we had to abandon it as there was always the risk of the authorities sending tape recordings for interpretation.

The tapping menace seems to have faded away with the passing years, but the taping menace has increased to formidable proportions with the coming of tiny transistor tape recorders. People are buying them mainly, it seems, for the purpose of playing practical jokes on their friends by recording some of their foolish remarks (such as we all make at times) for reproduction later.

I can appreciate a joke as well as any man, but I am beginning to feel the strain of constantly keeping a guard on my tongue, and I realize that I must do something drastic to combat the menace by technical means, and it is here where some of you who are more up on the technique of tapology than I am, can probably help me. How can I generate a magnetic field of sufficient strength to wipe out the tape of a recorder which may be in the pocket of the person I am talking to?

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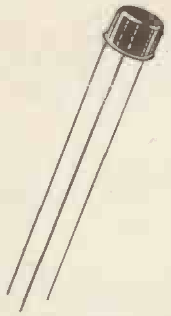

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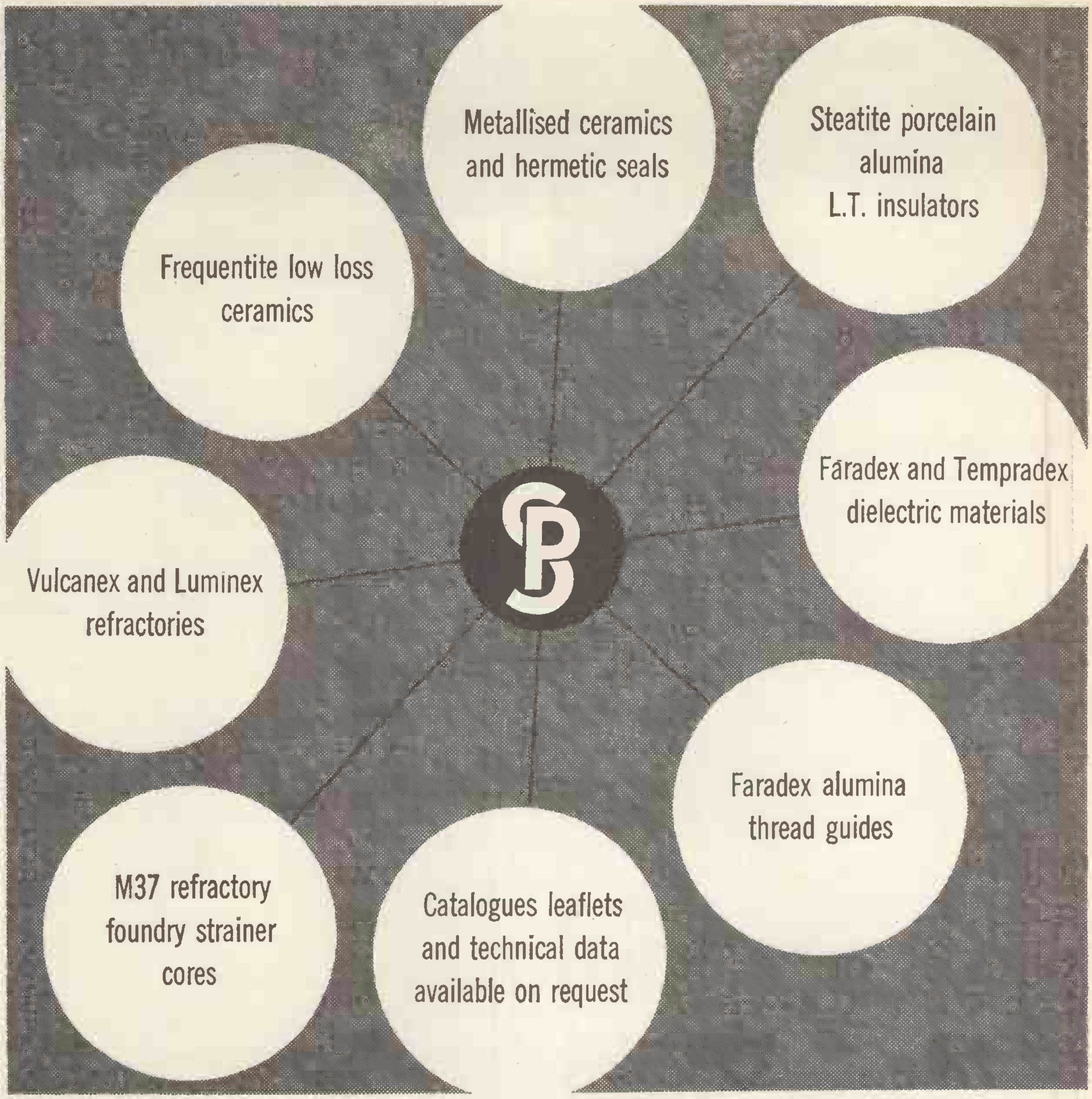
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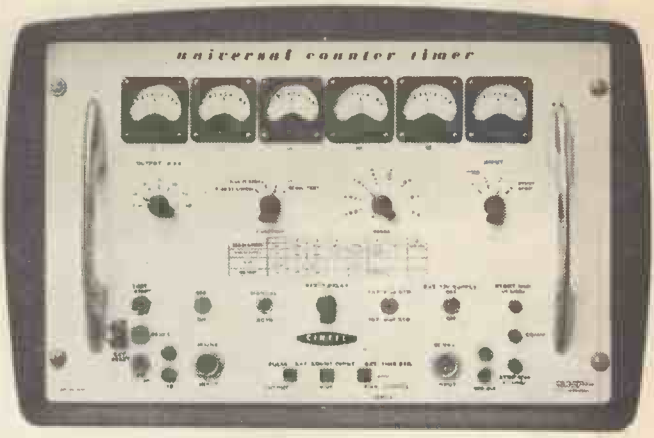

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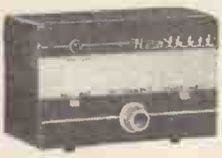

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Hi-Fi Stereo Pre-Amplifier for low-output Hi-Fi P.U.s. Input 2 mV. to 20 mV. Output adjustable from 20 mV. to 2 V. 40–20,000 c/s. Also suitable as low-noise R.C.-Coupled high-gain monaural amplifier. **£6.17.6**

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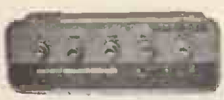

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Incorporates all worthwhile features for high fidelity stereo and mono. Push-button selection, accurately matched ganged controls to ±1 dB. Negative feedback rumble and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape heads and any stereo or mono-pick-up. **£18.18.6**

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A NEW AND ATTRACTIVE CABINET in modern style designed to house all your Hi-Fi equipment (including tape deck and full-sized transcription record player). The cabinet parts are veneered and pre-drilled, with edging in Panoplex plastic strip, for ease of finishing. Complete with everything you need for assembly, including screws, hinges and even a padsaw! Left "in the white" for finishing to choice. Size 39¼ x 32 x 21⅞in. **£17.5.0**

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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.

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Specially developed to meet the varying needs of different homes, it will house Tape Deck and/or Record Player, F.M. Tuner and Stereo Amplifier. In addition, for the convenience of those to whom space is an overriding consideration, it is possible to house speaker systems at each end. For this purpose a loudspeaker kit, comprising two 4in. plus 8in. speaker systems, balance unit, speaker grille, cutting template, padsaw and mounting details are also available. Neutral hardwoods have carefully been selected so that the finished product can be stained and polished to individual choice. There is storage space for records, etc., also for power amplifiers. Dimensions: length 46½in., height 30in. depth 21in.

Mk. I for Tape Deck or Record Player £16 13 6

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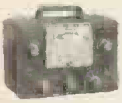

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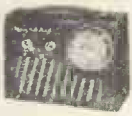

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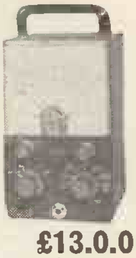

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Covers all amateur bands from 80 to 10 metres. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for V.F.O. Filters minimise T.V. interference. **£32.10.0**

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MSP-1M (with meters) £34.12.6

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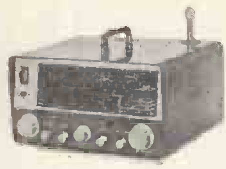
THE "MOHICAN" GENERAL COVERAGE RECEIVER KIT
Model GC-1U



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 for both the Ham and the short-wave listener. To overcome the problems of alignment, etc., the R.F. "front-end" is supplied as a pre-assembled and pre-aligned unit. Designed for outstanding performance, 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 strong steel cabinet in stove-enamelled green and powered by two 6 volt dry batteries (not supplied) mounted internally, it gives continuous frequency coverage from 550 Kc/s to 30 Mc/s in five bands; thus enabling world-wide reception. Electrical bandspread on five additional bands covers the amateur frequencies from 80 to 10 metres—each band having a scale length of approximately 8 inches. B.F.O. tuning and Zenar diode stabiliser. Size 6⅞in. x 12in. x 10in. **£38.15.0**

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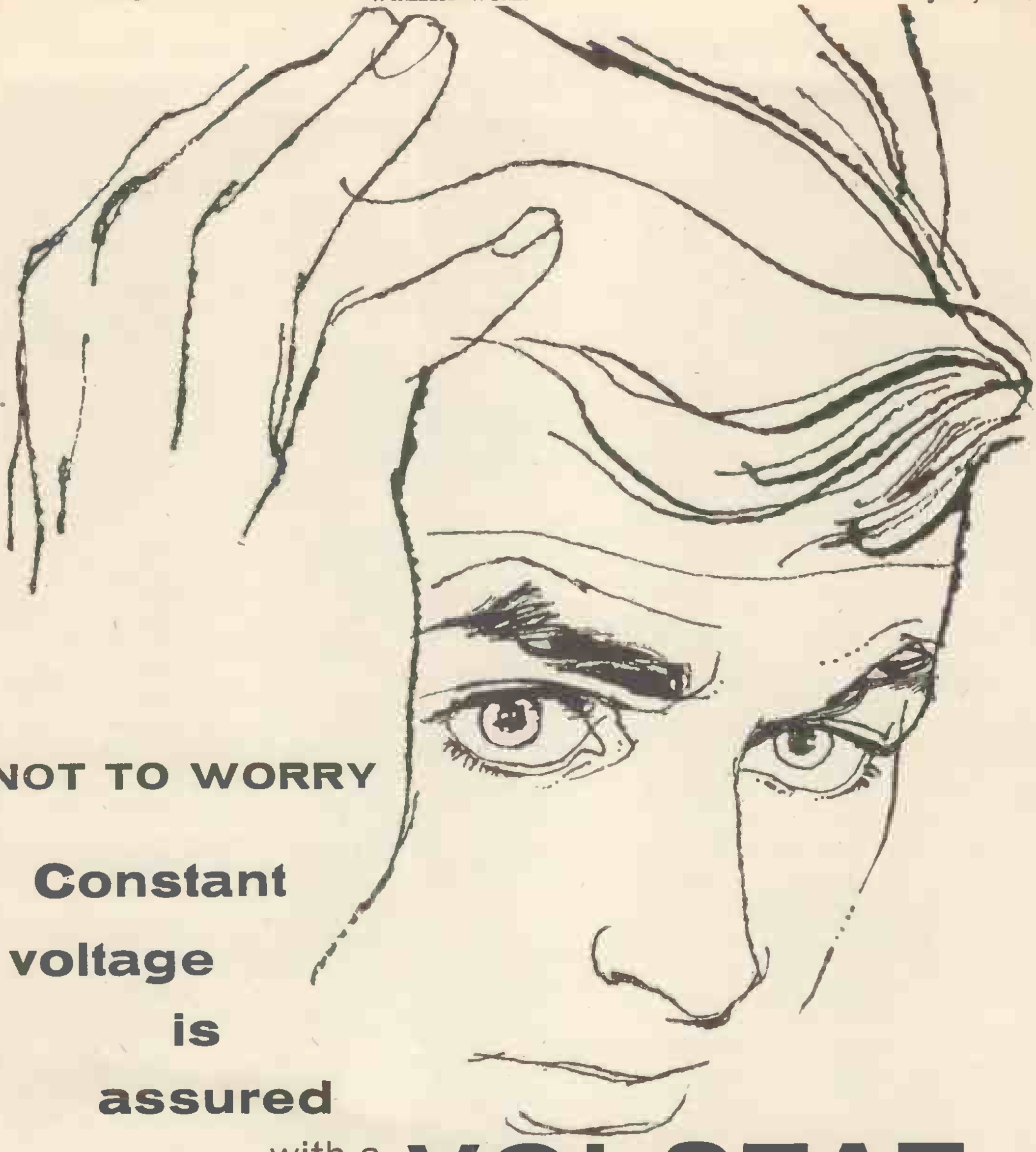

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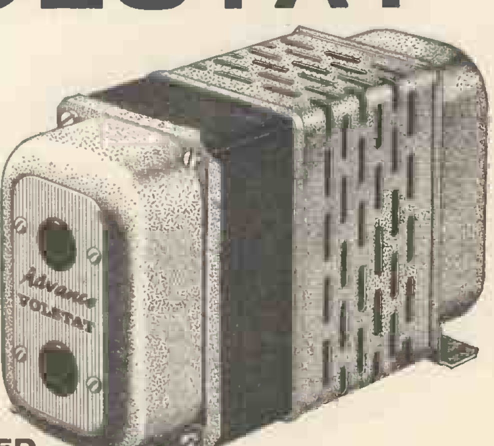

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Sub-miniature Driver Transformers for MULLARD 100 & 200mW transformerless output amplifiers

(Amplifiers using an OC71 and two OC72 transistors as described in Mullard technical communication Vol. 3 sub-heading No. 26 Page 188)

EN. 2592 for 200mW output

Dimensions $1 \times \frac{3}{4} \times \frac{3}{4}$in. high
Electrical Details Lp 5H at 150c/s 2V R.M.S. with 1.5mA. D.C. flowing.
Rp 184 Ohms
Rs 35 Ohms (Two bifilar wound sections)
Turns ratio 3.6 : 1 plus 1

EN. 2593 for 100mW output

Dimensions $1 \times \frac{3}{4} \times \frac{3}{4}$in. high
Electrical Details Lp 5H at 150c/s 2V R.M.S. with 1.5mA. D.C. flowing.
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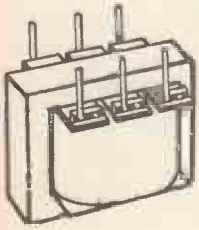
Rp 180 Ohms
Rs 11 Ohms each (Two bifilar wound secondaries)
Turns ratio 7 : 1 plus 1

BN. 2594 for 100mW output

Dimensions $\frac{3}{4} \times \frac{5}{8} \times 9/16$in. high
Electrical Details Lp 5H at 150c/s 2V R.M.S. with 1.5mA D.C. flowing.
Rp 570 Ohms
Rs 33 Ohms each (Two bifilar wound secondaries)
Turns ratio 7 : 1 plus 1



FINISH *The EN types can be supplied either vacuum impregnated with an approved varnish or wax. BN types varnish dipped only.*

FIXING *The transformers are supplied with leadout pins, which are quite adequate for fixing to printed circuit boards, but a mounting clamp can be supplied if desired.*

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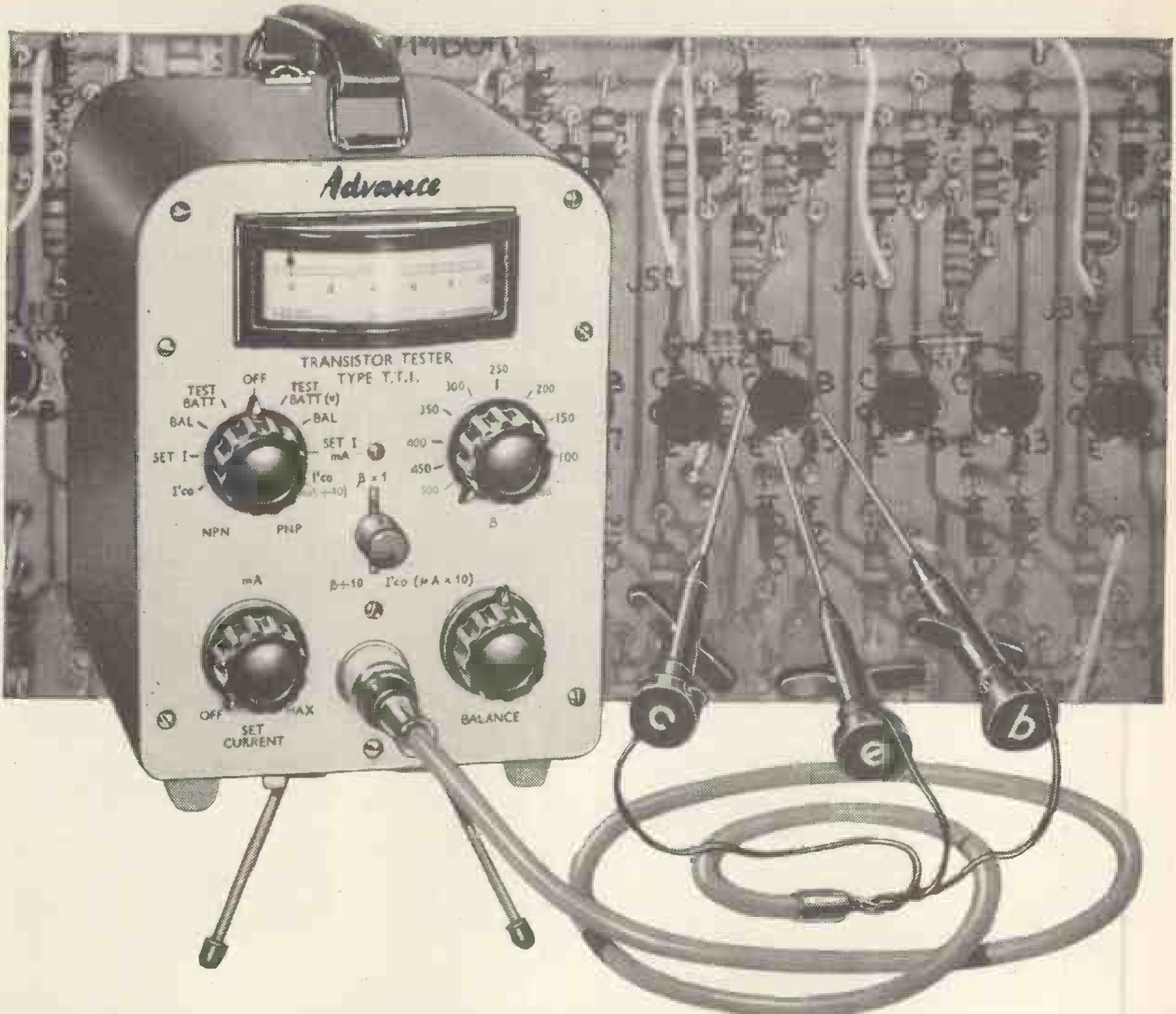

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Alphasil ·013" thick is produced in coil 30 inches wide, and can be supplied slit to narrower widths by arrangement.

TABLE OF WATTS LOSSES

	Frequency cycles/second	Guaranteed max. total losses at B. Max. 15 Kilogauss
ALPHASIL 62	50	·62 watts/lb.
ALPHASIL 56	50	·56 watts/lb.
ALPHASIL 51	50	·51 watts/lb.
ALPHASIL 46	50	·46 watts/lb.

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RIGHT—Core-loss testing of Alphasil by the 'double-lap' Epstein m..thod.

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ALPHASIL ·002HF	8,000	9·50 watts/lb. at B Max 2 Kilogauss

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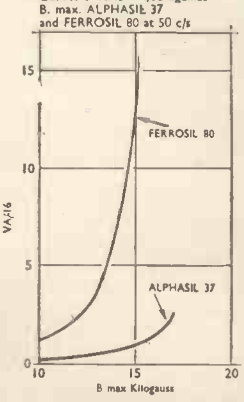

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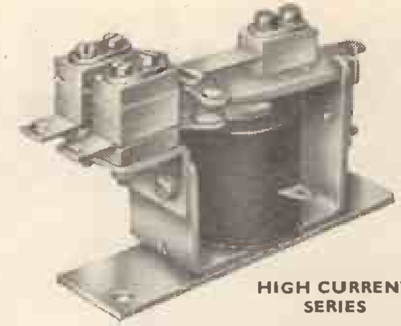

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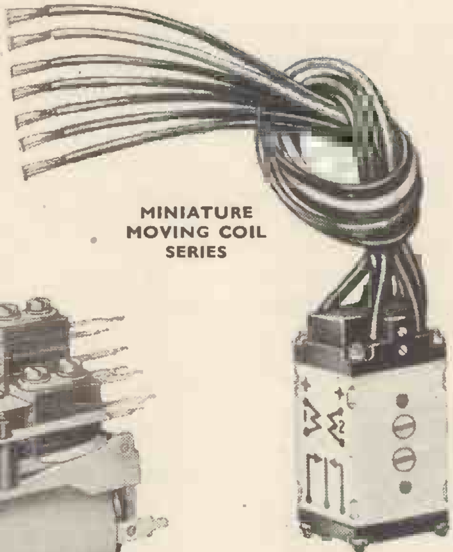

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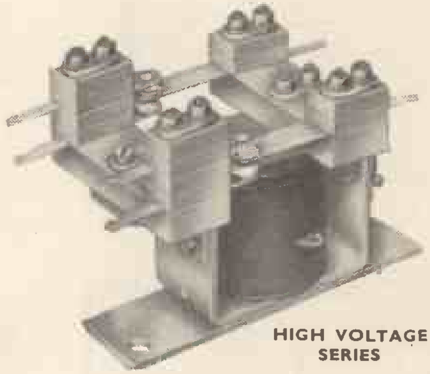

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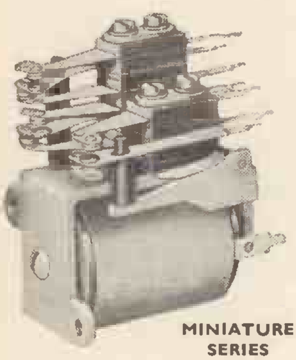

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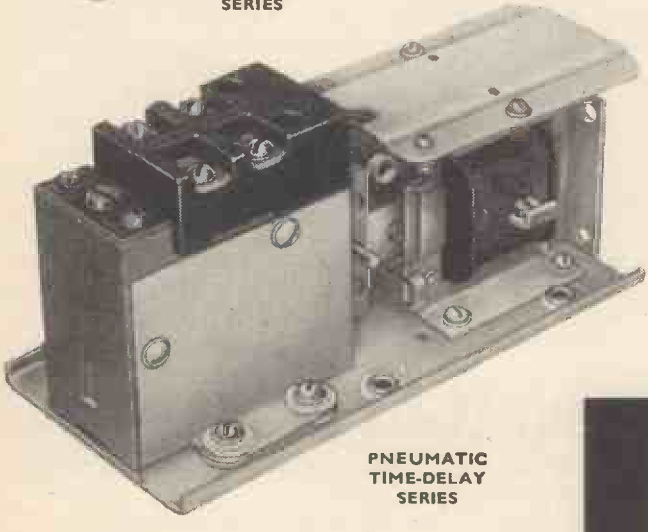

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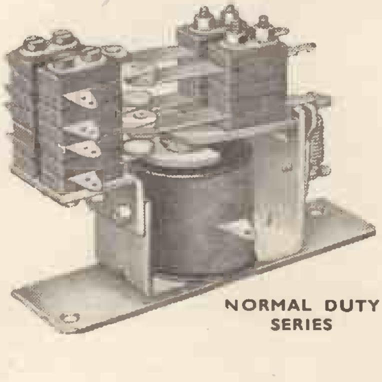

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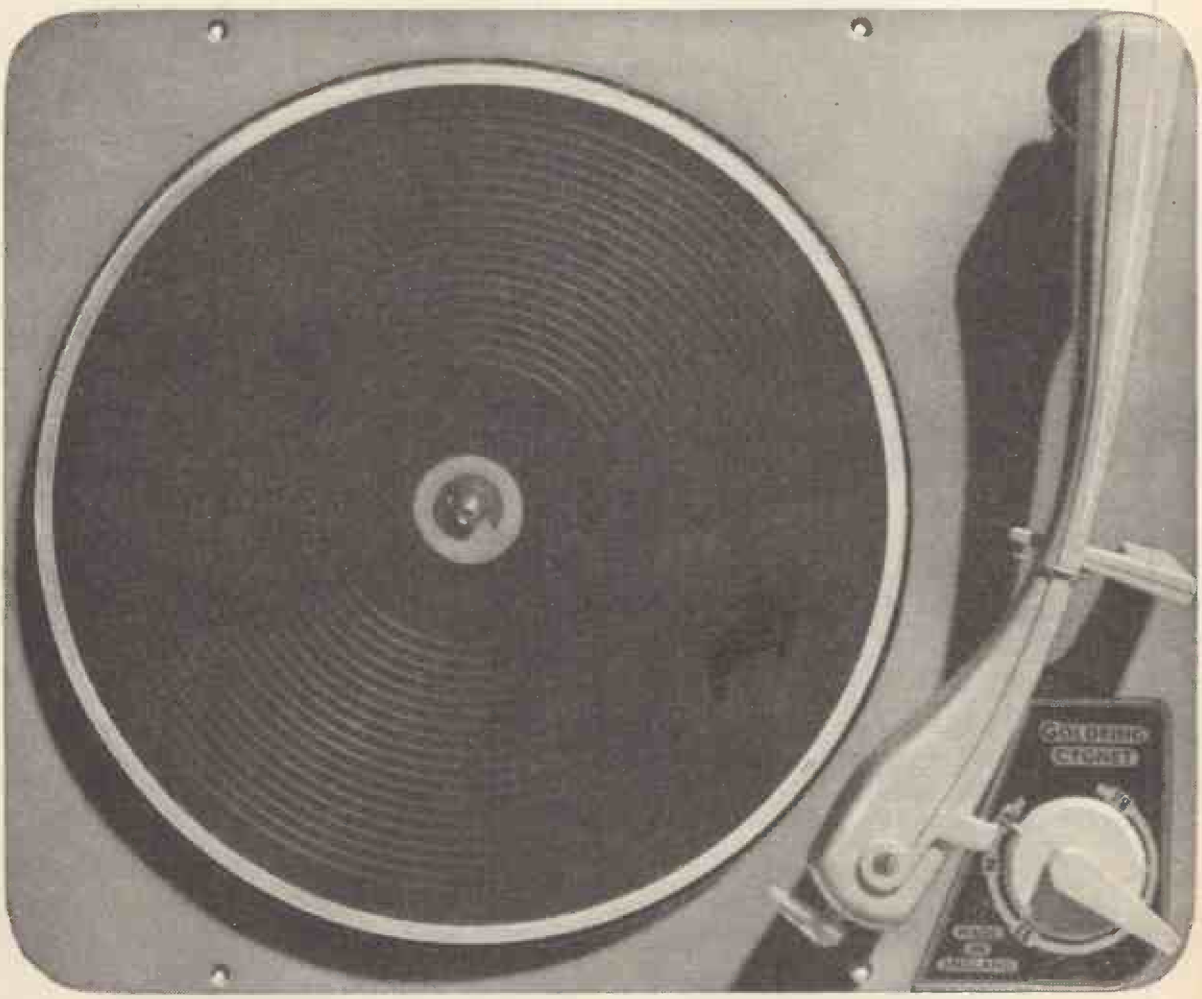

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	5"	900'	28/-	LRP/275
	5¾"	1150'	35/-	LRP/350
	7"	1800'	50/-	LRP/550
TYPE DP Double Play Tensilized Polyester	3"	300'	14/-	DP/90
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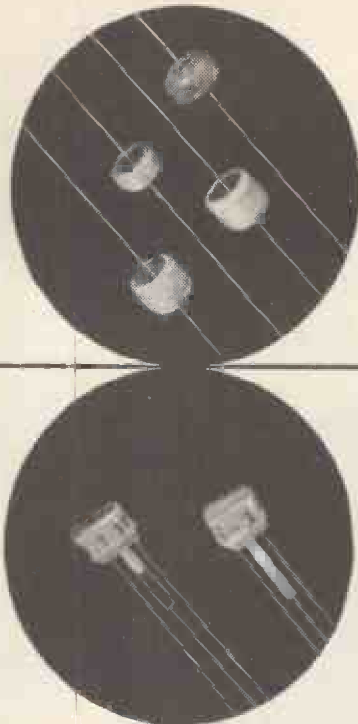

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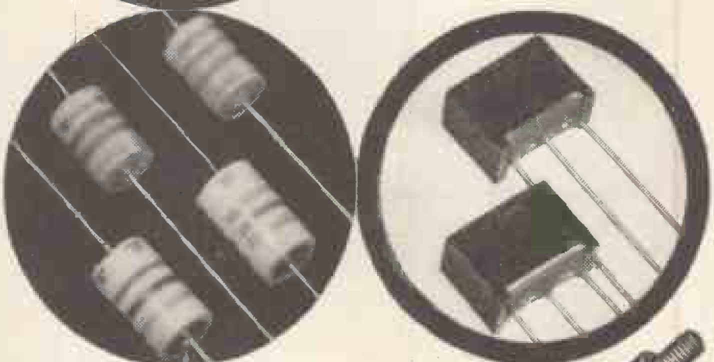

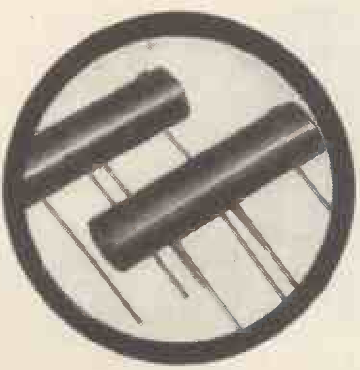

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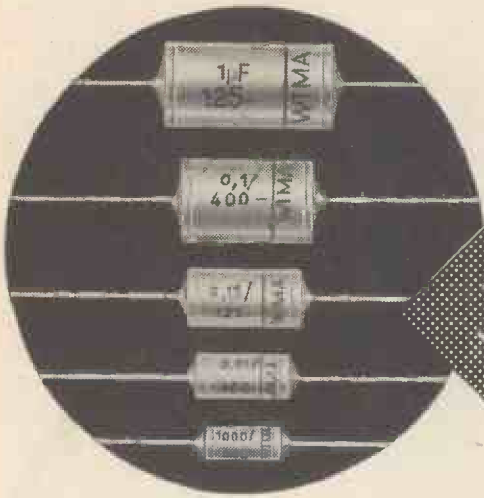

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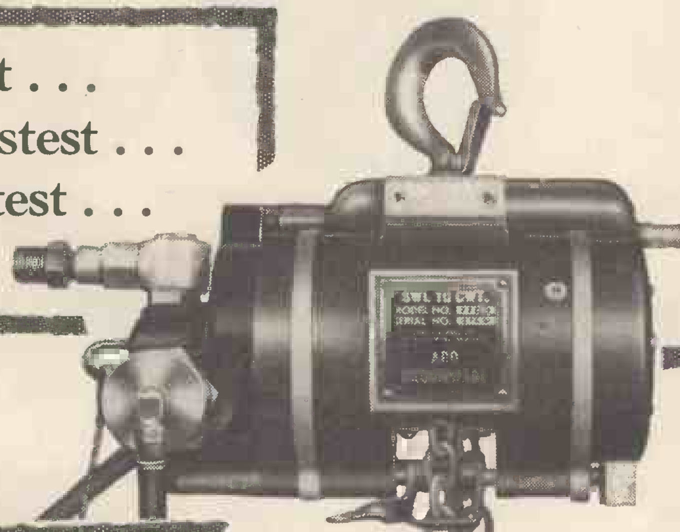

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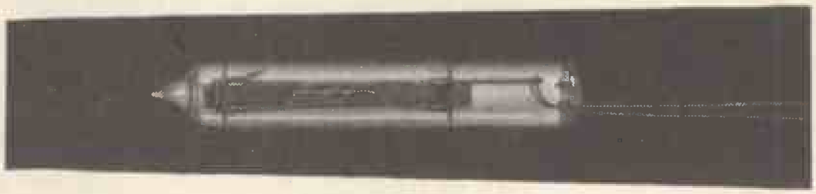

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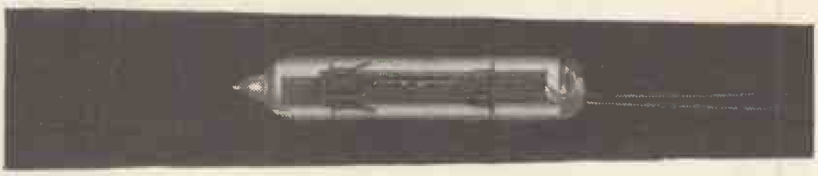

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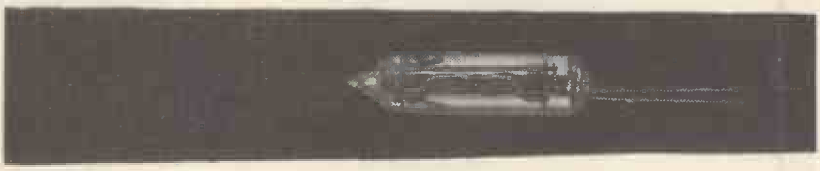

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Wearite 4B	£41	10	0	$119
Brenell Mk. V	28 gns.			$84
Brenell Stereo Deck	£33	16	0	$101

Brenell Pre-Amp. and Amp.	£24	0	0	$69

Microphones by Lustraphone, Reslo, Acos, Simon, etc.

● TAPES BY ALL LEADING MAKERS

★ SPEAKER SYSTEMS

Quad Electrostatic	£52	0	0	$149
Wharfedale SFB/3	£39	10	0	$113
Wharfedale Coaxial 12	£25	0	0	$72
Wharfedale Golden 10	£8	14	11	$20
Tannoy 12in. Monitor	£30	15	0	
Tannoy 15in. Monitor	£37	10	0	
WB. 1016	£7	12	3	$16
Goodmans AL.120	£29	10	0	$84
Goodmans AL.100	£23	10	0	$67
Goodmans Triaxiom	£25	0	0	$72
Goodmans 300	£11	5	9	$32
Goodmans 400	£16	1	0	$41
Kelly Ribbon Mk. II	£10	10	0	$30

★ MOTORS AND PICK-UPS

Decca Stereo P.U. complete	£21	0	0	$45
Lenco GL60 Trans. Unit	£27	12	6	$60
Lenco GL58/R, Stereo P.U.	£24	5	7	$53
Garrard 301	£22	7	3	$49
Garrard 4HF/Stereo P.U.	£19	4	8	$45
Connoisseur Motor Type "B"	£27	16	1	$59
Connoisseur, 2 sp. Motor	£16	13	1	$36
Goldring 700	£9	14	9	$21

★ AMPLIFIERS & TUNERS

Quad 22-Control Unit	£25	0	0	$73
Quad II Amplifier	£22	10	0	$65
Leak Stereo 20 Amp.	£30	9	0	$87
Leak Point One Pre-Amp.	£21	0	0	$60
Rogers Junior Stereo	£28	10	0	$82
Rogers Master Stereo Unit	£35	0	0	$100
Quad FM Tuner	£28	17	6	$60
Chapman AM/FM	£29	8	0	$60

Enquiries for all items by firms mentioned in this advertisement invited.

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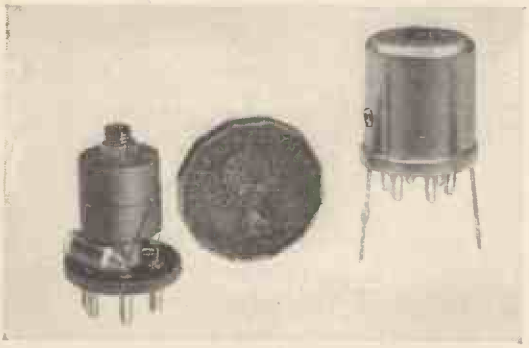

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16 x 9 x 8in. with Alum. Panel	£2	12	6
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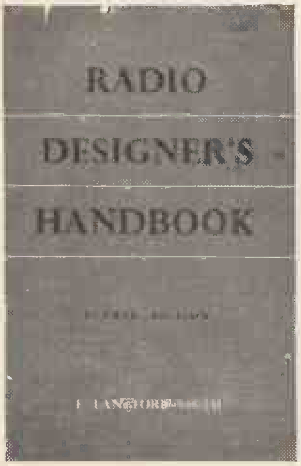

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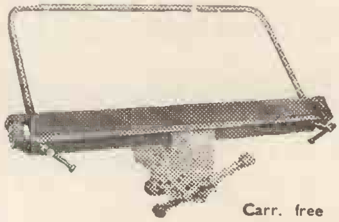

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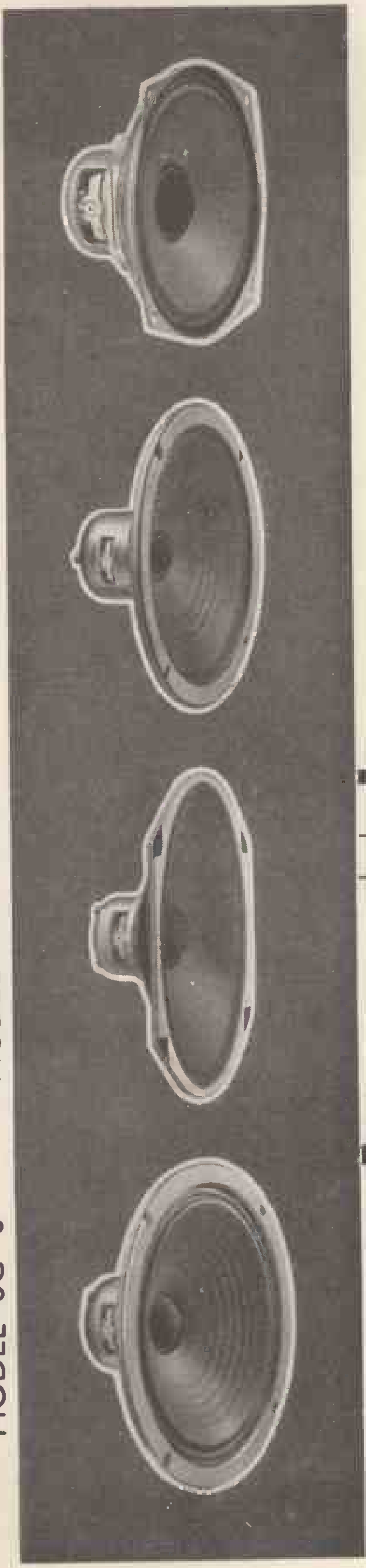

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7 x 3in.	37G	6500 g	20/6	6/7
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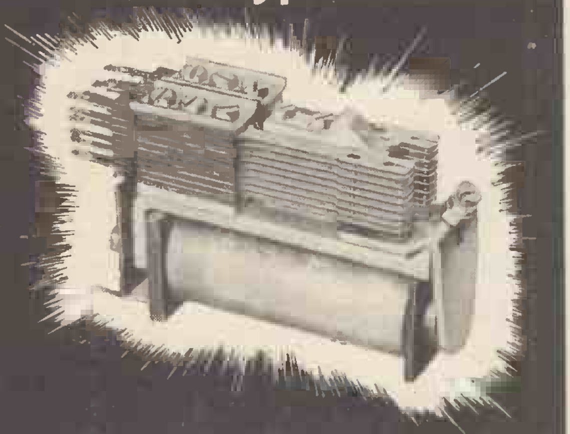
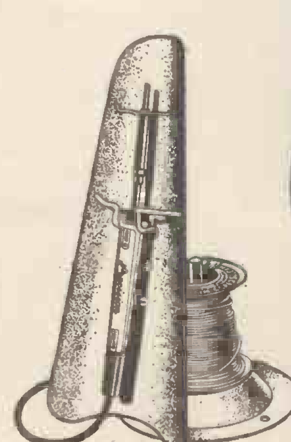



3/64"
5/64"
3/32"
5/32"
3/16"
3/16"



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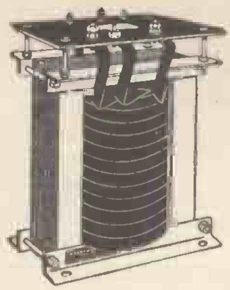

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12 V	15 A	£4
60 V	40 A	£25
110 V	4 A	£9
18 V	30 A	£9
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24 V	30 A	£12
30 V	25 A	£14
30 V	40 A	£13
55 V	15 A	£12
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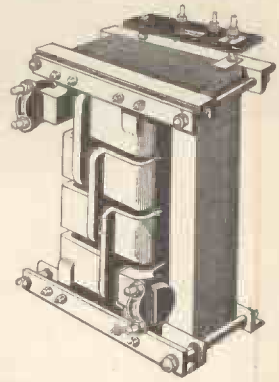
110 V	10 A	£13
40 V	25 A	£14
5 V	300 A	£20
6–12 V	50 A	£8
12 V	60 A	£12
12 V	100 A	£16
50 V	60 A	£27
10–20–30 V	100 A	£28
110 V centre tapped	25 A	£24
6–12–18–24–30 V	12 A	£8

5 V	7,000 A	£110
4 V	6,000 A	£94
8 V	3,000 A	£80
3 V	4,000 A	£61
10 V	700 A	£47
10 V	1,000 A	£64
10 V	500 A	£38
10 V	300 A	£30
12 V	1,500 A	£70
20 V	3,000 A	£129
20 V	4,000 A	£130
50 V	600 A	£80
6 V	300 A	£25
5 V	500 A	£31
2 V	2,000 A	£34
27 V	8,000 A	£225
100 V	700 A	£136



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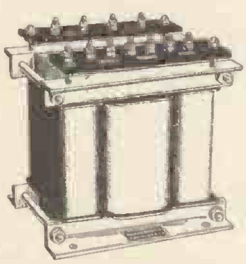

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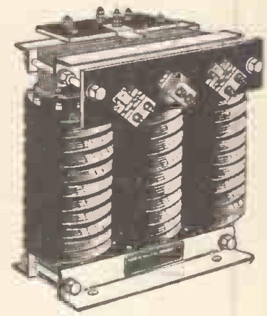

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100 A	£99	£116	£171

25% OVER-VOLTS AVAILABLE AS EXTRA

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For 240 V. AC. The larger outputs are available for 3-phase supply.
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Prices are without Meters and Regulators.

