An improved version of the Ediswan Stabilised power supply unit type R1103 is now available. The R.1103A provides an additional fixed unstabilised D.C. output of between 515 and 670 volts and its characteristics have been improved in two ways:

1. Voltage range increased to 200V-400V. (Previous minimum 250 volts.)
2. Full load current of 200 mA can now be taken at all output voltages. (Previously limited to 150 mA above 350 volts.)

**BRIEF SPECIFICATION:**

**INPUT.**—200-250 volts 40-100 c.p.s.

**OUTPUT.**—High stability D.C. output 200-400 volts adjustable in three ranges. In addition, a fixed unstabilised output of 515-670 volts and two unstabilised 6.3 volt A.C. heater supplies are provided.

**LOAD.**—Maximum 200 mA.

**STABILITY.**—A 10 volt change in mains input voltage results in an output change of less than 0.15 volts. A change from zero to full load results in an output change of less than 0.5 volts.

**OUTPUT RESISTANCE.**—Less than 3 ohms.

**RIPPLE.**—Approximately 5 mV R.M.S.

**OUTPUT CIRCUITS.**—All circuits isolated from earth. Heater supplies can be operated at up to 500 volts from earth.

**MOUNTING.**—The unit is designed for standard rack mounting or bench use.

Further information on this and other Ediswan Stabilised Power Units available on request.

The Ediswan Stabilised Power Supply Unit Type R.1103A

Price remains unaltered at £57. 0. 0 nett.
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31. GERMANIUM DIODES FOR TELEVISION RECEIVERS (continued)

Advertisement No. 30 in this series compared the germanium point-contact diode with the more familiar thermionic type, and discussed the significance of its characteristics. It was said that the main classification of germanium diodes was into low and high current types, which have, respectively, high and comparatively low reverse breakdown voltages. In the present advertisement typical applications of these two contrasted types of germanium diode are illustrated.

Reprints of these advertisements, supplemented by data for Mullard diodes, are issued free.

High Current Applications

A typical application is given in Fig. 1, which shows a video detector circuit using a Mullard OA70. The circuit operates at 30Mc/s, therefore the available recharging time for the capacitor is short, and the diode must have a low forward resistance which will pass a substantial charging current. The reverse resistance requirement is of rather less consequence. The value must be significantly greater than the 3.9kΩ resistor in order to prevent the capacitor discharging back through the diode. A value of 20kΩ is sufficiently high.

The OA70 fulfils these requirements. It has a low forward resistance (a typical diode will pass about 8mA for a voltage drop of 1 volt); and its reverse resistance is of the order of 100kΩ. The OA70 also satisfies another requirement which results from the high operating frequency: the completion of each rectification action in the diode must be rapid. This property (which is known as minimum hole storage) is comparable with rapid deionisation time in a thyratron. The OA70 is rated for use at frequencies up to 100Mc/s.

Fig. 2 shows a grid circuit limiter which is intended to prevent overload of the receiver during the warming-up period. The diode requirements are high forward current, a capacitance which is sufficiently low to avoid deterioration of the video frequency response, and a reverse resistance which is much greater than the forward resistance. The OA70 satisfies these requirements.

Low Current Applications

A low current type, such as the Mullard OA71, has, necessarily, a more negative turnover voltage and a higher reverse resistance than a high current type. This last characteristic is essential in some applications. For example, in a sound detector circuit the 3.9kΩ load resistor of Fig. 1 would be replaced by, say, 47kΩ, and the choice of diode lies between the OA70 (reverse resistance 100kΩ) and the OA71 (1MΩ), depending on the peak inverse voltage which will be encountered and on the value of the load resistor.

The noise limiter shown in Fig. 3 requires a diode with a high reverse resistance. A small current flows through the chain of 1MΩ resistors and holds the diode in its conducting region. The diode therefore provides a path for normal audio frequency signals. Interference, however, drives the diode into its reverse current region where the high reverse resistance virtually open-circuits the signal path.
New Ideas in Electro-Acoustics

In spite of the fact that the B.B.C.’s new v.h.f. service so far covers only a small part of the country, it seems the transmissions have stimulated a very wide interest in the whole field of sound reproduction—especially high-quality reproduction. As the report printed elsewhere in this issue on new electro-acoustic products at recent exhibitions will show, the industry has gone a long way to meet the growing demand that has arisen.

For sheer technical novelty, the new linear electrostatic loudspeakers are undoubtedly the highlights among the recent introductions. If development proceeds along expected lines the loudspeaker, from being the weakest link in the chain, may become the component that sets the pace for the rest. But, although the electrostatic speaker has captured so much interest a great deal of steady work has been done during the past year on moving-coil types, and some highly developed versions have appeared.

Tape recording is slowly gaining ground at the expense of the disc. In tape equipment the demand for automatic operation seems to be growing, and both beginner and expert will probably welcome devices such as those which allow the selection of either track without changing over the spools. It is a fact that many people’s enjoyment of a record is lessened if complicated manual processes are needed for working the reproducing equipment. Unfortunately, extreme simplicity in operation can only be attained at the cost of greater mechanical and electrical complexity. Obviously a happy balance has to be struck between conflicting factors, and present-day gear will meet most reasonable needs.

V.H.F. tuners or adaptors may at the present stage of development be legitimately regarded as electro-acoustic gear. Just as the user of a record reproducer objects to “fiddling” manual operations, so the listener to high-quality broadcasting objects to making constant adjustments of tuning. Frequency drift is quite a serious problem in all f.m. receiver design and its effects seem to go up in annoyance value in proportion to the quality of the associated amplifier and loudspeaker. Very few tuners appear to be entirely free of blame in this respect and there is a pressing need for a cheap and effective solution of the problem of drift. Crystal frequency control has not yet, so far as we know, been used in commercially produced domestic gear, but it may yet be offered to those who are not satisfied with anything short of the best.

Legalized Recording

Although the programme of the new Parliament does not contain any proposals of direct radio interest, one legislative measure foreshadowed in the Queen’s Speech may prove to be of considerable significance. It was stated that legislation will be introduced to reform the law of copyright; the reforms will be on the basis of recommendations made in 1952 in the Report of the Copyright Committee. The present Act, dating back to 1911, is obviously out of date, at any rate in relation to such comparatively recent developments as broadcasting and sound recording.

No doubt the proposed new Act will include the gist of a Bill which came before the last Parliament aiming at creating a special “right,” called the television exhibiting right, in transmissions by the B.B.C. and I.T.A.

As our readers know, there has been some controversy over the legal position of those who make records of broadcast transmissions in their own homes. It is generally believed that, so long as there is no element of public performance in the playing-back of the record, no infringement of copyright is committed. However, confirmation would be welcome.

On this question of recording “off the air,” most of our readers will, we imagine, endorse the views expressed recently by Norman Leevers, president of the British Sound Recording Association. Mr. Leevers, speaking at the B.S.R.A. annual dinner, said the reasonable interests of home recordists must be watched. The Association, while respecting the rights of copyright holders, artists and others, would oppose legislation aimed at preventing recording and playback of material within the home recordist’s domestic circle.
C ALCULATION of the more complex formulae encountered in the gentle art of electronics is a matter which involves us in lengthy labour, in the purchase of a book of nomograms, or in the memorizing of tricks enabling us to do it quickly by conventional moves on the slide rule. There is, however, yet another way of looking at the problem, namely, that of realizing that the fundamental operations of multiplication and division on the slide rule can be carried out in more than one fashion, and that by logical application of this elementary principle, considerable saving in time, and even improved accuracy, can be achieved—all without additional expense of money or of memory. In the following paragraphs, the combination of reactance and resistance in series or parallel connection are used as examples to illustrate this.

Looking at the slide rule set for the multiplication $2 \times 3 = 6$, we have in front of us also a means for carrying out the division $\frac{6}{2} = 3$. It looks a little unfamiliar at first, but it will soon be quite natural for us to make use of the fact that the dividend and the divisor on the stock coincide with the quotient and the end-mark, respectively, on the slide—and, of course, vice versa!

Armed with this knowledge (so obvious, once it is realized, that even a tired memory is not taxed by
Calculations

having to remember anything) and, further armed with the old trick of writing

\[ |Z| = \frac{R}{\sqrt{R^2 + X^2}} \quad \text{as} \quad |Z| = \frac{R}{\sqrt{\frac{R^2}{X^2} + 1}} \]

we can, for instance, find the impedance of a resistance of value R in parallel with a reactance of value X by the following simple operations:

(1) Set the end-mark of scale “C” over X on scale “D,” (Fig. 1, one arrow), and the cursor over R on scale “D,” (Fig. 1, two arrows); the quotient, \( \frac{R}{X} \), appears under the cursor line on scale “C” (Fig. 1, three arrows). It need not be read off; instead, \( \frac{R^2}{X} \) is found under the cursor line on scale “B” (Fig. 1, four arrows), then, mentally (with due care for its decimal value) one is added.

(2) The slide is now moved to bring \( \frac{R}{X} + 1 \), instead of \( \frac{R^2}{X} \), under the cursor line (Fig. 2, one arrow). This, of course, also brings \( \sqrt{\frac{R^2}{X^2} + 1} \) (instead of the old quotient, \( \frac{R}{X} \)), on scale “C” under the cursor line (Fig. 2, two arrows). The original dividend R is still in place, thus (by the customary method of division), the end-mark already points to the quotient, our required impedance, on scale “D” of the stock (Fig. 2, three arrows). There, without further work or worry (or feats of memory) it is ready for reading off, or, possibly more important, it is in the correct position for continuing with subsequent calculations.

The impedance of a resistance of value R in series with a reactance of value X is given by \[ |Z| = \frac{R}{\sqrt{R^2 + X^2}}, \] which can be converted to \[ |Z| = X \sqrt{\frac{R^2}{X^2} + 1}. \]

A start is made as before.

(1) Set the end-mark of the slide to X on scale “D” (Fig. 1, one arrow) and bring the cursor over R on scale “D” (Fig. 1, two arrows). Again, \( \frac{R^2}{X} \) is read off (Fig. 1, four arrows). But this time:

(2) Instead of moving the slide, the cursor is moved to \( \frac{R^2}{X} + 1 \) on the “B” scale (Fig. 3, one arrow).

No further moves are required, for the slide end-mark is still in place over X on the stock (Fig. 3, two arrows), the cursor is now in place over \( \sqrt{\frac{R^2}{X^2} + 1} \) on the slide (Fig. 3, three arrows), thus, \( X \sqrt{\frac{R^2}{X^2} + 1} \), the required product, appears automatically under the hair-line (Fig. 3, four arrows)—again on the stock and ready for further use if required.

Incidentally, some may hold that this method is a slightly more elegant alternative for solving the root of the sum of two squares—described in the February issue of this journal—requiring less resetting of the rule.

As admittance is the reciprocal of the impedance (absolute values, of course), this is an easy matter to deal with. For the parallel combination, the admittance can be read off directly from the “C” scale above the end-mark of the stock (Fig. 2, four arrows), whilst for the series combination it simply means moving the end-mark of the slide under the cursor line (Fig. 4, one arrow), and reading the result on the slide, above the end-mark of the stock (Fig. 4, two arrows). Why—simply because if \( xy = 1 \), then \( y = \frac{1}{x} \)

And there are still no tedious rules to be remembered—but for those who like afterthoughts it may be of interest to note that the series combination—\( \sqrt{\frac{R^2}{X^2} + 1} \)—of the root of the sum of two squares—can be carried out by the same method, only with slide and stock exchanging their roles. The resulting impedance then appears on the slide and proud owners of a reciprocal scale can find the admittance thereupon—saving the extra move of the slide (with some slight reduction in consequent wear and tear).

PLASTICS

Some of the more interesting Radio Applications Seen at the Plastics Exhibition

THE good adhesion to metal inserts by Epikote potting resin was demonstrated by Shell Chemicals at the Plastics Exhibition held at Olympia by British Plastics. A neon tube encapsulated in Epikote “828” had its glass envelope broken by external squeezing yet the neon continued to function as shown by the glow discharge when employed as a low-frequency oscillator. Epikote “828” is a pale amber-coloured liquid which on the addition of a curing agent solidifies at ordinary room temperatures. It is thus a useful potting agent for radio parts. Its good high-frequency qualities were exemplified by a 250-Mc/s oscillator totally enclosed in Epikote “828.” Scott Bader were showing Marco potting resins which also solidify without either heat or pressure.

The Telegraph Construction and Maintenance Company demonstrated the ease with which metal parts can be coated with Telcothene using the special powder they have produced for the purpose. It is available in various colours and the procedure is to apply the powder to the pre-heated article and then to “cook” for about five minutes in an oven at about 160°C. The coating has a high-gloss finish and possesses all the insulating properties of factory-produced Telcothene.

High-impact polystyrene, which is less brittle than the ordinary material, is being used now for radio cabinets and Ekco were showing examples produced by their plastics division. These cabinets have a smooth glossy surface, are tough, flexible and very resistant to impact.

It would seem that about 35 Mc/s is the optimum frequency for welding thin plastic sheet and fabrics; Rediweld use this frequency in their “Rediweld” series of electronic heaters, while 36 Mc/s is favoured for the “Radyne” series made by Radio Heaters of Wokingham.

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www.americanradiohistory.com
BOOKS RECEIVED


AIRCRAFT SUB-MINIATURE DIRECTION FINDER

The illustration shows the various units that comprise the latest Marconi sub-miniature automatic direction finder for use in aircraft. It weighs complete 23 lb only and is based on the well-known Bellini-Tosi system using fixed crossed loops, in this case wound on ferrite cores, and a goniometer search-coil embodied in the bearing indicator. The goniometer is motor-driven and automatically displays the radio bearing. Tuning-in of stations is manual and all control is carried out from a small unit. Alternative bearing indicators are available; both are shown here. The frequency coverage is 200 to 1,700 kc/s in three ranges.


VACATION COURSE FOR TEACHERS

The Ministry of Education, in conjunction with the Radio Industry Council, is to conduct a course for full and part-time teachers of radio and television servicing and of radio in telecommunications engineering courses.

The course, at Northampton Polytechnic, London, is from July 17 to July 27. Further details may be obtained from the Ministry of Education (Teachers' Short Courses), 36-38, Berkeley Square, London, W.1.

NEW MATERIALS HANDLING JOURNAL

The first issue of a new controlled-circulation quarterly, Materials Handling News, dealing with all types of labour-saving machinery, will be published on July 1 by Mechanical Handling, the journal which organizes the Mechanical Handling Exhibition.