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6 V	50 A	£47
6 V	100 A	£66
12 V	10 A	£15
12 V	20 A	£22
12 V	30 A	£28
12 V	60 A	£45
12 V	105 A	£62
12 V	210 A	£83
12 V	1,000 A	£185
24 V	12 A	£23
24 V	20 A	£27
24 V	30 A	£33
24 V	60 A	£41
24 V	105 A	£70
24 V	200 A	£86
24 V	750 A	£262

36 V	10 A	£26
36 V	20 A	£32
36 V	40 A	£42
36 V	60 A	£55
110 V	5 A	£44
110 V	10 A	£54
110 V	15 A	£68
110 V	20 A	£80
110 V	25 A	£90
220 V	130 mA	£15
250 V	6 A	£49
250 V	10 A	£70
250 V	15 A	£89
250 V	20 A	£110
1,200 V	225 mA	£30

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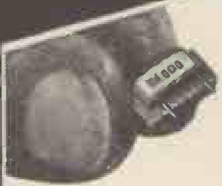

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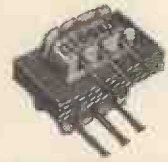

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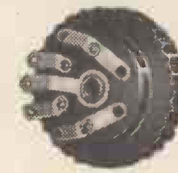

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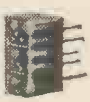

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brings out the best in any recorder

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In the DP4, with a uniform wide frequency response from 50 c/s to 15,000 c/s, Grampian have developed an outstanding, moderately priced instrument which will please the most exacting recordist.
The DP4 is equally suitable for Public Address, Broadcasting, Call Systems, etc.

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DP4/L, low impedance 25 ohms 86 dB below 1 volt/dyne/Cm².
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Retail Price: DP4/L complete with connector and 18ft. screened lead, £7/11. (Medium or High Impedance models, £1 extra).

A complete range of stands, swivel holders, etc., is available also.

A matching Unit (Type G7) can be supplied for adapting the microphone for a Recorder having a different input impedance, or when a long lead is required. Retail Price £3/5/-.

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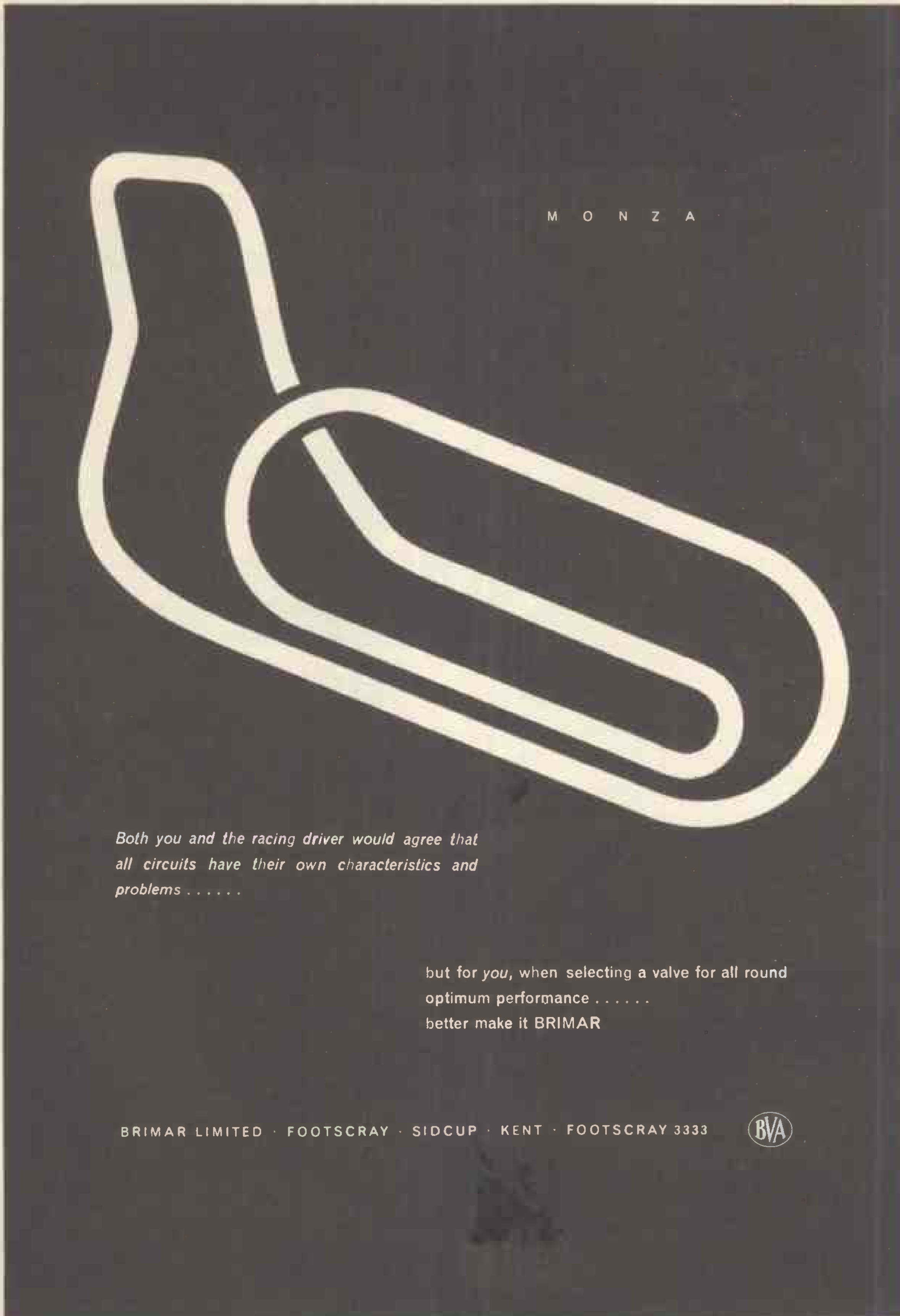
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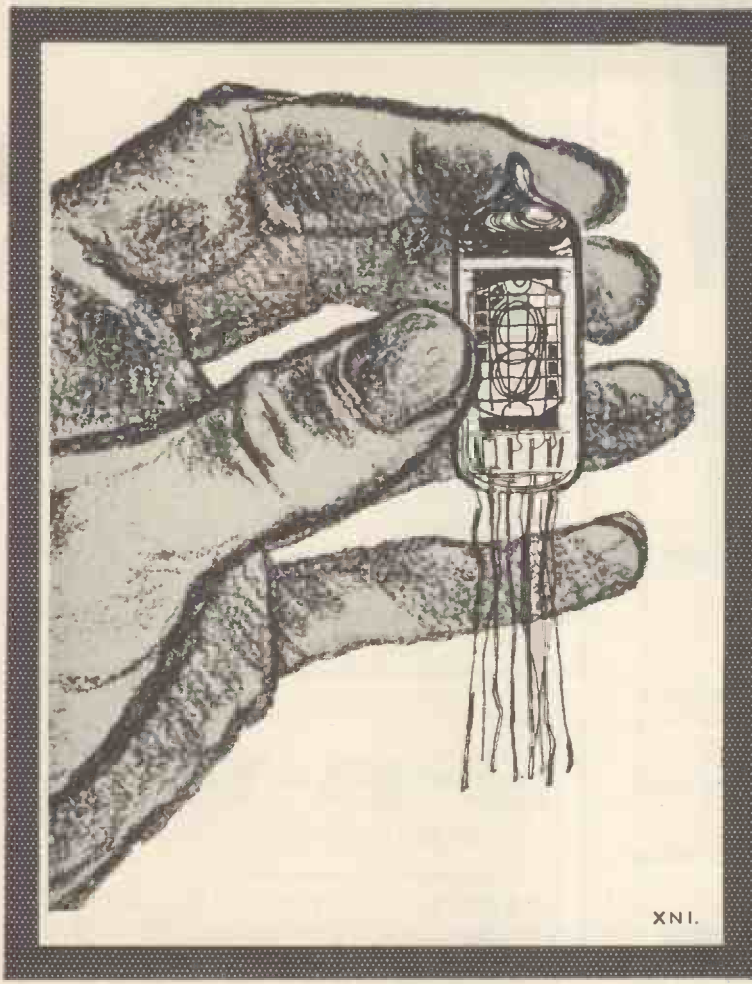

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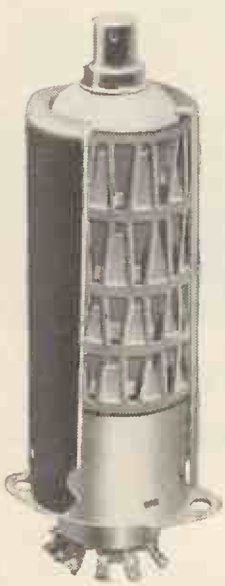

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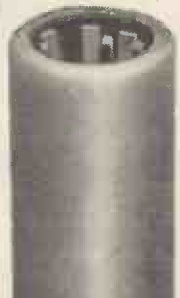

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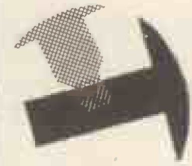

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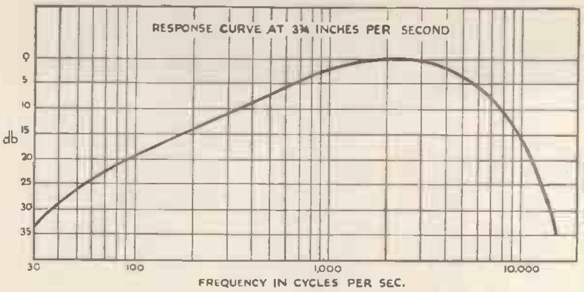

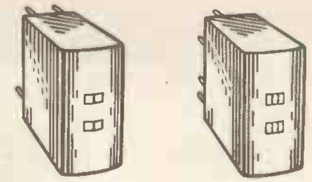

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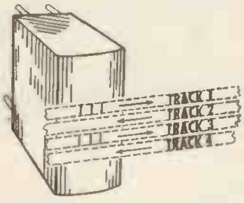
ACTUAL SIZE OF HEAD

HEIGHT ¾" DEPTH ¾" WIDTH ⅜"



TECHNICAL SPECIFICATIONS

PLEASE NOTE—Heads for the Four-Track Standard are themselves made to record on TWO Tracks, so that with the tape reversed (other way up) they record a total of Four Tracks (see Diagram)

RECORD/PLAYBACK HEADS

Track width	0.043 in.
Inductance	400mH at 1 Kc/s.
Gap	0.0001 in.
Bias Current	0.45–0.8mA.
Record Current	30–80μA.
Output	1.4–2 5mV. (at 2 Kc/s. at $3\frac{3}{4}$ in/sec.)
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Playback Crosstalk	Not measurable

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Summary of typical properties

Magnetic Properties	Supermumetal 50	Mumetal	Radiometal	Super Radiometal	Radiometal 36	R.2799
Initial Permeability	50 000	40 000	3 500	10 000	2 000	
Maximum Permeability	200 000	100 000	30 000	100 000	10 000	70 at 0°C 48 at 20°C
Saturation Ferric Induction (gauss)	8 000	8 000	16 000	16 000	12 000	3200 at 0°C 2200 at 20°C
Remanence, Brem, from saturation (gauss)	5 000	4 700	10 000	11 000	3 500	
Coercivity, Hc. (oersteds)	0.01	0.04	0.15	0.04	0.30	
Hysteresis loss at B sat (erg/cc/cycle)	13	38	1 000	400	450	
Curie Point (C)	390	390	500-550	500-550	280	60

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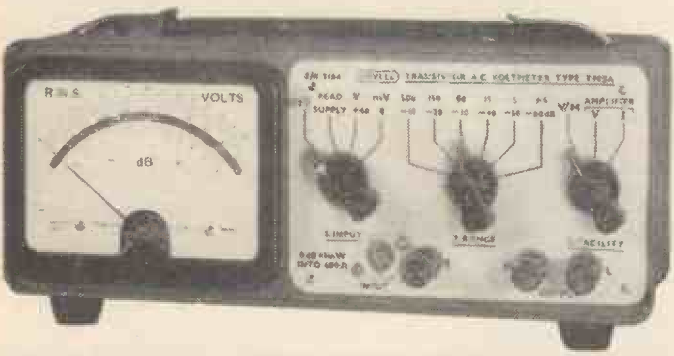

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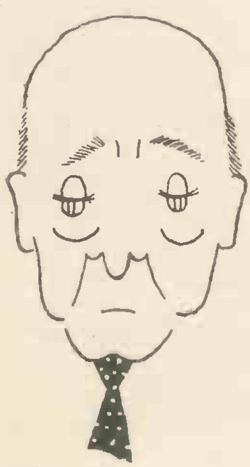

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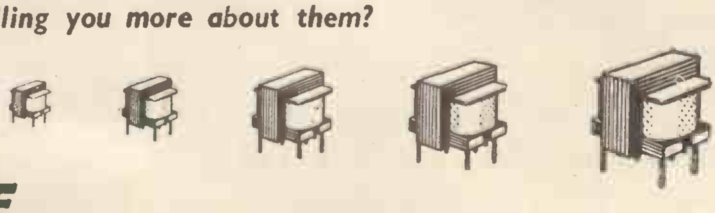

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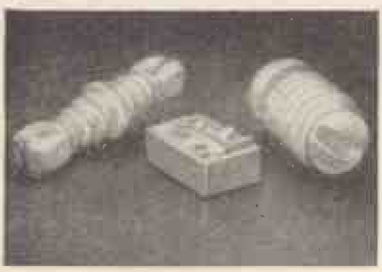

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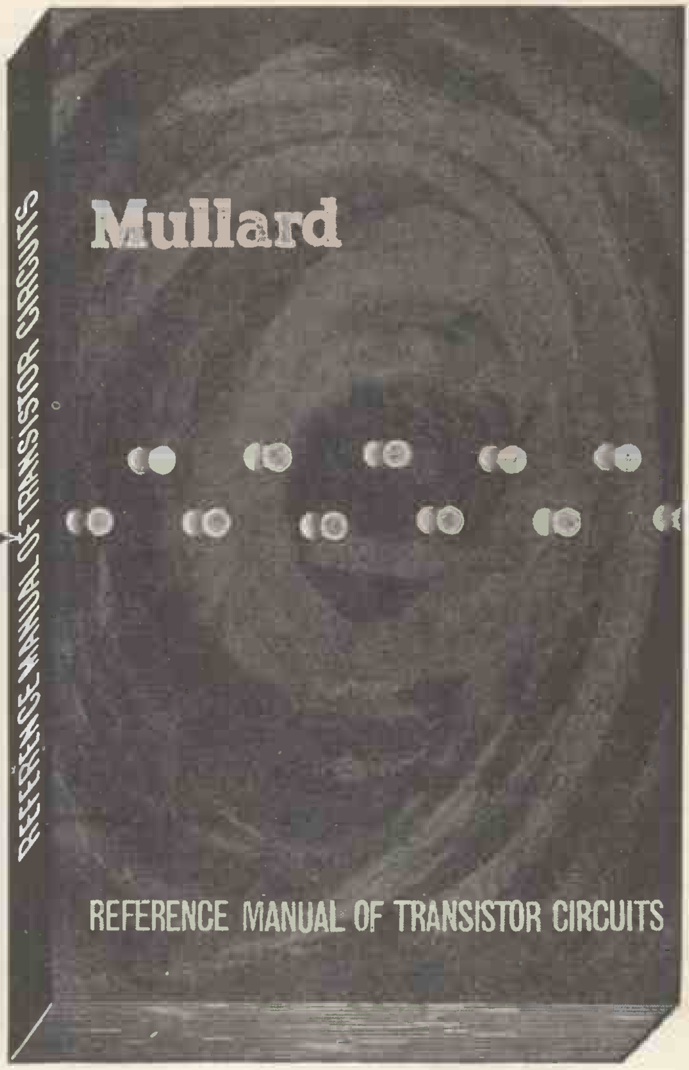

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"BELLING-LEE" NOTES

No. 30 of a Series

Some mechanical aspects of design: Part 3.

Continuing the subject of plugs and sockets, let us take a look at contact materials or, more specifically, beryllium-copper which is the material of which the resilient sockets of most top quality connectors are made today. There are two main reasons for this. The choice of materials combining high resilience with good electrical conductivity is in any case not very wide, and of those available, the two most commonly used, spring brass and phosphor-bronze, both suffer a serious loss of resilience under prolonged heating even at temperatures as low as 100° C. This, of course, is by no means an uncommon ambient for modern high performance equipment, and is considerably exceeded in normal soldering operations. The second reason, which is equally compelling, is that the two materials mentioned can only be stiffened by work hardening, and therefore they must be fabricated in a hard state if adequate final stiffness is to be achieved; this means that they cannot be formed to the very small radii which are inherent in intricate miniature parts. We shall see presently how beryllium-copper scores in this respect.

The softness of solid metals and alloys is due to their crystalline structure. The atoms within the crystals are arranged on a lattice pattern, which depends on the material and its temperature, and when the individual layers of the lattice can slip easily over each other in all directions, the material is soft. In the process of work hardening, as the material is distorted, definite planes of slip are set up, and further movement takes place less readily owing to interference at the grain boundaries, so that stiffness is imparted.

When beryllium-copper billets are processed, e.g. by rolling or drawing into sheets, strip, wire etc., this is carried out at a temperature around 800°C. Under these conditions the beryllium goes into solution in the copper, and by cooling the material quickly, e.g. by quenching in water, the beryllium is held in solution and the resultant material behaves very much like pure copper, i.e. it is soft. Of course it can be stiffened by work hardening but, and this is important, it can also be hardened by heat treatment at a moderate temperature. When raised to some 300°C and held there for 2 or 3 hours, the beryllium is thrown out of solution and deposited along the inter-crystalline boundaries where it acts like sand on the rails, reducing slip, i.e. increasing stiffness. This is known as precipitation hardening. The process is reversible, and by heating to the higher temperature of 800°C again, and quenching, the material becomes soft once more. If the alloy has been work hardened prior to heat treatment, the beryllium is precipitated between the slip planes as well, imparting extra hardness, and in the fully hardened condition there are few if any other non-ferrous metals to equal it. It is similar in character to many high grade alloy steels, but is non-magnetic and non-sparking, and evinces good anti-corrosion properties. The elastic limit is high, and the modulus of elasticity is low, with a high fatigue resistance. Its electrical and thermal conductivities, however, are high, being greater than for any other material of comparable mechanical properties. In addition to beryllium, a small percentage of cobalt or nickel (not more than 0.5%) is normally included mainly to improve the response to heat treatment.

For making intricate contacts, like those in "Belling-Lee" printed circuit connectors, the fully annealed (soft) alloy is used, and the tools work harden the contacts to slightly more than half-hardness at the points where maximum stiffness is required. Careful tool design is necessary so as not to overdo this. The subsequent heat treatment process is also critical, both as to duration and temperature. If it is not carried on for long enough, or the temperature is too low, full precipitation does not occur, and the material is not hardened sufficiently. On the other hand, if the process is continued for too long, migration of the beryllium takes place from the crystal boundaries and forms an agglomeration within the copper, while if the temperature is too high the precipitate is coarse in structure. The effect in both cases is to produce a loss of hardness, although the material is less ductile than it was before hardening*. Continuous quality control by micro-hardness testing is therefore applied to every batch of contacts before they are passed for plating and assembly.

(To be continued.)

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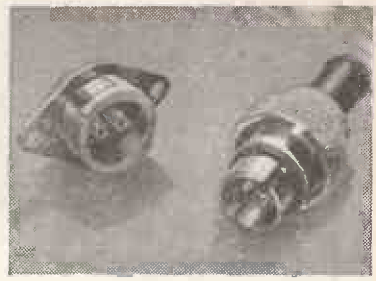

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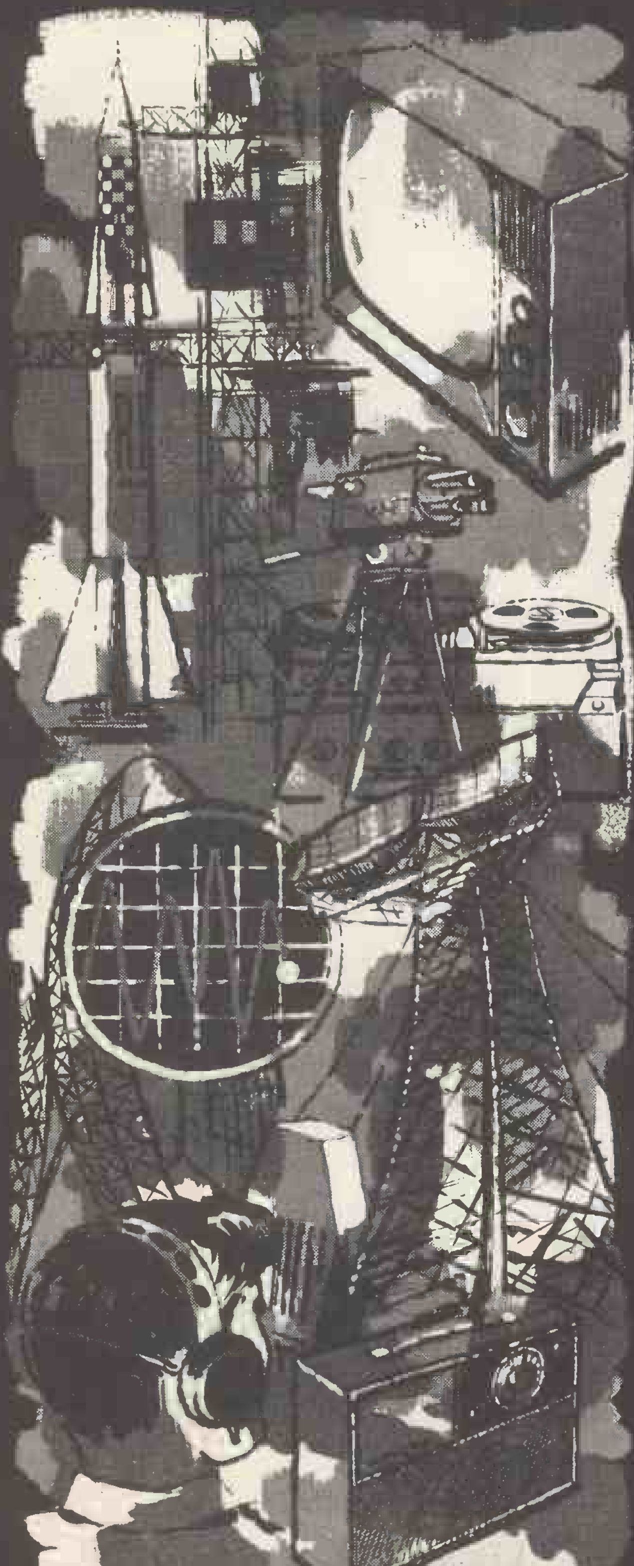

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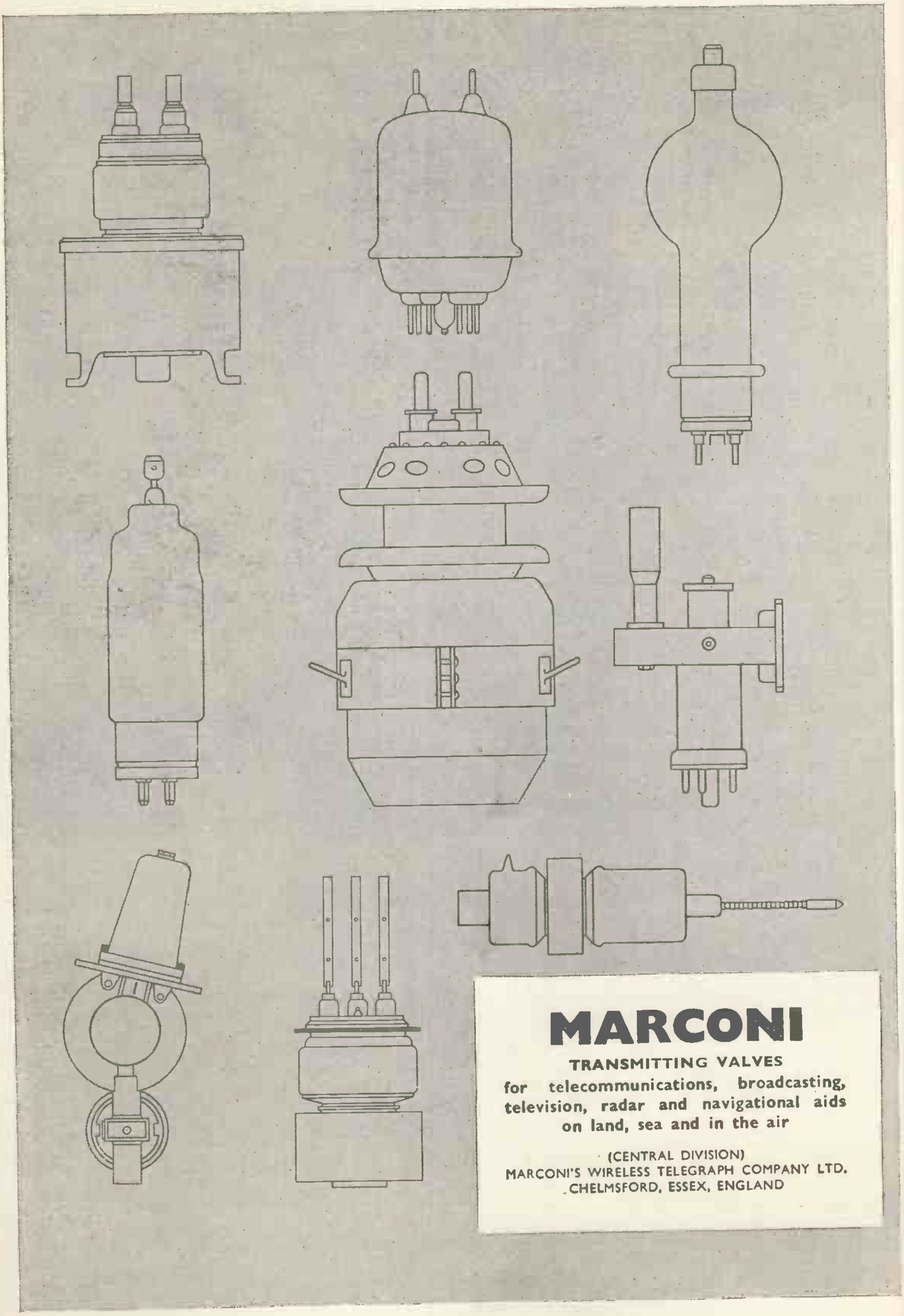

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Radiotelephones by ***ATE*** *— a vital service for isolated communities*

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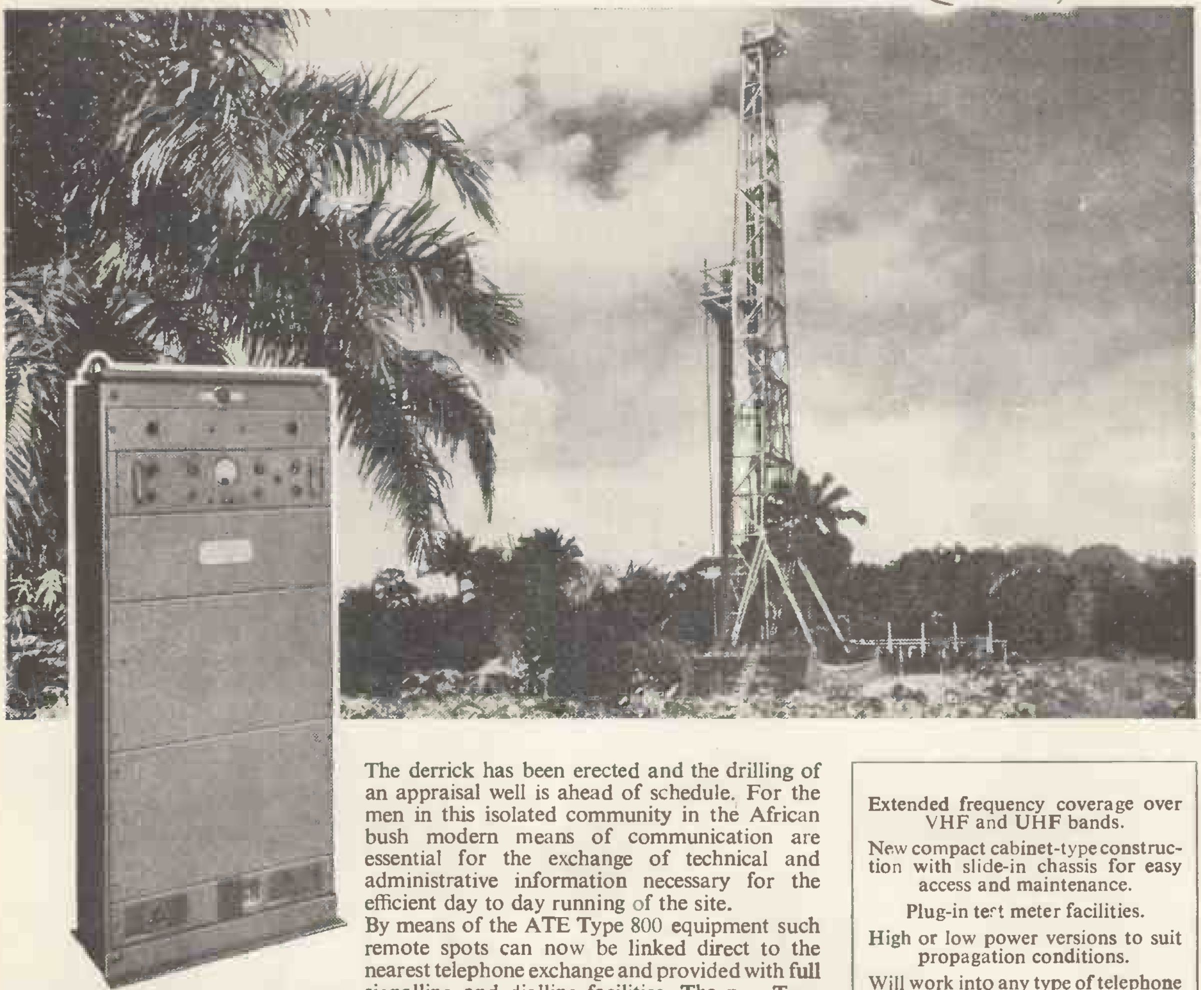

TYPE 800

ATE Radiotelephones are used by industrial, mining, agricultural, civil and military enterprises — and by research and survey teams — in 60 countries.

The derrick has been erected and the drilling of an appraisal well is ahead of schedule. For the men in this isolated community in the African bush modern means of communication are essential for the exchange of technical and administrative information necessary for the efficient day to day running of the site.

By means of the ATE Type 800 equipment such remote spots can now be linked direct to the nearest telephone exchange and provided with full signalling and dialling facilities. The new Type 800, latest in the ATE single channel VHF rural radio-telephone range, is specially equipped with full signalling and control equipment for this purpose. Exhaustive testing under actual climatic extremes has fully proved its outstanding practicability and efficiency.

Extended frequency coverage over VHF and UHF bands.

New compact cabinet-type construction with slide-in chassis for easy access and maintenance.

Plug-in test meter facilities.

High or low power versions to suit propagation conditions.

Will work into any type of telephone exchange with improved 'outband' tone signalling facilities.

Modern design conforming to British Post Office, Canadian Department of Transport and Crown Agents' specifications.

If you would like to know more about this new mains operated equipment or its battery operated counterpart, the Country Set, write for full particulars to your local representative . . . or send for Bulletin REB 4101/1

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300µV to 3V up to 900 Mc/s and D.C.

MILLIVOLTMETER TYPE 301

The Airmec Millivoltmeter Type 301 is a compact, lightweight instrument employing advanced circuitry to achieve a low noise level and a high degree of stability. It measures alternating voltages from 300 microvolts to 3 volts in the frequency range 100 c/s to 900 Mc/s, and direct voltages from 100 microvolts to 10 volts. A.C. inputs are rectified in a probe containing semiconductor diodes; for low frequency measurements the probe is plugged into a holder on the front panel, and alternative positions on the holder provide input impedances of 75 or 52 ohms. The advantage of this arrangement is that the attenuator handles only D.C., and is therefore free from frequency errors. The probe lead retracts into the case when not in use, stowage is provided at the back of the instrument for prods and mains cable, and the fuses and mains voltage adjustment are accessible without dismantling

•

FREQUENCY RANGE:
100 c/s to 900 Mc/s and D.C.

AC RANGE:
300µV to 3V in 8 ranges (also calibrated in dB relative to 1 volt).

DC RANGE:
100µV to 10V in 10 ranges.

ACCURACY:
AC: ± 5% fsd 1 mV to 3V up to 200 Mc/s ± 10% up to 900 Mc/s.
DC: ± 5% fsd 300µV to 10V.

INPUT IMPEDANCE:
AC: 120 kohms and 2pF at 100 kc/s; alternatives of 75 ohms and 52 ohms available at plug-in unit on front panel.
DC 5 Mohms.

Airmec

AIRMEC LIMITED, HIGH WYCOMBE, BUCKS. Tel: High Wycombe 2501.

Aspects of design 36

OPERATING CONDITIONS OF FIELD SCANNING OUTPUT STAGES* (PART 2)

This is No. 36 in the series of articles dealing with advanced problems in circuit design published by The Ediswan Mazda Applications Laboratory. No. 37 will appear next month. We shall be pleased to answer queries arising from this or other articles. Reprints of the first twenty-five articles, in booklet form, are available on request.

***In accordance with BS204: 1960 the internationally used term "field" replaces the previously used term "frame."**

CURRENT MEASUREMENTS

When designing output stages for field scanning in television receivers it is necessary to ensure that the stage is capable of providing sufficient scanning power in spite of production variations in components and normal variations in supply voltage. If the operating conditions are correctly chosen with respect to the published valve characteristics the need for early replacement may be avoided. The conditions must be chosen so as to provide a safety factor to accommodate production variations between valves and deterioration of characteristics during a reasonable length of life. Included in "Aspects of Design No. 35" were examples of measuring techniques whose purpose was to check that the minimum anode voltage at the end of the scanning stroke did not go below the minimum value stated in the valve data sheet. These further notes are intended to describe ways of ascertaining that the current swing demanded from the valve is within its capabilities during a reasonable length of life.

CURRENT WAVEFORM

Fig. 1 illustrates the circuit of a typical field scanning output stage. Because of the finite inductance of the transformer feeding the resistive load of the deflector coil, the anode current of the output valve must consist of a linear sawtooth component plus a parabolic component, in order to provide a linear scanning current. This gives rise to a total anode current waveform as shown in Fig. 2. Depending upon the relative magnitudes of transformer secondary inductance and deflector coil resistance, the required anode current may vary between the dotted curve (a) for a high inductance and the dotted curve (c) for a low inductance. It is advisable to adjust the inductance so that the required current waveform is close to that shown in the full curve (b) when the rate of change of current is close to zero at the beginning of scan. This leads to ease of linearising and renders the stage less susceptible to changes in operation due to production variations in components. This method of operation is often referred to as the mode of Zero Initial Slope (Z.I.S.)

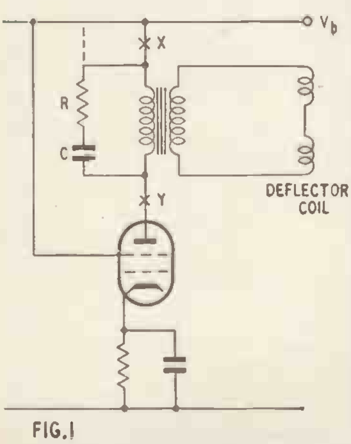

FIG. 1

ANODE CURRENT MEASUREMENT

It was pointed out in "Aspects of Design No. 3" that anode current measurements should be carried out using the lowest HT line voltage obtained over the range of receiver mains taps (with taps correctly adjusted) with this value further reduced to allow for variations in supply voltage. Assuming these conditions, if the stage is made to scan the face of a tube supplied with EHT of a value equal to the nominal design centre value of the receiver, normal production variations of deflector coil and transformer will be taken into account. It is under these conditions that the measurement of peak to peak current swing should be carried out (i_{app} in Fig. 2).

The anode current waveform may be examined by inserting an accurately measured resistor of about ten or twenty ohms in the anode circuit at point X in Fig. 1 and viewing the voltage waveform across this resistor on a d.c. connected oscilloscope. The oscilloscope must have no connection to earth and the insulation between it and mains supply must be adequate to withstand the HT supply voltage. If damping components C and R, or a voltage dependent resistor are connected across the transformer primary, the measuring resistor must be connected between the junction of these components with the primary and the HT line. If these components are returned separately to the HT line, as shown dotted, the true anode current waveform will not be displayed.

In some circuits the damping components are connected from the anode side of the transformer primary to earth as part of the linearising feedback circuit. In this case, the measuring resistor will show a true waveform only if inserted at point Y. This places more exacting demands on the insulation of the oscilloscope since it now has to stand the peak anode voltage of the valve during flyback. This may approach 1000 volts in many cases. However, if the impedance of the shunting components from anode to earth is greater than about 100,000 ohms, the error in connecting the resistor at point X will be negligible.

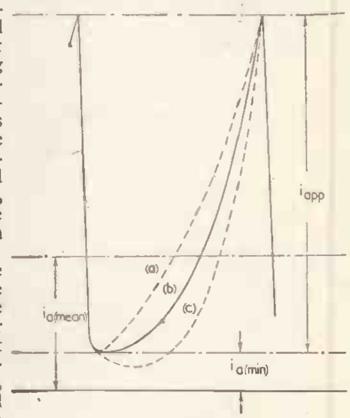

FIG. 2.

The peak to peak anode current swing measured in this way must be less than the value stated for the particular Ediswan Mazda valve.

CHOICE OF BIAS RESISTOR

Having established that the demanded current swing is within the capabilities of the valve it is necessary to ensure that the bias conditions of the valve are satisfactory. The receiver should be operated with nominal HT line and the amplitude of scan adjusted to be correct. The anode current waveform should again be viewed and the value of current at the minimum of swing noted (that is, $i_{a(min)}$ in Fig. 2). This requires a d.c. connected oscilloscope, as previously stated, and in addition the zero level of the oscilloscope should be known. This is not so simple as may appear at first sight when it may seem that all that need be done is to short circuit the measuring resistor and note the undeflected position of the trace. With many oscilloscopes, particularly those of the "high speed" type it will be found that if the zero is set and marked and then a waveform of fairly high amplitude applied, there will be a small drift immediately after application of the waveform. If the input to the oscilloscope is again short circuited, the trace will not return exactly to its original zero position but will drift to that position in one or two seconds. This difficulty can be overcome by wiring across the measuring resistor the contacts of a high speed relay so as to short circuit the resistor when the relay is energised. The relay may then be energised by a multivibrator free running at some frequency preferably greater than 25 c.p.s. (although it is possible to use much lower frequencies). This has the effect of periodically inserting a zero line on the trace, which simplifies measurement of minimum anode current.

The bias resistor should be chosen so that, using a valve with approximately nominal characteristics, the minimum anode current is approximately 22% of the mean anode current. This ensures that, using a 5% bias resistor, the anode current will not limit by swinging to zero either with variation of valves in production or during a reasonable length of life.

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Crown House, Aldwych, London, W.C.2
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Triode Tetrode for video output applications

EDISWAN MAZDA 30FL12

The 30FL12 consists of a high slope tetrode with frame grid construction for use in a video output stage, and a general purpose triode.

Higher peak current with an appreciably higher slope is available from the tetrode, as compared with the 30FL1, so enabling adequate video drive to be provided for the cathode ray tube, with anode loads down to 4,700 ohms. This low value of load eases the problems of HF video compensation.

The triode has identical characteristics to the 6/30L2.

Heater current (amps)	I_h	0.3
Heater voltage (volts)	V_h	9.8

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

		Triode	Tetrode
Anode Dissipation (watts) ..	$p_{a(max)}$	1.5	2.5
Screen Dissipation (watts) ..	$p_{g2(max)}$	—	0.8
Anode Voltage (volts) ..	$V_{a(max)}$	250	250
Screen Grid Voltage (volts) ..	$V_{g2(max)}$	—	250
Heater to Cathode Voltage (volts rms)	$V_{h\ k(max)rms}$	—	150*

*Measured with respect to the higher potential heater pin.

Inter-Electrode Capacitances†(pF)

		Triode	Tetrode
Input	c_{in}	2.3	8
Output	c_{out}	2.0	2.6
Control Grid to Anode ..	c_{g-a}	2.4	0.04
Grid Triode to Grid 1 Tetrode	c_{gt-g1}	0.003	
Anode Triode to Anode Tetrode	c_{at-aq}	0.012	
Grid Triode to Anode Tetrode	c_{gt-aq}	0.004	
Anode Triode to Grid 1 Tetrode	c_{at-g1}	0.008	

†Measured in fully shielded socket without can.

CHARACTERISTICS

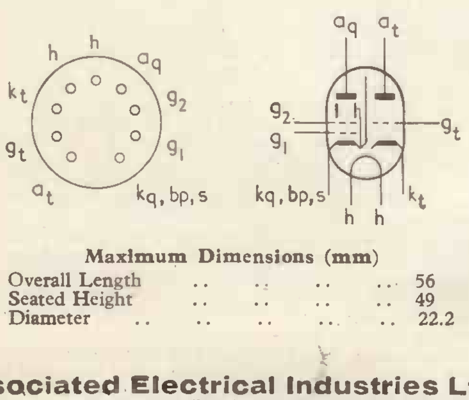
		Triode	Tetrode
Anode Voltage (volts) ..	V_a	200	180
Screen Grid Voltage (volts) ..	V_{g2}	—	180
Anode Current (mA) ..	I_a	10	10
Mutual Conductance (mA/V)	g_m	3.4	12.5
Amplification Factor	μ	18	—

TETRODE OPERATION AS VIDEO AMPLIFIER

Allowance must be made in circuit design, not only for component variation, but also for valve spread and deterioration during life. Values of tetrode peak anode current, for an average valve when new and at the assumed end-of-life point for any valve, are as follows:—

	V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)
Average New Valve	70	180	−1	40
Assumed End of Life Condition	60	180	−1	25

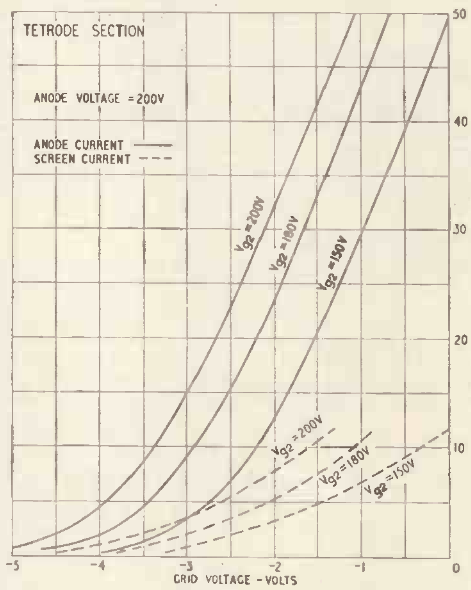
Mounting position: Unrestricted.
Base: B9A (Noval).

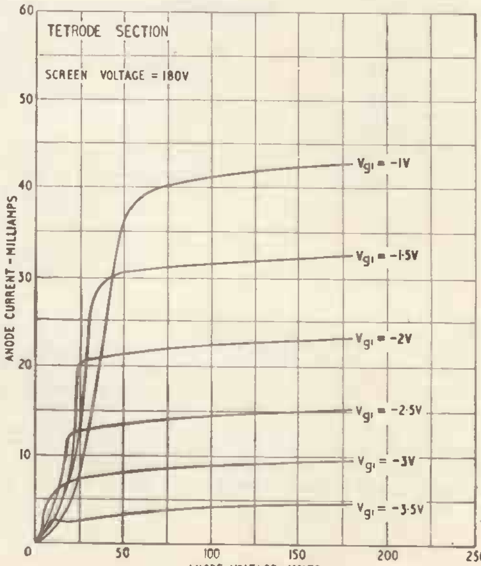


Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22.2

Tentative Characteristic Curves of Ediswan Mazda Valve Type 30FL12.





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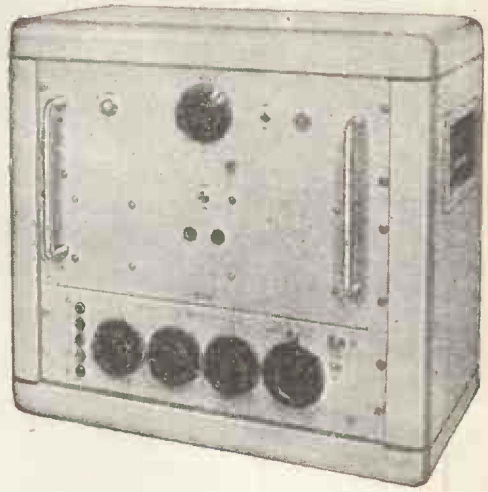
Vortexion quality equipment

120/200 WATT AMPLIFIER



Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise level —95 dB. A floating series parallel output is provided for 100-120 V. or 200-250 V. and this cool running amplifier occupies 12¼ inches of standard rack space by 11 inches deep. Weight 60lb.

30/50 WATT AMPLIFIER

Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1% and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than —85 dB referred to 30 watt.

It is available in our standard steel case with Baxendale tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.

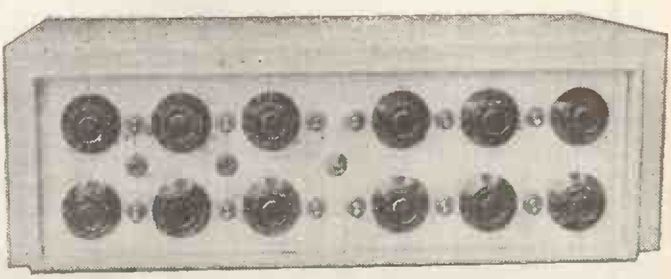
ELECTRONIC MIXER/AMPLIFIER

This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxendale 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 impedances 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 x 7in. rack panel form or in standard ventilated steel case.

Size 18 x 7½ x 9½in. 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. 4-way mixers and 2 x 5-way stereo mixers with outputs for echo chambers, etc. Details on request.

Full details and prices of the above on request

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LEAK, who gave the world the first very-low-distortion amplifier, now present a very-low-distortion moving coil loudspeaker system which sets a new standard.

The illustrations show the Trough-Line II F.M. Tuner, the Varislope Stereo Pre-Amplifier and the Stereo 20 Power Amplifier housed in the Southdown Cabinet, and above, the new Sandwich Loudspeaker System.

The new LEAK "SANDWICH" LOUDSPEAKER SYSTEM is the product of many years of research and development work

The cabinet is of unique construction which damps panel resonances and permits the loudspeaker motor to reproduce full clean báss without the "boxy" coloration of conventional cabinets. A 3in. and a 13in. moving-coil loudspeaker motor of novel design and a half-section cross-over network complete the system which gives the highest quality of reproduction over the whole frequency range of the input signal from records, radio, tape or microphone. THE GREATEST ADVANCE IN THE DESIGN OF MOVING-COIL LOUDSPEAKERS SINCE RICE-KELLOGG INVENTED THE FIRST UNIT IN 1925 HAS NOW BEEN MADE BY LEAK WITH A NEW INVENTION WHICH ELIMINATES BREAK-UP DISTORTION IN THE WORKING RANGE. The 13in. unit employs a new cone whose stiffness to weight ratio is 200 times better than the best cones which are currently available. The low stiffness of conventional cones results in the flexing of the cone at large amplitudes and break-up resonances. The new LEAK cone, which has immense stiffness for no greater weight than a conventional cone, has, for the first time, given us a loudspeaker which behaves as the theoretical ideal of a rigid piston; thus there is no flexing of the cone at large amplitudes and there is no break-up distortion within the frequency range handled by the loudspeaker. It is this freedom from coloration, produced in conventional systems by break-up distortion of the cone and cabinet resonances, which distinguishes the superior quality of reproduction of the LEAK "SANDWICH" LOUDSPEAKER SYSTEM from that of the best currently available loudspeaker systems. The cabinet measures only 26in. × 15in. × 12in.; it can be used in the vertical or horizontal position to suit the convenience of the user.

Price £39 : 18s.

See your LEAK dealer or POST THE COUPON now for full details of this superb new EQUIPMENT.

Please tick your requirements below:

- ☐ *New Loudspeaker System.*
- ☐ *Hi-Fi Equipment.*

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Separate bass and treble controls .. 8 gns.

Extra speaker if required (9 x 5in. high flux density) .... 1½ gns.

De luxe Cabinet

(to take two 9 x 5in. loudspeakers) 8 gns.

Standard Cabinet

(takes one 9 x 5 in. loudspeaker) .. 4 gns.

Latest Collaro Studio 4-track 3-speed transcriptor with pause and digital counter .... 13 gns.

Microphone, recording leads, 1,200 ft. 7in. spool and spare 7in. spool .. 3 gns.

Complete kit, de luxe cabinet with two 9 x 5in. speakers .... 29 gns.

Or deposit of £10 and 12 monthly payments of £1/15/6.

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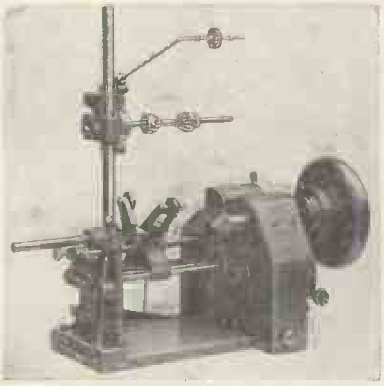

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"I find this set even better than you claim it to be and most certainly up to your usual standard of quality. I feel that nobody could fail to build it and get results. Even the first-time-ever novice, as your circuit diagrams and instructions are so clear and precise."

Mr. A. J. Simmonds, Welling, Kent.
"I purchased from you a week ago the Pocket 4 Transistor Kit. I put it together last night in 1½ hours, on switching on the set I was right on Radio Luxemburg. I must say thank you because not only has the set a very attractive appearance, it also behaves fantastically."

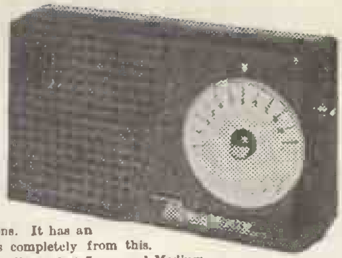
Over 1,000 letters received.

Pocket 5 Q.P.P.

This pocket receiver is just right for taking on holiday. It has a remarkable performance comparable in fact with portables being sold at £10 and over. It uses a three inch moving coil speaker to give high quality tone and the output is circuit push-pull. It completely tunes over the medium and long wavebands. The price is £4/15/- complete, postage and insurance 2/6 extra.

AVAILABLE AGAIN FROM 32/6

All circuits are reflex type and have been carefully tested and none need aerial or earth, also all are contained in proper radio cases (not adapted sandwich boxes) and use proper tuning condensers and scales.



POCKET 4 (3 Transistors, 1 Diode).
This set gives good performance in all areas and has real entertainment value, and can be heard all over the room in reasonably quiet conditions. It has an internal aerial and works completely from this. Basically it covers Medium Waves, but Long and Medium Waves are available as an optional extra. Also, details are given of additional stages than can be added to bring the volume up to car radio level. Price for all parts and case (size 5½in. × 3in. × 2in.) as illustrated but less motifs is £2/2/6, plus 2/6 postage and insurance. Batteries are 10d. extra.

POCKET 3 (2 Transistors, 1 Diode)
This is the Pocket 4 less the audio stage. In Eastbourne, recognized as a poor reception area, the Home Service comes in at a comfortable level, and the Light Programme comes in well with the Long Wave addition. Some Continental stations are also receivable. The Pocket 3 is essentially a "close to the ear" receiver, and although it is fitted with a miniature loud-speaker the volume is not enough to be heard more than a yard or so away from the loudspeaker except in areas of high signal strength. A point worth noting, however, is that a conversion is available which enables the Pocket 3 to be made into a Pocket 4 with very little re-building. Price for all parts and case as illustrated, but less handle and motif is 32/6, plus 2/6 postage and insurance.

POCKET 5 (4 Transistors, 1 Diode and DLR 5 Speaker)
This is the Pocket 4 with the necessary additional parts to add on an audio stage to bring up the volume two or three times, also components are supplied for tone correction, and feed back, features which all go to improve quality of output. Constructors are recommended to build the Pocket 4 first, get this operating properly then add the additional Pocket 5 stage. The price of the additional stage is 12/6 making a total cost of £2/15/6, plus 2/6 postage and insurance. Long and Medium Wave parts for any of the above 6/6 extra. Batteries 10d. extra.

THIS MONTH'S SPECIAL OFFERS

Verdik Tape Recorder, very latest model 822 fitted with the finest tape deck available namely a Collaro Studio. Features include two tracks, three speeds 6 c.p.s. to 10 kc/s., frequency response 60 c.p.s. to 10 kc/s., 6 mv. sensitivity, 2 watt output. Tastefully styled portable case measures 15½ × 18 × 6½in. deep. Weighs approximately 26 lb. Uses 7in. spools, has magic eye record level indicator and record lock button to prevent accidental erase. Regular price 39 guineas, our price 33 guineas. Sent by insured tansport.

Verdik 10 watt Hi-Fi Amplifier, very latest model with pre-amp. control unit. Sensitivity 10 mv. for 10 watts, bass and treble lifts. Regular price 20 guineas, our price £14/19/6. Sent by insured transport.

American made Recording Tape. You must try this and will note its superior response. Acetate base. On plastic spools.

5in., 600ft.	16/-
5in., 900ft.	18/6
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7in., 1,200ft.	25/-
7in., 1,800ft.	35/-

1,000 ohm per volt A.C./D.C. Multimeter (ready built). Fifteen useful ranges volts up to 1,000 and current up to ½ amp. Resistance up to .2 meg. wide easily read scale with leads 59/6. Post and insurance 3/6.

PVC Connecting Wire, 25 SWG, 10,000 yds. for £10 assorted colours.

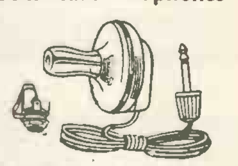
Transistorised Deaf Aids, by famous makers. Need attention, but complete, £3/10/-.

Acos Cartridge for Turnover Pick-up Head. As fitted to most popular record players for 78 r.p.m. and L.P. Price 10/- each.

Ditto for Stereo, 27/6.

Collaro Studio Tape Deck, latest transcription model, three motors, three speeds, push button controls. Price £12/10/- plus 5/- carriage and insurance.

Miniature Earphones



For Transistor Circuits or Deaf Aid. Very light weight and easy to wear, cord almost invisible, good quality production of music and voice, complete with miniature plug and socket, ready to use. Crystal and Magnetic, 9/-. Post and Insurance 1/-. Min. plug and socket as fitted to above. 3/6.

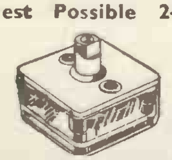
Solderless Transistor 3

Any boy from eight years onwards will easily make this pocket size transistor set. No soldering is involved and in fact the set can be made up virtually without tools. It is nevertheless a workmanlike job which, when completed, will receive Luxemburg and local stations entirely without aerial or earth. Uses two transistors and diode in reflex circuit. Other features include optional medium and long waves and loud speaker.

The parcel contains everything necessary to complete as follows:—
- Packet of Solderless terminals.
- Packet of Condensers.
- Packet of Resistors.
- Packet of Transistors.
- Connecting wire.
- Proper plastic transistor set case with printed scale and tuner.
- Hearing aid type headphone.
- Plug and socket with on/off switch, and full comprehensive easy to follow instructions.

Price 37/6 plus 2/6 post and insurance.

Smallest Possible 2-gang



With built-in trimmers, polystyrene cased, size only 1 × 1 × 7/16in., price 17/6. Smallest IF and oscillator to match, 21/-. P.P. input and P.P. output transformers 12/6. Circuit diagram free with any of above.

THE GOOD COMPANION

Largely due to the helpful criticisms and suggestions received from purchasers of our previous set "The Real Companion" we have improved and now supercede this with a new set which we call "The Good Companion." We feel confident that this new set is one of the finest of its kind available. The design is the combined efforts of our own technicians and of those of several of the leading manufacturers in the country, and the resulting set has a performance as good as if not superior to those selling at £20 and more. It has the *eight* transistor set performance.

Features include American Philco R.F. transistors and Mullard A.F. transistors —Q.P.P. output giving 750 mW—full coverage on Medium and Long—very fine tuning arrangement—excellent reception of difficult stations like 208—variable feed-back control—full tonal qualities—really superior looking cabinet size 11 × 8 × 3in. approximately—car aerial attachment—several months operation from battery costing only 3/6.

Circuit employs six transistors and two diodes, it incorporates all latest refinements, and oscillator I.F. Transformer are pre-aligned so no instruments are necessary. Any one who can solder competently can make this set. The instructions are fully comprehensive with plenty of illustrations. Service is available in the unlikely event of your getting into difficulties. All components fully guaranteed. Price of all components and cabinet to make set as illustrated £9/19/6. Post and insurance 5/-. Battery 3/6 extra.

Transistors for R.F., F.M., T.V. and U.H.F.

Frequencies quoted are approx. cut-off

SB 078 15-20 Mc/s.	8/6
SB 305, 20-30 Mc/s.	9/-
SB231R 40-50 Mc/s.	15/-
AMERICAN 2N1727 100-150 Mc/s	15/-
AMERICAN 2N1728 100-150 Mc/s.	12/6
AMERICAN T1832 1000-1300 Mc/s	25/-
AMERICAN T1833 1000-1300 Mc/s	25/-

SEND S.A.E. for transistor list and circuits.

Building A Scope ?

3in. oscilloscope tube, American made type No. 3FP7, base 6.3 v. 6. amp., heater, electrostatic deflection, brand new and guaranteed, with circuit diagram of scope, 15/- each, plus 1/6 post and insurance.

AGENTS WANTED

Agents wanted to make up these sets, send S.A.E. for details of special terms

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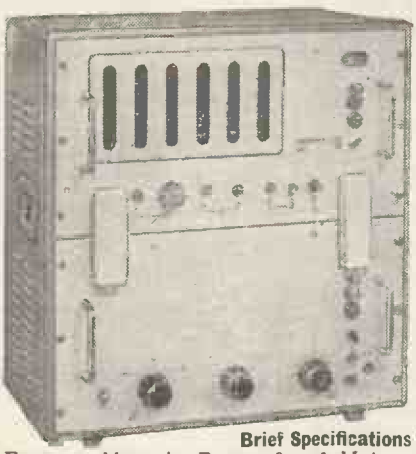
post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 66 Grove Road, Eastbourne, marked Department 2. Callers may use any one of the Companies below.

266 London Road, Croydon.	29 Stroud Green Road, Finsbury Park, N.4.	520 High Street North, Manor Park, E.12.	42-46 Windmill Hill, Ruislip, Middx.	246 High St., Harlesden, N.W.10.
Phone: CRO 6558.	Phone: ARChway 1049	Phone: ILFord 1011	Phone: RUIslip 5780	Phone: ELGar 4444.
Half-day, Wednesday	Half-day, Thursday.	Half-day, Thursday.	Half-day, Wednesday	Half-day, Thursday.

COUNTER AND FREQUENCY METER

Model 3006 is one of a very wide range of this type of equipment which we are able to supply. Please advise us your requirements, or ask for fully illustrated literature.



Brief Specifications:

Frequency Measuring Range 0 to 1 Mc/s.
Measuring Time 1 m/sec, 10 m/sec, 100 m/sec, 1 sec and 10 sec.
Accuracy $\pm$ 1 pulse $\pm$ quartz accuracy.
Time Measuring Range 10^{-5} to 10^{-7} sec.
Time Pulse 10μ/sec, 100 μ/sec, 1 m/sec, 10 m/sec, 100 m/sec, 1 sec, 10 sec.
Frequency $\pm$ 1 time pulse $\pm$ quartz accuracy.
Standard Quartz Frequency 100 kc/s $\pm$ 1 $\times$ 10^{-8} per week.

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Cables: "Teleset", Totton, Southampton.

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One of the most renowned American Communications Receivers ever manufactured. Widely used by all the Armed Services to maintain World-wide Communications and Monitoring Posts under all conditions. Employs 14 valves, and has 6 switched overlapping wave bands for complete coverage. Refinements include Mechanical Band Spread with Logging Scale, Automatic or Manual Volume Control. Automatic or Manual Noise Limiter, BFO with pitch control, RF and AF Gain Controls. Variable HF Tone Control, Variable Selectivity with Crystal Filter, Aerial Trimmer, Choice of Headphones or Speaker. Has internal mains power pack for nominal 115-230 volts A.C. In Black Crackled Case size 19¾in. W. x 11in. H.x 19¾in. D. Thoroughly reconditioned, immaculate in appearance, and in perfect working order. Covers 500 kc/s-32 Mc/s, price (add carriage 30/- and 50/- deposit on returnable transit case). **£45**
S.A.E. brings illustrated descriptive leaflet.

TRAWLER BAND R 1155s

The latest version of this famous Communications Receiver to be released by the Air Ministry. Covers 5 wave ranges 18.5-7.5 Mc/s., 7.5-3.0 Mc/s., 3.0-1.5 Mc/s., 1.5 Mc/s., 600 kc/s., 500-200 kc/s. As used by Coastal Command, Air-sea Rescue Launches, etc. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Have had slight use, but are in excellent condition. ONLY £12/19/6.
A.C. MAINS POWER PACK OUTPUT STAGE in black metal case to match receiver, enabling it to be operated immediately, by just plugging in, without any modification. Fitted with 8in. P.M. speaker £6/10/-. DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.
Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

UNIVERSAL VOLT—OHM—MILLIAMMETER

Reads A.C. and D.C. Volts up to 1,000 in 5 ranges at 1,000 o.p.v., D.C. Current (3 ranges) to 500 mA. Resistance readings to 200 Kohms in 2 ranges. Basic movement 300μA sensitivity. Easily read open scale. Dimensions 5¼in. x 3½in. x 2¼in. Beautifully made, and fully guaranteed. Complete with leads, prods and internal battery. ONLY **59/6**

H.R.O. SENIOR COMMUNICATIONS RECEIVERS. Complete with all 9 coils, giving coverage of 50 kc/s—30 Mc/s. Checked and in perfect working order. Rack mounting type 18 gns., Standard Table Model 21 gns. (Carr., etc. 22/- either type.)

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BC 342 RECEIVERS. A few only of these famous American sets covering 1.15-18.0 Mc/s., in six bands. Internal 115 v. A.C. Mains pack. A super receiver in first-class condition and perfect working order. ONLY £25 (carriage 15/-).

12-WAY SCREENED CABLE. In 10ft. lengths, fitted with plugs, originally made for No. 19 Wireless Set. UNUSED. ONLY 15/- per lead.

UNISELECTOR. 25 way 8 bank 15 ohm coil for 24 volt operation, unused ex-brand new equipment, only 62/6.

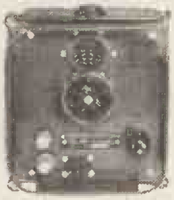
SPRAGUE CONDENSERS. Metal cased wire ends. New, .01 mfd. 1,000 v. and .1 mfd., 500 v. 7/6 per dozen. Special quotes for quantities.

W 1191A WAVEMETER. Crystal controlled heterodyne frequency meter covering 100 kc/s. to 20 Mc/s. in 8 switched bands and is virtually the British BC221. Power requirements 2 v. L.T. and 40-60 volts H.T. Complete with Calibration Book, Crystal, Operating Valves and full set of spares. Used but in perfect order. ONLY £5 (carriage 15/-).

ACOS TYPE 39-1 STICK MICROPHONE. With screened lead and stand 39/6.

CRYSTAL DESK MICROPHONE. With screened lead and built in stand 16/6 (post either 1/6).

CRYSTAL CALIBRATOR No. 10



A superb Crystal Controlled Wavemeter. Has directly calibrated dial for nominal coverage of 1.5-10.0 Mc/s. but may actually be used from 500 kc/s. up to 30 Mc/s. Complete with 500 kc/s. Crystal, 2 valves type IT4, 1 of 1R5 and 1 of CV286 (Neon Stabiliser), and Instruction Book. Size 7in. x 7½in. x 4in., weight 5 lbs. Used but in first class condition. ONLY £2/19/6. Carr. 3/6.

BC 221 FREQUENCY METERS

Coverage 125 kc/s to 20 Mc/s. and known the world over as a first class standard. Complete with original calibration book, crystal, valves, and instruction book. Used, but in very good condition. ONLY £16. Illustrated descriptive leaflet available on request.

20,000 OHMS PER VOLT TESTMETER

Just purchased from the Air Ministry, these magnificent American **PRECISION** Testmeters provide 31 ranges for reading Voltage Current and Resistance, 6 Decibel ranges, 7 Output ranges, and facilities for testing Electrolytic and Paper Condensers. Single switch control, meter size 4½in. x 4½in. with Red and Black scales, mounted on Black and Silver Panel size 8½in. x 7in., which is fitted into sturdy wood carrying case with removable hinged lid and compartment for leads, etc., the overall size being 10in. x 9in. x 6in. Has 7 D.C. Voltage ranges up to 6,000 volts at 20,000 ohms per volt, 7 similar ranges at 1,000 ohms per volt, 7 similar A.C. ranges at 1,000 ohms per volt, 7 D.C. Current ranges from nought microamps to 12 Amps., 3 Resistance ranges up to 60 Megohms, 6 Decibel ranges from −12 to +70 DB, 7 Output ranges up to 6,000 volts. Supplied with test leads, internal batteries, and operating instructions. Case finished medium Oak, and fitted with leather handle. In excellent condition, thoroughly checked before despatch. 40 only available—first come first served.

ONLY **£9/19/6** (post etc. 5/6).

Further details on receipt of S.A.E.

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Type CV 1596 equivalent to Cossor O9D as used in oscilloscopes by Cossor (339 series). Hartley and Erskine (13 series). Listed at £12/10/-. Our price £2/19/6 (carriage 5/6). Brand new in makers' crates.

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F.S.D.	SIZE AND TYPE			PRICE
25 microamps	D.C.	2½in. Proj.	circular	59/6
50 microamps	D.C.	2½in. Flush	circular	59/6
50 microamps	D.C.	3½in. Flush	circular	80/-
1 milliamp	D.C.	2½in. Flush	circular	30/-
1 milliamp	D.C.	3½in. Flush	circular	50/-
200 milliamp	D.C.	2½in. Flush	circular	12/6
20 amps	D.C.	2in. Proj.	circular	7/6
40 amps	D.C.	2in. Proj.	circular	7/6
300 volts	A.C.	2½in. Flush	circular	25/-
500 volts	A.C.	2½in. Flush	circular	25/-

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Just purchased from the Air Ministry. First class condition, thoroughly overhauled and checked on all ranges. Complete with leads and internal batteries. The 50 Range Model 7, ONLY £12/10/-, OR the superlative 20,000 ohms per volt Model 8, ONLY £17/10/- (reg. post on either 5/-). S.A.E. for full details.

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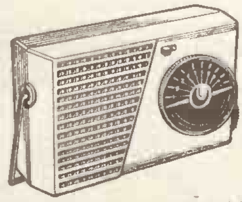

Designed by the technical staff of *Practical Wireless*, easy to build, using printed circuit, and 1st Grade Matched Transistors and Diode. Full Medium and Long Wave coverage to internal speaker. All parts sold separately (new components only) enabling you to buy as required, and full detailed price list will be sent on request. Constructional details 1/6. TOTAL COST INCLUDING BATTERY AND CABINET. £8/19/6.

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UNBEATABLE IN PERFORMANCE AND APPEARANCE

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SPECIFICATION
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Size 4⅜ x 3 x 1¼in.

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- Reception of Radio Luxembourg guaranteed (most areas).

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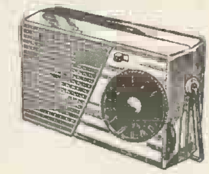
MEDIUM AND LONG WAVE POCKET SUPERHET
(as described November *P.W.*)



- A sensitive superhet with 150mW push-pull output on 2½in. speaker. Uses 6 first-grade Mullard transistors and printed circuit. Moulded cabinet. Red, Blue or Cream.
- All parts sold separately. Send for list. Illustrated Building Plans 1/6 plus post.

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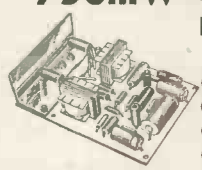
MULLARD TRANSISTORS

OVER 50% REDUCTIONS
OC44 11/-; OC76 8/-; OC45 10/-; *OC81 8/-; OC71 6/6; OC170 13/6; *OC72 8/-; LC171 14/6; OC75 8/-; OC140 36/-; OC201 36/-; OC26 25/-. Complete list free on request.
● Special reductions for matched sets.

750mW 4-TRANSISTOR

PUSH-PULL AMPLIFIER

(over 1 watt peak output)



- Uses OC71/OC81D, 2—OC81.
- ±3 dB 70 c/s to 12 kc/s.
- Overall size 3 x 2¾ x ⅞in.
- Built on printed circuit.

BUILT AND TESTED **69/6** p.p. 1/6 OR COMPLETE KIT **62/6** p.p. 1/6.

Ideal for Record Player, Intercomm. Baby Alarm, for Tuners, etc.
● 3 ohm output, fully guaranteed, 9 volt operated ●
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Multi-Meter. (List price £24/10/-)
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Complete with Avo Test Leads and Batteries. Fully guaranteed new condition.

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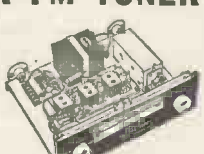
TRANSISTOR FM TUNER

Fully tunable with A.F.C., A.G.C. Incorporating 5 Transistors and Printed Circuit Pre-assembled units.
- 2-OC171 and 3-OC170 Selected Transistors.
- Fully Tunable 85 to 108 Mc/s.
- 10.7 Mc/s. I.F. audio output

A new design for Hi-Fi to feed quality valve or transistor amplifiers.



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All Parts **18 gns.** P.P. 3/-

Fully Illustrated Book 3/6

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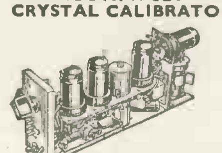

10 kc/s. 100 kc/s., 1 Mc/s. 6-valve and neon modulator P.P. 2/6. **79/6**
With handbook (New Condition)

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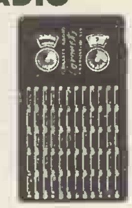
Fidelity "CORONET"



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- Size 2⅞ x 4⅞ x 1½in.
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- Guaranteed for 12 months.
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9½ gns Reg. Post 2/6. (INCL. BATTERY)

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- Super 3 Three-Transistor and Diode Earphone Radio. All components. No extras to buy. 37/6. P. & P. 1/6.
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- 7-transistor medium, long and short wave superhet. Pre-built units. Full plans and details. 2/6 plus post.
- SEND FOR DETAILS OF OTHER UNITS AVAILABLE.

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OFFICE OR HOME TELEPHONE PICK-UP AMPLIFIER

BUILT, TESTED, READY TO USE
£5.10.0 P.P. 2/6

- No more "Holding Up" wasting time waiting for your call to come through. When it does the amplifier can be switched off if required. **No** connections, just Sellotape the pick-up coil to back of phone as above.
- **5-inch speaker; 3 months' battery life. Now with 400mW output**

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EX 1920, 1985, 1986, 1987, 2-METRE MULTI-CHANNEL AIRBORNE EQUIPMENT

★ TRANSMITTER (LESS VALVES)	5/-	P.P. 2/6
★ RECEIVER (LESS VALVES)	5/-	P.P. 2/6
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★ 9.72 MC/S I.F. STRIP DOUBLE TUNED WITH 6 VALVES	25/-	P.P. 2/6

FULL CIRCUIT DIAGRAMS 1/9. POST FREE

'POCKET' SOLDERING IRON. 220/250 v. 30 watt Iron. Complete with wallet. Handle unscrews to protect element. **18/6** P.P. 1/- Brand new Guaranteed.

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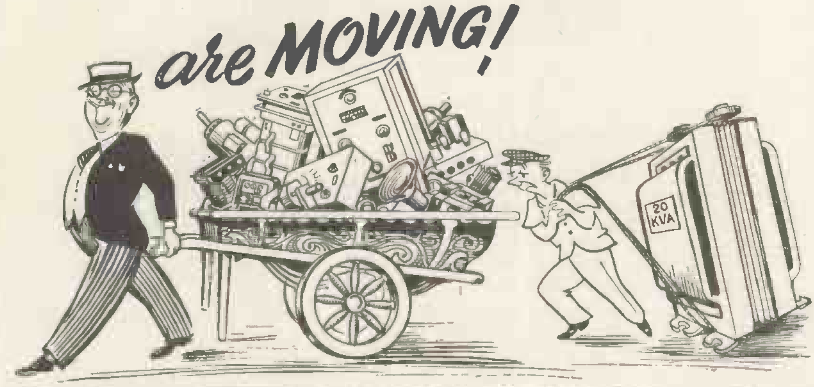
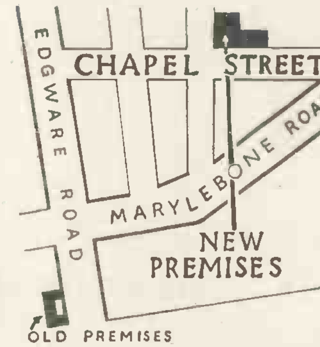




SPECIAL OFFER: LATEST A.M. RELEASE. Isolation Transformers. Pri. tapped 100, 200, 220, 240 v. Sec. 225 v. 1.1 Amps. Tropically rated. Guaranteed £3/5/-. Carr. 7/6.

EXCLUSIVE PURCHASE OF A.M. HEAVY DUTY TRANSFORMERS
Tapped to give the following specifications: Pri. 440-400 v. S.P. Sec. 220 v. or 110 v. 600 watts.
Pri. 220 v. Sec. 220 v. or 110 v. 600 watts.
Pri. 220 v. Sec. 55 v. 10 amps. All winding. Double wound, £5/19/6. Carr. 7/6.

SPECIAL OFFER BRAND NEW PARMEKO SEALED TRANSFORMERS. Pri. tapped 200-220-240 v. Sec. 4-volt C.T. 36 amps. Tropically rated. 25 kV. D.C. insulation. Size 9 x 8 x 8 inches plus 4 inch terminals. Offered at a fraction of maker's price. £9/10/-. Packing and carriage 15/-.

SUNVIC ADJUSTABLE THERMOSTATS TYPE T.S.1. Suitable for control up to 300 deg. C., 27/6. P.P. 3/6.

TANGENT HEAVY DUTY ALARM BELLS. 6-inch gong. A.C. 200-240 v., 35/-. Carr. 4/-. 8-12 v. D.C., 27/6. Carr. 4/-.

ADMIRALTY THERMOMETERS. 20-210 deg. F. Built-in metal cylindrical case, length 12ins., dia. 1in. Ideal for the lab., workshop or the home. Brand new at a fraction of maker's price, 7/6. P.P. 1/6.

PANTON ATTENUATORS. 3,000Ω in 41 stud contact steps, 15/-. P.P. 1/6. 500Ω in 15 steps, 10/6. P.P. 1/6.

NON-KINKABLE TWIN CABLE. 23/0076 rubber covered braided with cotton. 25-yard coils 12/6. P.P. 1/6.

H.T. RECTIFIER VOLTAGE DOUBLER. A.C. 180 v. Max. D.C. 336 v. Nom. 270 milliamps. 10/6. P.P. 2/-.

EQUIPMENT WIRE, P.V.C. 14/0076, 100-yard drums, 6/6. P.P. 1/6. Henley Rubber Covered Braided with cotton, 40/0076, 50-yd. drums, 5/-, P.P. 2/-. 110/0076 50-yd. drums 7/6. P.P. 2/6. 162/0076 50-yd. drums, 10/6. P.P. 3/-.

20 S.W.G. 100-yard coils 6/6. P.P. 1/6. Various colours. Transparent 14/36, 100-yd. coils 7/6. P.P. 1/6.

TWIN 20 S.W.G. 100-yard coils 13/6. P.P. 2/-.

We wish to announce that as from the end of June 1961 our new address is 9 and 10 Chapel Street, London, N.W.1. The telephone numbers Pad 7851 and Amb. 5125 remain unchanged.

Our new premises will be larger and thus will enable us to improve considerably on our service in every respect. Our premises at 169-171 Edgware Road, London, W.2, will remain open until the end of Sept. 1961 where we will be holding a *genuine clearance sale* of oddments and remnant lines of electronic and radio equipment.

S.T.C. RECTIFIER SUPPLY UNIT No. 11 TYPE ZB 10235

Specification:—A.C. input 100-260 volts. 45-65 cycles. D.C. output 24 volts 11 amps. and 130 volts 600 ma. very conservatively rated. L.T. and H.T. completely smoothed. All circuits fused. Mains on/off switch. Built in grey metal cabinet. Height 5ft. 0in., width 1ft. $7\frac{1}{2}$in., depth 1ft. $1\frac{1}{2}$in. Weight 200 lbs.

These units were originally designed to supply L.T. and H.T. power in conjunction with Bay Power No. 3, to S.O.S./T. 3-channel telephone system, but are ideal heavy duty L.T. and H.T. supply units for the electronic industry, research laboratories, schools, etc. Guaranteed 20 amp. output. Complete with Instruction Book and circuit. Supplied brand new at a fraction of the maker's price.

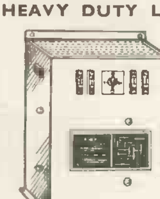
£22.10.0 ex-warehouse

SPECIAL OFFER. BRAND NEW A.M. LEAD ACID ACCUMULATORS. 2 volt 14 A.H. Size $6\frac{3}{4}$in. high, 2in. sq. Ideal for constructing 6 or 12 volt batteries. 4/11 each. P.P. 2/-. Six for 27/-. Carr. 5/-. With charging instructions.

EXCLUSIVE PURCHASE EXIDE 12 v. 4 A.H. UNSPILLABLE LEAD ACID BATTERIES. Size $4\frac{1}{4}$ x 4 x $3\frac{3}{4}$in. Weight $4\frac{1}{2}$ lbs. Latest type. Specially designed for Rocket Electronic equipment. Maker's price £9 each. Supplied brand new with charging instructions. 52/6 each. P.P. 2/6.

1/10 H.P. A.C. MOTORS. 220-240 v. Cap. start. Reversible 2,850 r.p.m. Cont. rating. $\frac{1}{4}$in. dia., Spindle length 1in., 55/-. Carr. 4/-.

WESTINGHOUSE HEAVY DUTY L.T. SUPPLY UNITS TYPE 115. A.C. input 200-250 volts. D.C. Output 26 amps. into a 24 volt (nominal) battery. Rating continuous. Max. ambient temp. 35 deg. C. Completely smoothed and stabilised. Built in metal case approx. size 17 x 21 x 19 inches. With fitted fuses. On/Off switch. Reconditioned as new. £32/10/- ex warehouse. Original maker's price over £100.



AMERICAN HEAVY DUTY AUTO TRANSFORMERS. "C" core winding. Completely enclosed in metal container, $7\frac{1}{2}$ kVA. 115-230 v., £17/10/-. Ex warehouse. We have London's largest selection of auto transformers, 110-240 v. available from stock. Let us know your requirements.

JUST ARRIVED. AMERICAN FIELD TELEPHONE CABLE. Single 2-mile drums. Brand new, at a fraction of maker's price £7/10/-. Ex. Warehouse.

SANGAMO SYNCHRONOUS MOTORS A.C. 200-250 v. Size $1\frac{3}{4}$in. dia., 7/6. P.P. 1/6. Also attached to gear train unit, containing over 30 gear wheels, 10/-. P.P. 2/-. Gear train unit separately, 2/6. P.P. 1/-.

HEAVY DUTY L.T. TRANSFORMERS
LONDON'S LARGEST SELECTION

No. 1. Pri. 220-240 v. Sec. 50 v. 60 amps. Very conservatively rated, **£17/10/-.** Ex warehouse.
No. 2. Pri. 240. Sec. tapped 4.6, 11 v. 200 amps. **£9/10/-.** Carr. 10/-.
No. 3. Pri. 230 v. Sec. tapped 11, 11.5, 12, 12.5 100 amps. tropically rated, **£9/10/-.** Carr. 10/-.
No. 4. Pri. 240 v. Sec. 14 v. 200 amps., **£9/10/-.** Carr. 15/-.
No. 5. Pri. 220-240 v. Sec. 26 v. 36 amps. Very conservatively rated, **£9/15/-.** Carr. 15/-.
No. 6. Pri. 220-240 v. Sec. 20 v. 3 amps., **£6/15/-.** Carr. 7/6.
No. 7. Pri. 240 v. Sec. 20 v. 20 amps., **£4/17/6.** Carr. 7/6.
No. 8. Pri. 240 v. Sec. tapped 6, 12 v. 20 amps., **72/6.** Carr. 5/-.
No. 9. Pri. 240 v. Sec. tapped 12, 18 v. 10 amps., **47/6.** Carr. 5/-.
No. 10. Pri. tapped 200-240 v. Sec. 13 v. 15 amps. C.T.; and 80 v. 0.25 v. Very conservatively rated, **67/6.** Carr. 7/6.
No. 11. Pri. 230 v. Sec. 24 v. 7 amps. and 30, 32 v. tapped, 2 amps., **52/6.** Carr. 4/-.
No. 12. Pri. 200–220–240 v. Sec. tapped 17, 18, 20 v. 15 amps., **£3/19/6.** Carr. 5/-.
No. 13. Pri. 200–220–240 v. Sec. tapped 30, 32, 34, 36 v. 5 amps., **57/6.** Carr. 4/-.
No. 14. Pri. 200–220–240 v. Sec. tapped 10, 17, 18 v. 10 amps., **57/6.** Carr. 4/-.
No. 15. Pri. 200–220–240 v. Sec. tapped 48, 56, 60 v. 1 amp., **27/6.** P.P. 3/6.
No. 16. Pri. 200–220–240 v. Sec. tapped 10, 17, 18 v. 7 amps., **45/-.** Carr. 4/-.
No. 17. Pri. 230 v. Sec. 6.3 v. 5 amps. and 6.3 v. 1 amp. and 65 v., **85/-.** Very conservatively rated, **15/-.** P.P. 2/6.
No. 18. Pri. 200–220–240 v. Sec. 6 v. 5 amps., **12/6.** P.P. 2/6.
No. 19. Pri. 200–220–240 v. Sec. tapped 9-15 v. 4 amps., **22/6.** P.P. 3/-.
No. 20. Pri. 200–220–240 v. Sec. tapped, 12, 20, 24 v. 2 amps., **25/-.** P.P. 3/-.
No. 21. Pri. tapped 110–230 v. Sec. 75 v. C.T. 0.25 amps., **29/6.** P.P. 3/-.
No. 22. Pri. 100, 120, 200, 220 v. Sec. 230, 240, 250 v., 260 v. 50 mA. Conservatively rated, **27/6.** Carr. 3/6.
No. 23. Pri. 240 v. Sec. tapped 12–24 v. 1 amp., **13/6.** P.P. 2/6.
No. 24. Pri. 240 v. Sec. tapped 9–15 v. 1½ amps., **15/6.** P.P. 2/6.