Materials handling, properly applied, can benefit all industries large and small, yet many firms are still not making the maximum use of the equipment available; it is to such people that Materials Handling News is addressed.

The first issue will appear on July 1; those wishing to receive copies should write to Dorset House, Stamford Street, London, S.E.1.

WIRELESS WORLD, JULY 1955
Radioactive Aids for Industry

Establishment of a New Research Group at Harwell

THE problem of disposing of radioactive by-products from nuclear reactors is not likely to present any difficulty for many years to come, as the demand for sources of radiation by industry is at present greater than the supply. Many chemical reactions proceed with greater facility in the presence of radiation, e.g., the polymerization of ethylene, and the "vulcanization" of rubbers, particularly those of the silicone type.

Improvements can also be effected in the end-products, and the increased heat resistance of irradiated polythene is already engaging the attention of cable makers.

In our own field it has been found* that irradiation of transistors can reduce the recovery time and in-
crease the speed of operation under pulse conditions, as, for example, in calculating machines.

To explore the widening field of application for radiation sources and to help users to make the best use of the supplies which will soon be available, a Technological Irradiation Group has been formed at Harwell by the United Kingdom Atomic Energy Authority. Research will be carried out not only with the "gross fission products" (and specially extracted elements such as caesium 137 and strontium 90) but with the intense radiations which will be available from uranium fuel rods during the storage period after removal from reactors and before chemical processing to separate the uranium and plutonium. The Group will also be equipped with van de Graaff accelerators for general research into irradiation problems.

I.T.A. COVERAGE TESTS

Reports received by Belling & Lee of reception of their experimental 1-kW transmitter G9AED on the I.T.A. site at Craydon are summarized by the dots on this map. They indicate where properly "locked" pictures have been obtained, and at all such points it is expected that reception will be good on the future I.T.A. transmissions. A great many reports were naturally received from the central London area, but these have been omitted for the sake of clarity. The map is based on the I.T.A. one released earlier in the year (April issue, p. 154) and shows the estimated coverage of the 60-kW temporary transmitter now under construction in terms of a primary service area (white) and a secondary service area (shaded). Although there are dots beyond these areas, it must not of course be expected that everyone "in the black" will get good reception.

WIRELESS WORLD, JULY 1955

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WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

I.T.A. Northern Stations

AS foreshadowed in our March issue I.T.A. has found it necessary to use two transmitters operating in Band III to cover Lancashire and Yorkshire instead of one as is done by the B.B.C. in Band I.

The first of the two sites to be chosen is on Winter Hill, Rivington Moor, some five miles north-west of Bolton. A 450-ft mast, now under construction at Marconi's, who are also providing the transmitting equipment, will be erected on the site which is 1,450 ft above sea level. Coverage is expected to extend in the north to Barrow-in-Furness, south to Stoke-on-Trent and west to Colwyn Bay. Eastwards the coverage will be limited by the ridge of the Pennines. It is planned to have the station operating with an e.r.p. of 100 kW by the spring of next year. The e.r.p. will eventually be increased to 200 kW.

The probable site for the Yorkshire station is Ovenden Moor, near Halifax, but no decision has been announced at the time of going to press.

Northern Electronics Show

OVER fifty exhibitors, including commercial firms, Government establishments, universities, hospitals and research associations, will be present at the tenth annual electronics exhibition to be held by the Institution of Electronics (Northern Division) at the College of Technology, Manchester, from July 14th to 20th. The opening ceremony will be performed at 2.30 p.m. on the first day. Equipment to be shown ranges from colour television to location of thunderstorms, from computers and counters to electrostatic deposition of flock, from timing lamp operations to measuring sound produced by fluorescent lighting chokes, and also includes a good deal of conventional test gear. A programme of forty lectures and sixteen film shows on electronic subjects will be running concurrently with the exhibition.

Admission tickets can be obtained by forwarding a stamped addressed envelope to the Institution secretary, W. Birtwistle, at 78, Shaw Road, Thornham, Rochdale. Catalogues (2s including postage) and lecture and film show programmes (4½d including postage) are also available.

Swedish Television

THE Swedes hope to start up a regular television service on July 1, 1956. A total of some 50 transmitting stations is planned: one of 100 kW, 28 of 60 kW, two of 10 kW, eight of 3 kW and 11 of 1 kW. A large demand is expected for foreign equipment such as studio and camera equipment, booster-station installations, coaxial cables, radio links and, at the outer, for receiving sets. The Swedes will use the 625-line system and 25-picture frames per second. At present there is a 5 kW station operating from the Technical High School in Stockholm with a weekly experimental programme.

It is estimated by the Swedish committee planning the future of television that within 14 years of the inauguration of regular services there will be nearly a million licence-holders in Sweden.

Thoughts on Broadcasting

SOME points made by Harold Bishop, director of B.B.C. Technical Services, in his inaugural speech as president of the Radio Industries' Club:—

V.H.F. Broadcasting.—We are delighted by the positive steps the industry has taken to get it started; already over 50,000 sets have been distributed.

Interference.—There is danger in over-simplifying the design of television receivers. Interference from line time bases is a serious blot on the copybook of the industry.

Colour.—We are going to do some experiments, but in my opinion it will be a long time before there is any colour television service in this country.

Receiving Aerials seem to need a great deal of attention. An integrated design [for all broadcasting] is needed.

Eurovision.—The number of television receivers in Europe outside the United Kingdom is under half a million. Bear this in mind when talking about programme exchanges.

Manpower.—Not enough is being done to encourage young chaps to join electronics; we want the help of science masters in schools.
PERSONALITIES

Rudolf Kompfinger, who came to this country from Austria in 1934 and since 1952 has been in the United States working on microwave valves at the Bell Telephone Laboratories, New Jersey, is to receive this year's Duddell Medal from the Physical Society. It is being awarded in recognition of his work in this country on the travelling-wave valve of which he was the originator. He described the valve in our November, 1946, issue. During the war he was a temporary experimental officer in the Admiralty (undertaking research in the Physics Department of the University of Birmingham), and in 1944 when he joined the University of Oxford where he stayed until going to the United States.

The degree of D.Sc.(Eng.) has been conferred by the University of London on Dr. A. Rosen, Ph.D., M.I.E.E., for his work in the field of telecommunication cables. Dr. Rosen, who has been consultant engineer (telecommunications) with British Insulated Callender's Cables, Ltd., since 1953, was formerly chief engineer (telecommunication cables) with Siemens Brothers. He has written a number of papers on r.f. cables, some of which have appeared in our sister journal Wireless Engineer.

Robert L. Green, A.M.I.E.E., has joined Winston Electronics, Ltd. (who have recently moved to Shetpperton, Middx.) as senior development engineer responsible for telecommunications research and development. Born in Holland, Mr. Green, who is 33, came to this country during the war and was with the General Electric Company at Shaw, Lancs, before joining Standard Telephones and Cables in 1943. During his nine years with S.T.C. at Footscray, Kent, he was concerned with the design and development of machinery for the production of valves.

The superintendent of the new Electronics Department of Metropolitan-Vickers, at Trafford Park, Manchester, is E. T. W. Barnes, who has been, since 1953, superintendent of the radio department (which is incorporated in the new department). He joined the company as a college apprentice in 1930. The assistant superintendent of the department is D. E. Thornhill, B.Sc.Tech., Grad.I.E.E., who joined the company as a vacation apprentice in 1936. Dr. L. W. Brown, B.Sc., Ph.D., M.I.E.E., F.Inst.P., who has been chief engineer of the radio department since 1950, is chief engineer of the new department. He was with B.T.H. from 1943 to 1950, where he was responsible for radar development, prior to which he was for three years a scientific officer at T.R.E., Malvern. T. R. Goode, now assistant chief engineer of the electronics department, has also held the same position in the radio department. J. L. Russell, A.M.I.E.E., who since 1947 has been in the company's electronic control engineering department, becomes assistant chief engineer (special applications) in the new department. L. H. J. Phillips, who is appointed sales manager of the department, was at one time during the war head of the radio department of R.A.E., Farnborough, and subsequently became deputy director of communications development in the Ministry of Aircraft Production. He has been sales manager of the Metropolitan-Vickers radio department since 1945.

E. Cattanes, B.Sc., M.Brit.I.R.E., has joined the Solartron Electronic Group, Ltd., Thames Ditton, Surrey, as a senior commercial executive. In 1934 he started and managed in Paris the French subsidiary of A. C. Cossor, Ltd., and in 1937 he managed the newly formed Cossor Instruments Division in London, being responsible for introducing, in 1938, the double-beam oscillograph. After periods of service with Airene, Ltd., and the English Electric Company, he went to Canada in 1952 and returned to this country at the end of 1953. He is now chief director of the Council of Brit.I.R.E. and from 1948 to 1952 was chairman of the industrial electronics section of the Radio Communications and Electronic Engineering Association.

D. H. W. Busby, whose article giving the design for a pre-amplifier appears in this issue, has been with Mullard for the past five years, prior to which he was for 2½ years in R.E.M.E., where he worked on gunnery control equipment. While with Mullard he has been concerned with problems encountered in the production of cathode-ray tubes and more recently with valve applications especially on the audio side.

F. W. Hollings, who has been with the Dubilier Condenser Company for 36 years, has retired from the position of secretary and has been appointed a director. He is succeeded by H. S. Clemenov.

Victor G. Oastler, who has been in charge of the Marconi Marine Aberdeen depot since 1948, has been transferred to the main London depot (East Ham) where he will be deputy manager until the retirement in September of the present manager, C. T. Sanders. Mr. Oastler joined Marconi's as a sea-going operator in 1929. The new manager at Aberdeen is Alexander P. Goodman. After sixteen years' duty at sea he joined the technical staff in Bombay in 1942 and became an inspector there in 1949. The new manager of the company’s Port Said service depot is George A. Dwyer. He joined the company in 1929 and after 12 years at sea was appointed to the shore technical staff.

BIRTHDAY HONOURS

A baronetcy is conferred upon Sir George Nelson, head of the English Electric-Marconi group of companies. Harold Bishop, director of B.B.C. Technical Services, receives a knighthood.

Appointments to the Order of the British Empire include:—

Philip H. Spagnolotti, director and general manager, Kolster-Brandes, Ltd. (O.B.E.).
Richard W. Lewis, chief chemist, Burndett, Ltd. (M.B.E.).
Robert J. Parker, senior telecommunications superintendent, Cable and Wireless (G.P.O.), Birmingham (M.B.E.).

Recipients of the British Empire Medal include:
Sydney F. Alexander, technical officer, Post Office Research Station, Dollis Hill; William D. H. Lockerby, technical officer, Radio Telegraphy Terminal, G.P.O.; and Harold Robertson, radio technician, No. 20 Maintenance Unit, R.A.F.

IN BRIEF

The number of broadcast receiving licences current in the U.K. passed the Fourteen Million mark during April. At the end of the month the total was 14,017,447, of which 4,580,725 were for television—an increase of 76,959 during the month.

V.H.F. Demonstration.—Although the B.B.C. has at its disposal the means of propagating information to over 95 per cent of the population, it cannot demonstrate to its listeners the advantages of v.h.f. broadcasting. In order, therefore, to bring to the notice of listeners in the London area the benefits of the new v.h.f. service, a special demonstration using comparative recordings has been arranged at the Science Museum, which is open on weekdays from 10 to 6 and on Sundays from 2.30 to 6.

The report of the Institute of Physics for 1954 records that the membership has risen from 4,749 at the end of the year. It also records that of the 54 candidates who sat for the newly established Graduate examination, only 19 were successful. The number of candidates taking the final
examinations for National Certificates in Applied Physics was 206 at the Ordinary level and 75 for the Higher Certificate, compared with 151 and 55, respectively, in 1953.

At the recent Diamond Jubilee celebrations of the Birmingham College of Technology a number of associate-ships of the College were awarded. Among those to whom associate-ships were presented by C. F. Partridge, head of the Department of Electrical Engineering, were John M. Beddoes, radar research engineer, Decca Radar; Trevor H. Robinson, graduate apprentice, Marconi's; Kenneth J. Adderley, graduate apprentice, G.E.C.; and Michael J. Hampton, student apprentice, G.E.C.

In a statement summarizing the work of the Professional Appointment Bulletin (9, Victoria Street, London, S.W.1) it is recorded that in 1954 it submitted particulars of over 9,000 engineers for vacancies in civil, mechanical and electrical engineering. Incidentally, the majority of electrical vacancies called for experience in electronics and light current engineering.

The annual report of the Radio Industries Club records an increase in membership of 33 during the year, bringing the total at the end of March to 874. Harold Bishop, director of B.B.C. Technical Services, who has been a member of the Club since 1943, succeeds C. O. Stanley (Pimlico) as president. Frank London (marconi) and F. H. Robinson (Odhams) are respectively chairman and vice-chairman.

Gift of Test Gear.—A complete set of 10-cm test equipment was recently presented to the Kingston-on-Thames Technical College by Decca Radar, Ltd. It will be used as part of the normal laboratory programme for full-time Higher National Diploma and B.Sc. (Eng.) degree courses and for post-graduate courses in microwave and pulse technique. The presentation was formally made by S. R. Tanner, the company's director of research.

Standard TV Set.—According to information published in the E.R.U. Bulletin, the new television set manufactured have agreed to produce, in addition to their own individual models, a standard receiver with a 43 cm (17in) tube, priced at about D.M.700 (£60). L.C.C. Mobile Radio.—Although in London few places are more than two miles from an ambulance station, the L.C.C. is introducing, experimentally, a radio-telephone service for its ambulances. Six ambulances and a staff car are to be equipped and a headquarters station set up at a cost of £2,975.

1955-56 Prospectus.—Details of full-time day courses in telecommunications engineering and servicing, one-day- or week-end courses organized at the request of the Radio Industry Council and evening classes in telecommunications engineering, servicing and one or two specialist courses are given in the new prospectus sent to us by the Northern Polytechnic, Holloway, London, N.7.

B.R.E.M.A. Council.—We were misinformed as to the representative of English Electric on the Council of B.R.E.M.A. (see page 256 of our last issue). H. C. Timewell represents the company and not D. C. Spink who is no longer with English Electric.

The aggregate attendance during the ten days of the recent Northern Radio Show, at City Hall, Manchester, was 90,385.

Audio Convention.—The 1955 convention of the Audio Engineers Society of America will be held in the Hotel New Yorker, New York, from October 12th-15th and will run concurrently with the annual Audio Fair. At the end of its first year the India Institution of Telecommunication Engineers, New Delhi, had more than 1,000 members. The publication of a quarterly journal has been started.

A reader has a number of back issues of Wireless World (August, 1949, to June, 1953) which he is willing to give to the club. Can guests be addressed to B. F. H., care of the Editor.

Is THIS AN IDEA for the G.P.O.? The Belgian postal authorities are now using the cancellation stamp to popularize television.

PUBLICATIONS

Abstracts of all new British Patents—whether of U.K. or foreign origin—are given in Patents Abstracts Journal which is published weekly by the Technical Information Company, of Liverpool. There is a subject index of short titles for each of the three main groups—general and mechanical; chemical; electrical—and it is claimed that the information is published within ten days of the patents being available for public inspection. The complete journal costs £26 a year but each of the sections is available separately.

Plastics Materials.—A new 62-page booklet, which lists alphabetically, according to chemical type, plastics materials and their manufacturers, is issued by the British Plastics Federation. A short note on the outstanding properties is given as a preface to the section devoted to each type of material. The booklet, "Buyers' Guide to Plastics Materials and Machinery and Equipment for the Plastics Industry," is obtainable from the Federation, 47-48, Piccadilly, London, W.1, price 2s 6d.

A proper system of book-keeping is essential to even the smallest business; we do not apologize, therefore, for bringing to readers' notice an authoritative book on the subject issued by our publishers. "Book-keeping for Small Traders," by J. Unett, is published by Iliffe and Sons Ltd., price 12s 6d. (Postage 4d.)

We understand from the R.S.G.B. that it is now able to supply from stock the 1955 A.R.R.L. Handbook (mentioned in our May issue, page 246).

Appendices dealing with the Suppression of Interference caused by flasher signs are included in the revised edition of the British Standard "Electric signs and high-voltage luminous discharge-tube installations" (BS559, price 5s).

INDUSTRIAL NEWS

In his review of the year, Viscount Chandos, chairman of Associated Electrical Industries, Limited, of which B.T.H., Edison Swan and Metropolitan-Vickers are members, stated that a new factory designed specifically for the production of Ediswan cathode-ray tubes was being built at Sunderland. When this is brought into use later this year it will release space at the Brimsdown factory for advanced development of tubes for coloured television. Viscount Chandos also stated that a new electronics factory is planned for B.T.H.

Another factory at Hove has been acquired by Mullard for the assembly of valves and cathode-ray tubes. At the present factory at Wilbury Villas, which employs about 175 people, and at the new factory at Cromwell Road, which will accommodate up to 350, the valves are made from sub-assemblies produced at another of the firm's thirteen factories.

A. Jennings of Murphy Radio, Limited, has accepted an invitation to serve on the 16-member Statutory Advisory Committee of the Board of Trade concerned with the preparation of forms and instructions for a sample census of distribution and other services for 1956.
Marine Exhibition.—A number of manufacturers of radio communication equipment and electronic aids to navigation are participating in the Engineering, Marine and Welding Exhibition which is to be held at Olympia, London, from September 1st to 15th.

In order to associate its name more directly with its specialized manufacture of high vacuum equipment, the title of W. Edwards and Co. (London), Limited, of Manor Royal, Crawley, Sussex, has been changed to Edwards High Vacuum, Limited.

A model of the new laboratory planned specifically for developing colour television by Sylvania-Thorn Laboratories, Limited, was shown at the Summer Exhibition of the Royal Academy in London. The laboratory will be built on the Great Cambridge Road, Enfield.

A travelling display of cables and wires and various materials used for insulation has been put into service by British Insulated Callender’s Cables, Limited, and is touring the United Kingdom. During July it will be in London and the Home Counties.

A hand-held underwater television camera and associated equipment has been supplied by Pye Canada Limited for the arctic survey to be undertaken by H.M.C.S. Labrador.

Cossor Instruments, Ltd., formerly the instrument division of A. C. Cossor, Ltd., has been incorporated as a subsidiary company in the Cossor group.

Sound Sales, Ltd., inform us that their application for the registration of the trade mark “A-Z” has been accepted by the Patent Office.

The new headquarters of the General Electric Company, Limited, Midland sales organization, was recently opened at Magnet House, Newhall Street, Birmingham. It has a radio and television service department. The G.E.C. has also opened new premises in White House Road, Ipswich.

The Scottish Service Department of E. K. Cole, Limited, has been transferred from 26, India Street, to 17, Carrigan Street, Glasgow, G.2 (Tel.: Central 3633).

Winston Electronics Limited have moved from Hampton Hill to their new factory and offices in Goyvet Avenue, Shepperton, Middlesex (Tel.: Walton-on-Thames 2732).

Recent additions to the ever-growing number of organizations using mobile radio-telephone equipment include paper merchants and laundries. Pye are supplying the receiving equipment for four vehicles used by Phillips, Mills and Company for the collection of wastepaper in Greater London, for eight vehicles used on the 400-acre site of the paper mills of Albert E. Reed and Co., at Aylesford, near Maidstone, and for three of the vans used by Wigram Laundries, Limited, of Shepherds Bush, London. Pye have also received orders from the Dorset and Carmarthen county ambulance services for eleven and twenty mobile installations, respectively, together with a fixed station for each.

EXPO S

Increasing Radio Exports.—Provisional figures issued by the Radio Industry Council for exports during April show a further increase. The month’s figure was £2,969,213. This brings the total radio exports for the first four months of the year to over £10.5M which is an increase of more than 10 per cent on the same period last year.

The Companhia Telephonica Brasileira (Brazil’s telecommunications organization) has placed contracts for the supply of equipment for a cable and radio network for multi-channel telephony with Standard Telephones and Cables, Limited, through the associated company Standard Electrica S.A., of Brazil. The network of radio links, operating on a frequency around 4,000 Mc/s, covers some 300 miles in thirty-mile hops. Seven radio channels in each direction are provided and each of these can carry up to 600 telephone circuits.

Of the twenty-four British and foreign manufacturers who submitted tenders to the Egyptian Police Authorities for the supply of equipment for an extensive radio network, Marconi’s have been awarded the contract. It provides for the supply of 221 v.h.f. mobile stations and 132 transmitters and 139 receivers for fixed stations. In addition, an inter-city h.f. system has been planned involving the supply of twenty-four 500-watt transmitters, associated h.f. receivers and receiving terminal equipment. Marconi’s are also providing masts, aerials and ancillary gear.

E.M.I. Electronics, Limited, of Hayes, have supplied to the Companhia Shell de Venezuela, in Caracas, a console control desk providing for four microphone inputs and eight line inputs and a portable 4-channel mixer unit. The control desk will be used to feed programme material from various sources to a film recording unit and to tape and disc recorders. The Shell Company provides films and film material for regular programmes from two Venezuelan television stations.

Representation of United Kingdom manufacturers of industrial and medical electronic equipment and television components and accessories is sought by B.I.B. (Belgium-Ireland-Britain), S.A., 21 rue Defacqz, Brussels, Belgium.

United Motor and Electrical Company, of 387, Skinners Road South, Colombo, Ceylon, ask to be put in touch with manufacturers of a.c. and d.c. test and measuring instruments.

I.T.A. MIDLAND TRANSMITTER.—This is the Pye equipment to be installed at the I.T.A. Midland television station to be built at Common Barn Farm, Hints, some five miles south-east of Lichfield, Staffs. It is estimated that its service area will extend as far south as Gloucester, to Chesterfield in the north, Shrewsbury in the west and Market Harborough in the east. Initially the station will have an e.r.p. of 100 kW, eventually to be increased to 200 kW. The mast and aerial system are being supplied by Marconi’s.

Wireless World, July 1955
Developments in Sound Reproduction

NEW PRODUCTS AND TRENDS AT RECENT EXHIBITIONS

At least two London exhibitions in the late spring—those organized by the British Sound Recording Association and by the Association of Public Address Engineers—are devoted exclusively to sound reproduction, and a third, the Radio and Electronic Component Manufacturers' Federation's show, can always be relied upon to include a substantial proportion of electro-acoustic components. The following notes are gleaned from visits to all three exhibitions and give some idea of the activities which have reached fruition in the development departments of the firms exhibiting.

Microphones.—An interesting transmitter-microphone, operating without trailing leads, has been developed by Leevers-Rich for use in film production and broadcasting. It measures only 4½ in x 1 in x 3 in and can be clipped into the breast pocket, when the 3-in diameter condenser microphone resembles the projection of a fountain pen top. (Alternative forms are available.) The transmitter, which has an output power of 5 mW, operates at 70 Mc/s and is energized from miniature batteries. The condenser microphone is omni-directional and the effective frequency range is 30–10,000 c/s. At the receiver, which is a.c. operated and takes the form of a 19-in rack unit, a limiter controls the variations of r.f. level due to movement of the transmitter for input signals above 1 μV.

Another unobtrusive microphone, this time of normal direct-connected type, is the Model LFV59 "Full Vision" made by Lustraphone. This has been designed for singers and other artists and measures only about 1 in in diameter. It is of the moving-coil type and is suitable for hand or stand use.

The trend towards smaller physical dimensions is also seen in the M7 moving-coil and M8 ribbon microphones made by Film Industries. These measure respectively 2½ in and 1½ in in diameter and make use of semi-flexible tubing instead of swivel joints for adjusting the angle of the head.

The Reslo ribbon microphone is now available in a redesigned screen with matching transformer in the base. The ribbon is 2 microns in thickness and is die formed to a shape which gives visual indication when the designed tension has been applied. This microphone, and the Reslo miniature moving coil, are characterized by the ingenuity of the mechanical design, which combines a high electro-acoustic performance with ease of assembly and positive alignment.

Pickups.—The Leak "Dynamic" (moving-coil) pickup has been retooled for mass production at a reduced price, with an improved performance over the original model. Playing weights are 2 to 3 gm on 33⅓ r.p.m. records and 5 to 6 gm 78 r.p.m. shellac records. The damped high-frequency resonance is 20 c/s ±5 c/s and a level response ±1 db is claimed from 40 c/s to 20 kc/s. A diamond stylus is standard on both the long-playing and 78 r.p.m. heads.

In a new Cosmocord high-output turnover crystal pickup, replaceable flat strip cantilevers are used for...
each stylus. The type GP59-3 has a Rochelle Salt element and a tropical version, GP61, is available with a barium titanate element. A special head, HGP55, has been introduced for the Burne-Jones pickup arm with the correct dimensions for minimum tracking error.

Precise adjustment of playing weight with a calibrated scale is provided in a new "transcription" pickup arm developed by Goldring. No springs are used and the counterbalance is effected by variable leverage.

A new record for the testing of fine-groove (33 r.p.m.) pickups is available from the British Sound Recording Association, 295, Regent's Park Road, London, N.3. It carries fourteen frequencies between 50 c/s and 10kc/s and the lateral velocities conform within 0.5 db to the CCIR standard combining a 450/sec bass cut with a 50/sec top lift. The recorded velocity at 1,000 c/s is 1 cm/sec.

**Gramophone Motors.**—The Model 301 variable-speed a.c. mains transcription turntable is now in quantity production and the final design incorporates many detail refinements. In addition to resilient mounting of the driving motor, all controls, and even the mains leads, are spring-mounted to isolate the turntable from all sources of vibration. Speed variation is by means of a magnetic brake.

Designed for professional "dubbing" work, the Connoisseur (Sugden) variable 3-speed motor, recently introduced, employs a synchronous driving motor running at constant speed, and a variable reduction drive gives a range of 2% on any of the three speeds.

**R.F. Tuners.**—The establishment of the v.h.f. sound service has redirected the interest of high-quality enthusiasts to the potentialities of B.B.C. programmes, and a number of f.m. tuners suitable for connection to high-quality amplifiers are now available.

Permeability tuning in conjunction with temperature-compensating capacitors, and an i.f. limiting stage as well as a ratio detector to discriminate against a.m. interference are features of the Armstrong Model FM56.

The Acoustical Manufacturing Company's f.m. tuner, in its redesigned form, incorporates a unique tuning indicator in which two small neon lamps show at a glance when the station is in tune, or whether it is mistuned to the right or left of the correct setting. A frequency error of 1 part in 10,000 is detectable. Adjustable station indicators are provided, and the frequency range of 87.5 to 108 Mc/s covers both British and American v.h.f. broadcast bands.

In addition to the Type FM81 variable-tuned unit C. T. Chapman (Reproducers), Ltd., have introduced a three-station version (FM82) with switch selection of the Light, Home and Third programmes of the B.B.C. Each pre-tuning trimmer has a range of 88-100 Mc/s. A tuner unit with facilities for both f.m. at v.h.f. and amplitude modulation on other wavelengths is also available from this firm for the many people who are interested in world-wide reception. Two versions are made, Type S5/FM, with medium, long and one short-wave range, and Type SSE/FM, with three short-wave ranges and the medium waves in addition to the 87.5-100 Mc/s range for f.m.

**Amplifiers.**—The prototype of a transistor amplifier with an output of 10 watts was shown by Lustraphone. It uses two Mullard experimental power transistors in the output stage and is claimed to have a substantially flat response from 50 c/s to 10,000 c/s. A small 12-volt accumulator is recommended for the power supply and the current drain is 1.5 A at full output (0.25 A quiescent). The dimensions of the case are only 6in x 4in x 4in.

The "Astronic" range of portable p.a. amplifiers made by Associated Electronic Engineers, Ltd., is notable for the convenient arrangement of the controls on a horizontal surface, and for the strength and rigidity of the steel carrying case. Model A1267 is for mains or battery operation and has a built-in vibratory convertor. The power output is 40 watts.

The new Lowther amplifier (Type TP10) makes use of the latest Mullard EL34 output valves in a triode-pentode method of connection. The output impedance is less than 0.4 ohm and a damping factor of 40 is claimed over the frequency range of 7 c/s to 70,000 c/s. Another new Lowther product is a variable low-pass filter with a cut-off at 18 db/octave continuously variable between 2 and 20kc/s. It is designed to work with most high-quality amplifying equipments.

Detail improvements in the Rogers range of ampli-
fiers include an "ultra-linear" output stage and provision for a radio input in the Mk. III version of the RD Minor. The RD Junior amplifier/control unit has a specification which meets most domestic requirements with an output of 8-10 watts, and the RD Senior with 25 watts is suitable for schools and gramophone societies. An interesting detail of the RD Junior is the "impedance plug" loudspeaker matching arrangement. Three plugs for 2-3, 6-8 or 12-16 ohms are provided and the correct value of feedback resistor is selected according to the plug in use.