"GUNFIRE" ELECTRIC TIME SWITCHES

A.C. 200–240 v. 20 amp. switch contacts, make and break once every 24 hours. Complete with mounting bracket, and earth strip. Supplied brand new at a fraction of maker's price, **69/6.** P.P. 2/6.

VENNER 14-DAY CLOCKWORK TIME SWITCHES. 5-AMP. SWITCH CONTACTS. One make one break every 24 hours. Complete with two-pin Mounting bracket and key, **32/6.** P.P. 2/-.

CROMPTON PARKINSON 4½in. A.C. MI AMMETERS. 0–30 amps. flush mounting, **27/6.** P.P. 3/6. **250-0-250 MICROAMMETERS** design 2½in. square, flush. By Ernest Turner. Brand new and guaranteed, **42/6.** P.P. 2/6.

A.M. CAPACITORS TROPICALLY RATED AND GUARANTEED

AMERICAN HIGH VOLTAGE CAPACITORS. 10 mfd., 1,500 v., wkg., **15/-.** 8 mfd., 1,500 v. wkg., **12/6.** 16 mfd. 400 v. wkg., **8/6.** 50 mfd., 400 v. wkg., 330 v. wkg. A.C., **17/6.** 10 mfd. Tubular Pyronal, 300 v. D.C., **7/6.** 10 mfd., 600 v. DC, working, **8/6.** Please add 2/- P.P. on all capacitors.

BRITISH TYPES. 1 mfd. 5,000 v. wkg., **17/6.** 1 mfd. 2,500 v. wkg., **12/6.** 0.1 mfd., 5,000 v. wkg., **10/6.** 4 mfd., 1,500 v. wkg., **10/6.** 6 mfd., 1,000 v. wkg., **8/6.** 8 mfd., 600 v. wkg., **6/6.** 8 mfd., 400 v. wkg., **5/6.** 8 mfd., 500 v. wkg., **6/-.** 8 mfd., 250 v. wkg., **5/-.** 0.25 mfd., 5,000 v. wkg., **12/6.** 0.5 mfd., 500 v. wkg., **2/-.** 0.01 mfd., 5,000 v. wkg., **2/6.** 15 mfd. 250 v. wkg. A.C., **12/6.** Please add 2/- P.P. on all capacitors.

AMERICAN HIGH VOLTAGE CAPACITORS. 2 mfd. 10,000 volts wkg., **£8/10/-.** Carr. 7/6. 1 mfd. 20,000 volts wkg., **£7/10/-.** Carr. 7/6. 0.25 mfd. 25,000 volts wkg., **£6/10/-.** Carr. 7/6. Supplied brand new in maker's cartons at a fraction of original price.

SPECIAL PURCHASE!!
NIFE ALKALINE BATTERIES 6-VOLT 75 A.H. TYPE LR7 SUITABLE FOR ENGINE STARTING

Five 1.2 v. cells crated and connected to give 6 v. Brand new and fully guaranteed. Size of crate 15½ x 12 x 6½in. **£7/10/-.** Carr. 15/-.

FERRANTI A.C. VOLTMETERS
0–300 v. 6-inch dial. Flush mounting. Supplied Brand New at a fraction of maker's price. **£4/15/-.** 5/- Carr.

A.M. LT SMOOTHING CHOKES. Resistance ½ ohm. Ideal for smoothing 12–24 v. D.C. 5 amps. Tropically rated, **17/6.** Carr. 4/-.

ARON 50 AMP. A.C. CHECK METERS. 200–250 v. single phase. Supplied brand new and guaranteed. **37/6.** Carr. 3/6.

GUARANTEED SHILLING SLOT METERS. A.C. 200/250 v. 5 amp. **£3/15/-.** 10 amp. **£4/5/-.** 20 amp. **£5.** 30 amp. **£6.** All meters set for 2d. or 3d per unit. Carriage 7/6.

COLVERN W.W. PRECISION POTENTIOMETER. 2½in. dia., 3-gang, 2,000 + 5,000 + 5,000 ohms. 3 gang 200 + 500 + 500 ohms. 3-gang 500 + 500 + 500 ohms. **22/6.** P.P. 2/6. 2-gang 40 k + 40 k ohms. **17/6.**

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1000Ω, 2 M., 1 thermal delay, 6 sec. CO, **15/-.** 1000Ω, 2 HDM, 2 HDB, **12/6.** 1000Ω, 4 HDM, 1 HDB, **15/-.** 6000Ω, 4 M, 2 B, **12/6.** 6000Ω, 2 M, 2 B, **10/6.** 1000Ω, 1 CO, 2 M, before B, **12/6.** 6000Ω, 4 M, **10/6.** 22,000Ω, 2 M, **15/-.** 250Ω, 4 M, 2 B, **10/6.** 100Ω, 3 M, **8/6.** 50Ω, 2 HDM, **8/6.** 2000Ω, 4 HD, CO, **15/-.** 2000Ω, 2 M, **10/6.** 500Ω, 1 CO, 2 B, **12/6.** 100Ω, 1CO 1 M, before B, **10/6.** 1000Ω, 3 CO, **12/6.** 1000Ω, 3 M, 1 B, **12/6.** 2000 + 5000Ω, 2 CO, **10/6.** 2000Ω + 5000Ω, 4 CO, **12/6.** 5000Ω, 1 M, 1 B, **10/6.** 25Ω, 1 HD, B **8/6.** 25Ω, 1 HDM, 2 M, **8/6.** P.P. on all Relays 1/6.

AMERICAN TYPE. 235Ω 2 CO, **7/6.** 400Ω 2 CO. sealed, **10/6.** 10,000Ω 1 CO, 1 M, sealed, **10/6.** P.P. 1/-.

AMERICAN LEACH CONTACTORS. A.C. 110 v., 3-pole, 250 v. 20 amp. contacts. Size 4½ x 4 x 3in. Brand new in maker's cartons, **25/-.** P.P. 2/6.

A.M. CONTACTORS. 12 v. D.C., 2 HD, C.O., 1 CO., 1 B, brand new, **10/6.** P.P. 2/-.

ADMIRALTY HEAVY DUTY A.C. 230 v. CONTACTORS. Double-pole 40 amp. contacts. Brand new in maker's cartons, **59/6.** Carr. 4/-.

A.M. HEAVY DUTY SLIDING RESISTORS
LARGE SELECTION

12,000Ω 0.003 amps., double tube geared drive slider control, **45/-.** Carr. 5/-.
20Ω 2.3 amps., slider control, **17/-.** P.P. 3/6.
29Ω 5 amps. slider control, **27/6.** P.P. 3/6.
3Ω 10 amps. slider control, **15/-.** P.P. 3/-.
1.5Ω 15 amps. slider control, **12/6.** P.P. 2/6.
1Ω 12 amps. slider control, **10/6.** P.P. 2/6.
0.4Ω 25 amps. geared drive control, **17/6.** P.P. 3/-.
Non-adjustable. Tapped.
45Ω + 12Ω 6.5/4 amps., **17/6.** P.P. 3/6.
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2Ω 6 amps., **7/6.** P.P. 2/-.
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BERCO INSTRUMENT POTENTIOMETERS. 3in. dia., 10 watts 50 kΩ, 20 kΩ, 50Ω, **8/6** each. P.P. 2/-. 2in. dia., 4 watts, 300Ω, 100Ω, **5/6** each. P.P. 1/6. 3in. dia. 100 kΩ, screened, **10/6.** P.P. 2/-.

S.T.C. F.W. BRIDGE RECTIFIERS
Supplied brand new at a fraction of maker's price.
No. 1. Max. A.C. Input 150 v. D.C. output 12 amps., **£9/10/-.** Carr. 10/-.
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No. 3. Max. A.C. input 36 v. D.C. output 54 amps., **£9/10/-.** Carr. 10/-.
No. 4. Max. A.C. input 36 v. D.C. output 36 amps., **£8/10/-.** Carr. 7/6.
No. 5. Max. A.C. input 36 v. D.C. output 18 amps., **£6/10/-.** Carr. 7/6.
No. 6. Max. A.C. input 18 v. D.C. output 18 amp., **55/-.** Carr. 5/-.
No. 7. Max. A.C. input 25 v. D.C. output 12 amps., **57/6.** Carr. 5/-.
No. 8. Max. A.C. input 18 v. D.C. output 15 amps., **47/6.** Carr. 4/-.

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OC78, 8/6 (Matched Pair, 17/-).

EDISWAN MAZDA TRANSISTORS. The very latest types:
XB/102 7/6; XB/103 7/6; XC/101 10/6; XA/101 12/6; XA/102 12/6.

SPECIAL OFFER. Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XB/102, XB/103, 2 matched XC/101. Price 79/6.

CRYSTAL DIODES. General Purpose GEX00, each 1/-. Per doz. 9/-.
All other types in stock.

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All types in stock. Example:
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CAN BE BUILT FOR ONLY 99/6
Post & Pkg. 5/-.

For A.C. mains 200/250 v. Medium and long wave. Uses 2 latest double-purpose valves EBF89 and ECL80, contact cooled rectifier. 5in. P.M. Speaker. Handsome plastic cabinet in cream, pastel green, pink, blue. Overall size: 8½in. wide, 4½in. deep, 5in. high.
FULL DATA, circuit diagram, etc., 1/6. (Free with parcel).
All components available separately.

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PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION
CAN BE BUILT FOR (including valves) **7 GNS.**
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SPECIAL LOW-PRICED F. M. TUNER PARCEL

Uses Philips permeability tuning heart, freq. coverage 88–100 Mc/s. 2 I.F. stages. 3 valves, plus magic eye and EZ80 rect., Self-powered. Dim.: 8×6×5½in. Complete Parcel circuit diagram, data.
99/6 P. & P. 8/6.
All components sold separately

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Mdl. SUPER 12/FS/AL. Aluminium voice coil, 15 ohms, 17,000 lines, foam plastic suspension, 15-30 watts peak. Brand new in maker's cartons. List £17/10/-.
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3½in.	4in.	5in.	6½in.	8in.	10in.	12in.
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★ 7in. × 4in. elliptical speaker.

Instruction booklet giving full details, illustrations, dimensions, circuit diagram and shopping list 2/6 (returned if you order).

★ 12-CHANNEL TURRET TUNERS ★

Large selection, many by famous makers such as Cyldon, Brayhead, Plessey, Cossor, etc., all I.F.s. New and unused. Let us quote you for the model required. Examples: 33-38 mc/s., 29/6, 6-9 mc/s., 59/6. 9-14 mc/s., 59/6, 14-25 mc/s., 59/6.

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FERRANTI. 12in. types T12/44 or 9in. type T9/3 4 v. heater......... 49/6
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16in. METAL CONE, famous make, type T901/A, 6.3 v., 0.3 amp. heater .. £6.19.6
Carr. & Insur. 21/-.

17in. 90 degrees C.R. TUBES
Seconds but in perfect working order and guaranteed 79/6
Carr. and insur. 12/6.

RE-GUNNED C.R. TUBES
GUARANTEED FOR 12 MONTHS

Type	From			Carr. & Ins.
12in. round	£5	10	0	12/6
14in. rect.	£5	10	0	12/6
15in. & 16 round	£5	19	6	12/6
17in. rect.	£5	19	6	12/6
21in. rect.	£7	19	6	21/-

KAPURA Mdl. U1 MULTI-TEST METER
Complete with test leads.
59/6
Post 2/6
Brand new fully guaranteed

Sensitivity: 1,000 ohms per volt A.C. and D.C. **Ranges:** (A.C. and D.C.) 0-10-50-250-500-1,000 v. D.C. current 0-100-500 m/a. 0-1 m/a. (used at 0-10 v. range). **Resistance:** 1-2,000 ohms (centre 24 ohms). 100-200,000 ohms (centre 2.4 k.). **Size:** 5in. × 3in. × 2½in.

OTHER MULTI-METERS
Model EP-10K, 10,000 ohms per volt, AC/DC, **£5/19/6.** Post 2/6.
Model 200H. 20,000 ohms per volt, AC/DC, **£6/19/6.** Post 2/6.
TAYLOR 127A. 20,000 ohms per volt, AC/DC, **£10.** Post free.

20,000 VALVES IN STOCK
CONDENSERS, RESISTANCES. High stability Resistances, Electrolytics. All values and sizes stocked.

207 EDGWARE ROAD, LONDON, W.2
Few yards from Praed Street, PADdington 3271/2

42 TOTTENHAM COURT ROAD, W.1
Nearest station Goodge Street. MUSeum 2605

Both addresses open all day Saturday. Close 1 p.m. Thursday.

PLEASE ADDRESS ALL MAIL ORDERS TO DEPT. W, AT ABOVE EDGWARE ROAD ADDRESS.

R.S.C. (M/c) Ltd. LIVERPOOL MANCHESTER LEEDS BRADFORD

Personal Shoppers welcomed at: 73 Dale Street (Nr. Exchange Station) | 8-10 Brown Street (Market Street) | 5-7 County (Mecca) Arcade, Briggate, Leeds, 1 | 56 Morley St. (above Alhambra)

TERMS: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage stated. Trade supplied. Post order to: Mail Order Dept. 29-31 Moorfield Road, Leeds, 12.

R.S.C. HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only

25½ GNS. Carr. 17/6. OR DEPOSIT £5/7/6 and 12 monthly payments of 42/-. Cash price if settled in 3 months.

Can be assembled in ½ hour.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR. THE LINEAR LT45X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 x 4in. LOUDSPEAKER. Reel of Best Quality TAPE, Spare Tape Spool, a Portable Cabinet, size approx. 16 x 13 x 9in., finished in durable and attractive duo-tone Policrome and connection diagram for wiring amplifier to transcriptor.

FEATURES INCLUDE:
★ 3 SPEEDS ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZING FOR EACH SPEED. ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS Fast rewind ★ TAPE MEASURING AND CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.
Full descriptive leaflet supplied on receipt of S.A.E.

HI-FI 10 WATT AMPLIFIERS

BRAND NEW CARTONED MANUFACTURERS DISCONTINUED MODEL. A REMARKABLE OPPORTUNITY. **£6.19.9** Carr. 7/6.
Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mike and gram. Separate bass and treble controls. High sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed, tested and in perfect working order. Please state speaker matching required when ordering.

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F. and double Diode Second Detector delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram-position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. input depending on Ae location. Only 250 v. 15 mA H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS

HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.

BASS REFLEX CABINET. Specially designed for above speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18 x 12 x 10in. Strongly made. Handsome appearance. Ensure superb reproduction for only £3/19/6.

MULTI-METERS

CABY A10 Basic meter, sensitivity 155 micro-amps. A.C. and D.C. ranges. £4/17/6.
CABY B20. Sensitivity up to 10,000 ohms per volt A.C. and D.C. £6/10/-
EAGLE. A.C. and D.C. 10,000 ohms per volt. £5/19/6.

ACOS HI-FI CRYSTAL 'MIKES'

Mic 40 Hand or Desk type **27/9** (Listed 45/-)
39-1 Stick type **39/6** (Listed 5 Gns.)
Limited number.

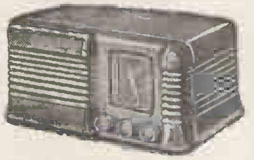
VALVES! Full range at really competitive prices.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9.
Type BM2. Size 8 x 5½ x 2½in. Supplies 120 v. 90 v. and 60 v., 40 mA and 2 v. 0.4 a. to 1 amp., fully smoothed, THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2 v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator.
Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.

POWER PACK KITS. Only 19/11. Fully smoothed H.T. output of 250 v. 60 mA and L.T. supply of 6.3 v. 1.5 amp. Consisting of Double Wound Mains Transformer 230/250 v. 50 c.p.s. A.C. primary. Selenium Rectifier. Smoothing Choke, Double Electrolytic Condenser, Aluminium Chassis and Circuit.

THE SKY FOUR T.R.F. RECEIVER



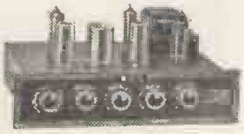
A design of a 3 valve 200-250 v. A.C. mains L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, SP61, 6F6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-point wiring diagram, instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

R.S.C. A12 STEREO AMPLIFIER KIT

4 GNS. Carr. 5/6

A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watt) stereo amplifier providing really life-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value.

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. Outputs for 3 ohm speakers. Point-to-point wiring diagrams and instructions. Illustration full wiring details and priced parts list. 1/9. Assembled and tested 59/6 extra.

8 GNS. Carr. 7/9.

POCKET PORTABLE TRANSISTOR

RADIO DESIGN. Employing 2 Brimar R.F. Transistors, 1 output Transistor, and crystal diode, Ferrite Rod Aerial, Miniature Speaker unit. Handsome Plastic Case. Constructional Envelope 1/6. Total building cost 49/9.

PRACTICAL WIRELESS SUPER SIX POCKET PORTABLE

6 Transistor Superhet Radio. Full constructional details etc., 1/6. All required parts including attractive plastic case and dial, printed circuit and first grade transistors. Only **£8/19/6**

EXTENSION SPEAKERS. Handsome walnut veneered cabinets. All standard 2-3 ohms. 6½in. 29/9; 8in. 35/9.

SELENIUM RECTIFIERS

L.T. Types	
2/6 v. ½ a.H.W.	1/9
6/12 v. 1 a.H.W.	2/9
Following F.W. (Bridge)	
6/12 v. 1 a.	3/11
6/12 v. 2 a.	6/11
6/12 v. 3 a.	9/9
6/12 v. 4 a.	12/3
6/12 v. 5 a.	14/6
6/12 v. 6 a.	15/6
6/12 v. 10 a.	25/9
6/12 v. 15 a.	35/9

H.T. Types H.W.	
120 v. 40 mA	3/9
250 v. 50 mA	3/11
250 v. 60 mA	4/11
250 v. 80 mA	6/11
250 v. 250 mA	12/9
Contact Cooled	
250 v. 80 mA	6/11
250 v. 50 mA F.W. (Bridge)	8/11
250 v. 75 mA F.W. (Bridge)	10/11

RECORDING HEADS. Baird Record Playback and Erase (housed in one container). 9/6 pair.

VARLEY 2 v. 14 A.H. **ACCUMULATORS.** New ex Govt. 5 x 3 x 1½in. 5/9 each, 3 for 15/-.

JASON F.M. TUNER. Type FMT1. All parts including Dial, Punched Chassis and Valves. Power supply required 180 v. 25 mA and 6.3 v. 1.5 a. £6/19/6

EX GOVT. SMOOTHING CHOKES

60 mA 10 h. 400 ohms	3/11
80 mA 20 h. 900 ohms	5/11
100 mA 5 h. 100 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

Battery Chargers and Kits for 200-230-250 v. 50 c/s. A/C. Mains

HEAVY DUTY KIT

6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0-7 amp. meter. Variable Charge Selector. Fuses, fuse-holders, panels, plugs and circuit. Only 59/6. Post 4/6.

CHARGER TRANSFORMERS

200-230-250 v. 50 c/s.

0-9-15 v. 1¼ a.	12/9
0-9-15 v. 2½ a.	15/9
0-9-15 v. 3 a.	16/9
0-9-15 v. 5 a.	19/9
0-9-15 v. 6 a.	23/9

BATTERY CHARGER KITS

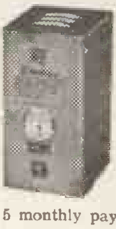
Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.

6 v. or 12 v. 1 amp.	24/9
As above, with ammeter	32/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 2 amps. (inclusive of ammeter)	42/9
6/12 v. 4 amps.	49/9
6 v. or 12 v. 4 amps., with variable charge rate selector and ammeter	59/9

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only **49/9** Carr. 3/9.

ASSEMBLED 6 v. or 12 v. 4 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. **69/9** Carr. 5/-. Or Deposit 13/3 and 5 monthly payments of 13/3.

As above, but for 6 amp. charging 4 GNS. Carr. 5/-. Or Deposit 16/- and 5 monthly payments of 16/-.

MICRO-AMMETERS

0-50 micro-amp. Diameter 2½in. approx. Scaled 0-100. Flush mounting, 29/6.

EX GOVT. MAINS TRANSFORMERS

Primary 0-110-200-230-250 v. 275-0-275 v. 100 mA, 6.3 v. 7 a. 5 v. 3 a.	22/9
Input 200-250 v. 50 c.p.s. 250 v. 60 mA 6.3 v. 2 a.	10/11
Primary 200-250 v. Sec. 12 v. 20 a.	49/9
Primary 230 v. 400-0-400 v. 200 mA	29/9
Primary 200-240 v. Sec. 3.500 v. 5 mA 2 v. 2 a.	39/9
50 watts, 0-110/120-230/250 v.	8/11

D.C. SUPPLY KITS. Suitable for electric trains. Consist of mains trans. 200-250 v. 50 c.p.s. 12 v. 1 amp. selenium rect. (F.W. Bridge); 2 fuseholders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number, 33/9.

HEAVY DUTY EX GOVT. SELENIUM RECTIFIERS

With large square aluminium cooling fins. 12 v. 15 amp. F.W. (Bridge). Limited number. 19/6.

EX GOVT. CASES

Well ventilated, black crackle finished, undrilled cover Size 14 x 10 x 8½in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

RELAYS. Carpenter Type Polarised, 2 x 9,500 turns at 1,685 ohms. 13/9. Miniature type G.E.C. 670 M1092 sealed wire ends 4 c/overs platinum, 12/9.

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC38, 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 OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT. Price in kit form with easy to follow wiring diagrams.

ONLY Carr. 10/-. **11 gns.** Or Factory built using latest EL34 output valves and with 12 months' guarantee. 14 GNS. TERMS ON ASSEMBLED UNITS. DEPOSIT 33/3 and 9 monthly payments of 33/3.

Protective Cover 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/cs. ± 12 D.B. to − 6 D.B. at 12,000 c/cs. hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12×9×9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS, IDEAL FOR USE WITH MUSICAL INSTRUMENTS, SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

FULL RANGE OF LINEAR HIGH FIDELITY AMPLIFIERS ALWAYS IN STOCK.

GL3A MINIATURE 3 WATT GRAM AMPLIFIERS

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11¼×2¼×2¼in. 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. Guaranteed 12 months. Only 59/6.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5. a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

P.M. SPEAKERS. 2-3 ohms 2½in. Perdio 21/9. 5in. Goodmans 17/9. 7×4in. R.A. Elliptical 19/9. 6½in. Rola 19/9. 8in. Rola 19/9. 8in. Goodmans 25/9. 8×6in. Elac. with high flux magnet 25/9. 10in. R.A. 28/9. 10×6in. Ellipical Goodmans 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms, 10 watts, 12,000 lines. 59/6.

TWEETERS, 4in. Plessy, 3 ohms 18/9. R.A. 15 ohms 25/9.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

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, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx. 12×9×7in. For A.C. mains 200-250 v. 60 c/cs. Output for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 51/- extra.) ONLY **8 Gns.** Carr. 10/-

If required louvred metal cover with 2 carrying handles can be supplied for 18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/10 and 9 monthly payments of 24/10. Send S.A.E. for illustrated leaflet detailing ready-to-assemble Cabinets. Speakers, Microphones, etc. with cash and credit terms.

R.S.C. PORTABLE GUITAR AMPLIFIERS

JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 mv. High Flux 8in. l/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly made cabinet (size approx. 14×14×7in.). Finished in attractive and durable polychrome and fitted carrying handle.

£8.19.6 Carr. 7/6. Or Deposit £1 and nine monthly payments £1.

Send S.A.E. for leaflet.

SENIOR 10 WATTS. High-Fidelity Push-Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated in 12in. P.M. for Bass notes and 1 7×4in. elliptical for Treble. Cabinet is well made and finished as for Junior model. Size approx. 18×18×8in. 15 Gns. Plus 10/- carr. H.P. TERMS DEPOSIT 34/9 and 9 monthly payments 34/9. Both models for 200-250 v. A.C. mains.

COLLARO CONQUEST 4-SPEED AUTO-CHANGERS. With studio pick-up with turnover head. Latest model for 200-250 v. A.C. mains. £6/19/6. Carr. 4/6.

B.S.R. MONARCH AUTO-CHANGERS. Type UA8. 4 speed T/O Pick-up with sapphire stylus £6/19/6. Carr. 4/6.

Any of the bove supplied with T/O stereo/monaural head for £1 extra.

COLLARO JUNIOR. 4-speed Single Players with Hi-Fi T/O crystal pick-up head, £3/19/6.

LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET. Gauss 12,000 lines. Speech coil, 3 ohms or 15 ohms. Only £4/19/6. Carr. 5/-. TERMS: DEPOSIT 11/- and 9 monthly payments of 11/-.

12in. 20 WATT 15,000 line l/speaker 15 ohms in Cabinet finished as above. Size 18×18×8in. £7/19/6 or Deposit 17/9 and 9 monthly payments of 17/9.

R.S.C. TRANSFORMERS Fully Guaranteed. Interleaved & Impregnated.

MAINS TRANSFORMERS. Primaries 200-250-250 v. 50 c/s.

FULLY SHROUDED. UPRIGHT MOUNTING.

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a. 2½-3-3in.	17/11
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	27/11
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	27/11
350-0-350 v. 100 mA. 6.3 v. 4 a., 5 v. 3 a.	27/11
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/11
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t. 5 v. 3 a.	49/9
450-0-450 v. 250 mA., 6.3 v. 5 a., 5 v. 3 a.	59/9

TOP SHROUDED DROP-THROUGH TYPE

260-0-260 v. 70 mA., 6.3 v. 2 a., 5 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., 5 v. 2 a.	18/11
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	26/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	26/9
300-0-300 v. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a. suitable for Mullard 510 Amplifier	29/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 5 v. 3 a.	47/9

FILAMENT TRANSFORMERS

6.3 v. 1.5 a.	5/9	12 v. 1 a.	7/9
6.3 v. 2 a.	7/6	6.3 v. 3 a.	8/11
0.4-6.3 v. 2 a.	7/9	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

50-80 watts 110-120 v./230-250 v.	11/9
150 watts 110-120 v./200-250 v.	27/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	3/9
Small Pentode 5,000Ω to 3Ω	4/6
Standard Pentode 5,000Ω to 3Ω	5/9
Standard Pentode 8,000Ω to 3Ω	5/9
Multi Ratio, Single or P/P 3 or 15Ω	6/9
Push-pull 8 watts EL84S to 3 ohms	8/9
Push-pull 8 watts EL84s to 15 ohms	8/9
Push-pull 10-12 watts 6V6 to 3Ω or 15Ω	16/9
Push-pull 10-12 watts to match 6V6 to 3.5-8 or 15Ω	17/9
Push-pull EL84 to 3 or 15 ohms 10-12 watts	17/9
Push-pull Ultra Linear for Mullard 510	27/9
Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., for 3 or 15 ohms	23/9
Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., or 4 or 15Ω fully shrouded	47/9

MICROPHONE TRANSFORMERS

120 : 1 High quality, clamped	6/9
120 : 1 High quality Mu metal screened	8/9

SMOOTHING CHOKES

250 mA., 5 H., 100Ω	11/9	80 mA. 10 H., 350 Ω	5/6
150 mA. 7-10 H., 250Ω	11/9	60 mA., 10 H., 400Ω	4/11
100 mA., 10 H., 200Ω	8/9	1 amp. 0.5Ω L.T. type	6/6

PARMEKO MAINS TRANSFORMERS. Fully shrouded.

500-0-500 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.	31/9

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. bass and treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves. Size only 6×5×5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5.19.6** Or Deposit 22/- and 5 monthly payments of 22/-. Send S.A.E. for leaflet.

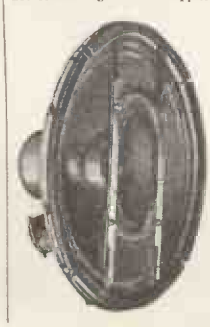
ACOS HGP 59 Hi-Fi Crystal Cartridges. (Turnover type with sapphire stylus.) Standard replacement for Garrard and Collaro. Only 19/9. B.S.R. Ful-Fi 19/9. Garrard GC2. 19/9. Acos Stereo/monaural 49/9.

LINEAR PRE-AMP/TREMOLO UNIT

Suitable for use with any Guitar Amplifier. Controls Volume, Frequency, Amplitude and switches. Valves: EF86 and EF80. Inputs for Guitar Pick-up or Mike, and Radio or Gram. Power required only 250/300 v. 20 mA. 6.3 v. 1 a. **5 GNS.**

LINEAR TAPE PRE-AMPLIFIER Type LP/1. Switched negative feedback equalisation. Positions for Record 1⅞in., 3¾in., 7½in. and Playback. EM84. Recording level indicator. Designed primarily as the link between Collaro Tape Transcriptor and high fidelity amplifier but suitable almost any Tape Deck. **9 GNS.** Send S.A.E. for leaflet.

R.S.C. STANDARD BASS REFLEX CABINET for 12in Loudspeakers, Acoustically lined and ported. Size 20in.×14in.×13in. Beautiful walnut veneer finish. Especially recommended for use with Speaker below £5/19/6. Set of four legs can be supplied for 29/6 per set.



PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms) consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only £5/19/6. Or Deposit 13/9 and 9 monthly payments of 13/9.

Each Model incorporates the highly successful HT/TR3 Amplifier (described below), thus ensuring truly "Hi-Fi" record and playback facilities.

All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and 1,200ft. Spool of Tape.

There are no "better value for money" Tape Recorders on the market—if you can't call and hear them send S.A.E. for fully descriptive leaflets.

Stern's "fidelity" TAPE RECORDERS

BEFORE YOU BUY—YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS

MODEL CR3/S. Incorporates the Collaro "STUDIO" TWIN TRACK 3-speed Deck operating at 1⅞in., 3¾in. and 7½in. speeds................ **£39.10.0**
H.P. Terms: Deposit £7/18/- and 12 months of £2/17/11.

MODEL TR3/Mk. VI. Incoporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck operating at 3¾in. and 7½in. speeds.... **£49.10.0**
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.

TAPE AMPLIFIERS and PREAMPLIFIERS presented from MULLARD DESIGNS

MULLARD TYPE "C" TAPE-PREAMPLIFIER ERASE UNIT

The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3-speed treble equalisation by FERROXCUBE POT CORE INDUCTOR. FOR WEARITE—COLLARO—TRUVOX or BRENNEL TAPE DECKS. (STATE which when ordering.) Includes separate Power Supply Unit.

KIT OF PARTS .... **£14.0.0** or ASSEMBLED **£17.0.0**
H.P. £3/8/- Deposit and 12 months at £1/4/11.
(Excluding Power Unit £11/15/- and £14/10/- respectively.)

MODEL HF/TR3 Mk. II TAPE AMPLIFIER

(Mullard Type "A" design)

A very high quality Amplifier incorporating 3-speed treble equalisation, by the latest FERROXCUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENELL or WEARITE Tape Decks (STATE which when ordering), has GILSON Output Transformer. Includes separate Power Supply Unit.

KIT OF PARTS.......... **£13.13.0** or ASSEMBLED.. **£17.0.0**
H.P. £3/8/- Deposit and 12 months at £1/4/11.

FOR THE HOME CONSTRUCTOR SPECIAL "COMBINED ORDER" PRICES

(a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit assembled and tested **£29.10.0**
H.P. Terms: Deposit £5/18/- and 12 months at £2/3/3.
(b) As above but Type "C" PRE-AMPLIFIER supplied as complete Kit of Parts **£26.10.0**
(c) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" PRE-AMPLIFIER and Power Unit.............. **£40.0.0**
H.P. Deposit £8 and 12 months £2/18/8.
(d) As above but the Type "C" supplied as complete Kit of Parts **£36.10.0**
(e) The BRENELL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and Power Unit.................... **£46.0.0**
H.P. Deposit £9/4/- and 12 months at £3/7/6.
(f) As above, but the Type "C" supplied as complete Kit of Parts **£43.0.0**
(g) The WEARITE 4A DECK with Type "C" assembled and tested **£56.0.0**
H.P. Deposit £11/4/- and 12 monthly £4/2/1.
(Carriage and Insurance on above quotes 10/- extra.)

EACH OF ABOVE CAN BE SUPPLIED IN PORTABLE CASE FOR £5/10/- extra. THUS FORMING A COMPLETE PORTABLE PRE-AMPLIFIER. SEND FOR DETAILS.

(a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK **£26.0.0**
(b) As above, but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £5/18/-, 12 months of £2/3/3......... **£29.10.0**
(c) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK.................... **£36.10.0**
(d) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £8, 12 months of £2/18/8. **£40.0.0**
(e) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENELL Mk. V TAPE DECK.................. **£42.0.0**
(f) As above but HF/TR3 ASSMEBLED and TESTED H.P. Terms: Deposit £9/2/-, 12 months of £3/6/9. **£45.10.0**
(g) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc......................... **£55.0.0**
H.P. Terms: Deposit £11, 12 months of £4/0/8.
(Carriage and insurance on each above is 10/- extra.)

Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE —and 1,200ft. SPOOL TAPE—ALL FOR.......................... **£9.0.0**
(Carriage and Insurance 5/- extra.)

SPECIAL OFFER OF TAPE

P.V.C. base on latest type plastic Spools. New, Boxed and Guaranteed.

225ft. on 3in. Spool	5/9
900ft. on 5in. Spool	18/6
1,200ft. on 5¾in. Spool	21/–
1,200ft. on 7in. Spool	21/–
1,800ft. on 7in. Spool	32/6

TAPE ACCESSORY KITS

(a) E.M.I., includes 3 reels Leader Tape, Splicer, Jointing Tape and Stop Foil **37/6**
(b) SCOTCH BOY, includes 3 reels Leader Tape, Splicer, and Jointing Tape............ **29/6**

A LARGE PURCHASE OF BRAND NEW and FULLY GUARANTEED TRUVOX and GARRARD TAPE EQUIPMENT ENABLES THESE OUTSTANDING PRICE REDUCTIONS

THE "MODEL HF/G2R" PORTABLE TAPE RECORDER (Original Price £33/0/0)

FOR ONLY **22 GNS.** H.P. Dep. £4/14/-, 12 months £1/13/9. (Carriage and Ins. 10/- extra.)

INCORPORATES THE LATEST GARRARD "MAGAZINE" TAPE DECK and MATCHING AMPLIFIER. Based on the successful MULLARD TYPE "A" DESIGN and specifically developed to operate the GARRARD DECK. PRICE INCLUDES THE GARRARD TAPE MAGAZINE and 4in. SPOOL OF DOUBLE PLAY TAPE. A Twin Track Recorder operating at 3¾in./sec. providing up to 1 hour 10 mins. playing time. The outstanding features being excellent performance and simplicity of operation. Incorporates EXT. SPEAKER SOCKET, also operates as independent amplifier for direct reproduction from P.U., mike or Radio tuner. Weighs only 22lb.

WE ALSO OFFER DECK and AMPLIFIER CONNECTED, TESTED, FOR IMMEDIATE OPERATION, 19 gns. H.P. Dep. £4 and 12 months £1/9/4. Carriage and Ins. 10/- ex. INCLUDES SPEAKER, tape Magazine and 4in. Spool of Double Play Tape. Comprises a complete tape recorder chassis ready for easy fitting into cabinet.

THE "MODEL TK/Mk. IV" PORTABLE TAPE RECORDER (Original Price £49/10/-)

FOR ONLY **£36.10.0** PRICE INCLUDES A 7in. SPOOL OF EMI TAPE.
H.P. Dep. £7/6/- and 12 months £2/13/6.
(Carriage and Insurance 10/- extra.)

INCORPORATES THE TRUVOX Mk. IV TAPE DECK, ROLA/CELESTION 9 x 5in. LOUDSPEAKER and the Truvox Type "K" AMPLIFIER specifically developed by Truvox Ltd. to correctly operate their Mk. IV Tape Deck. This combination affords first-class tape recording facilities.

A Twin Track Two Speed model operating at 3¾ and 7½in./sec. Incorporates SAFETY BUTTON (prevents accidental erasure). Ext. Speaker. TONE and VOLUME CONTROLS. Also operates as independent AMPLIFIER for direct reproduction from P.U. mike or Radio tuner.

WE ALSO OFFER THE DECK and AMPLIFIER AS FOLLOWS: Mk. IV TAPE DECK, £16/10/-. H.P. Deposit £3/6/-. 12 months £1/4/3. TYPE "K" AMPLIFIER, £15. H.P. Deposit £3. 12 months £1/2/9. COMBINED ORDER FOR BOTH DECK AND AMPLIFIER, £30. H.P. Deposit £6. 12 months £2/4/-.

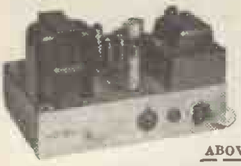
STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

FULLY DESCRIPTIVE LEAFLETS ON ALL OF ABOVE ARE AVAILABLE—BUT PLEASE ENCLOSE S.A.E.

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification



MULLARD "5-10" MAIN AMPLIFIER

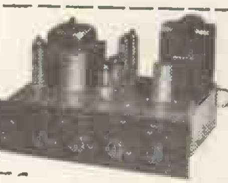
For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-linear PARMEKO or the PARTRIDGE Output Transformer.
Price: COMPLETE KIT (Parmeko O/put Trans.) **£10.0.0**
Alternatively we supply ASSEMBLED AND TESTED...... **£11.10.0**
ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6 - extra.

MULLARD'S 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIER but also perfectly suitable for other makes.
Supplied strictly to MULLARD SPECIFICATION and incorporating:
- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups and variable reluctance magnetic types.
- Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
- Sensitive Microphone Channel. ● Wide range BASS and TREBLE Controls.

Price: COMPLETE KIT OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£8.0.0**

COMPLETE MULLARD 5-10 AMPLIFIER



The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction.
Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA Linear Output Transformers.
Price: COMPLETE KIT. Parmeko Transformer........ **£11.10.0**
Alternatively we supply ASSEMBLED AND TESTED. **£13.10.0**
Hire Purchase (Assembled Amp. only). Deposit £2/14/-. 12 months at 19/10.
ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS **£7.10.0**
(Plus 6/6 carriage and insurance).
Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance).... **£8.19.6**

H.P. TERMS: Deposit £2 and 8 monthly payments of £1.
Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

COMPLETE STEREO AMPLIFIER

Meets the many requests for a low priced but good quality Stereophonic Amplifier. Output power is 4 watts. Inputs for Crystal Pick-ups and Radio Tuner.
KIT OF PARTS.......... **£8.10.0** or ASSEMBLED........ **£10.10.0**

Mk. II "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.
FOR THE CONSTRUCTOR.... **£10.0.0** or ASSEMBLED.... **£14.15.0**

SPECIAL CASH ONLY OFFER ! !

The very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY **£8.7.6** (Plus 7/6 carr. and ins.).
The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey Colour Rexine
—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-stage (plus Rectifier) AMPLIFIER........	£4	2	6
(b) The PORTABLE CARRYING CASE	£3	17	6
(c) 6½in. P.M. SPEAKER........		18	9

(Carriage and Insurance 4/- extra.)

STERN'S INTER-COMM or BABY ALARM

A small versatile Unit employing the new MULLARD ECL86 valve and designed to provide two (or three) way conversation up to extreme distances. Operates from A.C. mains 200 to 250 volts and as in all our designs only new high-grade and guaranteed components are incorporated.
PRICES—MASTER UNIT and ONE EXTENSION
KIT OF PARTS £6/17/6. (Available in August) ASSEMBLED AND TESTED £8. (Available mid-July)
The equipment consists of a MASTER UNIT, size only 8½" × 5½" × 6" and ONE EXTENSION (a second extension may be added at any time). The Master Unit incorporates switching and power supply, and with the chassis completely isolated from the mains is operated in absolute safety. Attractively presented in cases covered in quality leatherette.