Whiteley Electrical were showing a new high-quality amplifier and control unit with an output of 12 watts.

In the control circuit of the new Armstrong A10 amplifier, a worthy effort has been made to rationalize the chaotic pick-up equalization situation. Four principal response characteristics cover all the main British, Continental and American recording characteristics, which are listed and grouped. Minor differences are taken care of by the variable tone controls.

Pamphonic have produced a robust 12-volt "loud hailer" in which the amplifier and a rotary converter for h.t. are housed in a weatherproof metal case. Valve heaters are energized in the standby position and a microphone press-switch operates a relay to start the converter before speaking. The power output is 10 watts into a weatherproof re-entrant horn loudspeaker.

Loudspeakers.—A vintage crop of new loudspeakers can be reported this year. Undoubtedly the development which has attracted most interest is the realization that the push-pull electrostatic loudspeaker can be operated in such a way as to remove what was thought to be its inherent non-linearity of transfer characteristic. Indications are that ultimately it may set the standard for other items of sound reproduction equipment as far as harmonic distortion is concerned. H. J. Leak demonstrated a high-frequency electrostatic unit of the new type in conjunction with a 15-in moving coil with a cross-over at 700 c/s, and the prototype of a wide-range all-electrostatic reproducer (40 c/s to 20 kc/s) was shown working by the Acoustical Manufacturing Company.

An interesting new ribbon loudspeaker, which, like the electrostatic is driven over the whole of its radiating surface, has been developed by Kelly Acoustics. By the judicious use of modern magnet materials a flux density of 10,000 gauss has been achieved in the gap, giving a force/mass ratio of 4×10^6 dyne/gm (the diaphragm weighs only 8 milligrams). A "potted" coupling transformer presenting an impedance of 15 ohms is included. The frequency range is 3 to 20 kc/s.

Reslossound, in conjunction with the B.B.C. Research Department, have made a moving-coil direct-radiator loudspeaker unit for the range 2 to 20 kc/s. The spherical diaphragm is of metal and the coil is of self-supporting aluminium. The response is remarkably free from irregularities and the polar response is sensibly uniform over an angle of 90°.

A new 3-in diameter moving-coil "tweeter" is now incorporated in the Wharfedale 3-speaker reproducing system. The cone and coil assembly, which is mounted in a cloth surround and incorporates a centre spherical dome, weighs 1½ gm. The magnet system provides a total flux of 54,000 maxwells and a flux density in the gap of 13,000 gauss. This unit, known as the Super 3, is obtainable separately.
To provide the essentials of the performance of the Guy R. Fountain "Autograph" loudspeaker in more compact and somewhat less expensive form, Tannoy Products have produced the "G.R.F." enclosure with dimensions of 48in x 38in x 29in. A 15-in dual-concentric unit is employed with rear horn loading below 350 c/s and forward horn loading between 350 and 1,000 c/s to preserve a realistic source size on solo vocal and instrumental music, and a spacious distribution on orchestral items with a wider bass response. Above 1,000 c/s the radiation is from the non-directional concentric horn.

The Lowther TP1 corner reproducer, which has already established a reputation for good transient response, has had its performance in this respect still further enhanced by a new field magnet design giving a flux density of no less than 25,110 gauss.

In the Truvox "corner diffusion speaker" internal baffles are used to give a "three dimensional" distribution of output, and the effect is to increase the apparent size of the source.

For studio monitoring, G.E.C. have introduced a high-quality reproducer (BCS1865) consisting of two of their metal-cone units in an octagonal vented cabinet. The unit includes an auto-transformer for matching to 15 ohms.

Two-speaker combinations of any of the units comprising the Goodmans range moving-coil loudspeakers can be arranged in a simple cross-over network using standardized 4.5 mH chokes. Pairs of these chokes for constructing the cross-over unit are available from Goodmans at 37s per pair.

The Plessey 3-in inset loudspeaker, developed in conjunction with S.R.D.E. for Service equipment, is designed to give maximum intelligibility of speech under conditions of high ambient noise, and has maximum sensitivity in the range 800-5,000 c/s. The front of the diaphragm is protected by a perforated steel cover and the materials and finish are chosen to withstand extreme climatic conditions. The unit is available, without the sealed external housing and protective cover, for use in telecommunication equipment.

Magnetic Recording.—An event of considerable importance, particularly to owners of portable recorders with limited spool capacity, is the introduction by the Minnesota Mining and Manufacturing Company of a new thin tape ("Scotch Boy" Type 190M) giving a 50% increase of playing time from any given size of spool. The polyester film base is only 0.001in thick and the coating thickness has also been reduced, but an improved coating material ensures that there will be no reduction in performance.

Much attention is being given to the quality and uniformity of magnetic oxide coatings, not only from the point of view of sound reproduction but also for data recording in computers and for machine control.

Special equipment has been developed by the M.S.S. Recording Company for routine examination of tape production and for the analysis of faults. The tape is driven at 30 in/sec and 10 kc/s is recorded and played back at the full width of the tape. After passing through a 2-kc/s wide bandpass filter the output is rectified and applied as a d.c. component to the vertical deflection of a cathode ray tube. Movement of the spot is photographed on paper travelling horizontally at 15in/minute, giving a scale of 1 inch to 100ft of tape. Faults of duration more than 1 millisecond are detectable and the general shape of the curve reveals the qualities of the tape transport mechanism as well as of the tape itself. Tape intended for pulse data recording is tested by a different technique. The tape is modulated to saturation with square waves equivalent to a pulse density of the order of 200 per inch. On playback, any pulse failing to reach a given level causes a relay to operate and

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the tape is stopped. Alternatively the tape can be allowed to run and "drop outs" (tape elements with reduced sensitivity) are then registered on a "Dekatron" counting unit. Other demonstrations arranged by M.S.S. included the so-called Bitter technique for rendering the surface induction visible by applying a colloidal suspension of finely divided magnetite; and a sensitive tensile testing machine for observing changes in length of tape with changes of temperature, humidity, etc.

Collaro break fresh ground with a tape mechanism with many unusual features. Two similar driving motors are employed which are used in turn to drive the capstan. Thus, in conjunction with duplicated erase and record/playback heads, either track of a reel of tape can be used without changing over spools. An unusually heavy 62-in-diameter capstan flywheel is used to give constancy of speed, and in addition the wind-on tape tension is held constant by a feeler arm which is coupled to a friction clutch driving the drum. Tension is also controlled on fast rewind. A subsidiary feeler is used to show the amount of tape on the spool. Control is by an interlocked push-button system.

In the new Simon SP/2 portable tape recorder particular attention has been given to accessibility and valves can be changed and adjustments made through inspection covers at the back and side. Two EL84 valves in the output stage give an output of 10 watts, which can be usefully applied to external loudspeakers for p.a. work.

Grundig were showing a "Specialist" version of their tape recorder with a stated frequency range of 50-9,000 c/s at 32 in/sec and 40-14,000 c/s at 73 in/sec. Track changing is by press-button without changing spools. Wide-angle distribution of sound on playback is achieved by a large elliptical moving-coil loudspeaker in conjunction with two small high-frequency units mounted in the sides of the case.

All Wearite "Tapedecks" now employ synchronous capstan motors and have provision for 1,750-ft reels. Three types are available: A, with normal arrangement of heads; B, with separate record and playback heads for monitoring while recording; and C, with provision for simultaneous dual track recording. A wide variety of complete domestic, professional and industrial recorders incorporating the "Tapedeck" were shown.

Leevers-Rich, who specialize in tape recording for the film industry, television and sound broadcasting and have evolved the "Synchropulse" system of synchronizing sound and film, were showing examples of fine workmanship which included the Model DB2-21C machine. This incorporates its own test equipment for checking frequency response, signal/noise ratio and tape speed constancy. The whole equipment operates from a 12-volt battery, or from a.c. mains when available.

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**SHORT-WAVE CONDITIONS**

**Predictions for July**

![Graphs showing short-wave conditions for various cities](image)

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

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

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**WIRELESS WORLD, JULY 1955**

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Measurement of Non-Linearity Distortion

By M. G. SCROGGIE, B.Sc., M.I.E.E.

Need for a Method Corresponding with Aural Judgment

Despite television, interest in sound-reproducing equipment has never increased. For evidence one has only to look at the advertisement pages of this journal. It can hardly be denied however that present practice in specifying the non-linearity of such equipment is unsatisfactory. Out of a considerable number of specifications that were examined, one of them stated the percentage total harmonic distortion at a mentioned power output at two frequencies (40 c/s and 2 kc/s), one gave the same information at a single frequency (1 kc/s), one gave a curve of "total distortion" against watts output (frequency not stated), six gave the "distortion" or "harmonic distortion" or "total harmonic distortion" at a stated output but no stated frequency, two were "undistorted" up to a stated output, and the remainder were even vaguer.

What is the information we really want? Presumably something that will tell us how much unpleasantness we may expect at the maximum output, or alternatively how much output is available up to the point at which unpleasantness does not exceed a specified amount.

The basic principles of this matter have been reviewed so recently by "Cathode Ray" that the preliminaries can be abbreviated. As he says, unpleasantness is not measurable as such, so the only hope of obtaining quantitative information is to find some physical characteristic to which audible distortion is as nearly as possible proportional and measure that. There are of course various types of distortion. Of these, it can be assumed nowadays that frequency distortion can readily be brought under control. The other main type, to which the present discussion will be confined, is non-linearity. Unlike frequency distortion, the results of non-linearity in one unit of the audio chain cannot be compensated by opposite non-linearity in another.

Simple Methods

The problem is to observe and specify non-linearity so as to show how far it causes the reproduction to fall short of perfection. One common method is to apply a sinusoidal signal to the unit under test and to display the output waveform on an oscilloscope, using a linear time base. The fact that this is so often done can only be accounted for, surely, by the comparative ease of the procedure. The degree of distortion can be judged only by comparing what is seen with an invisible mental picture of a perfect sine wave, so the minimum that can be detected depends largely on the experience and skill of the observer and at best is not very small. A considerable improvement is to use a double-beam oscilloscope and compare the output waveform directly with the input, but even then the method is not sensitive enough for nearly linear units. It has its uses, but can hardly be classed as a method of measurement.

Another oscilloscope method is to display the transfer characteristic—the graph of instantaneous output against instantaneous input—by connecting as in Fig. 1. The ideal pattern is a perfectly straight diagonal line. One can much more easily judge departure from a straight line than from a sinusoid, and also more easily distinguish the nature of the distortion. But even so, the method is effective only for what would nowadays be considered comparatively gross distortion.

Need for a Single Figure

Obviously distortion shows up much more clearly if the comparatively large undistorted component of the output is removed. Both simple and elaborate arrangements have been described for filtering out the fundamental output and displaying the remainder—the distortion products—on the oscilloscope screen. This can be a most effective way of investigating distortion. But although distortion oscillograms are extremely informative to any one who can interpret them, for general purposes they have serious disadvantages. They cannot be communicated verbally. They are troublesome to reproduce accurately without photography. And they cannot readily be compared quantitatively with one another, nor enable the signal level to be set to a specific standard of distortion. So the need remains for some method yielding results that can be expressed numerically, preferably as a single figure.

Since the effect of non-linearity is to create signal components or products at frequencies not present in the original, the obvious solution is to compare the amplitudes of these products with that of either the whole output or the undistorted part of it. Stated in this way, the problem looks quite simple, but the more one examines it the more complicated and diffi-
cult it turns out to be. That is, if we have not forgotten that our quest is a measure that corresponds reasonably well with aural judgment.

The first complication arises from the division of distortion products into two classes—harmonics and intermodulation products. This division is a useful one for distinguishing products whose frequencies are multiples of the originals from those with sum and difference frequencies. But it is not such a basic distinction as is sometimes supposed.

The other outstanding question is whether and how the distortion products, if there are more than one, can be combined into a single distortion figure. There is no difficulty in combining as many as one likes, but again one must not forget the aim. Does the combined figure reliably correspond with aural judgment?

Whatever their reasons may be, advertisers of high-fidelity amplifiers seem at present to be in complete agreement on these two matters. If distortion figures are mentioned at all they shall be (1) harmonics and (2) intermodulation figure, viz., total harmonics expressed as a percentage of the whole output. This total is the r.m.s. voltage of all the harmonics together, and the distortion figure is therefore

$$100 \frac{V_2^2 + V_3^2 + V_4^2 + \ldots}{V_1^2 + V_2^2 + V_3^2 + V_4^2 + \ldots}$$

where \(V_1\) is the voltage of the fundamental, \(V_2\) the voltage of the second harmonic, and so on. Although this whole expression may look rather complicated, it is perhaps the easiest distortion figure to measure, which is presumably the reason for its common use. The apparatus (Fig. 2) consists of an oscillator with substantially less harmonic content than any equipment to be tested, a bridge or other device for balancing out the fundamental, and an amplifier and meter (theoretically r.m.s., but often not so in practice) for reading the distortion and comparing it with the total output. Such combinations are available commercially and can be used by unskilled persons.

When the distortion to be measured is of the 0.1% order, the requirement regarding purity of oscillator output is stringent, and filtration is likely to be needed; this in turn makes one anxious not to have to vary the frequency much. It is, of course, necessary to know the signal level or output power at which the distortion is read, and at a given level the distortion usually depends largely on the frequency. So unless the frequency also is stated, the significance of the reading is considerably reduced. If unmentioned, one would probably be safe in assuming it to be some middle frequency, such as 400 c/s or 1,000 c/s, and can only conjecture what it would be at 40 c/s!

* "Weighted" Components

There is general agreement that the unpleasantness of a given percentage distortion, as measured in this way, depends to a very large extent on how that percentage is made up. If 1% total distortion consisted of 1% second harmonic and nothing else, it would sound very much better than if the first 13 harmonics were all present to the extent of 0.29% each (making the same total r.m.s. value). Therefore in the absence of further information the "total harmonic distortion" is a very unreliable indicator of unpleasantness. In order to bring the total harmonic reading more into line with aural impressions it was proposed as long ago as 1936 that the higher harmonics should be "weighted" in direct proportion to the number of each harmonic, by multiplying the nth harmonic voltage by \(n/2\). The percentage, weighted in this way, can be written

$$100 \frac{V_2^2 + (2V_3)^2 + (2V_4)^2 + \ldots}{V_1^2 + V_2^2 + V_3^2 + V_4^2 + \ldots}$$

In 1950 D.E.L. Shorter produced evidence to show that this linear weighting is not drastic enough and that aural assessment is fitted more closely by a square law:

$$100 \frac{V_2^2 + (2V_3)^2 + (4V_4)^2 + \ldots}{V_1^2 + V_2^2 + V_3^2 + V_4^2 + \ldots}$$

He admitted a practical difficulty, that high harmonics present in quantities insufficient to be accurately measured may nevertheless, when weighted thus, contribute significantly to the total.