"Hi-Fi" LOUDSPEAKERS

WE HAVE IN STOCK A COMPLETE RANGE BY
GOODMANS—WHARFEDALE—W.B.
ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

THE "ADD-A-DECK"

INCORPORATING GARRARD "MAGAZINE" TAPE DECK and the MATCHED MODEL HF/G2P PREAMPLIFIER. Supplied on ONE CHASSIS (as illustrated). READY FOR USE.
PRICE: Including GARRARD MAGAZINE and a 4in. SPOOL DOUBLE PLAY TAPE (Carr. & Ins. 10/- extra). **18 gns.**
H.P. Deposit £3/16/- and 12 months of £1/7/8.
Provides complete tape recording facilities and designed to operate through the pick-up sockets of the standard type of RADIO RECEIVER, or an AMPLIFIER, from which really first class reproduction is obtained. It consists of a Twin Track Deck connected to the Pre-amplifier and operates at 3¾in./sec. speed, providing up to 1 hour 10 mins. playing time. Only needs connecting to the mains supply and pick-up sockets. Very simple to operate and easily installed in a cabinet, only four fixing screw being required.

PRICE REDUCTIONS

(a) The COMPLETE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-Stage Pre-Amplifier Control Unit...........	£15.15.0
(b) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested................ H.P. TERMS: Deposit £3/16/- and 12 months of £1/7/8	£18.18.0
(c) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit......	£21.10.0
(d) The Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested .... H.P. TERMS: Deposit £5 and 12 months of £1/16/8.	£25.0.0
(e) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier Control Unit	£21.10.0
(f) One "5-10" Amplifier (Parmeko Transformer) and the Dual Channel Pre-Ampifier both Assembled and Tested................ H.P. TERMS: Deposit £5 and 12 months of £1/16/8.	£25.0.0
(g) COMPLETE KIT OF PARTS to build Two "5-10" Main Amplifiers (incorporating Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit	£31.0.0
(h) Two "5-10" Amplifiers (Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested .... H.P. TERMS: Deposit £7/4/- and 12 months of £2/12/-. Carriage and insurance 7/6 extra.	£36.0.0

Prices quoted are subject to £1/6/- extra for Partridge Trans.

MULLARD FOUR CHANNEL MIXING UNIT

Self powered with Cathode follower output. Incorporates Two inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK-UPS and a Fourth for Radio or Tape.
KIT OF PARTS **£8.8.0** ASSEMBLED AND TESTED **£10.0.0**
Terms: Deposit £2 and 12 months at 15/-.
Model I.L. one microphone input matched for moving coil or ribbon mike £1/17/- extra.

STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREOPHONIC and MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 m/v.

Price: COMPLETE KIT OF PARTS **£12.10.0** Alternatively ASSEMBLED and TESTED **£15.0.0**
H.P. Terms on assembled unit: £3 Deposit and 12 months of £1/2/-.

STEREO "3-3" MAIN AMPLIFIER

Comprises two MULLARD 3-3 Main Amplifiers on one chassis. Operates with above MULLARD STEREO PRE-AMPLIFIER. Output power 6 watts. Inputs for Crystal Pick-up and Radio Tuner
KIT OF PARTS............. **£10.0.0** or ASSEMBLED...... **£11.15.0**

RECORD PLAYERS

Many at REDUCED PRICES ! ! ! Send S.A.E. for ILLUSTRATED LEAFLET

THE EMI 4-speed single record player with separate crystal pick-up	4 gns
B.S.R. MONARCH UA8 4-speed Mixer Autochanger with Crystal Pick-up	£6.19.6
THE NEW COLLARO "C 60" 4-speed autochanger unit with Studio "O" pickup	£7.19.6
The NEW COLLARO Model RP594, 4-speed Single Record Player, Studio Cartridge	£9.18.9
THE E.M.I. 4-speed Single Record Player, incorporating a high output crystal pick-up	£6. 9.6
B.S.R. MODELS UA12 and UA14. Each a 4-speed Mixer Autochanger with Crystal Pick-up	£7.19.6
Both available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records	£10.10.0
GARRARD RC209 4-speed Autochanger fitted with latest Crystal Pick-up	£8.19.6
The latest GARRARD TRANSCRIPTION MOTOR "301"..........	£22.7.3
The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.S. Crystal Cartridge	£18.7.6
GARRARD Model TA/Mk. II Single Record Player fitted with high output Crystal Pick-up, detachable head........................	£8.10.0

HIRE PURCHASE TERMS available on all units £8/19/6 and over
Carriage and insurance on each above 5/- extra.

! ! HOME CONSTRUCTORS ! !

A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS
Designed by the W.B. "STENTORIAN" COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Pre-amplifier, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screwdriver is required.
Fully illustrated leaflets are available, including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

H.P. TERMS ARE AVAILABLE ON ALL EQUIPMENT OVER £9.
FULLY DESCRIPTIVE LEAFLETS ARE AVAILABLE FOR ALL EQUIPMENT, BUT PLEASE SEND S.A.E.

STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

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and MAIL ORDER SERVICE

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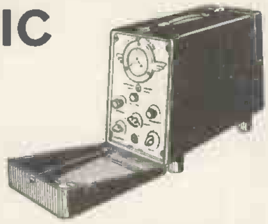
ELECTRONIC
IGNITION ANALYSER



Versatile, portable equipment specially designed for the critical analysis of aero-engine ignition systems. Displays entire performance of ignition system on a cathode ray screen while engine is running—simultaneously showing each plug firing in a side by side comparison. Reveals excessive carbon formation, faulty condenser, leaking cables, incorrect plug or contact breaker gap, worn cams, etc. Ten-step loading switch absorbs engergy from system and thus accentuates test to show-up deterioration in coil primary, secondary winding, condenser, cables, etc. Straightforward connection to system. Power supply can be switched to either 230/250 volts A.C. mains, or 6, 12 or 24 volts D.C. In attractive metal case 9 × 13¾ × 17¾in. deep. Complete with circuit, instructions and good and faulty trace drawings. Guaranteed serviceable.

£15.0.0 Carriage 10/-

SMALL HIGH-SPEED MOTORS

Robust, aircraft-quality, fan-cooled motors continuously rated at 11,000 r.p.m. from 115 volts 3-phase 400 c/s A.C. supply. Drive: ⅜in. fibre gear on $\frac{3}{16}$in. shaft. Gear easily removed. Size only 4¼ × 2in.

25/- Carriage 5/-

GEIGER COUNTER TUBES

Brand new, individually tested, fully guaranteed, low-voltage Halogen quenched Geiger Mueller tubes by a famous British manufacturer. Working voltage 400-450. Highly sensitive; effective length 11.8 cm. Background 90 counts/min., max. response 30,000 counts/min. Plateau 80 volts. Stainless iron electrode. Similar to tubes fitted in high-grade instruments and used in demonstration counters on BBC and ITV programmes. IDEALLY SUITED FOR HOME-BUILT GEIGER COUNTERS, BASIC EXPERIMENTATION, INSTRUCTION, and serious work too. Circuits of simple all-transistor and conventional valve counters supplied on request. At a fraction of the original cost.

25/- Carriage 2/-

PRESSURE SENSING INDUCTANCE

Highly sensitive device consisting of ferrite encapsulated 160 kc/s coil unit and aneroid capsule which changes frequency with changes of pressure. Coil Q43; capacitance 870 pF. In ⅞in. square aluminium can on 2¼in. diameter lightweight plug-in unit.

22/6 Carriage 2/6

TIME DELAY SWITCH

High-quality modern unit made by Teddington Controls (Type FHM/A) to control overrun of camera guns. Contains fast-running precision ball bearing, double armature motor and precision-made ball bearing gearbox and magnetic solenoid clutch. Designed for 24 volts D.C. but motor runs energetically at lower voltage. Totally sealed in robust diecast box size: 4½ × 3 × 3½in. Time delay 1½ sec. Brand new.

32/6 Carriage 2/6

BARGAIN OFFERS

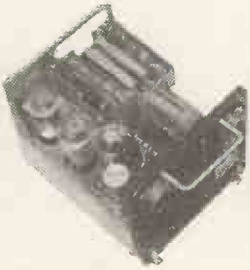
VCR139 (Cossor 23D equivalent) 2½in. cathode ray tube 15/-. Postage 2/6.
Mains suppressor in diecast sealed case, 2 for 5/-. Postage 2/-.
Double pole knife changeover switch on porcelain base, 2 for 4/-. Postage 1/-.
Pyrex aerial insulators, four 3in. OR one 8in., 6/-. Postage 1/6.
Neons, ten 115 volt for 19/-. Postage 2/6. Six 80 volts for 6/-. Postage 1/6.
G.P.O. electro-mechanical relays 0-9999, 5/-. Postage 2/6.
Bulgin type "M" microswitches, 4 for 10/-. Postage 1/6.
Metal rectifiers: selenium 6-12 volt 1½ amp., 9/6. 2½ amp., 9/6, 4 amp., 16/6.
Charging transformers: Pri. 200/250 volts, Sec. 3½, 9 and 17 volts, at 4 amp., 18/6. Postage 3/-.

TRANSISTOR AMPLIFIER KIT

Printed circuit, 500 milliwatt push-pull output. High impedance input, 3 ohm output. Two OC71 and two OC72. Supplied with all components, condensers, resistors, volume control, transformers and printed circuit board. Input 6-9 v. D.C. Circuit diagram and component layout supplied with each kit. Size of board 2⅝ x 5¼in.

52/6 post paid

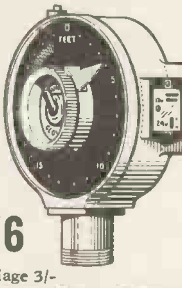
25 c/s Tuning Fork Drive AMPLIFIER



Modern, light-alloy cased. Drive unit type 114 containing a robust 8½in. induction sustained 25 c/s tuning fork with attendant induction pick-ups and waveform amplifier comprising 2 × DF50, CV1092 diode and 6L6 output. 5U4G rectifier and VS110 stabiliser in power supply derived from high-cycle transformer—easily replaced by standard mains type. High-grade components throughout. Easily removed, flexibly mounted tuning fork assembly energised by 6.3 volts A.C. only. Case size: 8½ × 7½ × 10½in.

New. **60/-** Carriage 3/-

CENTRE SCALE COUNTERS



Ex-R.A.F. camera film footage indicators. Consists of really compact lever solenoid which actuates a pawl on a ratchet wheel to move a pointer progressively round a circular dial. Works on either 12 or 24 volts D.C. and records 125 counts per revolution. Can be used as a lap marker for "Scalextric" car sets, mechanical counting, display, etc., or the lever solenoid could readily be adapted for use in modelling. In diecast case with centre toggle switch and reset button. Stick-on dial graduated 0-125 and instructions supplied. Size : 3⅛ × 1½in.

7/6 Carriage 3/-

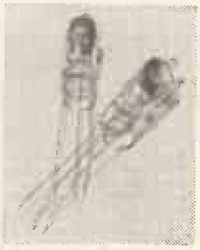
Master and Remote CONTACTORS

MASTER CONTACTOR is a robust, high quality, spring driven clock with balanced escapement driving a low friction pair of contacts that "make" every half-second. Mechanism is enclosed in temperature- and vibration-proof, sorbo-rubber lined box size 6 × 6 × 6in. Winding key and stop/start knob accessible below lid.

REMOTE CONTACTOR is a solenoid operated ratchet mechanism which is energised by the half-second impulses from the Master Contactor to turn a pointer at one rev. per minute over a 2in. dial with adjustable zero and quarter divisions. Additionally, a fibre cam on the ratchet wheel operates a pair of contacts that close for one quarter of every revolution. In first-class guaranteed condition.

30/- Carriage 5/-

COLD CATHODE TRIGGER TUBES



Sub-miniature cold cathode valve developed by Ericcson primarily for computer work, these GTR.120W tubes have great possibilities in a number of experimental electronic automatic control circuits. Anode-cathode running voltage of 95 to 140 at 4.5 mA, and at 290 anode volts require a trigger current of only 250 microamps to cause the anode to take over the discharge. Typical ionization time: 90 microseconds. Will withstand up to 310 volts with zero trigger voltage without self-igniting. Supplied complete with full performance data in original packs of 100 at the special price of

£5.0.0 Post paid

Minimum quantity supplied: 6 for 10/- Post paid.

C.R.T. BOOSTER TRANSFORMERS

TYPE A. OPTIONAL 25% and 50% BOOST. 2 V. OR 4 V. OR 6.3 V. OR 10.3 V. OR 13.3 V. MAINS INPUT. 12/6

TYPE A2. HIGH QUALITY, LOW CAPACITY, 10/15 pF. OPTIONAL BOOST 25%, 50%, 75%. MAINS INPUT. 16/6

TYPE B. MAINS INPUT. MULTI OUTPUT 2, 4, 6.3, 7.3, 10 and 13 VOLTS. BOOST 25% AND 50%. LOW CAPACITY. 21/- Full instructions supplied.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg.. ¼ w., 4d.; ½ w., 4d.; 1 w. 6d.; 1½ w., 8d.; 2 w. 1/-. HIGH STABILITY. ½ w., 1% 2/-. Preferred values 10 ohms to 10 meg. Ditto 5% 9d., 100 Ω to 5 meg.

WIRE-WOUND RESISTORS 25 ohms—10,000 ohms.

5 watt	1/3
10 watt	1/6
15 watt	2/-

12,500 ohms.—50,000 ohms. 10 w. 3/-

WIRE-WOUND POTS. 3 w. Pre-set Min. T.V. type Knurled Slotted knob. All values 10 ohms to 25 K. 3/- ea.; 30 K., 50 K., 4/-. Ditto ½ w. Carbon Track, 30 K. to 2 Meg. 3/-.

WIRE-WOUND POTS. 4 w. Standard size Pots. long Spindle High Grade. All values 50 ohms to 50 K. 6/6; 100 K., 7/6. W/W EXT. SPEAKER CONTROL 10Ω. 3/-.

O/P TRANSFORMERS. Miniature 3V4, etc., 4/6. Heavy duty 50 mA. 4/6. Multi-ratio push-pull 7/6. Ditto Push-Pull 10 watts 15/6. Push-pull 20 w. 6 k. C.T. 30/-. L.F. CHOKES. 15/10H 60/65 mA. 5/-. 10H 85 mA. 10/6. 10H 120 mA., 12/6. 10H 150 mA., 14/-.

MAINS TRANSFORMERS 200/250 v. A.C.

STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., tapped 5 v. or 4 v. 2 a. Ditto 350-0-350	22/6
MINIATURE 220 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET, 220 v. 45 mA., 6.3 v. 2 a.	15/6
SMALL, 200-0-200 50 mA., 6.3 v. 2 a.	17/6
STANDARD, 250-0-250, 65 mA., 6.3 v. 3.5 a.	17/6
HEATER TRANS., 6.3 v. 1½ a., 7/6; 3 amps.	10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 A.	22/6
AUTO. TRANS. 150 w., 0, 10, 120, 200, 230, 250 v.	22/6

ALADDIN FORMERS and cores, ¼in. 8d.; ⅜in. 10d. 0.3in. FORMERS 5937 or 8 and Cans TV1 or TV2. 2½in. sq. × 2⅛in. or ⅝in. sq. × 1⅛in., 2/- with cores. SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3. SOLON. Midget Soldering Iron. 220/40 v. 25 w., 24/-. MAINS DROPPERS. 3 × 1½in. Adj. Sliders .3 amp. 1,000 ohms 4/3. .2 amps. 4/3. .1 amp. 2,000 ohms 5/-. LINE CORD. .3 amp 60 ohms per foot, .2 amp. 100 ohms. per foot, 2-way or 3-way, 1/- per foot.

CRYSTAL MIKE INSERT by Acos 6/6

Precision engineered. Size only ⅛ × ⅛ × 3/16in.

ACOS CRYSTAL MIKE 40 .... Bargain 25/-

MIKE TRANSF. 50 : 1, 3/9 ea.. 100 : 1 Potted 10/6. LOUDSPEAKERS PM. 3 OHM. 2½in., 3in., 19/6. 5in. Rola 17/6. 8in. × 5in. Goodmans 21/-. 7in. × 4in. Plessey 18/6 10in. × 6in. 27/6. 14in. × 8in. 45/-. 8in. Plessey 19/6. 6½in. 18/6. 8in. Rola 21/-. 10in. R.A. 30/-. HI-FI TWEETERS. 4in. 25/-. 12in. Plessey, 30/-. 12in. 15 ohm, 45/-. 12in. Baker 15 wt. Stalwart. 3 or 15 ohm, 90/-. 12in. Baker ditto., foam suspension 15 ohm. £6. 12in. Baker Ultra Twelve £17/10. 20 c.p.s. to 25 k.c.s.

I.F. TRANSFORMERS 7/6 pair

465 kc/s, slug tuning miniature can 1⅞ × ⅞ × ⅞in. High Q and good bandwidth. Data sheet supplied.

CRYSTAL DIODE G.E.C., 2/-. GEX34, 4/-. 40 Circuits 3/-. H.R. HEADPHONES. 4,000 ohms, brand new, 15/- pair. SWITCH CLEANER. Fluid, squirt spout, 4/3 tin. TWIN GANG CONDENSERS. 365 pf. Miniature. 1⅞in. × 1⅞in. × 1⅞in., 10/-. 500pf. Standard with trimmers 9/-; Midget 9/-; less trimmers 7/6; Single 50 pf. 2/6; 100 pf., 150 pf., 5/6. Solid dielectric 100, 300, 500 pf., 3/6. VALVE HOLDERS. EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 pin 1/-. MOULDED Mazda or Int. Oct., 6d. B7G, B8A, B8G, B9A, 9d. B7G with can 1/6; B12A, 1/3; B9A with can 1/9. CERAMIC, EF50, B7G, B9A. Oct. 1/-. B7G, B9A cans. 1/-.

TELEVISION REPLACEMENT

Line Output Transformers
from 45/- each, NEW stock only
and other timebase components
Most makes available. S.A.E. with all enquiries

WAVECHANGE SWITCHES

2 p. 2-way, or 3 p. 2-way; short spindle	2/6
6 p. 4-way, 2 wafer, or 3 p. 11-w. 3 wafer, long spindle	6/6
2 p. 6-way, or 4 p. 2-way, or 4 p. 3-way, long spindle	3/6
3 p. 4-way or 1 p. 12-way, long spindle	3/6

Wave change "MAKITS" 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/-; 4 wafer, 19/6; 5 wafer 23/-; 6 wafer 26/6. TOGGLE SWITCHES. S.P., 2/-; D.P., 3/6; D.P.D.T., 4/-. MORSE KEYS, good quality, with morse code 2/6. FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a. 11/3; 4 a., 17/6; 6 a., 22/6. CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6. Charger circuit free. AMMETERS, 4 a., and 5 a., 13/6.

THE HI-GAIN BAND 3 PRE-AMP

Cascode circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack. Plans only 6d. Also Band I version same prices. (PCC84 Valve if preferred)

"REGENT" 4 VALVE

"96" RANGE VALVES

KIT PRICE £6. 6. 6.
Carr. 4/-

PRINTED CIRCUIT BATTERY PORTABLE KIT

Medium and long wave. Powerful 7 x 4in. high Flux Speaker. T.C.C. Printed Circuit and condensers. Components of finest quality clearly identified with assembly instructions. Osmor, Ferrite Aerial Coils. Rexine covered attache case cabinet. Size 12in x 8in. x 4in Batteries used B126 (L5512) and AD35 (L5040), 10/- extra. Instructions 9d. (free with kit). Mains Unit ready made for above, 39/6. Sold separately.

MONARCH RECORD PLAYER

SAVE POUNDS

BUILD IT YOURSELF using 4-SPEED BSR MONARCH AUTOCHANGER U.A.8. READY BUILT 3W. AMPLIFIER. HANDSOME PORTABLE CASE. HIGH FLUX 7×4in. LOUDSPEAKER. FULL INSTRUCTIONS SUPPLIED.

Total Price Carr. and ins. 5/-. **£12 . 10 . 0**

RECORD PLAYER BARGAINS

4 Speed Autochangers, BSR, U.A.8.	£6 15 0
Collaro Autochanger	£7 19 6
Garrard RC121 Mk. IID	£8 15 0
Garrard 209 or 210	£10 10 0
4 speed Single Players:	
EMI Stereo £6 19 6 Monaural...	£6 5 0
Garrard TA Mk. II	£8 8 0
Garrard 4 HF Transcription...	£17 19 6

Garrard Stereo Heads £2 extra.

AUTOCHANGER ACCESSORIES

Suitable player cabinets (uncut boards)	49/6
Amplifier player cabinets with cut boards	63/-
3-valve amplifier and 6½in. speaker for above.. Ready mounted on baffle 12in. × 7in., 3in. deep.	79/6

NEW MULLARD TRANSISTORS

Audio OC71 6/-; OC72 8/-. RF OC45 9/6; OC45 10/6. Weyrad Printed Circuit Components in Stock. 7 × 4in. Speaker 35 Ω 25/-.

465 Kc/s. SIGNAL GENERATOR. Total cost 15/-. Uses B.F.O. Unit ZA 30058 ready made. POCKET SIZE 2½ × 4½ × 1in. Slight modifications required, full instructions supplied. Battery 7/6 extra 69 v. + 1½ v.

VOLUME CONTROLS

Midget size: Long spindle. Guaranteed 1 year. All values. 5 K. ohms up to 2 Meg. No switch 3/-. D.P. Sw. 4/6 Linear or Log Tracks.

80 ohm Cable Coaxial

Semi air spaced, ¼in. dia. Ideal Band III **6d.** yd. Losses cut 50% 40 yds, 17/6. 60 yds. 25/-. FRINGE QUALITY AIRSPACED .... 1/- yd.

COAXIAL PLUGS .. 1/- LEAD SOCKETS .. 2/- PANEL SOCKETS .. 1/- OUTLET BOXES .. 4/6 BALANCED TWIN FEEDER per yd. 6d., 80 Ω or 300 Ω. TWIN SCREENED BALANCED FEEDER 1/6 yd. 80 ohms.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled, with 4 sides, riveted corners and lattice fixing holes with 2½in. sides 7 × 4in. 4/6; 9 × 7in. 5/9; 11 × 7in. 6/9; 13 × 9in. 8/6; 14 × 11in. 10/6; 15 × 14in. 12/6 and 18 × 16 × 3in., 16/6. ALUMINIUM PANELS. 18 s.w.g. 12in. × 12in., 4/6; 14 × 9in.. 4/-; 12 × 8in., 3/-; 10 × 7in., 2/3.

BLACK CRACKLE PAINT. Air drying. 3/- tin. P.V.C. CONN. WIRE, coloured, single or stranded 2d. yd. NEON MAINS TESTER SCREWDRIVERS, 5/-. CORED SOLDER RADIOGRADE, 4d. yd., ½lb. 5/-. PAXOLIN 1/16in. × 8in. × 10in., 1/6. ION TRAPS 5/-.

AMERICAN MAGNETIC RECORDING TAPE FERRODYNAMICS "BRAND FIVE"

5in. 600 feet	16/-	MYLAR DUPONT	
5in. 900 feet	18/6	Super High Fidelity	
5¾in. 1,200 feet	23/6	Double Play	
7in. 1,200 feet	25/-	5in. 1,200 feet	37/6
7in. 1,800 feet	35/-	7in. 2,400 feet	60/-

Illustrated Leaflet S.A.E.

Spare Reels, 3inch 1/6; 4in., 5in., 5¾in., 2/-; 7in., 2/6. "Instant" Bulk Tape Eraser and Head Defluxer, 200/250 v. A.C., 27/6. Leaflet S.A.E.

RECTIFIERS, RM1. 5/-; RM2, 6/-; RM3, 8/-; RM4, 16/-; RM5, 20/-; FC31. 27/6; 14A86. 17/6; 14A100, 21/-. MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6: Full Wave 75 mA., 12/6. 120 mA., 15/-. COILS. Wearite "P" type 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each. All ranges. TELETRON. L. and M. T.R.F. with reaction, 3/6. FERRITE ROD AERIALS. M.W., 8/9; M. & L. 12/6. T.R.F. COILS. A/HF. 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. TUNER COIL SET, 29/-. H.F. coil aerial coil. Oscillator coil two I.F. transformers. 10.7 Mc/s. Detector transformer and heater chokes. Circuit and component book, using four 6AM6 2/6. Complete kit FMT1 with Jason Calibrated dial and 4 valves. £6/5/-. or with New Jason Cabinet FMT2, £2 extra.

CONDENSERS. New Stock. .001 Mfd. 7kV. T.C.C., 5/6; 20 kV., 9/6. .1mfd. 7 kV. 9/6. 100 pf to 500 pf. Micas, 6d. Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1, 1/-; 0.25, 1/6; 0.5 1/9; 0.1/350 v., 9d.; 0.1/1,000 v., 1/9; 0.1 mfd., 2,000 v., 3/6; 0.01 mfd., 2,000 v., 1/9; 500 pf., 20 kV., 9/6 CERAMIC CONDS. 500 v. 0.3 pf. to 0.01 mfd., 9d. SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3. CLOSE TOLERANCE (1± pf.) 2 pf. to 47 pf., 1/6. DITTO 1% 50 pf. to 815 pf., 1/9; 1,000 pf. to 2,000 pf., 2/-. TRIMMERS. Ceramic 30, 50, 70 pf., 9d.; 100 pf. 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Phillips. 1/- ea.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	50/350 v.	5/6	16/450 v.	5/-
2/350 v.	2/3	100/25 v.	2/-	32/350 v.	4/-
4/450 v.	2/3	250/25 v.	2/6	100/270 v.	5/6
8/450 v.	2/3	500/12 v.	3/-	5,000/6 v.	5/-
8/500 v.	2/9	8+8/450 v.	3/6	8+16/450 v.	5/-
16/450 v.	3/-	8+16/450 v.	3/9	32+32/350 v.	5/-
16/500 v.	4/-	8+16/500 v.	5/6	32+32/450 v.	6/-
32/450 v.	3/9	16+16/450 v.	4/3	50+50/350 v.	7/-
25/25 v.	1/9	16+16/500 v.	6/-	64+120/350v.	11/6
50/50 v.	2/-	32+32/350 v.	4/6	100+200/275v.	12/6

SUB-MINIATURE ELECTROLYTICS (15 v.) 1, 2, 4, 5, 8, 25, 50 mfd., 100 mfd., 2/6 each. SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-; 25in. × 35in., 10/-, Tygan 52in. wide, 10/- ft., 26in. wide 5/- ft. Green or Red. Samples S.A.E.

NEW and boxed VALVES 90 day guarantee

1R5	7/6	6L6G	10/6	EA50	1/6	EY51	9/6
1S5	7/6	6N7M	6/6	EABC80	8/6	EY86	10/-
1T4	6/-	6Q7G	7/6	EB91	6/-	HABC80	12/6
2X2	3/6	6SA7M	6/-	EBC33	8/6	HVR2A	6/6
3S4	7/6	6SJ7M	6/6	EBC41	8/6	MU14	9/-
3V4	7/6	6SN7	6/6	EBF80	10/-	P61	3/6
5U4	7/6	6V6G	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6X4	7/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X5	6/6	ECH42	10/6	PCL82	11/6
6AM6	5/-	12A6	7/6	ECL80	10/6	PEN25	6/6
6BE6	7/6	12AT7	8/-	ECL82	10/6	PL82	10/6
6BH6	9/6	12AU7	8/-	EF39	5/6	PY80	7/6
6BW6	9/6	12AX7	8/-	EF41	9/6	PY81	9/6
6D6	6/-	12BA6	8/6	EF50	5/6	PY82	7/6
6FG6	7/6	12BE6	8/6	EF80	8/-	SP61	3/6
6H6GT	3/6	12K7	6/6	EF86	12/6	UBC41	8/6
6J5	5/6	12Q7	6/6	EF92	5/6	UCH42	9/6
6J6	5/6	35L6	9/6	EL32	5/-	UF41	9/6
6J7G	6/6	35Z4	7/6	EL41	9/6	UL41	9/6
6K6GT	6/6	80	9/6	EL84	8/6	UY41	8/-
6K7G	5/-	807	5/3	EZ40	7/6	U22	8/-
6K8G	7/6	954	1/6	EZ80	7/6	U52	7/6

DK96, DAF96, DF96, DL96, 8/6 each, 30/- set.

RADIO COMPONENT SPECIALISTS

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337 WHITEHORSE RD. WEST CROYDON

POSTAL SERVICE 1/-, OVER £2 FREE. C.O.D. 1/6. (EXPORT C.W.O. POST EXTRA.) Wed. 1 p.m. THO 1665 Buses 133 or 68

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3-34 LISLE STREET, LONDON, W.C.2

BC. 221 HETERODYNE FREQUENCY METERS

125 kc/s to 20Mc/s As new condition. Supplied complete with valves, crystal and calibration charts.

Only **£16** each

P/P 7/6.

Also available less calibration charts only £9/10/- each.

7.5 K.V.A. AUTO TRANSFORMERS. 115/230 volts. Brand new boxed, ex-U.S.A. £15 each. Carriage 10/-.

MARCONI TF-885 VIDIO OSCILLATORS 2 Ranges 0-30 kc/s, 30 kc/s-5 Mc/s., reconditioned to makers' specification. £125.

MARCONI TF-866A Q METER Reconditioned to makers' specification. £75.

15 PIN AMPHENAL CHASSIS UNITERS 3/6 pair. P.P. 6d.

FIELD TELEPHONES TYPE L. Generator bell ringing, 2 line connection. Supplied fully tested complete with batteries, 59/6 each. P/P 3/6.

1,000 WATT MAINS ISOLATION TRANSFORMERS 230 volt primary, 230 volt secondary. Ex-Admiralty heavy duty type. New, boxed, £5 each. Carriage 10/-.

24 AMP VARIAC TRANSFORMERS Primary 230 volts. Secondary adjustable from 185 to 250 volts at 24 amps. Can also be used in reverse. £12/10/- each. Carriage 10/-.

1 MEGOHM 1% WIREWOUND RESISTORS 10/- doz. P/P 1/-.

PHOTO VOLTAGE AMPLIFIERS These special units contain a 1 microamp Tinsley mirror galvanometer, twin selenium photo cell. 12 v. lamp, lamp housing and focusing unit. Brand new boxed, £9/19/6 each. Carriage 7/6.

MUIRHEAD CELL TESTERS Housed in teak case containing a 6in. scale 3 amp. D.C. meter and large variable rheostat for controlling current. Brand new, 32/6 each. P/P 3/6.

SOUND POWERED TELEPHONE HANDSETS Make simple intercom system. No batteries required. Just connect with twin flex. Brand new 15/- per handset. P/P 1/6.

FIELD TELEPHONES TYPE F.

Ideal for all intercom. systems, house, office, building sites, etc. Generator bell ringing, 2 line connection. Supplied complete with batteries and wooden carrying case, fully tested, £4/19/6 pair. P/P 5/-.

R.C.A. AR88D RECEIVERS

This world famous 14 valve receiver offered reconditioned, perfect working order and in superlative condition throughout. Frequency converage on 6 bands 500 kc/s to 32 mc/s. Circuit incorporates variable selectivity with crystal filter, tone control, aerial trimmer, b.f.o., a.v.c., R.F. and A.F. gain controls, mechanical bandspread, etc. Output is for phones or speaker. Operation 115 or 230 volts A.C. £35 each. Carriage 30/-.

BRAND NEW MEDRESCO HEARING AIDS Supplied complete with earpiece, leads, battery pouch. Brand new boxed, **only 32/6** each. P/P 1/-. Batteries 5/- extra.

COLLARO STUDIO TAPE TRANSCRIPTORS

Latest 1961 model. 3 speeds, $1\frac{7}{8}$, $3\frac{3}{4}$ and $7\frac{1}{2}$in./sec. Fitted with 3 separate motors, digital counter, press button switching, provision for fitting extra stereo head Fitted with new Bradmatic heads. Supplied brand new with instructions, complete with spare 7in. spool. £12 each. P/P 3/6. **Plus Free 1,200 Ft. Tape.**

AVO SIGNAL GENERATORS Frequency coverage 95 kc/s to 40 mc/s. Ideal for all general radio work. Variable attenuator, 400 cycle int. mod. or provision for ext. mod. Supplied fully tested and checked £7/19/6 each. P/P 3/6. Operation is from 2 v. and 60 v. batteries, but original Avo mains units can be supplied at 19/6 extra.

MINE DETECTOR NO. 4A

Will detect ferrous and non-ferrous metals. Complete and as new in transit cases. Supplied fully tested with instructions. 39/6 each. Carriage 10/-. Batteries 8/- extra.

MARCONI TF-373 UNIVERSAL IMPEDANCE BRIDGES Reconditioned to maker's specification. 0-100 H., 0-100 mfd., 0-1 megohm, 0-100 Q. each on 5 ranges at 1,000 c/s. £35 each.

VALVE VOLTMETERS No. 2 Laboratory instruments. Five ranges A.C. and D.C. 1.5 v., 5 v., 15 v., 50 v. and 150 v. Operation 200/250 volts A.C. Supplied as new, fully tested and complete with internally mounted H.F. probe. £17/10/- each. Carriage 10/-.

R1155 RECEIVERS MODEL L/N

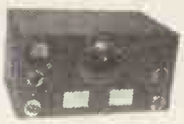
This model incorporates the 100-200 metre top band. Full coverage on 5 bands is 200 kc/s to 18 mc/s. Supplied fully tested and in perfect condition £12/19/6 each. Carriage 7/6. A combined 200/250 volt A.C. power unit and audio output stage to match 3 ohms supplied extra at 85/-.

AMERICAN ARB RECEIVERS Frequency coverage on 4 bands 195 kc/s to 9.05 mc/s. Precision vernier drive. Valve line-up: 12SA7, 4-12SF7, 12A6 and 991. Operation 24 volts D.C. Supplied fully tested and checked, £6/19/6 each. Carriage 7/6.

MULTI-RANGE TESTMETERS MODEL U1 1,000 ohms per volt A.C./D.C. Ranges: Volts A.C. 10, 50, 250, 500, 1,000 v. Volts D.C. 10, 50, 250, 500, 1,000 v. Current D.C. 1 mA., 100 mA., 500 mA. Resistance, 2,000 ohms, 200,000 ohms. Supplied brand new and guaranteed complete with instructions and leads 59/6 each. P/P 2/6.

SPARES KITS FOR CR.100 RECEIVERS. Contains 15 valves. 2-DH63, 2-KT63, 2-X66, 2-U50, 7-KTW61. Condenser and resistor packs, pots, toggle switch, output transformer, etc. All brand new, 59/6 each. P/P 3/6.

NATIONAL H.R.O. RECEIVERS



Senior model, table mounting. Supplied with complete set of 9 coils covering 50 kc/s to 30 mc/s. Circuit incorporates a meter, variable selectivity, crystal filter, 2 R.F. and 2 I.F. stages. B.F.O. A.V.C., R.F. and A.F. gain controls, etc. Output is for phone or speaker. Power requirements 250 v. 80 mA. and 6.3 v. 3 amps. Supplied fully tested and aligned and in superb condition throughout. Price 21 gns. Carriage 10/-. Power units are available 59/6 extra.

AR88D SPARES Complete wavechange switch assembly with screens. New, boxed, 17/6 ea. P/P 2/6. 1st I.F. transformers. New, boxed, 3/6 each. P/P 9d.

PAINTON MINIATURE JONES PLUGS AND SOCKETS

All new and unused.

2 pin	2/6 pr.	12 pin	5/6 pr.
4 pin	3/6 pr.	18 pin	7/6 pr.
6 pin	4/- pr.	24 pin	8/6 pr.
8 pin	4/6 pr.	33 pin	10/6 pr.

PARMEKO TABLE TOP TRANSFORMERS Input 230 volts 50 cycles. Output 620/550/375/0/375/550/620 volts 250 mA. 5 volt 3 amp., 5 volt 3 amp. Size $6\frac{3}{4} \times 6\frac{1}{4} \times 5\frac{1}{2}$in. Brand new, boxed. 45/- each. Carriage 3/6.

ROTARY CONVERTORS 24 volt D.C. input. Output 230 volts 50 cycles 100 watts, 72/6 each. Carriage 5/-.

R.C.A. PLATE TRANSFORMERS Primary 200/250 volt 50 cycles. Secondary 2,000/1,500/1,500/2,000 volts 500 mA. Supplied brand new, boxed, £6/10/- each. Carriage 10/-.

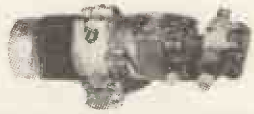
POST OFFICE 8 BANK UNISELECTORS Std. type, 25 position. Ex-brand new equipment. 62/6 each. P/P 2/-.

AN/APR4 SEARCH RECEIVERS Covers 38 to 1,000 mc/s with 3 plug-in R.F. units. TN16 38-95 mc/s. TN 17 74-320 mc/s. TN18 300-1,000 mc/s. Operation 115 v. 50-2,600 cps. Reconditioned to maker's spec. Superb order throughout, £75 each.

SANGAMO WESTON STANDARD VOLTMETERS Range 0-30 volts D.C. 1,000 ohms per volt. Correct to B.S. 89 pr. limits. 6in. mirror scale, £25 each.

SUB-STANDARD I.F. ALIGNMENT OSCILLATORS. 3 ranges covering 445 to 485 kc/s. Crystal controlled and fitted with precision variable attenuator. Operation 200/250 volts A.C. Brand new, £15 each. Carriage 10/-.

PLESSEY 24-VOLT D.C. PUMPS



Self lubricating, capacity 60 g.p.h. at 30 lb. sq. in. Will operate O.K. on 12 v. ½ BSP inlet/outlet union. Only 15/6 each. P/P 2/6.

HOURS OF BUSINESS: 9 a.m.-6 p.m. Thursday 1 p.m. Open all day Saturday. Please print name and address clearly.

G.E.C. SELECTEST MULTI-RANGE TESTMETER

D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mv.	7.5 v.	1.5 ma.	75 ma.
300 mv.	15 v.	3 ma.	150 ma.
1.5 v.	75 v.	15 ma.	750 ma.
3 v.	150 v.	30 ma.	1.5 amp.
15 v.	300 v.	150 ma.	7.5 amp.
30 v.	600 v.	300 ma.	15 amp.
150 v.	750 v.	1.5 amp.	Resistance
300 v.	1,500 v.	3 amp.	10 k. ohms
750 v.		15 amp.	100 k. ohms
1,500 v.		30 amp.	1 megohm

Incorporates overload trip and special safety interlocking switches. Supplied in perfect condition with leads, £9/19/6 each. P/P 4/-.

VOLTAGE	CURRENT
50mV D.C. only	1mA D.C. only
100 ,, ,, ,,	2 ,, ,, ,,
500 ,, ,, ,,	5 ,, A.C. & D.C.
1V ,, ,,	10 ,, ,, ,,
5 ,, A.C. & D.C.	50 ,, ,, ,,
10 ,, ,, ,,	100 ,, ,, ,,
50 ,, ,, ,,	500 ,, ,, ,,
100 ,, ,, ,,	1A ,, ,,
200 ,, ,, ,,	5 ,, ,, ,,
400 ,, ,, ,,	10 ,, ,, ,,
500 ,, ,, ,,	CAPACITY 0.01—20 mFds.
1,000 ,, ,, ,,	

RESISTANCE

10,000 ohms } using internal 1½ volt cell
100,000 ,, }
1 Megohm using internal 9 volt battery
10 Megohms } using external source of A.C. or D.C.
40 ,, } voltage.

POWER AND DECIBELS

Impedance	Power	Decibels 0=50W.
500 ohms	200 mW	− 25 to + 6
5,000 ohms	2W	− 15 to + 16
50,000 ohms	200 mW	− 25 to + 6

Fitted with automatic cutout. Supplied reconditioned as new, complete with batteries and leads, £12 each. Postage 3/6.

SIEMENS 1700 + 1700 OHM HIGH SPEED RELAYS
H.96e. Sealed type. S/pole c/over contacts. Brand new, 15/6 each. P.P. 9d.

FILMS AND EQUIPMENT COAXIAL PLUGS AND SOCKETS, 2/6 pr.

MINIATURE PYE COAXIAL PLUGS AND SOCKETS, 2/6 pr.

HI-FI RECORDING TAPES

AMERICAN C.B.S. First grade quality. Extended audio range. Brand new guaranteed, completely splice free.

5in.	std. play	600ft.	acetate	13/-
5in.	long play	900ft.	P.V.C.	16/6
5in.	double play	1,200ft.	Mylar	32/-
5¾in.	long play	1,200ft.	acetate	19/6
5¾in.	double play	1,800ft.	Mylar	37/-
7in.	std. play	1,200ft.	P.V.C.	21/-
7in.	long play	1,800ft.	acetate	28/6
7in.	double play	2,400ft.	Mylar	47/-

SYNCHROTAPE. First-grade quality, brand new guaranteed

3in std play, 175ft.	4/3	5¾in. std. play, 850ft.	15/6
3in. long play, 225ft.	4/9	5¾in. long play, 1,200ft.	18/6
5in. std. play, 600ft.	12/-	7in. std. play, 1,200ft.	19/-
5in. long play, 900ft.	16/-	7in. long play, 1,800ft.	27/-

BRAND NEW Boxed 100 MICROAMP METERS
Standard 2½in. flush round, panel mounting. Scale calibrated 0–100 microamps. 42/6 each. P/P. 1/3.