On a basis of musical harmony theory, one would not expect the unpleasantness of harmonics to conform to any simple law. For instance, the 15th is less discordant than the 15th. But Shorter suggests that the fact that his weighting formula relates to the sharpness of curvature of the waveform may be significant. Some further research on this would be helpful.

**Intermodulation Distortion**

It is not difficult to guess why weighted systems have failed to achieve popularity. In the first place, though it be granted that they are a closer approach to our ideal, they seem somewhat arbitrary and thereby lacking in authority. Perhaps more decisively from a commercial viewpoint, they give figures higher than the unweighted total, and so there is what in official jargon would be called a strong disincentive to use them. It is rather surprising that no one has thought of advertising on a system in which the lower harmonics would be divided by an appropriate factor! Lastly, the apparatus is more complicated, though for simple proportional weighting not unduly so—details of a suitable instrument will be given later.

Although one rarely, if ever, sees a weighted distortion figure, the more highly technical specifications do occasionally reveal the separate percentages of the first few harmonics. Such figures can be derived from the output waveform or the transfer characteristics, but only with a good deal of effort and when the distortion is fairly large. For general purposes it is best to measure them individually with a wave analyser, of which more anon.

So much for harmonics; how about intermodulation? It is sometimes regarded as quite a different kind of distortion. There is certainly general agreement that the unpleasantness of non-linear sound reproduction is due more to intermodulation products than to harmonics. Therefore, some say, intermodulation is inherently a more reliable index to distortion than harmonics. But this does not necessarily follow, and if intermodulation is chosen it should be for some better reason. For basically they are the same, and theoretically, given complete information about harmonic production, it is possible to calculate the intermodulation products, and vice versa. Or given the

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*But unless the distortion is more than about 10%, the denominator \(\sqrt{V_1^2 + V_2^2 + V_3^2 + \ldots}\) can be replaced, with negligible error, by \(V_1\).*
non-linearity and input signal amplitudes, the amplitudes of both harmonics and intermodulation products follow, so that the ratio of one to the other is known. From this it seems reasonable to conclude that either should do almost equally well as a measure of distortion. On the other hand, however, many workers state as known that intermodulation data line up well with listening tests whereas harmonics do not. From these many references let us take two examples. The first is by H. E. Roys. He compared the total harmonics with total intermodulation resulting from the playing of disk records of test signals (400 c/s alone and 400 c/s with 4,000 c/s), using styli of specified point radius. He repeated the tests with "masters" (electroplated "negatives" of original engraved disks) that had been excessively polished, resulting in shallow flat-bottomed grooves in the pressings. These tests showed a great increase in audible distortion and in total intermodulation, whereas total harmonic readings were hardly affected. Roys concluded that whereas the intermodulation method of test corresponded with audible distortion, the harmonic test did not. And since he confined this conclusion to disk recording and reproducing, there seems to be no reason to question it. But it has been quoted by others as evidence that intermodulation can vary quite independently of harmonics in the circumstances generally assumed, viz., two or more signals being handled simultaneously by a non-linear unit, such as an amplifier or gramophone pick-up. The nature of Roys' experiment, however, was entirely different, involving intermediate mechanical processes not subject to the usual assumptions about non-linearity. On the information available, it seems likely that the polishing affected the 4,000 c/s ripple most at the peaks of the 400 c/s waves, which would result in 400 c/s modulation of the 4,000 c/s in the reproduction without necessarily causing much distortion of the 400 c/s reproduction. Roys' argument for preferring intermodulation tests, while justifiable for the particular chain of processes with which he was concerned, is quite invalid for non-linearity as generally understood. The second example is one in which a particular form of intermodulation test on a deaf aid was found to correspond much better with aural tests than did the measurement of harmonic distortion. Examination of the distortion/frequency graphs obtained, however, shows that the frequency characteristic of the aid contained sharp peaks and deep hollows, and that these were responsible for the lack of proportionality between harmonic and intermodulation products. The strong indication of distortion by the preferred method of intermodulation measurement was due mainly to the frequency of the product measured, and a different kind of intermodulation method gave altogether different results. It is well that those of us whose distortion measurements are confined mainly to equipment with nearly flat frequency characteristics should be reminded that the simplifying assumptions that can be made for such equipment do not hold when the frequency characteristic is mountainous. Take for example the frequency characteristic shown in Fig. 3 and compare the distortion at 2 kc/s when measured as (a) the second harmonic, 4 kc/s, and (b) the difference frequency, 1.1 kc/s, between input signals at 2 kc/s and 3.1 kc/s. The amplification at 4 kc/s is more than 30 db down on that at 1.1 kc/s, so it is not surprising if method (b) gives a much higher reading under these conditions than method (a). The moral is to refrain from applying to one set of conditions a conclusion established for quite a different set of conditions.

Influence of Frequency Response

The conditions for which a definite intermodulation/harmonic ratio (usually between 3 and 4) has been calculated are ideally simple: frequency characteristic perfectly level over a band embracing all the frequencies involved, and transfer characteristic conforming to a simple power series. Even so, the ratio depends on the number and coefficients of the terms in the series, and on the relative amplitudes of the test signals. The influence of frequency response

![Fig. 2. Block diagram of the usual arrangement for measuring total harmonic distortion.](image)

![Fig. 3. Example of a frequency characteristic in which wide divergences between different methods of estimating distortion are to be expected.](image)

![Fig. 4. A simple frequency-discriminating system, representing a typical output stage, in which the ratio of intermodulation to harmonic distortion is very different from that calculated for systems with level frequency characteristics.](image)

<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order of Distortion</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>3rd</td>
</tr>
<tr>
<td>5th</td>
</tr>
<tr>
<td>7th</td>
</tr>
</tbody>
</table>
is particularly important in connection with distortion caused by iron cores. To demonstrate this, the writer measured the distortion across an iron-cored inductor connected to a generator giving either one or two sinusoidal signals (Fig. 4). First the harmonics of a single 60-c/s signal were measured; then the intermodulation products caused by signals at 60 c/s and 400 c/s in the amplitude ratio 4:1 and having the same combined peak amplitude as the single signal. The results are given in Table 1. Here the intermodulation/harmonic ratio is fractional. The impedance of the coil was varying over the 60 c/s cycle, causing distortion of the waveform at that frequency. But at 400 c/s the impedance of the coil was much higher; consequently the 400 c/s was not modulated in proportion to the 60-c/s distortion.

It must be remembered, too, that if there is a non-linear element somewhere in the middle of the unit being tested, the signal amplitude ratio at the input of that element may differ considerably from the ratio at the input to the unit, and the distortion amplitude ratios at its output may differ considerably from those measured at the output of the unit, as a result of frequency distortion before or after the non-linear element.

Standard Intermodulation Test

Two methods of intermodulation measurement have been sufficiently used and recommended to have achieved some degree of standardization. In the first, sometimes called the S.M.P.E. method, outlined in Fig. 5, the distortion is made to take place at a low frequency \( f_1 \) (say 100 c/s) and non-linearity is estimated by the extent to which a comparatively high frequency signal \( f_2 \) (say 1,000 or 4,000 c/s) of one quarter the voltage (12db down) is modulated by it. The distortion products occur at \( f_2 \pm f_1 \), \( f_2 \pm 2f_1 \), etc. If strictly carried out, the method indicates the total r.m.s. value of all these products, and so is analogous to &quot;total harmonic distortion measurement.&quot; It makes no distinction between products of different order.* And because the kind of non-linearity that generates \( n \)th harmonic also generates intermodulation of the \( n \)th order, it is not surprising if, in general, the unpleasantness increases with the order of intermodulation. There does not yet seem to be any conclusive evidence on the precise relationship, but the S.M.P.E. method is open to the same criticism as unweighted total harmonic measurement. It also possesses other possible causes of discrepancy, such as the characteristics of the output meter.

Following the same line of thought as with harmonics, one naturally inquires about weighting. The claim has been made that intermodulation measurement is self-weighting. This can be investigated with the help of ref. 11. We assume that a signal \( v = V_{cos}f_1 + V_{cos}f_2 \) is applied to an element having a single non-linear term \( kv \) and a level frequency characteristic. Column 2 in Table II shows the ratio of harmonic amplitude to fundamental \( V \). It is interesting to note that this value applies whatever \( v_{cos} \) is the only signal present or not. If next the signal applied is \( v = V_{cos}f_1 + V_{cos}f_2 \), column 3 shows the ratio of the coefficient of the \( n \)th order intermodulation product, \( cos(w_1 - n w_0 t) + cos(w_2 - n w_0 t) \), to \( V \). The intermodulation/harmonic ratio is given in column 4. If \( V \) is identified as \( V_1 \) in the two-signal input, \( V_1/V \) goes out, and the ratios are as in column 5. Compared with the harmonics, the intermodulation products are weighted in direct proportion to their order, \( n \). Since these ratios apply to both sum and difference products, they are multiplied by 2 in the S.M.P.E. method, which combines both.

The relative signal amplitudes just considered do not, however, present a fair comparison. A single signal used for harmonic distortion measurement should, to be comparable, have the same peak value as the double signal used for intermodulation. Column 6 therefore shows the ratios when \( V = V_1 + V_2 \). If, as in the S.M.P.E. method, \( V_1 = 4V \), and the ratios are doubled, the results in column 7 show a weighting that begins feebly in the right direction and then reverses. The values for second and third order distortion agree with those calculated (and checked by experiment) in ref. 11. Distortion confined to the second order can be realized approximately in a single triode without negative feedback, and third-order distortion in a push-pull stage; but the other conditions (distortion of one order only, higher than the third) are artificial. In any case, fourth-order products are inevitably accompanied by much larger second-order products, fifth by third, sixth by fourth and second, and so on, and these alter the ratios tabulated for second and third order, the tendency being to

* An intermodulation product of frequency \( p f_1 \pm q f_2 \), resulting from frequencies \( f_1 \) and \( f_2 \), is said to be of the \( p+q \) order (but some writers refer to it as the \( p+q-1 \) order).

---

**TABLE II**

<table>
<thead>
<tr>
<th>Order of distortion, ( n )</th>
<th>Relative harmonic amplitude</th>
<th>Relative intermod. amplitude</th>
<th>Intermod./ harmonic ratio, ( R )</th>
<th>( R ) when ( V = V_1 )</th>
<th>( R ) when ( V = V_1 + V_2 )</th>
<th>( 2R ) when ( V = 5V_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 kV</td>
<td>2kV_1</td>
<td>2V_1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3.20</td>
</tr>
<tr>
<td>3 kV</td>
<td>3kV_1^2</td>
<td>3V_1^2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3.84</td>
</tr>
<tr>
<td>4 kV</td>
<td>4kV_1^3</td>
<td>4V_1^3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4.08</td>
</tr>
<tr>
<td>5 kV</td>
<td>5kV_1^4</td>
<td>5V_1^4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4.08</td>
</tr>
<tr>
<td>6 kV</td>
<td>6kV_1^5</td>
<td>6V_1^5</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>3.92</td>
</tr>
</tbody>
</table>

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**WIRELESS WORLD, JULY 1955**

www.americanradiohistory.com
equalize the ratios. This is another fact that upsets the self-weighting theory.

Thus each different non-linear transfer characteristic has a different ratio of intermodulation to harmonics, and the ratio depends on whether the distortion products are measured separately or lumped together, but for practical non-linearities and no frequency discrimination it is fair to say that, as regards weighting, total intermodulation measurements show no advantage over harmonics. In fact, it is easy to see from Table II that if one uses signals of equal amplitude \((V_1 = V_2)\) the weighting is the wrong way round!

The S.M.P.E. equipment has therefore been modified in various ways at the indicating end with a view to giving some degree of weighting to the higher-order products. In one variant\(^16\) called the peak-sum method, the indicator measures the peak value of the modulation-frequency output instead of the r.m.s. or the mean-rectified. When only one modulation frequency is present (because the distortion is all second or third order) all three values are of course in fixed proportion to one another, but in all other cases the modulation-frequency output is non-sinusoidal and its peak value is equal to the sum of the peak values of all the separate distortion components—provided that at some phase their peaks all coincide. Even if they always did (and it does not appear that this can be guaranteed) the result does not really amount to weighting, for the increase in reading due to the addition of any distortion component is quite independent of its order.

In another modification\(^12\), named after Le Bel but basically the same as that described much earlier by Bartlett\(^2\), the indicator is a cathode-ray oscilloscope, which displays the modulated high-frequency signal without rectification, on a time base covering one cycle of the low-frequency signal, as in the usual c.r.o. method of measuring depth of modulation\(^13\). When there is no distortion the trace has a rectangular envelope as in Fig. 6(a). Second and third order distortion produce patterns such as (b) and (c) respectively. Le Bel reckons the distortion by adding up the depths of all the “notches,” such as \(A_i\) in the pattern, counting both top and bottom. The sum of all the notch depths—two in (b) and four in (c)—is divided by \(B\) and expressed in per cent. Third-order distortion therefore counts twice as much as second-order distortion causing the same depth of modulation. This seems to contradict a graph given with the original description of the method, connecting the notch-depth percentage with the unweighted S.M.P.E. intermodulation percentage, and stated to apply to amplifiers of all types. It should be noted that notch depth \((A/B)\) is not the same as depth of modulation (which is \(A/(2B-A)\)) except at 100\% at low values it is nearly twice as great, not counting the additional doubling when the bottom notch is included. The weighting is a step in the right direction, but bears no simple relationship to the systems mentioned in connection with harmonics. Unless the c.r. tube is of a precision type and the pattern is carefully measured, the method is not suitable for testing modern low-distortion equipment.

Incidentally, the ratio of between 3 and 4 when measuring total intermodulation with a 4 : 1 signal ratio as in the S.M.P.E. method is sometimes quoted\(^8\) as ground for saying that such measurement is more sensitive than harmonic measurement. But it has been shown\(^11\) that with some kinds of non-linearity the ratio may be as low as 1; and in any case the intermodulation percentage is reckoned with reference to a signal of only one fifth the amplitude that would be used for harmonic measurement, so this supposed advantage is illusory.

**Another Standard Method**

Quite different from the S.M.P.E. method is the C.C.I.F. method\(^2\)\(^3\)\(^4\). The input signals are equal in amplitude and differ in frequency by a constant frequency; it is the single distortion product at this difference frequency that is measured. The great advantage of this method is that distortion can be measured over the whole frequency band. On the other hand, only second-order distortion is measured. So, for example, a well-balanced push-pull amplifier would be made to appear almost distortionless, notwithstanding that it might have severe odd-order distortion, in which case one's ears would flatly contradict the instrument reading. The measuring instrument is preferably a wave analyser, which however need not operate at more than one or two fixed frequencies. Since neither of the two signals is stronger than the other, the frequency at which the distortion is being made to occur is ambiguous.

It is clear that (notwithstanding suggestions to the contrary) no one of all these many methods of measuring non-linearity distortion can be relied upon to give readings in agreement with listening tests, unless some restrictions are placed on the nature of the items tested. For testing iron-core transformers, Williams and Eastop\(^3\)\(^4\) prefer harmonic measurements to intermodulation, because there are fewer variables and...
correlation is as good; for film and disk recording, the S.M.P.E. intermodulation method has become firmly established\(^{18, 15, 21}\); for hearing aids both these methods are regarded as useless and the C.C.I.F. method strongly advocated\(^{19}\).

**Suitability of Methods**

What do we conclude from all this? Surely that the method or methods chosen must be those that experience has shown to agree with aural judgment, over the whole range of equipment to be tested and the whole range of distortion liable to occur in it. Thus, for routine tests of similar units in which the kind of distortion is unlikely to vary and one only wants to check that the amount is tolerable at a specified level, quite a simple total harmonic or intermodulation system may do. If the kind of distortion is liable to vary, then a weighted system would be preferable. An advantage of a total system is that it can be applied where (as sometimes in reproduction from records) the frequency is not constant enough for wave-analyser readings. On the other hand, during development of new equipment, in which every possible kind of distortion must be investigated before final approval—and especially where different kinds of equipment are developed—it is necessary to have apparatus capable of separately measuring all the distortion components under any desired conditions; in other words, at least a generator producing two signals variable over the full frequency range, and a wave analyser. Such equipment is somewhat expensive, but it is proposed to describe in a future issue apparatus capable of a wide range of reasonably accurate measurements and of being constructed at moderate cost.

For investigating distortion at low frequencies, the choice lies between measuring the harmonics of a single signal at that frequency or the modulation by it of a relatively high-frequency low-amplitude signal. As regards the signal generator, the advantage of needing only one signal for harmonics must be considered against the advantage of needing less extremely pure waveform in the two required for modulation. As regards output-measuring equipment, if total unweighted values are required the balance between harmonics and intermodulation is perhaps fairly even. But a weighted total reading is more easily obtained for harmonics. Separate measurement of each order of distortion necessitates a more selective wave analyser for modulation than for harmonics, but the frequency characteristic of the unit under test is less likely to affect the relative amplitudes, and the distortion measured can be at more audible frequencies.

At high frequencies, neither system yields a series of distortion products, corresponding to the different orders, within the a.f. band. But if there is second-order distortion, beating between upper frequencies is audibly objectionable, and this is where the C.C.I.F. method (or something like it) is valuable. In recording and f.m. systems, the amplitude of the high frequencies is increased by pre-emphasis, and any overloading at these frequencies yields distortion products at lower frequencies, which are not reduced by the subsequent de-emphasis so become relatively more prominent.

At medium frequencies no particular method is always the best, and choice depends on circumstances. While the need for versatility and flexibility thus seems to exclude all hope of standardization, there ought not to be a greater variety of test conditions than is really necessary. The writer would like to suggest that, except where special circumstances indicate otherwise, a fixed distortion-product frequency somewhere in the most audible part of the band (say 1,000-2,000 c/s) should be adopted. A fixed frequency simplifies apparatus and operation, and removes one of the biggest sources of disagreement between meter readings and aural appraisal of their widely dissimilar frequency characteristics. Choice of a middle frequency ensures that what is read is actually highly audible distortion, even though it may be generated by tones of relatively low audibility.

For example, suppose the chosen frequency is 1,320 c/s (this rather odd choice was to minimize the risk of spurious responses). Then Table III shows typical (but not necessarily the best possible) input frequencies for measuring the distortion at representative points in the a.f. band. Adoption of the widely used 4:1 amplitude ratio is recommended, because it leads to distortion that is predominantly at the frequency of the stronger signal, and does not discriminate against the higher orders like equal signals.

Although he may in that respect be unfashionable, the writer refrains from making the claim that the scheme he recommends gives complete correlation between measurements and audible distortion, but does suggest that it may be less liable to be "caught out" by particular circumstances than some for which such claims have been made.

Perhaps the most instructive form in which the results of measurements according to such a scheme can be presented is as graphs (one for each strong-signal frequency) showing as separate curves the variation of each distortion product with output power. There is some evidence\(^{14}\) that the point where odd-order intermodulation starts a rapid rise corresponds to the onset of audible distortion. Whether this generalization is valid or not, it is important that any distortion data should bring out two things: (1) Whether the distortion is mainly second or third, and (2) Whether the series converges rapidly (so that products above the third are negligible) or slowly (so that there are appreciable quantities of the higher orders, indicating some sharp curvature in the transfer characteristic).

In equipment in the high fidelity class, products higher than the third ought to be negligible, so particulars of distortion in its specification would normally be much less formidable than Table III might suggest. Along with the assurance that all higher-order modulation is less than 0.7% it should

<table>
<thead>
<tr>
<th>Order of modulation product</th>
<th>Frequency of weak signal</th>
<th>Frequency of strong signal</th>
<th>when measured is:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>65 c/s</td>
<td>800 c/s</td>
<td>3,000 c/s</td>
</tr>
<tr>
<td>1 (fundmtl.)</td>
<td>1,320</td>
<td>1,320</td>
<td>1,320</td>
</tr>
<tr>
<td>2</td>
<td>1,385</td>
<td>2,120</td>
<td>4,320</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(or 10,680)</td>
</tr>
<tr>
<td>3</td>
<td>1,450</td>
<td>2,920</td>
<td>7,320</td>
</tr>
<tr>
<td>4</td>
<td>1,515</td>
<td>3,720</td>
<td>10,320</td>
</tr>
<tr>
<td>5</td>
<td>1,560</td>
<td>4,520</td>
<td>13,320</td>
</tr>
<tr>
<td>6</td>
<td>1,645</td>
<td>5,320</td>
<td>16,320</td>
</tr>
<tr>
<td>7</td>
<td>1,710</td>
<td>6,120</td>
<td>19,320</td>
</tr>
</tbody>
</table>

**Table III**

*WIRELESS WORLD, JULY 1955*
LETTERS TO THE EDITOR

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

Transistor Letter Symbols

FURTHER to D. Nappin’s letter (your May issue) on this subject, the inter-service symbol for a switch has for some years been the letters SW. Recently, however, this has been modified by BS530 (Supplement No. 1 amended) which lists “mandatory designations” and “designations normally used” in Tables 1 and 2 respectively. The latter table lists the letter S for a switch.

I, personally, favour the suggestion put forward by Mr. Thompson (in the same issue). The letter Y is so far not in use in the Tables referred to above, and the similarity to the circuit symbol is a very good argument for its adoption.

Signals Research and Development Establishment.

K. J. NEIGHBOUR.

Since the thermionic tube was given the name of “valve” because it would not permit a reverse flow of electrons, and since a transistor, properly used, has the same characteristic, it seems to have the same claim as the former to the word “valve” and hence to the symbol V. The Americans, of course, have no problem. For them, tubes, with a T, are being replaced by transistors, also with a T. No doubt those amongst us whose valves have “plates” fed from “rails” and control grids apparently made of corrugated iron will follow in this also.

College of Technology, V. MAYES.

Manchester.

F.M. Receiver Design

I AM surprised that M. R. Murray in his contribution on the ratio detector on page 245 of your May, 1955, number made no reference to an article on f.m. reception by D. H. Roddymay in the March, 1948, issue of Wireless World (page 103).

This latter article gives a convincing but simple explanation of the suppression of unwanted amplitude modulation. I am afraid Mr. Murray did not convince me that his unbalanced circuit was capable of the necessary suppression. The statement is made that the a.f. output follows the ratio $V_{c}\cdot V_{s}^{-1}$. This statement is not substantiated nor are its consequences followed up.

I disagree with his statement that with a suitably designed circuit the ratio $V_{c}\cdot V_{s}^{-1}$ follows faithfully the original audio modulation. This is only true when second and higher orders of small quantities are neglected.

Malvern, Wores. F. L. MORRIS.

I FAIL to understand why Messrs. Amos and Johnson should choose the ratio detector for their f.m. receiver. While saving a valve may be of prime importance to a set maker, it should surely not be decisive to the home constructor. It seems illogical to save a valve at the cost of trebling the distortion (on the figures quoted in the article) and feed the output, as most will be doing, into a high-quality amplifier in which no expense has been spared to get the distortion down to the 0.1% level. Or is there some mystic reason why 3% in the detector does not matter, but 3% in the output stage does (perhaps “Cathode Ray” can enlighten us?). Incidentally, what has happened to Thomas Roddymay’s circuit? Does it really work?

Redhill, Surrey. J. K. CARTER.

Proprietorship of Band III

ON May 11 it was announced that the B.B.C. have ordered transmitting equipment to enable them to start a second television programme on wavelengths in Band III.

Declaring my interest in one of the programme contractors companies (Associated-Rediffusion, Ltd.), I wrote


REFERENCES

22 Sturley, Radio Receiver Design, 1st edn., Part 2, p. 82.
LETTERS TO THE EDITOR

A letter to The Times (printed May 13) to protest against any attempt by the B.B.C. to take Band III channels.

It is generally accepted that the five Band I channels which the B.B.C. already use cover an area almost equal to that which the eight Band III channels can cover when Band III is completely cleared for television purposes. On these grounds, the entire Band III will be required to take the I.T.A. programmes to the whole country in a similar manner as all of Band I is required to take the B.B.C. programme to the whole country.

It might, of course, be argued that it would be better to have an entirely new deal and that both Band I and Band III should be shared by the B.B.C. and I.T.A. that may be thought by some that Band I channels should be used for such large integral areas as London, the Midlands and parts of the North of England for both B.B.C. and I.T.A. transmissions and that technically it would be better for Band III channels to be used for the smaller areas.

On this basis a complete re-examination of Band I and Band III allocations may be desirable. However, in view of all the factors considered and specially the dislocation that would be caused to existing television installations on the new system it may be better to leave the B.B.C. with the five Band I channels, in which case the I.T.A. are certainly entitled to all the eight channels in Band III.

It is quite feasible that the B.B.C. and I.T.A. should provide second programmes but surely the proper frequency allocations for such second programmes should come, in the case of the B.B.C., from any spare facilities they may have available in Band I, and similarly, in the case of the I.T.A., any spare channel they may find in Band III. If as is very likely, neither the B.B.C. nor the I.T.A. can find sufficient spare channels in Band I and Band III respectively to provide their respective second programmes over the major part of the United Kingdom, then both the B.B.C. and the I.T.A. must look to Band IV for the additional programme service.

The I.T.A. are having many obstacles put in their way and have to overcome public resistance to the expense of converting sets to Band III reception. The I.T.A. and its programme contractors are quite prepared to meet these obstacles and are fully confident they will overcome them. It is hoped that the B.B.C. will not be frightened of meeting a similar challenge, possibly shared with the I.T.A., in opening up Band IV for second programmes.

Associated-Rediffusion, Ltd. PAUL ADORIAN.

"F.M. Tuning Indicator"

IT SHOULD be pointed out that although the indicator described in the June issue displays ingenious circuitry it passes grid current back through the ratio detector. This is undesirable and places the device out of court.

To align a discriminator it is usual to use a centre-reading valve voltmeter, a simplified version of which is all that is required as a tuning indicator. Using a single valve, sufficiently biased to stop grid current and a meter movement as an indicator, it is very easy to arrange a suitable circuit. Nothing more elaborate is needed.

Hayes, Middx. C. H. BANKS.

The author of "F.M. Tuning Indicator" writes—

I am grateful to Mr. Banks for his comments, although I cannot help feeling he is being a little hasty in so summarily putting the device out of court.

The grid current which flows is quite negligible, being limited by the 2-MΩ resistor R1. In practice, connecting the indicator to a working ratio discriminator circuit causes no measurable change in its characteristic whatsoever, even when the audio take-off point has a positive voltage of some 10 volts or so. The latter state of affairs would, of course, occur only if the associated receiver were badly out of tune.

The simple unbalanced single-valve indicator described by Mr. Banks would only be attractive when high voltage swings were available at the audio take-off point and the error introduced would be proportionately small. This is due to the drift inherent in such a circuit, especially when unregulated power supplies are employed.

J. R. DAVIES.

"As She Is Spoke"

E. L. E. PAWLEY's letter (March issue) on the B.B.C.'s use of terms relating to words and recordings does not explain the meaning of the mysterious announcement often made at the end of a broadcast of music or of a play, namely, the announcement that "the performance was recorded."

In plain English this means that a record (for future reproduction) was made of the performance while it was being broadcast. Is this what the announcement is intended to mean in B.B.C. English? Or is it intended to mean that the performance was not actually a performance at all, but was what the B.B.C. calls "a broadcast from a pre-recording"?

Incidentally, is not the B.B.C.'s use of the term "a broadcast from a pre-recording," and its attempt to distinguish this from the playing of a record, an example of confusion of thought? A "broadcast from a pre-recording" is nothing but the playing of a record. There can be no pre-recording of a performance; there is only a recording or only a record of a past performance. The length of time that elapses between the recording of the past performance and the playing of the record is quite irrelevant to the nature of the broadcast.

It seems that the real distinction that underlies the curious terminological distinction drawn by the B.B.C. is merely the distinction between the playing of a record made by a gramophone company and the playing of a record that they have made themselves.

Osterley, Middx. R. H. NISBET.