BRAND NEW METER BARGAINS

20 microamp	D.C.	M/coil	flush round	2½in.	69/6
25 microamp	D.C.	M/coil	proj. round	2½in.	59/6
50 microamp	D.C.	M/coil	proj. round	2½in.	49/6
100 microamp	D.C.	M/coil	flush round	3½in.	62/6
1 milliamp	D.C.	M/coil	flush round	2½in.	25/-
1 milliamp	D.C.	M/coil	flush square	4in.	69/6
5/0/5 milliamp	D.C.	M/coil	flush square	2in.	12/6
30/0/30 milliamp	D.C.	M/coil	flush round	2½in.	9/6
4 amp.	R.F.	Termo	flush square	2in.	7/6
7.5 amp.	D.C.	M/iron	proj. round	3½in.	10/6
100 amps	D.C.	M/coil	proj. round	6in.	65/-
25 volts	D.C.	M/coil	proj. round	2in.	8/6
120 volts	D.C.	M/coil	flush round	3½in.	32/6
300 volts	A.C.	M/coil	flush round	2½in.	25/-
500 volts	A.C.	M/iron	flush round	2½in.	25/-
1500 volts	Electrostatic		proj. round	2½in.	25/-

Please add postage.

L.T. TRANSFORMERS
Suitable for charging or models. All primaries tapped 200/250 volts.

3.5, 9 or 17 v. 1 amp.	9/9
3.5, 9 or 17 v. 2 amp	14/3
3.5, 9 or 17 v. 4 amp	16/6
9 or 17 v. 6 amp	26/-
3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volts 2 amps	18/6
3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volts 4 amps	27/6

Please add postage.

SELENIUM L.T. METAL RECTIFIERS
Full wave bridge connected, all new and guaranteed.

12/18 v. 1 amp.	4/3	24/36 v. 1 amp	9/6
12/18 v. 2½ amp	6/9	24/36 v. 2 amp	13/6
12/18 v. 4 amp	9/9	24/36 v. 6 amp	22/6
12/18 v. 5 amp	12/6	24/36 v. 10 amp	45/-
12/18 v. 6 amp	13/6	24/36 v. 15 amp	47/6
12/18 v. 10 amp	22/6	36/48 v. 6 amp	32/6
Please add postage.		48/60 v. 10 amp	82/6

COLLINS TCS RECEIVERS

Frequency coverage on 3 bands 1.5 to 12 mc/s. Valve line-up 12SA7, 12SQ7, 2-12A6, 3-12SK7. Power requirements: 12 v. L.T. and 225 v. H.T. Externally store soiled but internally good condition. £5/10/- each. Carriage 10/-.

SPEAKER BARGAINS

All new and guaranteed.

2½in. 3 ohm Elac	17/6
2½in. 15 ohm Purdio	17/6
3in. 3 ohm R.A.	17/6
4½in. 3 ohm Plessey	15/6
5in. 3 ohm Goodmans	15/6
6½in. 3 ohm Elac	17/6
8in. 3 ohm R.A.	19/6
10in. 3 ohm Elac	27/6
12in. 3 ohm Plessey	29/6
12in. 15 ohm Plessey	42/6
7 x 4in. 3 ohm Plessey	15/6
8 x 2½in. 3 ohm Goodmans	17/6
8 x 6in. 3 ohm Rola	17/6
10 x 2½in. 3 ohm R.A.	17/6
10 x 6in. 3 ohm Plessey	27/6
13 x 8in. 3 ohm E.M.I.	47/6

Please add postage.

PARMEKO TRANSFORMERS
Primary 115/230 volts. Secondary 350/0/350 volts 150 ma., 6.3 volts 4 amps, 5 volts 3 amps. Brand new, 32/6 each. P/P 2/-.

POTTED TRANSFORMERS
Primary 230 volts. Secondary 350/310/310/350 volts 220 ma. Total of 6.3 volt 13 amps, 5 volts 3 amps. 49/6 each. P/P 2/6.

RECORD CHANGERS

B.S.R. UA8 Mono 4 speed	£6 12 6
B.S.R. UA8 Stereo 4 speed	£6 12 6
B.S.R. UA12 Stereo 4 speed	£7 10 0
B.S.R. UA14 Mono 4 speed	£7 19 6
Collaro Studio Mono 4 speed	£6 19 6
Collaro Junior 4-speed single players with pickup	£3 15 0

All new and guaranteed. Post extra.

MINIATURE TRANSISTOR TRANSFORMERS
Size $\frac{13}{16}$ x $\frac{15}{16}$ x $1\frac{1}{16}$in. Push-pull driver 4.5 : 1 and push-pull output 20:1 (3 ohm). Supplied brand new boxed with data. 9/6 the pair. P/P 6d.

SPARE PLASTIC SPOOLS. 3in. 1/6, 5in. 2/-, 5¾in. 2/3, 7in. 2/6.

PLASTIC SPOOL CONTAINERS. 5in. 1/6, 5¾in. 2/-, 7in. 2/3. Scotch metal 10½in. spools 5/-.

Please add postage.

MINIATURE PERSONAL EARPIECES
Available high (crystal) or low (magnetic) impedance. Complete with lead and plug and panel jack. Brand new only 7/6 each. P/P 6d.

R.C.A. LOUDSPEAKERS
High quality 8in. 3 ohm speaker housed in black crackle case to match AR88 or H.R.O. receivers. Brand new boxed, 45/- each. P/P 3/6.

PORTABLE PRECISION VOLTMETERS

Brand new moving iron instruments by famous manufacturer. Housed in polished teak case. 8in. mirror scale. 2 ranges, A.C. or D.C. 0 to 160 v. and 0 to 320 v. Accuracy within 2%. £5/19/6 each. P/P 3/6.

G.W. SMITH & CO (RADIO) LIMITED
Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
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CLYNE RADIO LTD.

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Open: Tottenham Court Rd., 9 a.m. to 6 p.m. Mon to Fri., Sat. 1 p.m. Holloway Road and Camberwell, 9 a.m. to 6 p.m. daily. Thurs. 1 p.m., Sat. 5.30 p.m.

●

If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

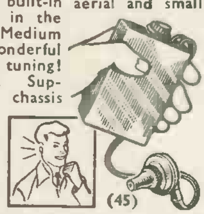
●

Our advantageous H.P. and Credit Sale Terms are available on any single item over £5. Your enquiries invited. Please print your name and address!

NEW BRANCH NOW OPEN
AT
9 CAMBERWELL CHURCH ST., S.E.5.

Telephone: RODney 2875
Situated 25 yards only from Camberwell Green.
OPEN ALL DAY SATURDAY

"PAGEBOY" 2-TRANSISTOR POCKET PORTABLE



Completely portable—NO EXTERNAL AERIAL OR EARTH REQUIRED. This is an amazing little receiver with built-in aerial and small enough to be held in the palm of the hand. Medium wave reception at wonderful volume. No fiddley tuning! —condenser tuned! Supplied with drilled chassis and colour coded components. Easily assembled with the aid of the easy-to-follow assembly instructions provided. (45) Total cost of all necessary components, including transistors, wiring wire and even solder **ONLY 32/6** plus 1/6 P. & P. Battery 3/- extra. Ardente type deaf-aid earpiece complete with cord and plugs extra at 12/6. Parts price list and Easy Lay-out Plans 2/- post free. Callers welcome to hear this set demonstrated at any of our branches. Our reputation is your guarantee.

OUTSTANDING METER IMPORT!

20,000 OHMS PER VOLT!!

MODEL 200H. Volt-ohm-Milliammeter

RANGES:
A.C. VOLTAGE: 10, 50, 100, 500, and 1,000 volts (10,000 ohms per volt).
D.C. VOLTAGE: 5–25, 50, 250, 500, and 2.5k. (20,000 ohms per volt).
D.C. CURRENT: 0–50 micro-amps., 0–2.5 m/a., 0–250 m/a.
RESISTANCE: 0–6k 0–6 meg. (300 ohm. and 30 k. at centre scale).
CAPACITANCE: 10 pf. to .001 mfd., .001 mfd. to .1 mfd.
Actual size 4½x3¼x1in.
DECIBELS: −20 to +22 db.

A fully guaranteed pocket size meter, knife edge pointer, top quality, supplied complete with test prods and full operating instructions at **£6.19.6 ONLY**
Plus 2/6 P. & P.
Optional extra, attractive carrying case 13/6 only. (Bona-fide trade enquiries invited.) Leaflet available.

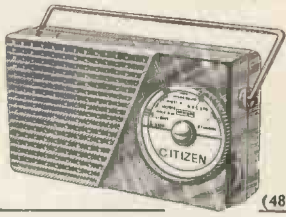
● *JUST ARRIVED! NEW!*

CRYSTAL MICROPHONE. Sensitive Miniature Lapel-type. Complete with clip and screened lead. Brand new, 17/6, plus 6d. P. & P.

SMALL SOLDERING IRON. Complete with vinyl carrying case, mains lead and 2-pin plug, A.C. 230 v. Handle unscrews and becomes protective cover for the bit. Only 18/9, plus 1/- P. & P. Spares available. Bit 1/3, Element 4/6.

LIGHTWEIGHT HIGH RESISTANCE HEADPHONES. 4,000 ohms, adjustable headband, brand new. Limited quantity at 13/6 per pair, plus 1/- P. & P.

THE "CITIZEN"



(48)

Introducing our new Sensitive 5-Stage (4 transistor plus diode) pocket transistor receiver—for full Medium Wave reception—with the following outstanding features:

- ★ Completely self-contained—No external aerial or earth required.
- ★ Genuine 2½in. High Flux P.M. Speaker.
- ★ Push-Pull output.
- ★ Genuine Ediswan transistors.
- ★ Socket provided for personal listening.
- ★ Socket provided for connection to Car Aerial.
- ★ Volume Control with on/off switch—Condenser tuning.
- ★ Easy assembly on colour coded pretagged circuit board.
- ★ Attractive Red polystyrene cabinet measures 5¼×3×1⅜in., chrome handle, attractive dial.

Suitable crystal deaf-aid type miniature ear-piece fitted with miniature jack plug at ONLY 7/6 extra, if required.
All parts available separately—itemised list and full assembly instructions sent for 1/6 post free.

Hear this amazing little receiver at any of our branches

All required components including full instructions, solder, etc. and battery at special inclusive price of Plus 2/6 p. & p. **ONLY 95/-**
Yes NINETY FIVE SHILLINGS ONLY! Nothing more to spend.

THE "WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE

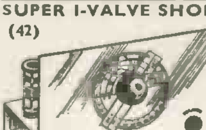
400 MILLIWATTS OUTPUT


(43)

To build yourself, Medium and Long waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6¾in. x 4½in. at base tapering to 4in. at top.
Very attractive two-tone grey Vynide covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. ★ Weight—complete with long-life 7½ volt battery—4½lb. ★ Mazda high-grade transistors throughout. ★ High-Flux 7in. x 4in. Elliptical Speaker. ★ Slow motion tuning. ★ Co-axial socket at rear for direct connection to Car Radio Aerial. ★ Improved reception by use of seven-section plated telescopic aerial disappearing into Cabinet when closed, 34in. above Cabinet when fully extended.
Construction simplified by Bakelite chassis board with the following components already mounted: I.F. Transformers (3). Oscillator Coil, Trimmer, Bank, Output Transformer, Interstage Transformer, Aerial Brackets and Earth Bar. SPECIAL INCLUSIVE PRICE for all required components, full assembly instructions—nothing more to buy—is £10/19/6 plus 3/6 P. & P. Alignment service available. Full assembly instructions and individually priced parts list, all of which are available separately, 2/6, post free.

SUPER 1-VALVE SHORT-WAVE RADIO

(42)



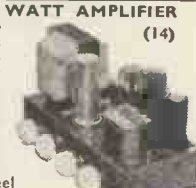
World-wide coverage at most reasonable cost. Covers 40–100 metres with the coil supplied. Can be extended to cover 10–100 metres. Provision is also made for the addition of two extra valve stages. Employs the famous Acorn-type 954 valve. All necessary components can be supplied complete with full assembly instructions at **ONLY 35/-** plus 2/- p. & p. Send 2/- for point-to-point wiring diagram and price list.

PRINTED CIRCUIT CAR RADIO


(39)

(for Home Construction). We are proud to be able to offer this New type Car Radio employing up-to-the-minute circuitry, special 12 volt valves and transistorised output stage. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Wavebands. NO VIBRATOR PACK IS REQUIRED. This is a really compact receiver that will fit any car. Comprehensive assembly instructions are provided with all necessary components, including valves and transistor at a Special New Low Inclusive Price of Only £11/19/6 plus 3/6 p. & p. Instruction booklet with itemised price list, full description, dimensions, etc. available separately at 3/6 post free.

THE R.C. 3/4 WATT AMPLIFIER


(14)

Compare the advantages. Treble bass AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250v. Valve line-up: 6V6GT, 6SG7 metal. 6X5GT. Negative feed-back. Built on stove enamelled steel chassis, measuring only 8in. x 4in. x 1¾in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at £4/5/- only, plus 2/6 p. & p. or Instruction Book fully illustrated for 1/- post free. This amplifier can be supplied assembled, tested and ready for use at £5/5/-, plus p. & p.

THE NEW LOOK RAMBLER PORTABLE


(J)

This wonderful little Medium and Long wave battery superhet incorporates 1R5, 1T4, 1S5, 3V4 miniature valves, 5in. speaker and frame aerial. Housed in smart two-tone Red/Grey cabinet. All required components at the NEW LOW PRICE of £6/5/-, plus 2/6 p. & p., or with the latest low consumption "96 range" valves at the NEW LOW PRICE of £6/15/-, plus p. & p. Uses all-dry batteries AD35 (1/6). B126 (9/-). Full descriptive instruction book, itemised price list, diagrams, etc., available separately at 1/6 post free.

(2) MAINS UNIT FOR ABOVE
Fits into battery compartment. A.C. 200/250 v. All required components at ONLY 47/6, plus 1/6 p. & p., or assembled and tested at £3/5/-, plus p. & p. (Also suitable for many other portables.)

VISIT OUR FULLY EQUIPPED
HI-FI SHOWROOM
AT TOTTENHAM COURT ROAD FOR DEMONSTRATIONS OF THE LATEST
HI-FIDELITY EQUIPMENT
BY ALL LEADING MANUFACTURERS

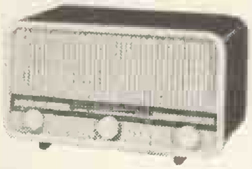
We stock equipment of Quality by all leading makers: i.e., Leak, Quad, Armstrong, Dulci, Ferrograph, Reflectograph, Vortexion, Tannoy, Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, Garrard, Lenco, B.T.H., Pamphonic, Simon, Brenell, Collaro, Telefunken, Fi-Cord, etc., etc. A full range of high quality cabinets to suit all purposes is on show, i.e., "RECORD HOUSING," "W.B." "A.D." etc. Enquire about our interesting part-exchange scheme for personal callers. H.P. Available

PLASTIC TAPE SPOOLS. Best quality. 3in. 1/6, 5in. 2/-, 5¾in. 2/3, 7in. 2/6. **PLASTIC SPOOL CONTAINERS** for spool sizes 5in. 1/6, 5¾in. 2/-, 7in. 2/3. Any single item plus 6d. P. & P. Orders over £1, post free.

LANGUAGE COURSES ON TAPE!

Complete Elementary Course in French, Italian, German or Spanish. Phrase book supplied. 5in. long play tape, 55 minutes at 3¾ i.p.s. Price ONLY 29/6 per course, Post Free! Trade Supplied.

NEW! "POPULAR FOUR"



IMPROVED APPEARANCE AND PERFORMANCE!

A new three valve plus miniature contact-cooled rectifier, mains T.R.F. Receiver is now available. New De Luxe Cabinet, polished walnut finish, cream trim, attractive horizontal dial (as illustrated). Quality 5in. P.M. speaker. Specially wound high gain super-sensitive Denco coils. Medium and Long Wavebands. Excellent (47) Continental reception! Overall dimensions: 12in. x 6in. x 5in. A.C. 200/250 v. Simple construction with guaranteed results. Easy to follow practical and theoretical diagrams supplied. All necessary components, down to the last nut and bolt, are offered at a **SPECIAL INCLUSIVE PRICE OF £5/5/0**, plus 3/6 p. & p. Instruction book available separately 1/6, post free. ALL PARTS AVAILABLE SEPARATELY.

RECORD PLAYERS

Full range at usual competitive prices. Interesting H.P. facilities

E.M.I. MODEL 985 4-SPEED SINGLE RECORD UNIT. Very latest type. Heavy 8¾in. dia. turntable, low flutter performance. 200/250 v. with tap at 80 v. for operating amplifier valve filament if required. Complete with matching pick-up with mount and rest. Brand new and fully guaranteed. **ONLY 89/6**, plus 3/6 P. & P. Pick-up available separately, complete with mount and rest 25/-, plus 1/6 P. & P.

JUST ARRIVED! 4-SPEED BATTERY OPERATED VERSION OF ABOVE

6 volt operation complete with pick-up **£5/9/6** plus P. & P. 3/6.

TRANSISTOR AMPLIFIER now available for use with the above battey player. Compact size, 500 milliwatts output, printed circuit construction, tone and volume controls. Supplied complete with 8in. x 2in. 20 ohms matching quality speaker. Price only 89/6 plus 2/6 P. & P.

LATEST GARRARD MODEL 210. Four-speed manual or automatic. 10in. and 12in. records of same speed can be mixed in any order, wired for stereo, attractive white colour scheme. Price 10½ gns., plus 3/6 P. & P.

LATEST COLLARO 4 SPEED AUTOCHANGER MODEL C60 Complete at £7.18.6, plus 3/6 P.&P.

LATEST B.S.R. UA14. 4-speed Attractive appearance. Wired for stereo. Fully guaranteed. **£7/19/6**, plus 3/6 P. & P.

B.S.R. UA14. Stereo/Monaural. Fully guaranteed. **£8/19/6**, plus 3/6 P. & P.

B.S.R. UA8. Brand new and guaranteed. Few only. Monaural, **£6/19/6**. Stereo/Monaural, **£7/19/6**. Both plus 3/6 P. & P.

RADIO JACK (25)

Covers local medium wave stations variably tuned. Compact self contaied unit requiring only connection to aerial (no power supplies reqd.) for 1st class reception when used in conjunction with your tape recorder or high gain amplifier. All necessary parts available at a special inclusive price of only **19/6**. P. & P. 1/6.

FRUSTRATED EXPORT. Not repeatable! **L., M. and S.W. SUPERHET RECEIVER.** Manufactured by McCarthy for export. At present for operation on 6 volts, but conversion details supplied free.

Valve line-up: 6K8G, 6K7G, 6Q7C, 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8in. P.M. Speaker, 4 watts output. P.U. socket. Ext. L.S. socket etc. Tone control. Fitted in polished wood cabinet, size 21¾in. x 10½in. x 10½in. These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price **£5/19/6** only plus P. & P. 7/6, plus 27/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

12in. BAKERS SELHURST LOUDSPEAKER. 15 ohms, 15 watt 30-14,000 cps. Brand new, **£4/10/-**. P. & P. 3/6.

SUPER MAGNETIC RECORDING TAPE SPECIAL!!!

Famous American Ferrodynamics **"BRAND FIVE"**

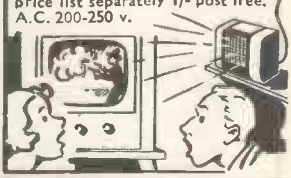
An enthusiast's "must." Brand new (NOT SUB-STANDARD) High grade Acetate Base. 5in. 600ft. **16/-**, 5in. 900ft. **18/6**, 5¾in. 1,200ft. **23/6**, 7in. 1,200ft. **25/-**, 7in. 1,800ft. **35/-**. Extra quality Mylar Dupont, 3in. 300ft. **13/-**. 5in. 1,200ft. **37/6**, 7in. 1,800ft. **44/-**, 7in. 2,400ft. **60/-**. Each on plastic spool. All Post free. *Trade enquiries invited.*

DECCA PORTABLE AMPLIFIER. As supplied in famous DECCAMATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3½ x 8¾in. Only **59/6** plus 2/6 P. & P.

SPECIAL CELESTION 8 x 6in. elliptical high flux loudspeaker 30/- plus 1/- P. & P. to fit.

VERY ATTRACTIVE PORTABLE CABINET in two-tone rexine covering for accommodating the above items and ancillary equipment 75/- plus 5/- P. & P. **Note.** If the above three items are purchased together they will be supplied at the special inclusive price of **£7/2/6** plus 6/6 P. & P.

This highly efficient unit is simple to assemble, extremely sensitive and may be installed in a matter of minutes. Completely **SAFE** employing a double wound mains transformer. Attractively finished in Red and Grey (washable) "Lionide" with cream plastic escutcheon. Size only 7½in. x 3¾in. x 6¾in. Supplied in kit form complete with mike at ONLY **72/6** plus 2/6 p. & p. or assembled and tested **89/6** p.&p. 2/6. Suitable mike flex available at 3d. a yard. Instruction book and price list separately 1/- post free. A.C. 200-250 v.



THE P.W.
"ROADFARER"

Now available the "OSMOR" version at special inclusive price of

£16.19.6 Plus 2/6 p. & p.

A completely self-contained transistor portable with many novel features. For battery or mains operation. Medium, Long and V.H.F. bands. Full details and individually priced parts list on request.

★ TAPE RECORDER CONSTRUCTORS ★

TELEPHONE PICK-UP COIL. Designed to feed into the microphone input of either a tape recorder or any high gain amplifier. Easily attached to telephone by rubber suction attachment. The coil is electrostatically shielded to minimise hum pick-up. When positioned on telephone this model is more than adequate for a fully modulated tape recording. Brand new complete with 5ft. shielded cable. ONLY **14/-**. P. & P. 1/6.

COLLARO TAPE PRE-AMPLIFIER AND BIAS OSCILLATOR. Complete with power pack for use with Collaro Mk. IV deck. 4 valve plus EM81 magic eye. 110–240 v. A.C. Input sensitivity: microphone socket 5 m/v., auxiliary socket 500 m/v. Speed equalisation switch gives compensation at all 3 speeds. Full wiring instructions included. List price £21. Limited quantity only at **£15/19/6**. P. & P. 5/–.

LATEST COLLARO STUDIO TAPE TRANSCRIPTOR. Latest type incorporating Record, Interlock, Lever, Button, 3 motors, 3 speeds, 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push-button controls. **£12/19/6** plus 5/– P. & P. Usual H.P. facilities.

LATEST B.S.R. "MONARDECK." Single speed Tape Deck. Takes 5¾in. spools—3¾ i.p.s. At only **£8/5/-** plus 5/– P. & P.

TAPE RECORDER AMPLIFIER. Suitable for use with either of the above Tape Decks, and most other types. For A.C. mains, 4 watts output. 40-12,000 CPS at 7½ i.p.s. ± 3 db. Facilities for superimpose. Valves: 6BW6, ECL82, 12AX7, EMB4, and contact cooled metal rectifier. Radiogram input, microphone input, monitor facilities (can be used as straight through amplifier), volume control and separate treble and bass controls. Chassis measurement 11½ x 3 x 4¾in. Supplied complete with attractive grey/blue escutcheon plate finished in black and gold. Circuit diagram and connecting instructions included. Price **£11/5/-** only, plus 3/6 P. & P. If purchased with either of the above decks, both items post free!

ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE. Suitable for above amplifier and Collaro Studio deck. Limited quantity only at **79/6** plus 3/6 P. & P.

MIC 45-1. Acos latest flat pistol-grip crystal microphone. Attractive black and gold finish. OUR PRICE **29/6** plus 1/- P. & P. **ACOS MIC 39-1.** Crystal stick microphone. List price 5 gns. Our price **39/6** plus 1/6 P. & P. **MIC 40.** General-purpose crystal microphone with desk stand. Our price **25/-** only plus 1/6 P. & P. **M.C. 24.** Imported, crystal. attractive streamlined polished metal case, incorporates muting switch. List price 64/–. OUR PRICE **42/-** only. 1/- P. & P.

TELEPHONES!!!
The Best value yet offered!

LIMITED QUANTITY

Attractive appearance.
Operate from 6-volt battery. Ideal for Home, Office, Factory etc. Simply turn handle and bell rings at other end. Any twin lighting type flex required for connection. Not new but good condition. Tested before despatch.

5 GNS. Per pair complete with batteries, plus C. & P. 7/6.

Suitable twin P.V.C. clear plastic flex 3d. per yard or 20/- per 100 yards.

CLYNE RADIO LTD.

THE COMPONENT SPECIALISTS

18 Tottenham Court Road, London, W.1.
162 Holloway Road, London, N.7.
9 Camberwell Church St., S.E.5.

TESTGEAR COMPONENTS (LONDON) LTD

15 ARCANY ROAD, SOUTH OCKENDON, ESSEX. TEL: AMBassador 1958

MAINS TRANSFORMERS

New "C" Core Potted Types. Primaries 190/240 in 10 v. steps.
Type 17732—Output 4 v. 1.1 A. 7.5 kV. Peak WKG. and 4 v. 1.1 A. 15 kV. Peak WKG. Price: £2.
Type 17725—Output 5 kV. RMS 1 M/A and 6.3 v. .2 A. Price: £2.
Type 20726—"C" Core. Not Potted. 600-0-600 v. 278 M/A RMS. 6.3 v. 1.6 A. 6.3 v. .6 A. 6.3 v. .8 A.-1.8 kV. DCW 5 v. 8 A. + 1.2 kV. DCW. Price: £3.
Type S.T.1—500-0-500 v. 300 M/A 5 v. 5 A. 6.3 v. 4 A. 6.3 v. 1 A. Price: £2.
Type S.T.6—6.3 v. 2 A. Tapped at 4 v. 5 kV. RMS WKG. Price: £1.

AIRCRAFT TRANSMITTER SPARES

We can offer large quantities of complete units and spare parts ex the Aircraft Transmitter/Receivers Types 1934/1935/1985/1986/1987. We welcome quantity enquiries for which we can quote very low prices.

OSCILLOSCOPE BASIC KIT

Consists of one 3½in. diam. Electrostatic C/R Tube (CV1547) and socket, EHT Transformer, Metal Rectifiers, and smoothing condensers for EHT supply. All new perfect material. A gift at £1, post paid.

TYPE 46 TRANSCEIVERS

The best bargain for many years. These fine Walkie Talkies are now available in new condition complete with all accessories at a give-away price. 3-Channel Crystal controlled T/X and R/X, supplied complete with one pair crystals, coil box, rod aerial, leads and plugs, valves, balanced armature headset with throat mike and carrying satchel. 1 watt output. Coverage 3.6-4.3 Mc/s. or 6.4-7.6 Mc/s. by means of Plug-in Coil Box. Inland buyers supplied with crystals in 3.5 or 7 Mc/s. band (state which required), other frequencies available for export. Requires only 150 v., 15 v. and 3 v. dry battery. Range over 10 miles. Full instructions and circuit supplied. These units have been "demobbed" by removal of the "Send Receive" switch. A replacement switch with fitting instructions is supplied. We offer this fine unit with all accessories as listed above at the ridiculous price of 30/- or two for 57/6. We will supply an extra 46 Set, complete with valves (but no accessories) as a source of spares for only 7/6 extra. Batteries are available at 18/6 per set. A low-priced Transistorised Kit of Parts for operation of above from 6 v. or 12 v. D.C. will soon be available.

CRYSTALS

FT.241 27nd Harmonic Type. 120 Crystals with fundamentals from 370 Kc/s. to 540.277 Kc/s. in steps of 1.388 Kc/s (Channels 270-389). From 448.611 to 472.222 inclusive and 500 Kc/s. Price is 7/6. All others 2/6 each or 6 for 10/- for any six consecutive channels. Special quotations for other assortments.

A/C RELAYS

Magnetic Devices 230 v. 50 c. Operated D.P.C.O. 1 amp Contacts. Price: 15/-.

B.C.221

The fine frequency meters are available in "as new" condition, complete with crystal, original calibration manuals and canvas cover. Price: £16. A few with modulation available at £19.

TRANSMITTER UNITS

The transmitter portion of the TR1986. Unusable in its present form, but a useful basis for a 2-metre T/X. Contains many useful parts including a 5-gang Butterfly Condenser. 10 Air Trimmers, etc. Price: 5/- or complete with QV04/7 (Driver) and TT15 (15 w. output on 144 Mc/s. with 300 v. plate). Final price: 27/6.

TRANSISTORS

New low prices for Mullard Transistors: OC.71. Price: 6/6. OC.75 Price 8/-. OC.81. Price: 8/-. OC.76. Price: 8/-. OC.170. Price: 15/6. OC.16. Price: 25/-. OC.28. Price: 36/-. OC.35. Price: 25/6. Also first-class substitutes for OC.71, OC.72 and OC.44. Price: 3/- each.

PLATE TRANSFORMERS

Input tapped 200-250 v. Output 500-0-500 v. One ampere. L.T. 6.3 v. 6 A., 5 v. 9 A., 6.3 v. 4 A. Price: £3/3/-.

50 MICROAMP METERS

Made by Sangamo Weston. Brand new. Type S.145. Size 3 x 2¾in. 850 ohms resistance. 4 scales operated by lever, "Set Zero," "0-3," "0-30," "0-300." Easily coupled to rotary range switch by cord or lever. Complete with suggested circuits, a gift at 20/-. Easily adjusted to 25-0-25 microamps.

METER BOXES

A range of attractive useful Meter Cabinets that can be supplied ready punched to take above meter. Useful for all kinds of testgear: a quality job with fully-formed pressed steel lids, welded construction, grey hammer finish enamel. Price: 4 x 5½in. Panel in depths of 2in., 3in. or 4in., 10/3, 10/9 and 11/3 respectively, or with 4⅝ x 7½in. panels, 12/-, 12/9 and 13/-. Available punched to take above meter 1/6 extra.

MOBILE RADIO TELEPHONES

Type B.44 Mk. 2 covers 60-95 Mc/s. Crystal controlled. Receiver is crystal controlled double superhet. Fully tropicalised, in robust waterproof aluminium case, built-in speaker and 12 v. power supply. Uses modern B7G tubes. Output 3 watts. Supplied in perfect order and aligned to your specified frequency. Size 14in. wide., 7in. high, 13in. deep. Complete with Manual and Plugs. Price: £20, carr. paid U.K. or F.O.B. London. Extras required are M/C Microphone. Price 17/6. Pair of Crystals (our selection in 4-metre band). Price 22/6 or supplied to your specified frequency, £6. Available for amateur use or export only.

SILICON RECTIFIERS

Sub-miniature silicon power diodes at new low prices. Made by one of England's greatest manufacturers. 250 M/A. D.C. output. Type (1) 400 P.I.V. Price 3/6. Type (2) 600 P.I.V. Price 5/6. Type (3) 800 P.I.V. Price: 7/6.

2-METRE R/X

Receiver portion of the SCR.522 TX/RX. Brand new with valves and conversion details for continuous tuning 144-146 Mc/s. Price: 30/-. Relay if required, 7/6.

RELAYS

As used in 1985, etc., Series Aircraft Transmitters. Size 1¼ x 1¼ x ¾in. 700-ohm coil. Operates on 12-24 v. or 6 v. with slight adjustment tension. Double pole changeover or single pole normally open (10 amp. contacts). Either type, price: 3/6.
U.S.A. P.O. TYPE RELAYS. Type APHC. 6,500 ohm 12 v. 2 M/A. S.P.C.O. Price: 2/6. Type APLC. 3,500 ohm 6 M/A. S.P.C.O. Price: 2/6.
AERIAL CHANGEOVER RELAYS. 12-24 v. operated, 4 P.C.O. Price: 3/6.

VALVES

All new and guaranteed.
12SQ7, 12SK7, 12A6, EL33, 6F33, 6L18, EF80, VR150/30, 50L6GT, 12AT6, 12AT7, 12Q7GT, 7B6, 25L6GT, 12AU7, 85A1, 12SA7, 3S4, 5U4G, 6J6, 6K8G, 6V6G, 6N7GT, 6AG7, 7Z4, 6SG7, 6Q7G, EY91, EF73, EF70, EC70, EF71, EN32, 90CV (Photo Tube), 6AK5, 6CH6, 1R5, 1S5, 1T4, 1L4. All above types 5/- each.

TRANSMITTING VALVES

Brand new and guaranteed.
813 Price: 37/6. 5B/255M (Miniature 807) Price: 12/6. 5B254G (ditto) Price: 12/6. QQV06/40 Price: 30/-. 1625 Price: 2/6. QV04/7 Price: 5/-.

TRANSISTORISED D/C-D/C CONVERTOR KITS

Incorporate toroid transformers, silicon rectifiers, standard transistors, heat sinks, input and output connectors, protective devices, circuit and instructions. Efficiency from 85% to 95% (on larger output types). All are 12 v. input. Types 1, 2, 3 and 5 have output of 300 v. tapped at 250 and 200 v. 4, 6, and 7 have outputs of 600 v. tapped at 500 and 400 v.
Type (1) 30 watts £5/15/-. Type (2) 45 watts £6/17/6. Type (3) 75 watts £7/17/6. Type (4) 75 watts £8/5/-. Type (5) 100 watts £8/15/-. Type (6) 100 watts £9/2/6. Type (7) 150 watts £11/11/-. All are available with dual voltage output at a small extra charge. D.C.-A.C. (400 c.) kits also available. All parts are available separately.

Terms of Business: All prices include postage or carriage. Handling charge of 1/6 on orders under 10/-. Payment cash or C.O.D. over £1. Export orders welcomed.

If you have ever written to us you will receive a copy of our comprehensive list within a few days, if not, then please let us have your name and address.

MAINS POWER SUPPLY UNITS. Potted and sealed transformer and choke by famous maker Mounted on metal chassis 6¼ x 7¼in., complete with 5Z4 rectifier valve and full smoothing. Input tapped 220-230-240 volts.
Output: 300 V. D.C. at 100 mA.
6.3 V. A.C. at 4.5 amp.
6.3 V. A.C. at 2 amp.
Rectifier supply 5 V. A.C. at 3 amp. Very conservatively rated. Price 47/6 plus P. & P. 8/-.

BRAND NEW VARIABLE VOLTAGE TRANSFORMER. For 230 volt A.C. input. in cases with meter, fuse and indicator light. Output constantly variable from 0—230 volt A.C. Type 15. 15 amp. Price £22/10/-. Carr. 15/-.

S.T.C. RECTIFIER. 36 plates by 120 mm. Bridge connected. Maximum A.C. input 60 volt. D.C. output 15 amp. New, perfect. Price 60/-. P. & P. 3/6.

S.T.C. BRIDGE RECTIFIER. New, perfect. 8 plates each 115 mm. Maximum A.C. input 36 v. D.C. output 5 ampere, 24 volt. Price 20/-. P. & P. 2/-.

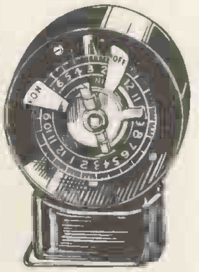
NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohm. 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

W. W. RHEOSTAT. New. 3.5K or 5K 25 watts. Price 7/6. P. & P. 1/6.

AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each. P. & P. 6/6.

HEAVY DUTY L.T. TRANSFORMER. Very conservatively rated for continuous duty. New. In manufacturer's cases. Input 110–260 volt multi-tapped. 50 cycles, single phase. Output 28–29–30–31 volts at 21 ampere. Price £6/15/-, carriage 10/-.

ROTARY SWITCH REGULATOR. 25 ohms, very conservatively rated at 4 amp., will handle 8 amp. Overall size 7 x 8 x 6in. Price 15/-. P. & P. 2/6.



8-day clockwork TIME SWITCH

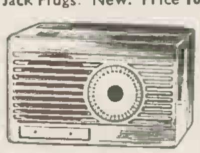
Contacts 2½ amp., 230 volt, 24 hour phase, ¼ hour divisions, allow setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 2/-.

EX P.O. MAGNETIC COUNTER. 3 ohm. type for 6 V. D.C. operation. 4 figures to 9,999. Price 8/6. P. & P. 1/3.

TANNOY P.A. LOUDSPEAKER. For outdoor use, metal exponential horn with 20in. square flare. Overall length 30in. Speech coil 15 ohms. Guaranteed in working order and good condition. Price £7/10/- Carriage 10/-.

20-WAY STRIP. Containing standard Post Office telephone Jack Sockets, overall size 11 x 3¼ x ¾in. New. Price 15/- each. P. & P. 1/6.

10-WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing Igranic Jack Plugs. New. Price 10/-. P. & P. 1/6.



MOULDED CABINET suitable for Transistor Set. Dual colour red/black. Size 5¼in. x 3¼in. x 1¾in. Gold metal dial. Price 7/6. P. & P. 1/6.

AVO METER MODEL 7. Individually tested on all ranges and guaranteed. Inclusive of Test Heads. £12/10/- each. P. & P. 5/-.

MULLARD TRANSISTORS. OC 170, 70 to 100 Mc/s., 13/6 each. OC 171, 100 to 200 Mc/s., 14/6.

Set of six 1 x OC 44: 2 x OC45: 1 x OC81D: 2 x OC81. Six for 39/6.

NEW P.O. RELAYS TYPE 3000. 2,000 ohm coil. 4 make 4 break, 12/6 each. P. & P. 1/-.

NEW RHEOSTAT 1,750 ohms 100 watt. Wound on ceramic former. In metal case with 1in. x ¼in. spindle. New in maker's packing, 32/6 each. P. & P. 2/6.

SUPERIOR BRAND NEW RELAY. 7,000 ohms coil. Will pull in at 750 microamps, and out at 450 microamps. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2½ oz. Price 18/6. P. & P 1/-.

MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each.

Operating current minimum 140 microamp., nominal 400 microamp, maximum 8 milliamp. One pole two way, or centre stable. Two way contact current 100 mA at 50 V A.C. or D.C. Size 1¼ x ⅞ x ¾in. Price 22/6 each.

G.E.C. SEALED RELAY. Type M.1090. 180 ohms coil, 6/12 volt. 4 C/O. Brand new. 18/-. P. & P. 1/-.

PACKARD BELL BRAND NEW RELAYS, 2 pole C/O. 6 volt 80 ohms. 7/6 each. P. & P. 6d.

MINIATURE RELAYS 250 ohms. Two makes. For operation on 4.5–9 volt. Ideal for transistor circuits. Weight just over 1 oz. Price 12/6 each.

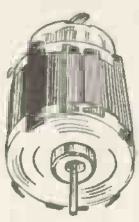
SIEMENS H.S. RELAY. Very latest type, sealed. H96E. 1,700 ohms plus 1,700 ohms, single C/O. contacts. Brand new with fixing clip. In maker's cartons. Price 16/6 each, plus 1/- P. & P.

SOLENOID OPERATED MAGNETIC RELAY. Type 5CW/3945, 4 pole changeover, 10 A contacts 24 v. operation. Brand new 13/6. P. & P. 1/6.

CARPENTER'S TYPE POLARISED RELAYS. 2 x 9,500 turns at 1,685 ohms. Price 22/6 each. P. & P. 1/-.

HIGH SPEED RELAY. Siemens Two bobbins 1,000 ohms each. New, 10/6 each. P. & P. 1/-.

FRACTIONAL H.P. MOTOR MADE BY FRACMO. For 230/250 volt A.C. Delivers 1/6th of a H.P. at 5,000 R.P.M. Complete with wire leads and 1in. x ¼in. spindle. Unused. Price 39/6 each. P. & P. 3/-.



NEW IMPORTED EXTREMELY EFFICIENT MOTOR with tremendous power weight ratio For 12 volt D.C. but very efficient on 6 volt. Three position switch. Weight 21 oz., size 1⅞in. x 1¼in. dia. Speed 7,000 r.p.m. Self lubricating 15/-, plus 1/- P. & P.

CONSTANT SPEED, PRECISION MADE, BATTERY DRIVEN D.C. GOVERNED MOTOR (Elliott Bros.). Commutator/brush incorporating loading ballast resistor 2,470 r.p.m. ± 2% at 12 volt. Loss on 8.5 volt only 4%. Size 1 1/32in. dia. x 2 3/32 in. long. Spindle .77in. long x .15575in. dia. Weight 4 oz. New. Price 25/-. plus 1/- P. & P. Ideal for portable tape recorders.

DESK TELEPHONE HANDSETS

Used but perfect. Complete with two-way calling system (buzzer), internal battery. All ready for simple two-wire connection. Price £3/2/6 each or £6 the pair. P. & P. 3/6 each handset.

DESK TELEPHONE SETS, similar to G.P.O. extension telephones. Each complete with automatic dial, internal bell and long connection core and junction box. Used but in perfect working order. Price £2/17/6 each. P. & P. 3/6.

DIALS ONLY FOR AUTOMATIC TELEPHONES. Used but in good condition. Price 12/6. P. & P. 1/6.

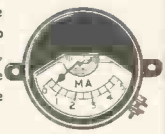
NEW BALANCED ARMATURE HEADPHONES. TYPE DLR5. Guaranteed perfect. Price 12/6 each. P. & P. 2/-.

METERS GUARANTEED PERFECT

Charging Types	
2½ amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2½in. fl. rnd.	11/6
7½ amp. D.C. M.I. 3½in. proj. rnd. ...	12/6
9 amp. D.C. Hot Wire W.R. 2½in. fl. rnd.	6/6
15 amp. D.C. M.C. 2in. rnd.	10/6
100 amp. A.C. M.I. 4½in. fl. rnd. ...	32/6
Voltmeters	
20 v. D.C. M.C. 2in. fl. sq.	10/6
30 v. M.I. 3in. proj rnd.	10/6
300 v A.C M.I. 2½in. fl. rnd.	22/-
400 v. A.C. M.I. 4½in. rnd.	35/-
90-180 v. A.C. M.I. 4½in. fl. iron ...	25/-
Milliammeters	
1 mA. M.C. 2½in. fl. rnd.	25/-
200 mA. M.C. 2½in. fl. rnd.	12/6
500 mA. M.C. 2½in. fl. rnd.	12/6
Microamp	
50 microamp., scaled 0-100, M-C. 2½in. fl. rnd.	42/6
500 microamp., M.C. 2½in. rnd. F.L. scaled 15/600 volt. NEW	16/6

Postage on all meters 1/- each.