"Needles for Talking Machines"

I AM grateful for "Free-Grid's" addendum (June, p. 302) to my article in the May issue. My beard is at present only very slightly flecked with grey and the year 1910 is extremely dim in my memory. It will not therefore be necessary for "Free-Grid" to continue collecting steel gramophone needles for his bed, as my statement on steel needle production at a rate of 6½ million per day in 1911 is indicative of an extremely large production, which obviously could not have grown overnight. And I had always understood that the long-haired grey beards, the cylinder-type machine "died" before the First World War, and I wonder if the Maguire's machine at 3s 6d could not possibly have been a job-lot for the inveterate bargain-hunter.

Apropos of there "being nothing new under the sun," I received a letter containing a sample of pure beryllium from Mr. H. J. Leal, who states that whilst foil 0.005 in thick is available it is impossible to work the material satisfactorily in its present state because of its highly crystalline nature; entirely apart from a prohibitive cost of £3 per square inch. I am concurrently investigating the production of stylus arms from pure beryllium by pressing a powdered aggregate to the final shape and then sintering at a fairly high temperature. This method is being successfully applied to a number of similar materials such as tungsten carbide, ferrites, etc.


CORRECTIONS

In referring to the Solartron square-wave generator, Type G031, on page 276 of the June issue, the output waveform rise and fall times were given in microseconds; they should have been in milli-microseconds.

Miniature Transistor Hearing Aid. The gain of the Multitone "Minuet" described on page 290 of the previous issue is 70db, and not 20db as stated.

WIRELESS WORLD, JULY 1955
Spurious Radiation from Wrotham

A Problem in Co-sited Transmitters

By J. R. BRINKLEY*

A RECENT issue of Wireless World contained an article on yet another radio controversy, namely "to co-site or not to co-site." It described some of the advantages and disadvantages of arranging I.T.A. television stations to be on, or near, existing B.B.C. television sites. As one of a number, and I think quite a large number, who suffer in the fringe of all B.B.C. services, existing and planned, I am indulging in a purely selfish hope that the I.T.A. will pick entirely different sites so that perchance someone else may have my I.T.A. fringe.

It would seem to me that there are some arguments in favour of co-siting stations in the same band, but a rigid policy of co-siting Band I and Band III transmitters would be to co-site these with Band IV and V stations would be ridiculous.

The subject of this article is, however, to draw attention to a somewhat different problem which has arisen as a result of carrying co-siting to the ultimate limit in the B.B.C. v.h.f. station at Wrotham. The high-power transmitters for the Home, Light and Third programmes at Wrotham are not only co-sited but share the same building and mast. Furthermore, all three transmitters are actually fed into the same aerial. The frequency separation between the programmes is approximately 2% of the carrier frequencies employed and since the design of filters to separate the three high-power carriers so closely spaced is necessarily a difficult proposition it is not surprising that interaction between transmitters is in evidence. The design of the aerial used has been described elsewhere. 3, 4

That transmitters which have any mutual coupling and are closely spaced in frequency can combine to produce spurious products is well known. 5 The phenomenon is due to the fact that each transmitter output stage as "seen" by the others is a non-linear device in which the separate carriers mix and produce new and unwanted components. At large transmitting sites, such as the G.P.O. station at Rugby and the B.B.C. station at Daventry where many transmitters operate, the phenomenon is well known. Such non-linearity can also occur on masts and stay wires, especially if these are rusty, and the noise and inter-modulation experienced from this cause when operating several v.h.f. sets simultaneously aboard warships became known as "rusty bolt effect." 6

The coupling taking place at Wrotham is, however, stable and appears to be due to direct coupling between the transmitters. The worst products are, of course, the third-order products which take the well-known forms $2A - B$, etc., and $A + B - C$, etc. The Figure shows the disposition of the third-order products relative to the carriers. The attenuation achieved in the band-stop filters is such that the level of these components is about 65 db below the carrier. This is a high degree of attenuation and eliminates audible cross-talk between transmitters, but unfortunately it still permits a high level of interference radiation. Thus third-order products have been measured at Hampstead (28 miles from Wrotham), Brentford (23 miles from Wrotham) and Danbury (31 miles from Wrotham) and they have been found to have field strengths of the order of 5 microvolts per metre. This will, of course, cause widespread interference to services on the frequencies concerned.

The interference has the curious and sometimes amusing characteristic of carrying the modulation of two or three of the programmes simultaneously. Since the deviations add, the total peak deviation is $\pm 225$ kc/s and the total sideband spread approximately $\pm 300$ kc/s. The overall effect of this is to render much valuable ether space unusable for the services for which it was intended. When it is remembered that multiple transmitter stations similar to Wrotham are planned in the vicinity of all populous centres throughout the country and that higher-order products also occur it will be seen that the matter is one of great importance and that this kind of interference must be eliminated.

In conclusion it must be emphasized that these spurious intermodulation products are unlike the normal harmonic radiation which takes place from high-power transmitters. They are different in three respects. First they occupy much more frequency space. Secondly, since they are close to the wanted carrier they are more difficult to filter. The third and most important difference is that they are completely avoidable. It is only necessary to employ separate aerials suitably spaced to avoid significant mutual coupling virtually to eliminate these troublesome components completely. Whether this can be done on a single mast or whether separate masts will be necessary is a matter for investigation but most assuredly the solution must be established before further stations are commissioned.

REFERENCES

1 "I.T.A. Transmitters" Wireless World, March, 1955, p. 120.

* Pye Telecommunications, Ltd.

![Diagram](image-url)

**Figure 1.** Third-order intermodulation products radiated from Wrotham.

**Wireless World, July 1955**

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THE circuit described in this article was designed primarily for use with the 20-watt high-quality amplifier described in last month's issue of this journal. The pre-amplifier requires a line voltage of 250 V at 3.0 mA and may be used with high-quality amplifiers requiring not more than 200-250 mV input, at high impedance, for full rated output. The circuit employs three Mullard EF86 high-gain low-hum pentodes and offers a maximum pickup sensitivity of 3.5-4 mV for 200 mV output. Provision is made for continuously variable tone control, playback equalization and high- and low-pass filtering.

Performance.—An output of approximately 200 mV from the pre-amplifier will fully load the 20-watt amplifier to its rated output. The total harmonic distortion at 400 c/s on any switch position for 200 mV output is not more than 0.1%. Since the gain control is at the output of the pre-amplifier the overload characteristic is the overall figure for the whole pre-amplifier, and at 20-db overload, i.e., for an output voltage of approximately 2 V, the total harmonic distortion for any switch position is not more than 0.2%.

Intermodulation distortion was measured by the S.M.P.T.E.† method at 40 c/s and 10 kc/s through the combination of the pre-amplifier and the power amplifier, due to the difficulties encountered when making such critical measurements at low levels on the pre-amplifier alone. With the gain control fully advanced and 20 watts equivalent sine-wave power output the intermodulation distortion was not more than 1%. With 20 db overload in the pre-amplifier, and the gain control set for 20 db attenuation in order to produce 20 watts equivalent sine-wave power output, the intermodulation distortion was not more than 3%. The intermodulation of the power amplifier alone at this level was found to be 0.7%. When measurements are made on positions which involve playback equalization it is necessary to weight incoming signals, due to the differing sensitivities at 40 c/s and 10 kc/s, to obtain the correct ratio through the pre-amplifier.

Background noise was measured on all switch positions and input sockets under practical conditions, which are stated in the summary of performance, and is referred to the nominal input sensitivity, since this is the most general way of stating the signal-to-background ratio. Since the gain control is at the output

* Mullard Valve Measurement and Application Laboratory.
† Society of Motion Picture and Television Engineers. See also "Electronic Measurements" by Terman and Pettit (McGraw-Hill).
of the pre-amplifier it follows that the stated signal-to-background ratio will be maintained at all settings of the gain control.

Layout. — Considerable thought has been given to layout, since many difficulties may be encountered when working at such high sensitivity, and the proposed layout was found to be very suitable from all considerations. In general with pre-amplifier circuits it is essential to adhere closely to the suggested layout if the published performance is to be obtained in practice. The components and sections of the pre-amplifier have been arranged in logical sequence as far as is compatible with satisfactory performance.

In order to obtain the required line voltage of 250 V in conjunction with the 20-watt power amplifier, it is necessary to arrange that a 56-kΩ resistor, decoupled by at least 8 µF, is introduced to drop the available voltage (410 V) at the power amplifier.

Input Stage.—Four input sockets are provided, one for radio and equalized tape, two for pickups and one for microphone, the basic sensitivity for each position being arranged by anode-to-grid feedback. The input is selected by switch SA1. The basic sensitivity of the pickup input is employed to make it possible to use pickups of sensitivities 3–6 mV on socket PU1 and suitable attenuation is introduced to facilitate the use of magnetic pickups and good-quality crystal pickups on socket PU2. The crystal pickup must be loaded suitably for output proportional to stylus velocity. By using a large proportion of the full gain of the first stage a microphone input sensitivity of 1.5 mV is obtained. The sensitivity for radio/tape input is basically 30 mV but has been attenuated to 100 mV in the circuit.

V2 and Tone Control.—V2 in Fig. 1 is employed as a convenient method of obtaining sufficient amplification to overcome the loss of the passive tone control which is included in the circuit. At the same time the use of anode-to-grid feedback offers a comparatively low source impedance and therefore has little or no effect on the tone control stage. The resistor R38 in the grid of V2 minimizes interaction between this stage and the input stage.

Underside of chassis showing positions of most of the components.
due to the inherent variation of impedance with anode-to-grid feedback.

The tone control stage was designed specifically to employ potentiometers which follow a logarithmic law, with 10% of maximum resistance at 50% rotation. It will be found convenient in practice to arrange that each potentiometer has a resistance, between slider and the earthy end, of 25 kΩ when the indication knob is at 50% rotation. Provided all the components of the stage are within the stated tolerances the "flat" position should be obtained very close to the 50% rotation position of the bass and treble controls. The curves in Fig. 2 show the tone control characteristics with the filter at Position 3, the "flat" position. The curves include the action of the high-pass filter.

Filters and V3.—When considering the choice of frequencies to be employed for low-pass filtering it was thought that a minimum number should be employed to preserve a certain measure of simplicity, whilst still maintaining a useful choice. Position 3 of switch SB is known as the "flat" position and limits the frequency response above 20 kc/s. Peak amplitude components beyond 20 kc/s are frequently contained in the output of wide-range pickups and may be greater than these below 20 kc/s. These inaudible components can introduce distortion or unnecessary limiting of available output power. Position 2 attenuates frequencies above 10 kc/s and is envisaged as being useful to curtail the effects of high-frequency distortion due to the input signal. Crystal pickups do not extend in frequency response much above 10 kc/s and at present the f.m. transmissions are not in general modulated above 10 kc/s; consequently this position may also be used to advantage under these conditions. Position 1 attenuates frequencies above 5 kc/s and is intended for use with microgroove records but is intended to enhance reproduction of standard shellac records with inherently high-surface noise. By the use of R-C filtering and feedback an attenuation is obtained at these frequencies of not less than 12 db/octave. A high-pass, or rumble, filter has been introduced into this stage to attenuate frequencies below 35 c/s, at a slope of not less than 12 db/octave, in order to obviate the possibility of sub-audio frequencies overlapping the system, and of causing motor rumble.

Output.—The 100-kΩ logarithmic gain control is an integral part of the output stage, since it is part of the feedback arm, and since the output it taken from this point it is of comparatively low impedance. The output of the pre-amplifier, however, should not look into an impedance less than 1 MΩ. It was found, in fact, that a capacitance of 400 pF could be placed across the output, with the gain control fully advanced, with negligible loss of output at 15 kc/s. This means in practice, for instance, 20 ft of co-axial cable of capacitance 20 pF/ft.

Playback Equalization.—Consideration of the utility of providing a number of playback characteristics resulted in a decision to use only one characteristic for microgroove and one for standard records. This departure from conventional design was decided not only from the point of view of a considerable saving in components but also from the fact that the majority of record manufacturers are recording nominally to the R.I.A.A. characteristic for microgroove recordings, and those remaining are sufficiently close to make it possible to compensate for the difference by judicious use of the wide-range tone controls available. The microgroove playback characteristic employed in this circuit is based upon the R.I.A.A. playback curve, but below 1 kc/s is slightly different to the extent of providing closer approach to a mean curve encompassing earlier recording characteristics. The standard playback characteristic is based upon the suggested E.M.I. playback characteristic, but is modified above 1 kc/s to provide additional cut to offset slightly the inherently higher noise level of standard recordings.

Acknowledgment.—The author wishes to express his thanks to Mr. W. A. Ferguson for his assistance in designing the pre-amplifier and for his constructive criticism in the preparation of this article.

REFERENCES

4 "The Pursuit of High Fidelity," booklet by E.M.I., Ltd.
### Resistor List of Component Values

<table>
<thead>
<tr>
<th>Resistor</th>
<th>Value</th>
<th>Tolerance</th>
<th>Power Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>82kΩ</td>
<td>10%</td>
<td>1W</td>
</tr>
<tr>
<td>R2</td>
<td>68kΩ</td>
<td>10%</td>
<td>1W</td>
</tr>
<tr>
<td>R3</td>
<td>680kΩ</td>
<td>10%</td>
<td>1W</td>
</tr>
<tr>
<td>R4</td>
<td>82kΩ</td>
<td>10%</td>
<td>1W</td>
</tr>
<tr>
<td>R5</td>
<td>8.2kΩ</td>
<td>10%</td>
<td>1W</td>
</tr>
<tr>
<td>R6</td>
<td>27kΩ</td>
<td>10%</td>
<td>1W</td>
</tr>
<tr>
<td>R7</td>
<td>82kΩ</td>
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<td>1W</td>
</tr>
<tr>
<td>R8</td>
<td>100kΩ</td>
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<td>1W</td>
</tr>
<tr>
<td>R9</td>
<td>5.6MΩ</td>
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<td>1W</td>
</tr>
<tr>
<td>R10</td>
<td>6.8MΩ</td>
<td>5%</td>
<td>1W</td>
</tr>
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<td>20MΩ</td>
<td>5%</td>
<td>1W</td>
</tr>
<tr>
<td>R12</td>
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<td>1W</td>
</tr>
<tr>
<td>R13</td>
<td>680kΩ</td>
<td>5%</td>
<td>1W</td>
</tr>
<tr>
<td>R14</td>
<td>390kΩ</td>
<td>5%</td>
<td>1W</td>
</tr>
<tr>
<td>R15</td>
<td>680kΩ</td>
<td>5%</td>
<td>1W</td>
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<td>R16</td>
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<td>1W</td>
</tr>
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<td>R17</td>
<td>1.5MΩ</td>
<td>0.25%</td>
<td>1W</td>
</tr>
</tbody>
</table>

* High-stability carbon. † The mains switch may be combined with this potentiometer.