Miniature latest type moving coil 0-5 milliamp meter, 1½in diameter, flush fitting, complete with fixing clip. Price 17/6. P. & P. 1/-.



MINIATURE LATEST TYPE MOVING COIL MICROAMP METER, F.S.D. 300 microamp, flush mounting, square rim 1⅞in. x 1⅞in. round dial 1½in. Ideal as field strength meter or output level recorder or tuning meter. Price 26/-. P. & P. 1/-.

LATEST TYPE ERNEST TURNER. 0-200 volt A.C. RECTIFIED M.C. METER. Flush mounting, round, 3in. scale. Price 37/6. P. & P. 1/6.

ROTARY CONVERTOR. Ex-W.D. for 12-volt D.C. input, output 230 volt 50 cycles at 100 watts. Housed in wooden carrying case with lid. Voltage control slider resistance, mains switch and 300 volt A.C. voltage output check meter. Perfect working order. Price £9/17/6, carriage 10/-.

PANEL MOUNTING TOGGLE SWITCH D.P.D.T. CENTRE OFF. 250 volt 3 amp. Price 5/6 each.

MINIATURE UNISELECTOR SWITCH. Two banks of ten plus home contacts one bank continuous of normal. 30 ohm coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6.

Postage and Carriage shown above are inland only. For overseas please ask for quotation. We do not issue a catalogue or list.

SERVICE TRADING Co.

PERSONAL CALLERS ONLY: **9 Little Newport Street, London, W.C.2** *Tel: GER. 0576.*
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Telephone: KINgston 4585

Tubes

HIGHEST QUALITY—NEW LOW PRICES

Carr. & Ins. 12/6 **GUARANTEED**

MOST MULLARD, MAZDA, COSSOR, EMITRON, EMISCOPE, BRIMAR, FERRANTI TYPES, PROCESSED IN OUR OWN FACTORY. New Mullard, Mazda & U.S.A. guns used. NEW 108K 19/-

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Yellow Spot, 2/9, Green Spot, 2/6, Red Spot, 3/6, White Spot, 4/6, Ediswan XB104, 8/6, XA103 (4 Mc/s), 10/-, XA104 (6/8 Mc/s), 12/-, O.C. 44 15/6, OC 45, 15/-, O.C. 70, 14/-, O.C. 71, 8/-, O.C. 72, 12/-, (Matched Pairs 22/-), V15/10P (10 watt power), 14/-, Yellow/Green, 5/-.

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*1L4	3/6	6L7G	6/-	25A6G	8/-	EBC81	7/9	*KT36	9/-	U107	11/-
1N5GT	9/9	6L18	8/6	*25L6G	6/9	EBF80	7/9	*KT44	7/6	U118	6/-
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2A3	7/9	*6Q7G	6/3	30P4	12/6	ECC31	9/6	KTW61	5/9	U147	5/6
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6AG7	7/9	7B7	7/9	9001	4/-	EF22	7/-	PCL84	7/6	UBF80	8/6
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6F14	9/6	12SK7	4/9	DK96	7/6	EN31	16/-	U18	8/-	UY85	6/6
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*6H6	2/-		4/9	DL35	9/6	Small	8/-	U24	15/-		5/6
*6J5G	2/9	12SN7GT		DL91	8/-	EY86	8/-	U25	12/6	VR150/30	
6J5GT	3/9		8/6	DL92	6/-	EZ40	6/6	U26	9/9		6/9
*6J7G	5/-	13D3	7/-	DL93	4/9	EZ41	7/-	U31	7/9	X63	9/6
6J7GT	7/6	14S7	22/6	DL94	6/9	EZ80	6/-	U35	11/-	X66	11/-
6K6GT	6/6	19BG6G		DL95	7/3	EZ81	6/6	U37	28/-	X76H	12/-
*6K7G	2/3		15/-	EA50	9d.	GZ30	11/-	U50	5/9	X78	14/6
6K7GT	4/9	20D1	8/6	EABC80	7/6	GZ32	8/9	*U52	4/9	X79	16/6
*6K8G	5/6	*20F2	8/6	EAF42	8/6	HABC80	9/6	U70	5/6	Y63	6/3
6K8GT	9/9	20L1	16/-	*EB34	1/6	HBC90	7/6	U71	8/-	*Z66	9/6

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2 v. 1.5 A.H. Size 4 x 1½ x 1in. Wt. approx. ½lb., 6/6.

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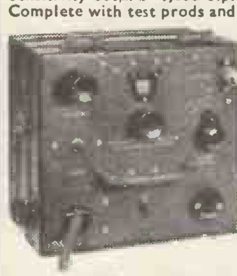
METER BARGAIN! POCKET MULTI-METER MODEL U.I. Sensitivity 300μA. 1,000 o.p.v. in 5 ranges, size 5¼in. x 3½in. x 2¼in. Complete with test prods and ready for use. **ONLY 59/6.** P. & P. 2/-.



WAVEMETER CLASS D. Freq. band 1,900 Kc/s. to 8,000 Kc/s. (158-37.5 metres) in two ranges. 1,900 Kc/s.-4,000 Kc/s., also 4,000 Kc/s. 8,000 Kc/s. Supply 6 v. D.C. input. Complete with twin crystal, spare vibrator, head phones, original instruction manual and transit case. As new **£5/5/-.**

UNREPEATABLE OFFER OF THE POPULAR TAYLOR VALVE **TESTER Model 45A.** Input 200-250 v. A.C. Will test English and American valves with filaments from 1.4 v. to 117 v. Perfect condition. Complete with full instruction manual. **£10.** Carr. 5/-.

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BRIDGE MEGGERS. Evershed and Vignoles Series 2 in perfect condition. 250 v. **£22.** Carr. paid. Leather case available at 20/- extra.

MARCONI SIGNAL GENERATOR TYPE TF517-F/1. Covering 10-18 Mc/s., 33-58 Mc/s., 150-300 Mc/s. In very good condition. Complete with full technical data and instructions. Unrepeatable at only £12/10/-. Carr. 20/-.

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MULLARD BRIDGE. Type GM. 4140/1. Mains operated from 100-250 v. A.C. Will test resistances from 0.1 ohm to 10 megohms and condensers from 10pf to 10mfd. Good condition and complete with instruction booklet. **£6/19/6.** P. & P. 2/6.

ROTARY CONVERTERS. 24 v. D.C. input. 230 v. A.C. output at 250 watts. With starting switch. New and unused **£15.** Carr. 7/6.
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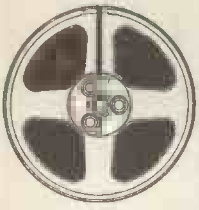
R.C.A. AR88-D RECEIVER Mint condition Freq. coverage 540 Kc/s., 32 Mc/s. £50. Carr. 20/-. Also L.F.s available. Freq. coverage 75-550 Kc/s., 1.5-30 Mc/s. £45. Carr. 20/-.

JUST ARRIVED! SUPER QUALITY AMERICAN "CBS" TAPES



BRAND NEW & GUARANTEED

CIP-6.	600ft.	5in.	Std. Play ..	13/-
LP-9.	900ft.	5in.	Long Play	17/6
CMXP-12.	1,200ft.	5in.	Dble. Play	32/-
CIP-9.	900ft.	5¾in.	Std. Play ..	16/-
LP-12.	1,200ft.	5¾in.	Long Play	19/6
CMXP-18.	1,800ft.	5¾in.	Dble. Play	37/-
CIP-12.	1,200ft.	7in.	Std. Play ..	21/-
LP-18.	1,800ft.	7in.	Long Play	28/6
CMXP-24.	2,400ft.	7in.	Dble. Play	47/-

Many other types available including "Scotch," "EMI," "Triton" etc. Send s.a.e. for our huge money saving literature on Tapes and Accessories.

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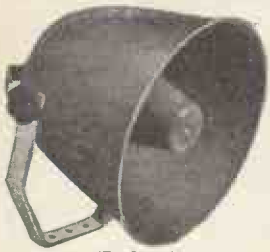


(Ex-Govt.)

Heavy duty 20 watts all-metal. 15 ohms. Diameter 15in., length 15in. (approx.), good cond. £6/10/-. Carr. 10/-. Ditto. Brand new, £8. Carr. 10/-.

50-WATT EX-GOVT. AMPLIFIER. Type III with 4-KT66's in paralleled push-pull. Standard 200–250 v. A.C. input. Output imped. 600 ohms line. High imp. gram. and mike input. Bass boost control fitted. Quality amplifier housed in strong metal case, ready for use. Terrific performance, £25. Carr. £1.

TELEFUNKEN STEREO HI-FI AMPLIFIER

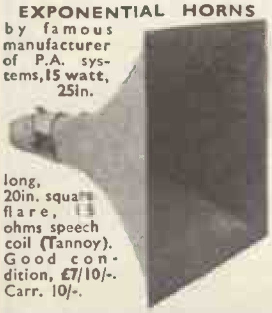
110/250 v. A.C. input. 5 watt undistorted output (10 watts nominal) size 12 x 9 x 2in., weight 9lbs. Illustrated leaflet available, our price £12/12/- carr. 5/-.

TRUVOX/TANNOY LOUD-HAILERS

With 180 ohm line transformer and condenser. Impedance 7½ ohms, handling capacity 8 watts. Complete in slope-front wooden case. Brand new 27/6. Carr. 4/6.

EXPONENTIAL HORNS

by famous manufacturer of P.A. systems, 15 watt, 25in. long, 20in. square flare, 15 ohms speech coil (Tannoy). Good condition, £7/10/-. Carr. 10/-.



NEW P.M. HEAVY DUTY SPEAKERS

Complete with O.P. trans., in all steel blue-grey double grilled cabinet. 6in. 30/-. 8in. 32/6. Carr. 3/6 ea.

TRANSISTORISED PORTABLE HI-FI AMPLIFIER MODEL JTM.12

A completely transistorised Hi-Fi Amplifier powered by 8 1.5 v. dry batteries. Power output 12 watts. Very low power consumption. Inputs for mike and gram can be used together for maximum usefulness. Separate volume controls for mike and gram, bass and treble tone controls. Size approx. 5in. x 11¾in. x 3in. Ideal for outdoor or indoor use for calling, announcing and entertaining. The only portable Hi-Fi amplifier available at this special price of only **£22**

Brand new with full instructions.

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RCA PLATE TRANSFORMERS. 190 to 250 v. primary. 50–60 cycles. Secondary 1,500–0–1,500 or 2,000–0–2,000 at 500 milliamps. Brand new and boxed. £6/10/-. Carr. extra.

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20 kV/A AUTO TRANSFORMER. 230/115 v. 50–60 cycles, by Jefferies Transformer Co., U.S.A. Perfect condition. £20. Carr. 20/-.

E.H.T. TRANSFORMER. 8,000–0-8,000 at 400 mA. Primary 230 v. 50 cycles. Oil filled. New and in original crates. £25. Carr. 25/-.

CONDENSER, oil filled. 240 mfd. 230 v. A.C. or 600 v. D.C. Made in U.S.A. Size 21in. x 5¾in. x 9in. Brand new in original cases, £7/10/-. Carr. 5/-.

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19in. Heavy duty all steel Standard drilling 5ft. 6in. angle uprights. £3/10/-. Carr. 15/-. 6ft. channel uprights £5. Carr. 15/.

Send S.A.E. for comprehensive list of P.A. equipment for outdoor and indoor use.

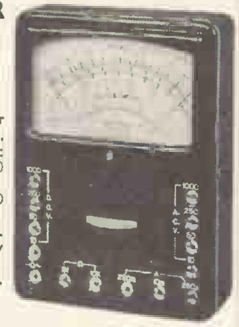
BRAND NEW IMPORTS!

HIGH QUALITY STEREO AMPLIFIER MODEL JS.15 FOR ONLY £20

Designed for Stereo and monaural reproduction from gram, tape recorder and tuners. (AM and FM)—a compact integrated unit with many outstanding features. 10 watts output (5 watts each channel). Inputs for crystal and dynamic pick-ups, tuner, tape (Aux). Selection control for Gram, Radio, Aux. Four position function control: Stereo, Reverse Stereo, Monaural Channel 1, Channel 2. Separate tone and volume controls for each channel. On/off slide switch and novel stereo balance indicator on front panel. The best value in stereo amplifiers available today. Attractive two-tone case for cabinet or shelf mounting. Supplied complete with full instructions. Fully guaranteed.

POCKET TEST METER MODEL TK.60

FOR ONLY **£4.0.0** Post Free



A pocket size individual circuit tester with bakelite panel and metal cabinet. Complete with test leads. Ranges:
D.C. Volts: 10–50–250–1,000 v. (4,000 o.p.v.).
A.C. Volts: 10–50–250–1,000 v. (2,000 o.p.v.).
D.C. Current: 250μA/10 mA/250 mA.
Resistance: 0–10 K ohms/0–1 M ohms (by 3V internal battery).
Decibels: − 20 to + 22dB (0dB −0.775v. -600 ohms.)
Size: 4¾in. x 3¼in. x 1¾in.

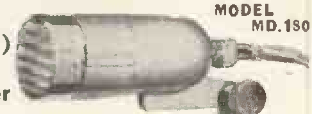
SUPER QUALITY TEST LEAD KIT No. 520

Comprises leads and prods, English and Continental type plugs, spade terminals and crocodile clips. Complete in attractive case **10/-**

POST FREE!

SUPER QUALITY HI-FI DYNAMIC (M/C) MICROPHONE with built-in transformer

MODEL MD.180



Suitable for hand or stand use. Complete with screened lead. OUTSTANDING VALUE **£4.15.0** POST FREE

CRYSTAL MICROPHONE MODEL BM.3

(Desk Stand as illus. 12/6 extra).

Three-way mike for hand, desk or floor stand use. Response 100–8,000 c/s. Sensitivity − 62dB. Length 7in. Head dia. 1¼in. Supplied with neck band and screened lead. Terrific performance!

OUTSTANDING VALUE AT ONLY **45/-**

TELESCOPIC FLOOR STAND

HEAVY 9in. dome chromium base, chromium stand with screw top. Extends to approx. 6ft. Suitable for above mikes, etc., £2/10/-, carr. 5/-.

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ALL BRAND NEW

"15in. VISCOUNT AUDITORIUM." 15 ohms at 400 c.p.s., 35 watts. Flux density 18,000. OUR PRICE £15.

"12in. P.M. HEAVY DUTY" 15 ohms, 15 watts, 30–14,000 c.p.s. OUR PRICE £4/10/-.

"SUPER HI-FI 25." 12in., 15 ohms., 25 watts. 25–20,000 c.p.s. Flux density 17,600. OUR PRICE £9/9/-.

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CRYSTAL CALIBRATOR No. 10 — A crystal controlled heterodyne wavemeter covering 500 Kc/s. to 10 Mc/s. (Harmonics up to 30 Mc/s.). Requires 300 V. 15 mA. and 12 V. 0.3 a. D.C., but can be easily modified for 120 V. and 1.4 V. working. Size 7 x 7½ x 4in. Good condition, complete with valves, crystal, instruction manual and circuit. ONLY 59/6. Post 3/6. This item available complete as above. **BRAND NEW** and with spare set of valves. £4/10/-. Post 3/6.

CANADIAN CRYSTAL CALIBRATOR. Uses double crystal and multivibrator circuit to give "pips" at 1 Mc/s., 100 Kc/s. and 10 Kc/s. Incorporates Modulator. With book. 79/6, post 2/6.

TRANSMITTER TYPE 36. A complete 50 watt TX for phone or CW. Covers 10-40 Mc/s. (10-15-20m.). Crystal or stabilised VFO. Push-pull 807's plate and screen modulate parallel 807's. Tested and ready to plug into AC mains. Complete with 16 valves, handset, operating instructions and circuit. Wooden cabinets may be somewhat damaged. £15. Carr. England and Wales £2.

MOVING COIL PHONES. Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 19/6. Post 1/6. **MATCHING TRANSFORMER** (for Hi impedance) i.e. for HRO, CR100, etc., with standard jack plug. 4/6.

SELENIUM BRIDGE RECTIFIERS. Funnel cooled. A.C. Input 45 v. RMS. D.C., output 30 v. 10 amps. BRAND NEW. Boxed. 45/–, post 3/6.

"C" CORE TRANSFORMERS. Pri. 230 v. 50 c.p.s. 510-0-510 at 275 mA. 375-0-375 at 83 mA. 6.3 v. at 9 A. 6.3 v. at 2A. (twice), 6.3 v. at 1A. (twice), 6.3 v. at 1.5A. 6.3 v. at 0.5A., 5 v. at 3A. 6¾ x 6 x 7¼in. high. Weight 25 lb. Removed from equipment but in perfect condition. 32/6. Carr. 5/6.

ADMIRALTY HT TRANSFORMERS Pri. 230 v. 50 c/s. Secs. 620-550-375-0, 375-550-620 v. (620 and 550 v. 200 m/amps. 375 v. 250 m/amps.), plus two 5 v. 3 amp. rectifier windings. Total rating 278 VA. Upright mtg. Wt. 25lb. Made 1953. **BRAND NEW.** Original boxes, 45/–.

CO-AXIAL RELAYS (Switch Type 78A). Simultaneously switch two separate inputs to alternative outputs. 24 volt D.C. coils (can be hand operated). Size (approx.) 5 x 3 x 3in., 8/6. Post 1/6.

PRECISION RESISTORS. One Megohm 1% 1 watt wire wound, ex-U.S.A. BRAND NEW. 10/6 per dozen.

MULLARD C. & R. BRIDGES. 0.1 ohm to 10 Megohms in 4 ranges; 10 pFd. to 10 mFd. in 3 ranges; Calibrate, Open Bridge, and % ranges. For 100/250 v. A.C. mains. Tested and guaranteed. £6/15/-. Post 3/6.

AR-88D RECEIVERS

One of the finest communications receivers ever made. Those we offer are in superlative condition, thoroughly checked and tested as regards calibration, alignment and sensitivity.
Personal shoppers can see for themselves that we have the finest receivers on the market. Those unable to choose their receiver personally can rely on our integrity to send them a first class set for ONLY £35.

RCA AR-88 SPEAKERS

A high quality 3 ohm unit fitted into heavy gauge black crackled steel cabinet, size 10½ x 11½ x 6in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker. CR 100, etc. In original cartons. BRAND NEW, 45/–. Post 3/6.

MARCONI CR100

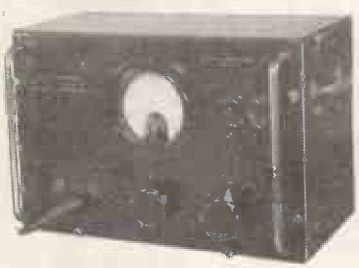
Still one of the finest surplus communication receivers. Ready for immediate use on A.C. mains. Of new appearance, completely overhauled and in perfect working order. Later model with noise Limiter, £25. Carr. England and Wales 30/–. Send S.A.E. for full details.

RECEIVERS R-1155B

A first-class 10-valve Communications receiver, covering 75 Kc/s. to 18 Mc/s. (16.2–4,000 m.) in 5 bands. The large scale and superior dual ratio slow-motion drive make tuning easy and the R.F. stage and 2 I.F. stages ensure world-wide reception. All the receivers we sell have been thoroughly overhauled, completely realigned and are in first-class working order. ONLY £9/19/6.

A.C. MAINS POWER PACK OUTPUT STAGE. In handsome black crackled steel cabinet to match the R-1155. Fitted with RCA 8in. speaker. Just PLUG IN and switch on! Only the finest quality components are used and we guarantee OUR power packs for 6 months. ONLY £6/10/-. Deduct 10/– when purchasing receiver and power unit together. Send S.A.E. for further details or 1/3 for 10-page illustrated booklet giving technical data and circuits etc. (Free with each receiver.) Add 10/6 carriage for receiver, 5/– for power unit.

MARCONI VALVE VOLTMETERS



Ranges: 0 to 1.5, 5, 15, 50, and 150 volts. Fitted with probe unit for RF measurements.
A.C. mains operation. In good condition and working order. A laboratory instrument for ONLY £8/19/6. Carr. 7/6.

SIGNAL GENERATOR I-196A

An American instrument with a continuous frequency range of 100 to 156 Mc/s. which was used for the alignment of the SCR-522, etc. There is provision for crystal control. A fixed I.F. generator at 12 Mc/s. is incorporated which requires a 6 Mc/s. crystal. (Crystals are not included.) Operation is from internal A.C. mains power unit (115 v.) or batteries. Contained in handsome wooden transit case 25 x 19 x 10in. 69/6. Carr. 10/6.

T.C.C. VISCONOL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3 x 1¾ x 5in. high. **BRAND NEW.** Boxed 8/6 each, post paid.
4 mfd. 600 v. wkg. CP 130T, 4/6 each, post paid.

MINIATURE RELAYS (ALL BRAND NEW and BOXED)

G.E.C., sealed, wire ends, 670 2M2B H/D M1095	8/6
G.E.C., sealed, wire ends, 670 Ω, 2 H/D makes, M1099...	15/-
G.E.C., sealed, wire ends, 5,000 Ω 2 c/o., plat., M1052	17/6
Siemens High Speed 1K + 1K Ω, 1 c/over	10/6

GIANT COMPONENT PARCEL

Contains 100 ½ and 1 watt resistors, 50 Hi Stab resistors, wire wound resistors, carbon and W/W pots, 100 capacitors (mica, paper, Sprague, bias, variable, etc.), valveholders, tag strips, metal rectifiers, sleeving, etc. All components are unused. GUARANTEED VALUE, 25/- plus 2/6 post.

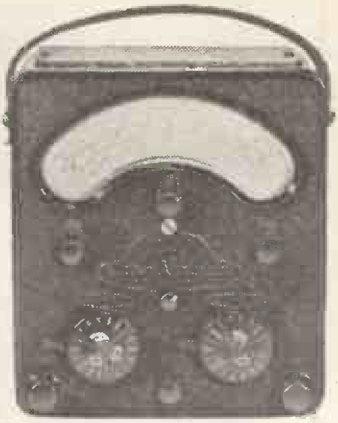
UNISELECTORS

25 Position, 8 bank double wipers. 24-volt operation. Removed from brand new equipment, 62/6. Post 1/6.

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.



AVOMETER MODEL 7

AVO MODEL 7 £12-10-0
AVO MODEL 8 £17-10-0

All meters are in perfect working order and first-class condition. Complete with batteries, leads and instructions. Please add 5/- for registered post and packing.

BC221 FREQUENCY METER 125 kc/s. to 20 mc/s.
This crystal controlled heterodyne frequency meter is too well known to need further description. Those we offer are complete with correct individual calibration book and are carefully tested and guaranteed. Condition is very good. **£16/-/-**

INFRA-RED MONOCULAR. See in the dark. Sealed unit with focusing eyepiece and incorporating Caesium cell and push-button operated Zamboni pile. Brand New in superb hide binocular type carrying case. Sold for experiment and not guaranteed working. 10/-. Post 3/6.

AIRCRAFT CINE CAMERA G45. Takes 25ft. of 16 mm. film. 16 frames per sec. Complete with 24 v. motor and lens. 29/6. Post 3/6.

GAUSS METERS

American type TS-15/AP. Made by Marion Electric for M.I.T. Radiation Lab. AS NEW. £7/10/–.

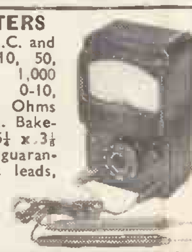
D.C./A.C. CONVERTERS. Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2½in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order. £9/19/6. Carr. 10/6.
Input 24 v. D.C. Output 230 v. A.C. 50 c/s, 100 watts. In grey metal case. BRAND NEW. 92/6. Carr. 7/6.

SANGAMO WESTON ANALYSER E772. A useful multi-range meter. Thoroughly overhauled and in perfect working order. For full details see previous adverts. £7/10/–. Carr. 4/6.

MICROAMMETERS

R.C.A. 0-500 microamps. 2½in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set BRAND NEW. Boxed. 15/–.
American 0-100 microamps. 2½in. square flush panel mounting. BRAND NEW. Boxed. 42/6.

MULTIMETERS



1,000 Ω/Volt A.C. and D.C. volts 0-10, 50, 250, 500 and 1,000 D.C. current 0-10, 0-100 mA. Ohms 0-2,000, 0-200K. Bakelite case size 5¼ x 3⅛ x 2¼in. Fully guaranteed with test leads, prods and internal battery, 59/6

Wilkinsons EST. 1921

RELAYS P.O. TYPE 3000

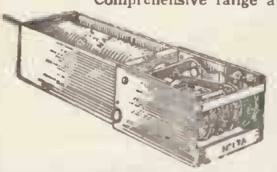
Built to your own specification
Keen Prices
Quick Delivery
Contacts up to 8-Changeover

KEY SWITCHES
Various P.O. types ex. stock.

MINIATURE RELAYS

Siemens High Speed Sealed			S.T.C. and G.E.C. Sealed			
2.2Ω+2.2Ω	H96A	15/6	700Ω	2 C.O.	4184GD	19/6
500Ω+500Ω	H96D	22/6	2500Ω	1 make	HD 4186EE	22/6
1700Ω+1700Ω	H96E	25/-	180Ω	2 m 2 b	M1087	19/6
Siemens High Speed Open			670Ω	4 C.O.	M1092	21/6
100Ω+100Ω	H85N	15/-	2500Ω	1 C.O.	M1022	22/6
1000Ω+1000Ω	H95A	17/6	5000Ω	2 C.O.	M1052	25/-

Comprehensive range available from stock.



MAGNETIC COUNTERS

Counting to 9999.
2-6 v. D.C., **15/-** each, post 1/6.
75-120 v. D.C., **15/-** each, post 1/6.
HIGH SPEED TYPE No. 100c., 100-120 v. D.C. 35/-, post 1/6.

ROTARY CONVERTER. Input 24 v. D.C. Output 220 v. A.C. 250 watts. Pedestal type with D.P. Ironclad switch. **BRAND NEW, £17/10/-, carr. 15/-.**

ROTARY CONVERTERS. Input 12 v. D.C. Output 230 v. A.C. 50 cy. 135 watts. The ideal job for T V. and tape recorders where A.C. mains are not available, **£8/10/-**, cge. 10/-. Also available with 24 v. D.C. input at same price.

BATTERIES. Portable Lead Acid type, 6 volts 125 ampere hours. In metal case 16in. x 8in. x 11in. (Two will make an ideal power supply for our 12 volt Rotary Converters). Uncharged £6/10/- each, carriage 15/-. 24 volts 85 amperes. £14 each, carriage 15/-.

NIFE BATTERIES. Nickel Cadmium, 6 volts 75 amps. Crated and connected. Brand new **£7/10/-**, cge. **15/-**. Special inter-crate connector supplied free with two batteries.

WESTALITE BATTERY CHARGERS. Made by Westinghouse (type BC14-6/40). Input 200/250 v. A.C., will charge 6 volt or 12 volt batteries at 0/40 amps. Coarse control switch with eight positions and fine control switch with four positions including "off." Built-in 0/50 ammeter. Fused A.C. and D.C., grey enamel finish, dimensions 24in. x 14in. x 13in. **£45 each.**

TELEPHONE SET TYPE "A." Ringing and speaking both ways on a four-core cable. Carries the voice loudly and clearly over any distance. Two handsets are supplied as illustrated and the set is complete with Pushes, Buzzers, Battery, Plugs and Sockets. Suitable 4-core PVC cable **10d.** per yard. Price **75/-** set, post 3/6.

TELEPHONE SET TYPE "K." The most compact telephone set available as the 4½in. flat battery and buzzer is built-in to the hand instrument. Ringing and speaking both ways on twin wire. instrument is complete with 5ft. flex. Easily hangs on the wall. Set of two instruments, **£5/10/-**, post 3/6. Two core flex **3d.** yard.

FANS INDUSTRIAL TYPE. 230/240 volt A.C. Capacitor Motor, 16in. blades, adjustable louvres, filter. Ideal for paint shop. Brand new, **£20**, cge. 25/-.

AIR BLOWER powered by a 230 v. A.C. motor, 15in. fan. Volume of free air at max. r.p.m. is 1,250 cu. ft. per min. At maximum efficiency 900 cu. ft. per min. Brand new **£25**, carriage 30/-.

AUTO CABLE waterproof. Single. 14/36. **20/-** per 100 yds., post 1/6.

PUMP Electrically Driven by a 24 v. D.C. motor. Works efficiently on 12 v. Totally enclosed, self lubricating driven through 4 to 1 reduction gearbox delivering 60 g.p.h./30lb./sq. in. Inlet and outlet unions ¼ BSP **37/6**, post 2/6.

CERAMIC WAFER SWITCHES. Full list available.

1 Bank 1 pole 3-way	4/6 each	2 Bank 2 pole 4-way	10/6 each
1 Bank 1 pole 5-way	5/6 each	3 Bank 1 pole 11-way	18/- each
1 Bank 2 pole 2-way	5/6 each	3 Bank 6 pole 2-way	7/6 each
2 Bank 1 pole 11-way	12/6 each	3 Bank 4 pole 3-way	7/6 each
2 Bank 1 pole 12-way	7/6 each	4 Bank 2 pole 4-way	18/6 each

Others including Paxolin types, 1 Bank 3/6, 2 Bank 5/-, 3 Bank 6/6, post 1/-.

HEADPHONES. High resistance 4000Ω with cords **17/6**, post 1/6.

SELENIUM METAL RECTIFIERS

Charging Rectifiers. Full Wave Bridge.		12 Volts 3 Amps.	16/6 each
12 Volts 1 Amp.	8/6 each	12 Volts 4 Amps.	20/- each
12 Volts 2 Amps.	13/6 each	12 Volts 6 Amps.	22/6 each

MAINS TRANSFORMERS to suit above rectifiers.

12 Volts 1 Amp	12/6 each	12 Volts 4 Amps CT107	29/6 each
12 Volts 2 Amps CT109	24/- each	12 Volts 4 Amps	25/- each

¼ H.P. CAPACITOR MOTORS

230/240 volts, 50 cycles, 1420 r.p.m. ½in. shaft on Standard foot mounting or with ⅜in. shaft, resilient mounting. Either type, **£5/10/-**, carriage 10/-.

VACUUM PUMP AND COMPRESSOR. Edwards type IV, ½in. shaft, complete with flywheel, couplings, oil filter and union, **£6/10/-**, post 3/6.

METERS GUARANTEED

F.S.D.	Size	Type	Price
100 Microamp	3½in.	MC/FR	80/-
50 Microamp	2½in.	MC/FR	75/-
250 Microamp	2½in.	MC/PR	40/-
500 Microamp	2½in.	MC/FR	37/6
1 Milliamp	2½in.	MC/FR	35/-
2 Milliamp	2½in.	MC/FR	25/-
30 Milliamp	2½in.	MC/FR	25/-
100 Milliamp	2½in.	MC/FR	25/-
200 Milliamp	2½in.	MC/FR	25/-
1 Ampere	2½in.	MC/FR	35/-
3 Ampere	2½in.	MC/FR	35/-
5 Ampere	2½in.	MC/FR	35/-
10 Ampere	2½in.	MC/FR	35/-
20 Volts	2½in.	MC/FR	35/-
30 Volts	2½in.	MC/FR	35/-
40 Volts	2½in.	MC/FR	35/-
500 Microamp	2in.	MC/FR	25/-
1 Milliamp	2in.	MC/FR	27/6
5 Milliamp	2in.	MC/FR	27/6
10 Milliamp	2in.	MC/FR	27/6
20 Volts	2in.	MC/FR	27/6
30 Volts	2in.	MC/FR	27/6
40 Volts	2in.	MC/FR	27/6
15 Amps	2in.	MC/FR	15/-
3 Amps	2in.	MC/FS	27/6
5 Amps	2in.	MC/FS	27/6
30-0-30 Amps	2in.	MC/FR	17/6
50-0-50 Amps	2in.	MC/FS	17/6
500 Milliamps A.C.	3½in.	MI/FR	40/-
25 Amps D.C.	2½in.	MI/FR	7/6
50 Amps A.C.	4in.	MI/F or PR	65/-
300 Volts A.C.	2½in	MI/FR	25/-

Postage on meters 1/6

New Taylor pocket-size Multimeter Model 127A, 20,000 ohms per volt, 20 megohms, 20 ranges, **A.C. & D.C. £10.** Post 2/6.
Complete list of meters available.

FREQUENCY METERS. 45-55 cycles per second, 230 volts, 6in. dia. Flush Round. Brand new in maker's box. **£10/10/-**, post 3/6.

METER RECTIFIERS 1 M.A., 5 M.A., F.W. bridge, **8/6**, post 6d.

AMMETER. 0-3 amp. D.C., by Turner, MC/FR, 6in. 90/-, post 2/6.

MICROAMMETER. 250 F.S.D. 3½in. F.R. Sangamo Mod. S37. Scaled for valve voltmeter. Circuit available free, **55/-**, post 1/6.

UNI-PIVOT GALVANOMETER, by Cambridge Instruments, 50-0-50 microamps, dia. 4in. Knife pointer, mirror scale. Complete with leather carrying case. Ideal for laboratory use, **£10**, carriage 3/-.

PORTABLE VOLTMETER. 0-160 volts A.C./D.C., accuracy within 2%, 8in. mirror scale, knife pointer, in polished case. A precision moving iron instrument at a very low price, **£4/19/6**, post 3/6.

PORTABLE AMMETER. 0-3 amp. A.C./D.C. 3in. scale in case with handle, **35/-**, post 2/6.

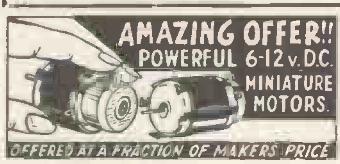
AVO TEST BRIDGES. 220/240 volt A.C. Measure capacities from 5 pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts and condensers leakage test, **£9/19/6**, post 3/-.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base.

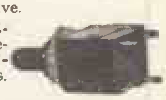
SLYDLOK FUSES. 15 amp. with rewirable cartridge fuse. Latest type G15 M.M. Complete with studs, nuts and washers, 3/6 each, post 6d. Also available 100 amp., type M.M. G 99, **14/6**, post 1/-.

T.C.C. CONDENSERS. Paper block type, 6 mfd. 400 v. A.C. wkg., **12/6**, post 2/6. 1 mfd., 10 kv. 65/- each. All types of condensers available—send for list.

RESISTORS EX STOCK, IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICES



MINIATURE PRECISION MOTOR, 12 v. D.C. Size 1⅝in. x 1¼in. diam. Latest development. Extremely powerful with low consumption. Weighs as little as two ounces and totally enclosed in polythene protective case. Three-position switch: forward, reverse and stop. 7,000 r.p.m., self lubricating and long life sintered bronze bearing, **15/6**, post 9d. Ask for free length of polythene flexible drive.



ATTENTION ALL MANUFACTURERS. ONE-HOLE FIXING SWITCHES. Single-pole change-over 3 amp., 250 volts A.C. **1/6** each, **12/-** doz., **£37/10/-** per 1,000. Ask for quotation for 5,000 or upwards. 100,000 available from stock now!

SOLENOIDS suitable for remote control, mechanical indicators, etc. 12v. D.C., 400 mA., 30Ω, 3¼in. arm, ½in. movement, 5/- each, post 1/6.

TERMINAL BLOCKS. 2-way 4/- doz., or box of 50 for **15/-**. 3-way 6/- doz., 50 for 22/6 post 1/6.

HEAVY DUTY SWITCHES suitable for switchboards. Carries over 100 amps. Consists of 2 S.P.C.O. coupled, **50/-** pr., post 3/-, or separately at **25/-**, post 3/-.

SATCHWELL THERMOSTATS adjustable between 70°-190° Fahrenheit. 0-440 v. A.C., 20 amps., 11in. stem. Fitted cover, 25/-, post 2/6.

ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Fahr., 250 v. 10 amp. A.C. Ideal for greenhouses, etc., 35/-, post 2/-.

CATHODE-RAY TUBES. VCR 139A, 2½in. diam., **30/-**, post 3/-.

MORSE KEYS. Totally enclosed in Bakelite case with easy access for all adjustments. Shrouded terminals. Overall size 5in. x 1½in. x 2in. with mounting holes, **10/6**. Post 1/-.

REMOTE CONTROL SWITCH. Double-Pole Changeover contacts, in tubular hand operated bakelite case, 4in. x 1in. 5/- each. Post 1/-.

L. WILKINSON (CROYDON) LTD.
19 LANSDOWNE RD. CROYDON SURREY
Phone: CRO 0839 Grams: WILCO CROYDON

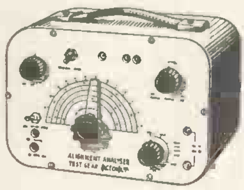
OSCILLOSCOPE

FOR D.C. & A.C. APPLICATIONS

Engineered to precision standards, this high-grade instrument is made available at the lowest possible price, incorporating the essential features usually associated with luxury instruments. This " SCOPE " will appeal particularly to Service Engineers and Amateurs. A high gain, extremely stable differential Y-Amplifier (30 mV/C.M.). Provides ample sensitivity with A.C. or D.C. inputs. Especially suitable for measurement of transistor operating conditions where maintenance of D.C. levels is of paramount importance. Push-Pull X amplifier; Flyback suppression; Internal Time base Scan Waveform available for external use; pulse/output available for checking T.V. Line O/P Transformers, etc.; Provision for external X 1/P and CRT. Brightness Modulation. A.C. mains 200/250 v. £15/15/- plus P. & P. 7/6 or 30/- deposit, plus P. & P. 7/6 and 12 monthly payments of 26/6.

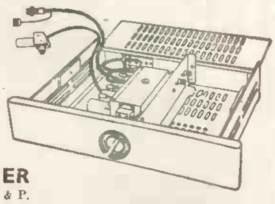
FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE

ALIGNMENT ANALYSER TYPE MC12



A.C. MAINS 200/250 volts. Provides:—"WOBBULATOR" (SWEPT FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0-60 pf. and 0-120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned circuit I.F. transformer, etc. to be rapidly determined. Cash price £6/19/6 and 5/- P. & P. H.P. terms 25/- deposit and 5/- P. & P. and 6 monthly payments of 21/6.

CHANNEL TUNER



Will tune to all Band I and Band III stations. BRAND NEW by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series) I.F. 16-19 or 33-38. Also can be modified as an aerial converter (instructions supplied).

Complete with knobs.

32/6 Plus 3/6 P. & P.

HEATER TRANSFORMER

To suit the above, 200-250 v. 6/- plus 1/6 P. & P.

B.S.R. MONARCH UA8 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 manual play position; colour brown. Dimensions: 12½in. × 10½in. Space required above baseboard 4¾in., below baseboard 2½in. Fitted with Full-Fi turnover crystal head. £6/19/6. Plus 5/- P. & P.

STEREO HEAD £7/19/6 Plus 5/- P. & P.

LINE E.H.T. TRANSFORMER

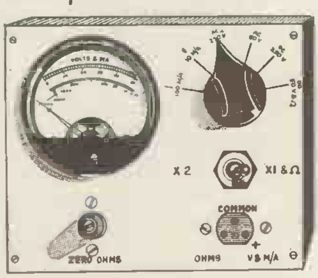
With built-in line and width control. 14 KV Scan Coil. 90in. deflection, on ferrite yokes. Frame O.P. transformer 500 pf. 18 KV. smoothing condenser. Can be used for 14in., 17in. or 21in. tubes.

Complete with circuit diagram **29/6** Plus 4/- P. & P.

As Above, but for 625 lines **£2.10** Plus 4/- P. & P.

FOCUS MAGNET suitable for the above (state tube), 10/-. 2/6 P. & P.

A.C./D.C. POCKET MULTI-METER KIT



2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamps 0-10, 0-100. Ohms range 0-10,000. Front panel, range switch, wirewound pot (for ohms zero setting), toggle switch, resistor and rectifier. 19/6. P. & P. 1/6. Wiring diagram 1/-, FREE with kit.

BATTERY RECORD PLAYER AND AMPLIFIER

Incorporating 45 r.p.m. " Starr " motor, " Acos " crystal pick-up, 3 transistor push-pull amplifier complete with transistors. Ouput 500 milliwatts. 49/6 plus 3/6 P. & P.

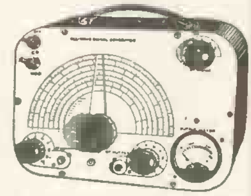
SIGNAL GENERATOR

Covering 100 Kc/s.-100 Mc/s. on fundamentals and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. × 6½in. × 5¼in., grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F., output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

Or 25/- deposit and 6 monthly payments of 21/6. Post & Packing 5/ extra.

£6/19/6

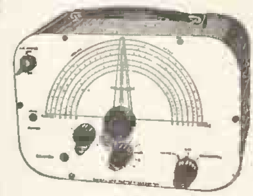
SIGNAL GENERATOR



Coverage 120 Kc/s.-230 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s., 84 Mc/s. Metal case 10in. × 6½in. × 4½in. Size of scale 6½in. × 3½in 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated R.F., Output continuously variable. 100 millivolts C.W. and mod. switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%. **£4/19/6**

Or 25/- deposit and 4 monthly payments 21/6. P. & P. 5/- extra

SIGNAL & PATTERN GENERATOR



£6/19/6 P. & P. 5/-.

Or 25/- deposit. P. & P. 5/- and 6 monthly payments of 21/6.

Coverage 7/6 Mc/s.-210 Mc/s., in five bands, all on fundamentals slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ±1% A.C. mains 200-250 v.

MAINS TRANSFORMER

All with tapped primaries 200-250 volts

0-160, 180, 200 v., 60 ma., 6.3 v. 2 amps., 10/6, 350-0-350, 70 ma., 6.3 v. 1 amp., 6.3 v. 2 amp., 10/6, 250-0-250, 70 ma., 6.3 v., 2 amp. 10/6. Postage and packing on the above 3/-.

3-TRANSISTOR POCKET RADIO

INCORPORATING MINIATURE SPEAKER
Plus GERMANIUM DIODE and PRINTED CIRCUIT

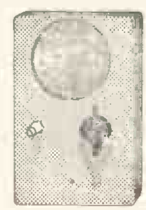
Size $3\frac{1}{4} \times 4 \times \frac{7}{8}$in.

Incorporating Ferrite Rod Aerial. Two Surface Barrier Transistors and one Audio. Tunable over medium and long waves.

To build yourself **39/6** Plus 1/6 P. & P.

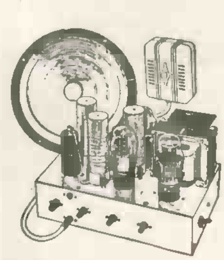
ALL PARTS SOLD SEPARATELY

Circuit diagram 1/6, free with kit.



All transistors guaranteed 100%

5-VALVE AMPLIFIER IDEAL FOR SMALL HALLS



High power—high quality. 200/250 A.C. 2 inputs, mike and gram bass and treble lifts. For use with Standard/L.P. Records. Two would be suitable for stereophonic. Ideal P.A. system, £3/19/6. P. & P. 1/6. CRYSTAL MIKE to suit, 15/-. P. & P. 1/6. 8" PM SPEAKER to suit. 12/6. P. & P. 6/6.

PORTABLE AMPLIFIER

On printed circuit for A.C. Mains 200/250 v. Size 4in. × 3in. with tone and volume control. Valves: ECL82 and EZ80. 39/6. P. & P. 2/6.

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The latest patented compact design 89GN. TAPE RECORDERS at a fraction of their original cost—limited quantity only. Compare these ● special features with *any* machine on the market at *double* the price.
COMPLETE WITH 1,200ft. of Scotchboy tape, crystal microphone, mains lead, spare plugs, manual and circuit. A high class instrument.

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- 3 unique Electro-magnetic heads
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- Output for separate amplifier
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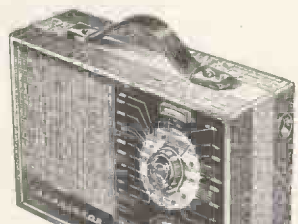
- Patented design for 7in. spools—only one of its kind in Europe
- High fidelity amplifier (60 to 12,000 c/s), can be used straight through.

THE "COUNTESS" IS OBTAINABLE ONLY FROM RADIO CLEARANCE LTD.

IN THE HOME, IN THE CAR, BY THE SEA, IN FIELDS AFAR,

THE "CONTESSA"

IS VOTED BEST OF ALL



A really remarkable 2-Band 6-Transistor Superhet Kit as displayed at the Radio Hobbies Exhibition.

The Contessa is the professional looking set with the professional performance.

Study these brilliant features which cannot be found in any other kit—

- Waveband coverage of 530 kc/s to 1,620 kc/s and 160 kc/s to 270 kc/s.
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- 5 : 1 ratio slow motion tuning.
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- Only first grade fully-guaranteed Mazda matched transistors and diodes are used.
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- Fully drilled printed circuit panel marked with component numbers.
- The two-colour case measures 10 x 7½ x 3¼in. and weighs approx. 4 lbs. when assembled.
- Battery lasts 4 months with normal usage.
- Book supplied with detailed assembly instructions, diagrams and circuitry.
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The Tape Deck using 3 motors, separate power pack included, 3 heads, 2 speed 3¾ and 7½ I.P.S. wow and flutter better than .2% at 7½ I.P.S., integrated. 6 Valve record amplifier and playback pre-amp, magic eye level indicator, finished in grey and white stove enamel. Specially designed to feed into any Hi-Fi system. COMPLETE including 1200 ft. Tape and 7in. Take-up Spool, **£35**. S.A.E. for Detailed Specification.

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The Weston Model 772 Type 6 super sensitive analyser. This precision designed multi range test instrument has a large visible finely divided scale giving some of the range shown. Range D.C. volts 20,000 ohms per volt or 1,000 per volt. 2.5 volt range 50,000 ohms. 10 volt range 200,000 ohms. 50 volt range 1 megohm. 250 volt range 5 megohms. 1,000 volt range 20 megohms. Ohms: 0-3,000 ohms, 0-30,000 ohms. 0-3 meg. 0-30 meg. D.C. milliamps: 10, 50, 250 IM/A or 50 microamps. A.C. volts: 1,000 ohms per volt. ONLY **£12/10/-** plus post and pkg. 7/6.

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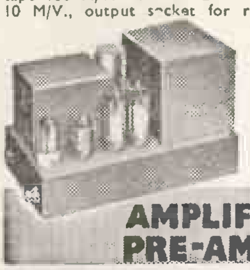
10 watt push-pull ultra linear Hi-Fi amplifier with pre-amp control unit. **Amplifier** Valves EF86, ECC83, 2-EL84, EZ81. Sensitivity 40 M/V for 10 watts, output impedance, 4, 8 and 16 ohms, spare supply for tuner, 200/250 V., A.C. **Pre-Amp.** valve EF86. **INPUTS** Radio 100M/V., tape 100 M/V. **GRAM** LP 50 M/V, 78 60 M/V. **MIC** 10 M/V., output socket for recording direct to tape recorder. **Treble** between −10DB and +12 DB at 10 KC/S. **BASS** between −10DB and +12 DB at 20 C/S. Finished in grey, green, stone enamel, control panel in gold lettering, fully guaranteed Original price 20 gns.



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The "Fleet 6," a wow of a transistor set that really gets the stations. New design 6 transistor superhet pocket receiver, using 6 guaranteed first grade transistors plus sensitive diode, push pull output, medium and long wave bands, new type printed circuit, high Q internal ferrite rod aerial, 2½in high flux speaker, provision for car aerial, overall size 6½ x 4¼ x 1½. Simple to follow instructions. All components guaranteed, service after sales. This is equal to many manufactured sets at double the price. All components including cabinet, transistors, speaker, circuit, etc., only **£8/19/6**, complete. Post and pkg. 3/6. PP4 Battery 2/- extra. All components sold separately. Send S.A.E. for details. Circuit and Instructions 2/6 post free.

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Made by famous manufacturer. Brand new. Upper or lower track, record/play-back, high impedance giving up to 12,000 c.p.s. at 7½ I.P.S. Output 5 m/volts at 1 KC. at 7½ I.P.S. Erase heads low impedance. Only **29/6** per pair. Post 1/-. State upper or lower track.

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Definitely the last of the remaining stocks of the

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A twin channel pre-amp. control unit, has 6 inputs for each channel. **INPUT SENSITIVITY** for 250 M/V or 1.5 V output **TUNER** 100 and 250 M V. Tape 100 M/V flats 250 M/V. **PICK-UP** 5 and 50 M/V. Frequency response: 40 c/s. to 15 Kc/s. **TAPE OUTPUT** 50 M/V., continuously variable bass and treble controls, loudness control and stereo balance control. Power required 6.3 V. at 1.3 amp. A.C. 350 v. at 5 M/A D.C. Will match any hi-fi amplifier. Manufacturer's price £28/10/- **OUR PRICE** now **£16/19/6**. Carr. and packing 10/-.

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High quality monaural power amplifier and pre-amp. compactly housed and suitable for shelf mounting or cabinet. Two EL84, three EF86, one ECC83, one EZ81. 20 watts peak; speaker impedance, 4, 8 or 16 ohms. Sensitivity: 4 M/V. on pick-up. 3 M/V, on tape. 100 M/V. on tuner, intermod. distortion 1% at 10 W. equivalent. Sinewave output. Maker's price £28/10/-. **OUR PRICE 19 gns.** Post and Packing 10/-.

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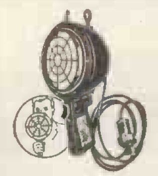

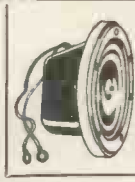

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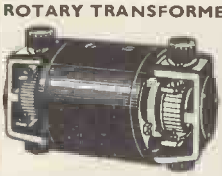
30 FOOT AERIAL MASTS. Complete assembly consists of 10—3ft. x 1in. dia. steel mast sections, mtg. base, guys, ropes, peg bag and pegs, insulators, stay plates and necessary fitting equipment. Comes to you complete with Hammer and Canvas carrying bag. NEW. **ONLY £4/15/-.**

ROTARY TRANSFORMERS TYPE HT.31.



Input: 11.5 volt, Output: 250 volt at 120 mA. Ex-Units but tested. 35/- each. Type **HT.32.** Input: 11.5 volt. Output: 490 volt at 65 mA. New in cartons. 20/- each.

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40 complete W/S No. 19. Mk. 3. Transmitter Receiver Stns. Includes set and P.U., carrier, waterproof cover and all necessary control boxes, head and microphone assemblies, aerials and bases, connectors, variometer and hardware. READY EXPORT PACKED AND TESTED FOR IMMEDIATE SHIPMENT. Send for full list and prices.

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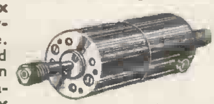

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BLOWER MOTOR. Made by Hoover. 80 volt D.C. Will operate on 240 volts A.C. with 8 mfd. condenser in series. **New and cartoned. 17/6 each.**

MINIATURE MODEL MOTOR (Not Ex-Govt.). Removed from Transistor Tape Recorders and in perfect condition. 3 to 12 volts. Dual spindle. fully reversible, protected bearings. Approx. 3/4,000 r.p.m. Size: 2¼in. long x 1in. wide. Spindle: ⅛in. x 1/32in.

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8 FOOT WHIP AERIALS. Supplied in 2 sections. No. 1 and 2. ZA/26800 and 26286. Each section collapsible down to 1ft., with retaining wire through each section. Ideal also for Radio Control, fishing rod or pennant mast. **7/6 complete. New.**

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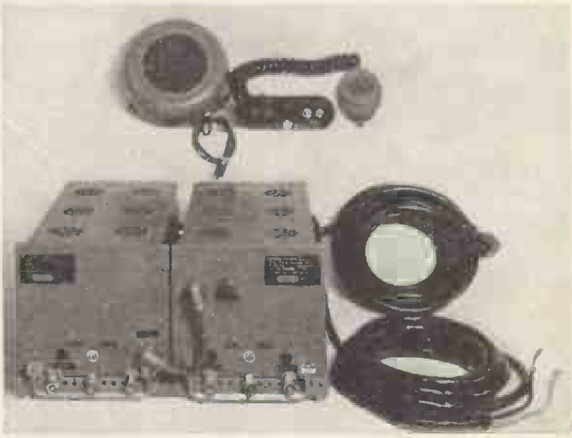

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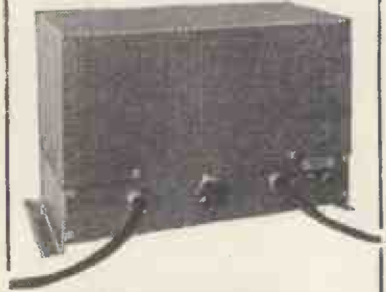

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AO/L
Aquila, Golf Road, Bromley, Kent

Due to further expansion, ABC Television invites applications for the following vacancies:—

- **SOUND BALANCER**
- **SOUND ASSISTANTS GRADE B**

Applicants should have previous TV experience and the ability to carry out first line maintenance.

- **ASSISTANT ENGINEERS**

Videotape, Telecine, or Communications
A thorough basic knowledge of electronics and the ability to maintain equipment is essential. Industrial experience in an allied industry would be an advantage.

- **SOUND DEVELOPMENT ENGINEER**

Previous experience in the field of audio development work essential.

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Applications must be made in writing to
The Personnel Manager, ABC Television Ltd.
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6 MULLARD transistors and diode superhet receiver kit, Push Pull output, ferrite rod aerial, 2½in. high flux speaker, CAMERA shape cover of fine leather Hide, with shoulder strap, MAJESTIC appearance.
CAN BE BUILT Complete for only £6/15/6 plus 3/- p. & p. and 2/- Battery.
Very, very easy to assemble. Circuit diagram and instructions supplied free on order.
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Manufacturers of:—

Miniature Precision Coils to Specification. Chokes, Delay Lines, Pulse Transformers etc. Also Stockists of Ferrite Material, Coil formers, Copper Wire, Insulating tape, etc.

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SHERWOOD TYPE for Goodmans 12" Speakers
£15-10-0

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REBUILT TV TUBES
FULLY GUARANTEED 12 MONTHS
Complete New Gun fitted in every Tube

12"	£4.0.0	17"	£5.0.0
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Immediate Delivery
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An **INSPECTOR OF POLICE (SIGNALS)** is required by **GOVERNMENT OF NYASALAND.**

Choice of contract terms for 1 tour 2-3 years with 10% gratuity or permanent and pensionable terms. Commencing salary according to age and experience in scale rising to £1,285. Cost of living allowance of 5% of salary also payable. Initial outfit grant and annual uniform allowance. Free passages. Liberal leave on full salary.

Candidates of good education and physique, normal vision without glasses, must have sound knowledge of maintenance and installation of H.F. and V.H.F. fixed and mobile simplex and duplex radio telephone systems. Experience in the maintenance of low power petrol/electricity chargers and alternators would be an advantage.

Apply to **CROWN AGENTS, 4 Millbank, London, S.W.1,** for application form and further particulars, stating age, name, brief details of qualifications and experience and quoting reference M2A/50901/WF.

UNICAM INSTRUMENTS LIMITED

This Company specialises in the production of high quality optical instruments for use in spectrum analysis and has an international reputation as a leader in this field. At all stages of manufacture the best standards of workmanship are needed.

We have vacancies for men with electronic experience for testing. Radar and radio technicians with fault-finding experience would be suitable.

If you have the kind of background which you think would fit you for this interesting work in a pleasant University city, please let us have full details of your qualifications and experience.

Write to:

The Works Manager,
Unicam Instruments Limited,
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quoting reference E.S.55.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

PRODUCTION GROUP

INSTRUMENT MECHANICS

Windscale and Calder Works, and Chapelcross Works require 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, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training Courses in Specialised Techniques are provided for successful applicants having suitable Instrumentation background.

Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion prospects are good.

Applications to:

Works Labour Manager, Windscale and Calder Works, Sellafield, Seascale, Cumberland

or

Works Labour Manager, Chapelcross Works, Annan, Dumfriesshire, Scotland.

PLYMOUTH AND DEVONPORT TECHNICAL COLLEGE

Tavistock Road, Plymouth.

Principal: E. Bailey, B.Sc., F.R.I.C., A.M.I. Chem. E.

RADIO OFFICERS COURSES

Full-time courses start in September 1961 for P.M.G., Radio and M.O.T. Radar Maintenance Certificates. Applications, giving particulars of previous education, should be made now to the Principal.

INSPECTORS & TESTERS

fully experienced, required for testing and inspecting VHF Radiotelephone or telegraph equipment. Interesting work using own initiative with advanced techniques, pleasant working conditions in attractive country district. Apply with details of experience and remuneration expected to the

Personnel Officer,
A.T. & E. (Bridgnorth) Ltd.,
Bridgnorth, Shropshire.

SOUTHAMPTON TECHNICAL COLLEGE

Principal: F. T. West, M.B.E., A.I.Struct.E., M.I.Prod.E.

Department of Electrical Engineering

Head of Department: K. E. Everett, M.Sc.(Eng.), B.Sc.(Hons), A.C.G.I., A.M.I.E.E., M.Brit.I.R.E.

Places are now being allocated in the following Full-Time Courses in the Department of Electrical Engineering from September 1961:

Communication Engineering and Electronics:

Three-year course leading to College Diploma which exempts from Graduateship Examination of British Institution of Radio Engineers. Minimum age 16 years.

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Two-year course leading to the Postmaster General's First Class Certificate for Radio Officers and the Ministry of Transport Certificate in Radar Maintenance. Holders of these qualifications become qualified Radio and Radar Officers in the Mercantile Marine. Minimum age 16 years.

Further details and forms of application may be obtained from the Registrar, Southampton Technical College, St. Mary Street, Southampton.

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Resulting from continued expansion in the computer field, a number of vacancies have arisen for Graduate Electronic Engineers and for Technicians of O.N.C. standard. The additional staff are needed for technical supervision and maintenance of Digital Computer Installation. Vacancies exist in London, Birmingham, Sheffield, Coventry and Manchester.

Training will be provided for this interesting work and there are opportunities for rapid promotion to positions of responsibility. Salaries are generous and in proportion to ability. Pension plan.

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Personnel Manager,
THE NATIONAL CASH REGISTER COMPANY LTD.
206-216 Marylebone Road, London, N.W.1.

COUNTY OF ESSEX
SOUTH-EAST ESSEX TECHNICAL COLLEGE, Longbridge Road, Dagenham

MARINE RADIO OFFICERS' COURSES

The College offers full-time courses of one or two years' duration leading to the 1st and 2nd Class P.M.G. Certificates and the M.o.T. Radar Maintenance Certificate. Applications for enrolment should be made as soon as possible. Late enrolments may be considered up to 11th September, 1961. Officers possessing the P.M.G. 2nd Class or both 1st and 2nd Class Certificates may join the course at appropriate points to complete their qualification.

For further particulars apply to the Principal.

NORTHERN POLYTECHNIC

Holloway, N.7. NORTH 1686

DEPARTMENT OF PHYSICS

SESSION 1961-62

Advanced Part-Time courses in

Electrical Discharges in Gases.
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These courses are open to any workers in appropriate fields. In suitable cases they can lead to the degree of M.Sc.

Enquiries should be addressed to The Head of the Department of Physics.

A SENIOR TEST EQUIPMENT ENGINEER

HAWKER SIDDELEY AVIATION

is sought to assume responsibility for the design and development of equipment used to test missile control circuits. Preference will be given to graduates but applicants with H.N.C. in electrical engineering or those who are members of an appropriate institution are also invited to apply. Experience of electronic servo testing, modern techniques of A.C. and D.C. measurement also H.M. Services requirements for missile ground equipment would be an advantage.

Rented housing may be available after a reasonable waiting period.

Please write, giving your age, qualifications and experience to:

The Personnel Manager (Ref. SH. 171),
THE DE HAVILLAND AIRCRAFT COMPANY LIMITED,
Gunnels Wood Road,
Stevenage, Hertfordshire.

THE DE HAVILLAND AIRCRAFT COMPANY LIMITED

VACANCIES IN GOVERNMENT SERVICE

A number of vacancies, offering good career prospects, exist for:—

RADIO OPERATORS MALE
CYPHER OPERATORS MALE AND
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Write, giving details of education, qualifications and experience, to:—
Personnel Officer, G.C.H.Q. (RCO/3)
Foreign Office,
53, Clarence Street, Cheltenham, Glos.

INTERNATIONAL AERADIO Limited require Aircraft Radio Maintenance Engineers for service overseas. A.R.M.E. "A" and/or "B" licences essential with experience of ground radio equipments desirable. Salary and allowances dependent on area of operation and family commitments; free accommodation, pension fund, insurance and medical benefits, generous U.K. leave.

Applications to Personnel Manager, 40 Park Street, London, W.1.

FOR SALE

"SHELL" TAX LOSS COMPANY,
RADIO MANUFACTURING.
TAX LOSSES APPROX. £25,000.

WRITE BOX No. 5015,
c/o "WIRELESS WORLD."

UNITED KINGDOM
ATOMIC ENERGY AUTHORITY
THE RADIOCHEMICAL CENTRE
AMERSHAM, BUCKS.

requires an

ELECTRONIC INSTRUMENT TECHNICIAN

for the Instrumentation Section of the Physics Department.

The man appointed will be responsible for the calibration and maintenance of the wide range of electronic instruments used for radiation measurements throughout the Centre. Supervisory experience and the possession of a National Certificate would be an advantage.

The Centre manufactures and distributes radioisotopes and is situated 25 miles north-west of London on the edge of the Chiltern Hills.

Salary: £1,060-£1,210.

Assisted housing and superannuation schemes. Five-day week.

Application forms from :

The Personnel Officer,
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for work on the development of digital and analogue recording equipment. Applicants should have a degree or H.N.C. and experience in the design of electronic and electro-mechanical apparatus. A good salary will be paid to the right man. This is a excellent opportunity for a young man of high ability to join a progressive and expanding Company.

TECHNICIAN

H.N.C. or O.N.C. standard with experience in electronic and electro-mechanical equipment for work mainly on the quality control and testing of electronic equipment.

DRAUGHTSMAN

preferably with O.N.C., experienced in electronic and chassis layouts and small mechanical assemblies, for interesting work on tape recorders.

Contributory Pension and Life Assurance Scheme.
Free Sickness Insurance.

Apply: **Personnel Manager,**
AMPEX ELECTRONICS LTD.,
Arkwright Road,
Reading.
Tel.: Reading 84221.

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LEARN-AS-YOU-BUILD PRACTICAL RADIO COURSE
Build your own 4-valve TRF and 5-valve superhet radio receiver Signal Generator and High-quality Multimeter.

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It brings the FREE I C S Prospectus containing full particulars of I C S courses in Radio, Television and Electronics.

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Must be able to carry out production alignment of transistor radio receivers. Highest rates of pay plus very substantial bonuses. Existing holiday arrangements will be honoured. Free transportation to and from work.

Apply to:— **Works Manager (Mr. W. Chandler),**
FIDELITY RADIO LIMITED,
Archdale Works,
Blechynden Street,
LONDON, W.11
Telephone: PARK 1321.

EVERSHED

Work of an advanced nature is now being handled in our INSTRUMENTATION Division and exceptional men are sought to fill the following vacancies in the Test Rooms:

(a) **ELECTRONIC TEST ENGINEERS** for the production, testing and trouble-shooting of instrument and amplifier equipment employing transistors and other semi-conductor devices. A knowledge of electrical temperature measurement an advantage and an H.N.C. or O.N.C.(E) qualification is desirable.

(b) **INSTRUMENT ASSEMBLERS/TESTERS** with experience in light assembly and calibration of pressure gauge indicators.

(c) **SKILLED WIREMEN,** especially with experience of instruments and control panel wiring.

Those accepted will be on a STAFF basis with usual benefits including contributory pension scheme; 3 weeks' annual leave after 5 years' service; excellent social, sports and canteen facilities; and ideal working conditions. Current holiday arrangements honoured.

Please write or call:

Personnel Manager (Ref. 154),
Evershed & Vignoles Ltd.,
Acton Lane Works,
CHISWICK, W.4.

QUARTZ CRYSTAL PRODUCTS

AUTOMATIC TELEPHONE & ELECTRIC COMPANY LTD.

have two vacancies in this field:

A SENIOR ENGINEER to direct and generally supervise the development and pre-production programmes for several Quartz Crystal projects. The work includes circuit development and transistorised oscillator design.

Applicants must have previous laboratory experience in piezo-electrics and possess a Higher National Certificate or equivalent qualification in physics or telecommunications. This is a responsible position involving both technical and administrative responsibilities and a salary commensurate with age and experience will be paid.

A PROJECT ENGINEER to take charge of the development of precision oscillator crystal units and filter crystal units. Previous industrial or laboratory experience in piezoelectrics is essential and candidates should possess appropriate academic and/or professional qualifications.

The position offers considerable scope for a man in the age range 26-40 who wishes to follow a career on research and development work in the piezoelectric field and a salary commensurate with age and experience will be paid.

There is a contributory superannuation scheme in the Company and assistance with housing problems will be given in approved cases.

Applications, giving full details of age, qualifications and experience should be sent to:—

The Personnel Manager,
AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.,
Strowger Works, Liverpool, 7.

RADIO OFFICER

Required by EAST AFRICA HIGH COMMISSION, Directorate of Civil Aviation, on contract for 1 tour of 24-27 months in first instance. Salary according to age and experience in scale (including Overseas Addition) rising to £1,479 a year. Gratuity at rate of 25% of total salary drawn. Outfit allowance £30, and Education allowance. Free passages. Liberal leave on full salary.

Candidates, over 28 years of age, must possess either a 1st Class P.M.G. Certificate or 1st Class M.C.A. Flight Radio Operator's Licence or equivalent qualification.

Successful candidate will be required for watchkeeping communicator duties at Nairobi, Entebbe or Dar-es-Salaam, or as watching assistant to a Radio Superintendent at an out-station.

Apply to **CROWN AGENTS, 4 Millbank, London, S.W.1,** for application form and further particulars, stating age, name, brief details of qualifications and experience and quoting reference M2A/51252WF.

SOUTH-EAST ESSEX TECHNICAL COLLEGE

Longbridge Road, Dagenham

Required September, 1961:—

Grade "B" Assistant for Marine Radio Officers Course. Candidates must hold final Class P.M.G. Certificates and M.o.T. Certificate in Radar Maintenance. Ability to teach Morse and Commercial Procedure essential.

Salary scale: £700 × £27.10.0—£1,150 per annum, plus London Allowance (£38 or £51).

Application form and further particulars from the Clerk to the Governors.

PHILIPS ELECTRICAL LIMITED

45, Nightingale Lane, S.W.12.

ENGINEERS required for the service and installation of X-Ray equipment. Candidates with O.N.C. (electrical) of Electronics experience would be considered. Also applicants with electronics experience as trainees. Applications with full details should be addressed to the Personnel Officer, at the above address, quoting reference SE2/61.

A CAREER IN AUTOMATION

Imperial Chemical Industries Limited, Wilton Works

has vacancies for

INSTRUMENT ARTIFICERS

for the installation and maintenance of all types of process instruments in a large new chemical works operating at Wilton in the North Riding of Yorkshire.

This is a comparatively new trade which is expanding rapidly; short training courses are available for tradesmen selected for this work.

Applications are invited from apprentice trained

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Trade Union rates of pay are in operation with opportunities to earn bonus. Recreational and welfare facilities are available; there is a pension fund and a Profit Sharing Scheme. A subsistence allowance will be paid pending the allocation of a house.

Apply in writing to the

Labour Officer, Imperial Chemical Industries Limited, Wilton Works, Middlesbrough.

EMI

ENGINEER INSPECTORS

Engineer Inspectors are required by the Inspection Department of the Feltham laboratories of EMI Electronics, Ltd., to join a team carrying out electronic inspection of complex electronic equipment under development, and to conduct liaison with teams and workshops. A sound engineering background with experience of similar work is necessary. Candidates should have H.N.C. (Electrical Engineering) or equivalent.

Starting salaries will be determined by qualifications and ability and it is Company practice to review salaries annually on the basis of ability and potential.

Please write, giving full details and quoting **Ref. Ia/1/58,** to:

Personnel Manager,
EMI ELECTRONICS LTD.,
HAYES, MIDDLESEX.

ANTARCTICA

Vacancies exist for **WIRELESS OPERATOR MECHANICS** to serve with the **FALKLAND ISLANDS DEPENDENCIES SURVEY** in the Antarctic for 2 years. Salary is at the basic rate of £500 a year. Whilst in the Antarctic everything is provided free of charge including quarters, food, clothing, cigarettes, etc. Generous cash payment on completion of service.

Candidates, between 20 and 30 years of age and single must be able to transmit and receive morse at 20 w.p.m. (plain language or code) and be capable of elementary maintenance of wireless transmitting and receiving equipment.

Successful candidates will be required to leave U.K. in October/November.

Apply to **CROWN AGENTS, 4 Millbank, London, S.W.1**, for application form and further particulars, stating age, name, brief details of qualifications and experience and quoting reference M2A/51277/W.F.

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OUTPUT TRANSFORMERS (Secondaries for 3.75 and 15 ohms)

T.44. 5-10 amp. ultra linear, 8,000 olm. 43% tappings, 30/-. P/P. 2/-.
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T.56. 5-10 amp. 300-0-300 v. 100 mA. 6.3 v. 2.5 a., cT 6.3 v. 1 a., 27/-. P/P. 2/6.
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T.143. 7 watt stereo 250-0-250 v., 150 mA., 6.3 v. 4 a. cT., 6.3 v. 1 a., 33/-. P/P. 2/9.
T.141. 3 watt, 300-0-300 v., 60 mA., 6.3 v. 1 a., cT., 6.3 v. 1 a., 22/-. P/P. 2/-.
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TRANSISTOR TRANSFORMERS, write for details.

All transformers fully guaranteed, all shrouded fully except T140 and TB. Write for our fully illustrated catalogue, with all data.

SPECIAL OFFERS T44 and T55, 59/-; T143 and two T142's, 82/-. P/P. 3/6 on both.

Mullard's latest Publication detailing the complete range "CIRCUITS FOR AUDIO AMPLIFIERS," 8/6. P/P. 1/-.

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Light Engineering Company in the Midlands is requiring the above for the testing of Electronic Equipment on Government Contracts and Commercial Television.

Applicants with a knowledge of this type of testing, and wishing to obtain well-paid positions, should apply stating qualifications and experience to the Personnel Manager, Box No. 5003, c/o "Wireless World."

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Experience in one or more of the following:—

ELECTRICAL (1) Maintenance of radio communication receivers.
(2) Sub-assembly lay out, wiring and testing of radio-type chassis.
(3) Fault finding in and maintenance of electronic apparatus.
(4) Maintenance of teleprinter or cypher machines and associated telegraph equipment.

MECHANICAL Instrument makers and general machinists with bench fitting and machine shop experience for construction of experimental and prototype electronic equipment.

BASIC PAY £9 18s. 2d. plus merit pay in the range of 10/- to 100/- per week. Merit pay will be assessed at interview, based on ability and the necessary basic qualifications.

Opportunities for eventual permanent and pensionable posts. Five-day week; good working conditions; single accommodation available.

Apply in writing to: Personnel Officer, G.C.H.Q. (RDC/3), 53, Clarence Street, Cheltenham, Glos.

NORTHERN POLYTECHNIC

Holloway, N.7. NORTH 1686
DEPARTMENT OF PHYSICS
SESSION 1961-62

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SANDWICH COURSE in the Physics and Technology of Electronics, leading to the Diploma in Technology and exemption from examination requirements of The Institute of Physics and of the Institution of Electrical Engineers.

PART-TIME COURSE leading to Graduateship of the Institute of Physics (Grad.Inst.P.).

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Ordinary National Certificate, S.2, S.3.
Course available to students of 16 or over, having appropriate passes at G.C.E. O-level, or S.1. Higher National Certificate.
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Enquiries should be addressed to:
The Head of the Department of Physics.

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INSTALLATION AND COMMISSIONING ENGINEERS

are required for

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Marconi's Wireless Telegraph Co. Ltd. can offer attractive openings to suitably experienced and qualified personnel in connection with the erection and commissioning of

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TELEVISION TRANSMITTERS

Other openings exist at all levels and some are very suitable for ex-R.A.F. radar Fitters and Mechanics. In particular we have attractive openings for Senior Engineers whose qualifications and experience enable them to accept considerable responsibility, but we can also consider graduates or similar qualified engineers who have as yet little experience in this field. Applicants must be prepared to travel. Good U.K. salaries and attractive allowances.

Please write giving full details of qualifications and experience to Mr. J. L. Scott, c/o Group Personnel Services, English Electric House, 336/7 Strand, London, W.C.2, quoting reference WW 2004A.

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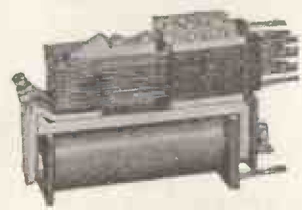

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SIEMENS HIGH SPEED C/O RELAYS

250+250 ohms Twin Coils 7/6
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1,000+1,000 ohms Twin Coils 10/6
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G.E.C. MINIATURE SEALED RELAYS

No.	Ohms	Build Ups	Voltage	Price
Z530003	670	4 C/O	27 v.	£1 2 6
Z530005	2	2 C/O	1.3 v.	12 6
Z530008	670	2 C/O	24 v.	19 6
Z530010	40	2 C/O 2K	7 v.	17 6
Z530014	2	1 C/O	1.3 v.	10 6
Z530015	40	1 C/O	6 v.	12 6
Z530016	180	1 C/O	12 v.	19 6
Z530018	2,500	1 C/O	48 v.	£1 2 6
Z530019	2	2 C/O 2K	1.3 v.	14 6
Z530020	2	4 C/O	1.3 v.	16 6
Z530021	2	2M	1.3 v.	10 6
Z530022	2	1M 1B	1.3 v.	12 6
Z530023	2	2B 2M	1.3 v.	12 6
Z530024	40	2M	6 v.	12 6
Z530025	40	1M 1B	6 v.	12 6
Z530026	40	2B 2M	6 v.	15 0
Z530027	180	2M	12 v.	17 6
Z530028	180	1M 1B	12 v.	17 6
Z530030	670	2M	24 v.	17 6
Z530031	670	1M 1B	24 v.	17 6
Z530034	2,500	1M 1B	48 v.	£1 2 6
Z530480	670	2B 2M	24 v.	19 6
Z530430	5,000	2 C/O	48 v.	£1 9 6
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S.T.C. MINIATURE SEALED RELAY

No.	Ohms	Build Ups	Voltage	Price
4184GD	700	2 C/O	24	19 6
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1/6 Post & Packing on all relays.

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SIGMA TYPE 4C1 OR ALLIED TYPE G. 1B 1 Amp. contact, 5,000Ω coil. Current 4 mA. ± .5 mA. Will operate with change of current of .2 mA. Secondhand 5/6

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SIEMENS TYPE HIGH SPEED SEALED RELAYS. 1 C.O. 500 mA. contact Twin Coil 2×145Ω. Operating current 15 mA. with coils in series and 30 mA. with coils in parallel. Secondhand 5/-

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Type 3000: 500Ω Coil, 2 CO contacts........ 7/6
Type 3000: 100Ω Coil, 2B+2M contacts. Operates on 6V. 7/6

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Delivers approx. 5 Watts power at 7,000 r.p.m. Dimensions 1½in. long × 1¼in. dia. Shaft extension .077in. dia. × .4in. long. Centre-off reversing switch integral with the motor. Self-lubricated sintered bronze bearings. Brand new........ 15/6 post free.

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CRYSTAL OSCILLATOR UNIT: Colpitts oscillator tuned to third harmonics of 9.3333-9.5333 kc/s. crystals, CV2209; Trebler CV417, Amplifier CV417, Trebler CV417 and Amplifier CV417........ 12/6, p.p. 2/6

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KRN3	CV217	4.0	1,350	255	7.4	10	15	9,738 mean	I.O.	£3
	CV228	6.3	220	—	500	—	450	4,615 mean	B7G	£9
KRN6/3	CV238	4.0	250	138	—	8	100	3,030 mean	I.O.	£5
726A	CV676	6.3	330	400	—	—	100	3,290 mean	—	£4
707B	CV1768	6.3	300	300	—	—	140	3,315-3,680	I.O.	£3
723A/B	CV1795	6.3	330	400	—	—	20	8,702-9,548	I.O.	£2/10
417A	CV2642	6.3	1,000	200	40.0	50	50	2,650-3,300	I.O.	£2
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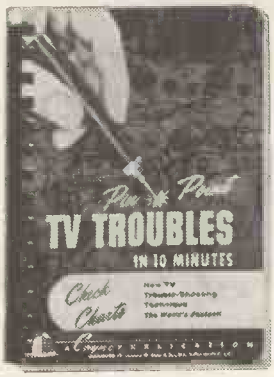

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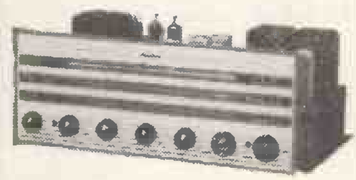

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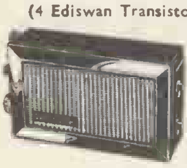

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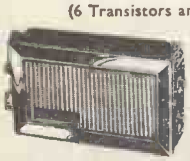

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(b) TECHNICAL Class Grade III radio Signals Command.
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QUALS. Full apprenticeship or equiv. training plus ONC, or C. & G. Inter. or Technicians cert. or equiv. qualn. Applications considered from those taking the final year of these certs. in 1961. Appointments will be unestablished but opportunities for permanent appointments are likely to arise. Salary scale £827-£988; age 28 and over start at £884. Prospects of promotion to higher ranks with max of £1,747. Applications and further details from Air Ministry C.E.3f, London, W.C.1, or any Employment Exchange quoting for post (a) City O/N 16 and post (b) City O/N 1134. [9578

RADIO and television servicing mechanic instructor (unestablished) required at Government Training Centre, Perivale, Middx. Applicants must be British subjects who have served the usual trade training followed by at least 5 years' recent experience. A good knowledge of theory and practice is required. C. and G. Certificates or equivalent preferred but not essential. Must be able to control and teach adult trainees. Prospects of eventual establishment. Starting salary at age 30 and over £1,033 p.a., rising to £1,116 p.a. after 2 years' service.—Application forms obtainable from Regional Controller, Ministry of Labour, Hanway House (Room 317), Red Lion Square, London, W.C.1. [9562

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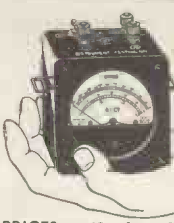

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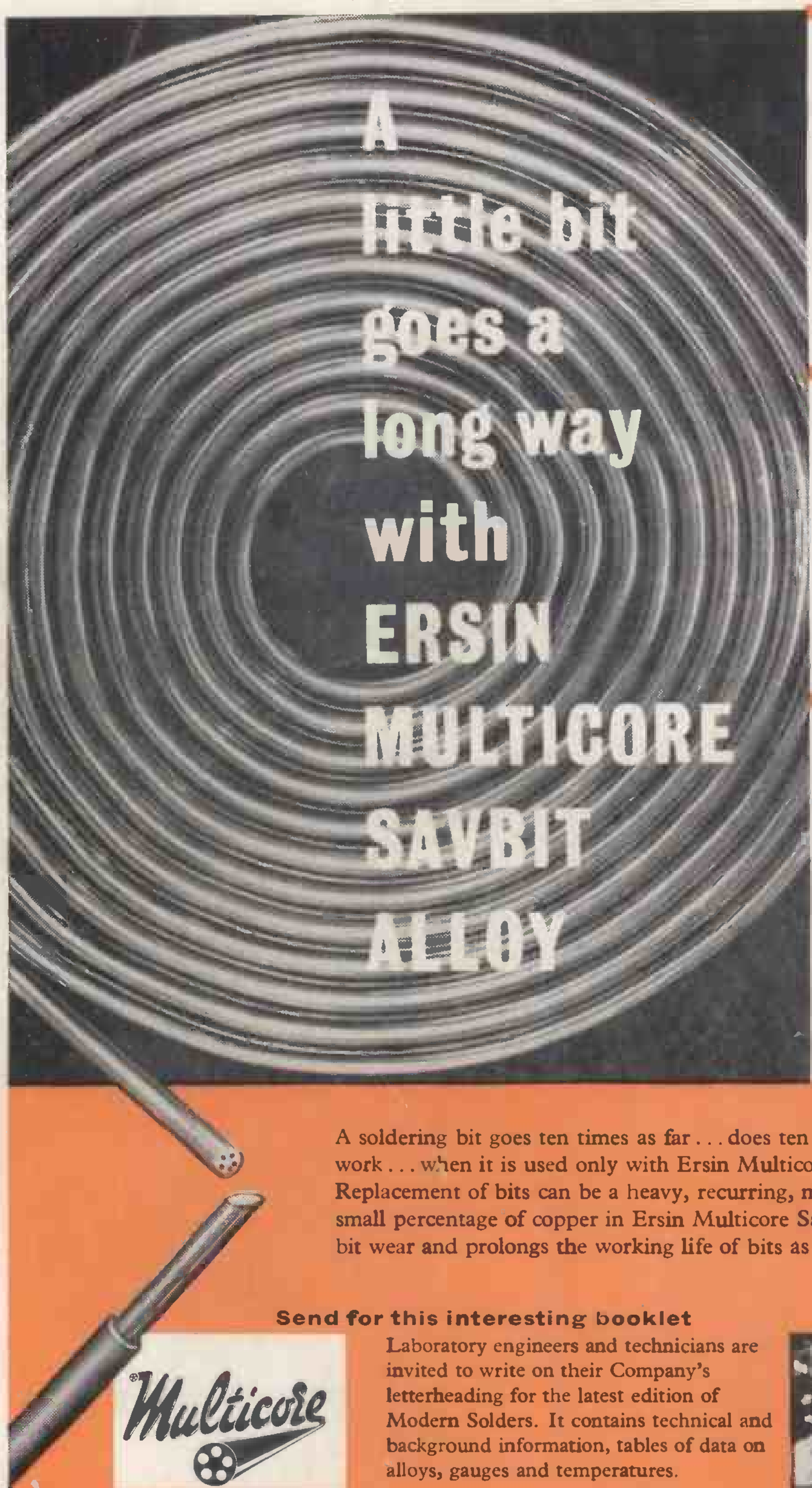

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