### Capacitor List of Component Values

<table>
<thead>
<tr>
<th>Capacitor</th>
<th>Value</th>
<th>Type</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>820pF</td>
<td>Paper</td>
<td>5%</td>
</tr>
<tr>
<td>C2</td>
<td>470pF</td>
<td>Silver mica</td>
<td>5%</td>
</tr>
<tr>
<td>C3</td>
<td>120pF</td>
<td>Paper</td>
<td>5%</td>
</tr>
<tr>
<td>C4</td>
<td>120pF</td>
<td>Silver mica</td>
<td>5%</td>
</tr>
<tr>
<td>C5</td>
<td>0.1µF</td>
<td>Paper</td>
<td>350 V d.c. wkg.</td>
</tr>
<tr>
<td>C6</td>
<td>50µF</td>
<td>Electrolytic</td>
<td>12 V d.c. wkg.</td>
</tr>
<tr>
<td>C7</td>
<td>0.1µF</td>
<td>Paper</td>
<td>350 V d.c. wkg.</td>
</tr>
<tr>
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<td>Electrolytic</td>
<td>350 V d.c. wkg.</td>
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<td>C9</td>
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<td>Paper</td>
<td>350 V d.c. wkg.</td>
</tr>
<tr>
<td>C10</td>
<td>50µF</td>
<td>Electrolytic</td>
<td>12 V d.c. wkg.</td>
</tr>
<tr>
<td>C11</td>
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<td>Paper</td>
<td>350 V d.c. wkg.</td>
</tr>
<tr>
<td>C12</td>
<td>560pF</td>
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<td>5%</td>
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<tr>
<td>C13</td>
<td>8200pF</td>
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<td>Paper</td>
<td>150 V d.c. wkg.</td>
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### Summary of Performance

- **Sensitivity:** (220 mV output at 1 kc/s).
- **Radio/Tape Input Impedance:** 100 kΩ, 100 mV
- **PU1 LP Input Impedance:** 100 kΩ, 4.0 mV
- **PU1 7B Input Impedance:** 100 kΩ, 5.0 mV
- **PU2 LP Input Impedance:** 100 kΩ, 50 mV
- **PU2 7B Input Impedance:** 100 kΩ, 60 mV
- **Microphone Input Impedance:** 1 MΩ, 1.5 mV

### Distortion
- Total harmonics better than 0.1% on all positions at approximately 200 µV output.
- Total harmonics better than 0.2% on all positions at approximately 2 V output.
- Intermodulation: see text.

### Filters
- Low pass at 5 kc/s, 10 kc/s and 20 kc/s, cut off better than 12 dB/octave.
- High pass at 35 c/s, cut off better than 12 dB/octave.

### Background Noise
- **Radio/Tape input socket loaded with 100 kΩ:** 64 dB.
- **PU1 input socket short-circuited:** (54 dB).
- **PU1 input socket short-circuited (PU2 o/c):** 78 dB.
- **PU2 input socket load with 50 kΩ (PU1 o/c):** 55 dB.
- **PU2 input socket load with 50 kΩ (PU1 o/c):** 56 dB.
- **Microphone input socket short-circuited:** 45 dB.

### Valves
- Mullard EF86 (three).

### Switches
- **SA 2-pole 4-way make-before-break wafer switch.
- **SB 3-pole 3-way make-before-break wafer switch.

### Indicator Lamp
- **6.3 V, 0.04 A.

### Circuit Voltages

<table>
<thead>
<tr>
<th>Component</th>
<th>D.C. Voltage (V)</th>
<th>Meter Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>C9</td>
<td>215</td>
<td>1000 V d.c.</td>
</tr>
<tr>
<td>C10</td>
<td>210</td>
<td>1000 V d.c.</td>
</tr>
<tr>
<td>Anode V3</td>
<td>95</td>
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</tr>
<tr>
<td>Screen grid V3</td>
<td>80</td>
<td>1000 V d.c.</td>
</tr>
<tr>
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<tr>
<td>Anode V2</td>
<td>90</td>
<td>1000 V d.c.</td>
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<tr>
<td>Screen grid V2</td>
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<td>Cathode V2</td>
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<tr>
<td>Screen grid V1</td>
<td>80</td>
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</tr>
<tr>
<td>Cathode V1</td>
<td>2</td>
<td>10 V d.c.</td>
</tr>
</tbody>
</table>

The voltages were measured with a Mode 8 "Amovimeter" (20,000Ω/Volt) with zero input signal.

### Power Supply
- **High tension:** 250 V at 3 mA.
- **Heaters:** centre tapped 6.3 V at 0.6 A.
Further Notes on the

**F.M. TUNER**

*Details of the Oscillator Circuit Layout and Notes on Frequency Stability*

By S. W. AMOS, B.Sc. (Hons.), A.M.I.E.E., and G. G. JOHNSTONE, B.Sc. (Hons.)

Since the publication of the articles on the f.m. tuner in the April and May issues letters received have indicated that further information concerning the layout of the oscillator components may be desirable and the accompanying diagram has been prepared to help constructors. This is an underside view of that part of the chassis immediately surrounding the oscillator coil. It is drawn approximately to scale, and shows that the connecting wires of the capacitors have been cut very short; if this precaution is not taken the inductance of the capacitor wires may cause such a change in effective reactance that the required oscillator frequency and coverage may be unobtainable.

In the prototype f.m. tuner best oscillator stability was obtained with the negative-temperature coefficient capacitor C, enclosed in the screening can of the inductor L, but some layout changes were made in producing the model which was photographed for the May issue and subsequent experience with this model has shown that stability is best with C, underneath the chassis and soldered directly to the anode tag of oscillator valveholder, as shown in the diagram. The anode lead of the capacitor should be cut to approximately the same length before soldering the component in position. In order to accommodate C, at this point it was found convenient to rotate the oscillator coil through 180 degrees from the position shown in the photographs. The accompanying layout diagram illustrates this reorientation.

**Repeat Performance: Mr. Briggs Does it Again**

The seating capacity of the Royal Festival Hall was again unequal to the demand for tickets for G. A. Briggs' second London lecture-demonstration of sound reproduction on May 21st. The programme followed broadly the lines of last year's demonstration (reported in our December, 1954, issue) with the addition of live and recorded choral singing and an excerpt from a tape recording in the Festival Hall of a public concert, played back at exactly the same acoustical level as the original. Drawing on his fund of experience as a loudspeaker manufacturer and a musician, Mr. Briggs once again delighted his audience with a wise and witty commentary.

The accompanying photograph, taken from behind the loudspeakers during Thurston Dart's harpsichord recital, shows (on the extreme right) a section of the Goldsmiths' Choral Union, and about a third of the Festival Hall audience.
Transistor Equivalent Circuits

1.—Introductory Derivation of Valve Circuit

By W. T. COCKING, M.I.E.E.

SUMMARY.—In the series of articles of which this is the first, some equivalent circuits for the triode transistor are developed. In order that this development may be fully understood, the method of finding equivalent circuits is first explained in detail for the familiar thermionic valve. This also establishes the necessary conventions for current and voltage. It is shown that, within the usual limits of straight-line approximation to the valve characteristics, the valve equivalent circuit is valid for static d.c. conditions as well as for a.c.

At the present time, transistor literature is very confusing to the newcomer. The physics of the transistor is extremely difficult; few people have any real understanding of it and, most certainly, no one knows all about it. It may well be years before the internal action of the transistor is as readily understandable as that of the valve.

In the meantime we have to use the transistor and it is fortunate that we can do so without knowing anything about what goes on inside it. As it reaches us from the manufacturer, the transistor is a small object having three wires labelled emitter, base and collector. By making measurements at these wires we can find out all we want to know about the transistor in order to use it. We can apply known voltages and measure the resulting currents. We can then plot families of characteristic curves and we can devise equivalent circuits.

An equivalent circuit is one which behaves in the same way as the real circuit or apparatus as far as it is possible to determine it by external measurement. If an exact equivalent circuit of a transistor could be constructed from an assemblage of ordinary components, then if all these parts were enclosed in a box it would be impossible to distinguish it from a real transistor by any external measurement. We could not tell whether the box contained the equivalent circuit or the real thing.

In practice, it is rarely possible to achieve exact equivalence. Only approximate equivalence can be reached. Usually, the approximation is a good one so long as the voltages and currents at the terminals are kept within certain limits; it may be, too, that it is good only as long as the operating frequency is kept below a certain figure.

Very commonly, the approximate equivalent circuit holds only for alternating voltages and currents and does not hold at all for d.c. operating conditions. It is then strictly called the a.c. approximate equivalent circuit. This is the kind with which we are all familiar in connection with the thermionic valve and it is the sort that is usually derived for the transistor.

This a.c. equivalent circuit is adequate for most practical purposes and it is usually derived directly, without any regard for the d.c. conditions. This at once introduces all sorts of possibilities for the convention to be adopted for the direction of current flow and so on. A great deal of confusion can be avoided by keeping the d.c. conditions firmly in mind the whole time; indeed, there are advantages in deriving first a d.c. equivalent circuit, extending it to cover a.c. and d.c., and only then dropping the d.c. conditions.

This is an unorthodox approach, but one which is very helpful.

The current and voltage convention often causes difficulty in the literature on transistors, because authors do not always make it clear which one they adopt. Another difficulty which confronts the beginner is that transistor circuit theory is usually completely divorced from valve circuit theory. This seems to be a deliberate policy with some writers. They seem to think that the transistor is so different from the valve that its circuit theory must be a distinct subject.

This is, of course, quite contrary to the principles of economical teaching. However different the valve and the transistor may be in their internal form and internal operation, they are not very different from the point of view of basic circuit theory. In fact, the transistor is very nearly equivalent to a valve with internal feedback and, in some cases, a valve circuit can be produced which has precisely the characteristics of the transistor. It seems to the writer, therefore, that the best approach to transistor circuit theory is via valve circuit theory and that it should be treated as merely an extension of the latter.

In these articles, several equivalent circuits for the transistor will be derived and the relations between them demonstrated. This is an essential pre-requisite for discussing transistor circuit theory, but we shall not here go into circuitry at all deeply.

Many people are not very familiar with the methods of deriving equivalent circuits and it is best to start, therefore, by deriving the rather familiar equivalent circuit for the thermionic valve. Because they are accustomed to the valve and to its equivalent circuit,
the method of deriving the latter will be much more easily understood than if the procedure were applied straight away to the transistor.

A typical triode valve circuit is shown in Fig. 1. In the grid circuit there is a generator of alternating voltage $v_g$ and a grid-bias battery $E_{gb}$. The grid potential with respect to the cathode is

$$V_g = v_g - E_{gb} \quad \ldots \quad \ldots \quad (1)$$

The polarity of $v_g$ shown in Fig. 1 refers, of course, to the positive half-cycle in accordance with the usual convention.

In the anode circuit there are a load resistance $R_a$ and an h.t. battery $E_{ht}$. The anode potential with respect to the cathode is

$$V_a = E_{ht} - I_a R_a \quad \ldots \quad \ldots \quad (2)$$

These relations apply to the external circuit of the valve and must also apply to the external circuit of any equivalent circuit which we use to represent the valve.

The relations between $V_{gb}$, $V_a$, and $I_a$ depend upon the valve itself and can be measured for any specimen. We can, for instance, keep $V_{gb}$ at some fixed value and measure the current $I_a$ for a series of values of $V_a$. We can then change $V_{gb}$ to some other value and repeat the measurement. When the results are plotted as a graph, we obtain a family of anode-voltage—anode-current curves, each curve for a different value of grid voltage. It is usual for the curves to represent equal changes of grid voltage.

A typical family of such curves is shown in Fig. 2. In the higher-current regions, the curves approximate closely to equally-spaced parallel straight lines but, in the lower regions, they depart considerably from this. The dotted equally-spaced parallel lines in Fig. 2 thus represent a good approximation to the real valve curves over the limited region where the two nearly coincide.

It is possible to draw such nearly-coincident straight lines anywhere on the graph but, in regions where the real curves are considerably bent, the approximation will be good only within a very small region.

It can be seen from Fig. 2 that, if the values of $V_{gb}$, $V_a$, and $I_a$ are such that the operation is confined to the region where the straight lines approximate the real curves closely, we can assume that the straight lines do represent the valve characteristics with very little error. An approximation of this nature is at the basis of all normal valve equivalent circuits, which is why they are usually said to be valid only for small signals. In the practical use of equivalent circuits this restriction is always implicit, but, in deriving them, we can forget it.

In deriving the equivalent circuit, we can regard the dotted lines of Fig. 2 as representing the characteristics of an ideal valve, and we use only these ideal characteristics. If we examine Fig. 2, it will be clear that one particular line (which may, or may not, actually be drawn) for one particular value of $V_{gb}$ will pass through the origin. This line is the graphical representation of a resistance of value $V_a/I_a = \delta V_a/\delta I_a = r_a$, where $\delta$ means a very small change in the value of the quantity to which it is pre-fixed. Since the lines are all parallel $\delta V_a/\delta I_a = r_a$ is the same for them all, but $V_a/I_a$ is not only different for all other lines but varies for all points along them. The value of $r_a$ corresponds to the normal definition of the a.c. resistance of a valve, and is the a.c. resistance of an ideal valve. The d.c. resistance is constant only for the line passing through the origin and it is then the same as the a.c. resistance.

Now, if we were presented with a device in a sealed box with two accessible terminals and, by applying a series of external voltages to it and measuring the resulting current, we obtained a characteristic like Fig. 3, we should conclude that the box contained a resistance and battery in series. We should say that the resistance had a value $R = \delta V/\delta I$ and that the battery had a voltage equal to the intercept of the characteristic with the zero current axis and acted to

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Fig. 2. Typical triode characteristics are shown by the full-line curves and an idealized approximation to them by the dotted lines.

Fig. 3. Single characteristic similar to any dotted line of Fig. 7, but extended to negative current.

Fig. 4. Circuit giving exactly the characteristic of Fig. 3.

Fig. 5. An ideal diode added to Fig. 4 prevents the negative current of Fig. 3 and gives the circuit a characteristic like a dotted line of Fig. 2.
oppose the applied voltage. We should unhesitatingly adopt the equivalent circuit shown boxed in Fig. 4 with the convention for direction of current and battery polarity shown.

The characteristic of Fig. 3 is, however, identical with any one of the ideal ones of Fig. 2, with the exception that negative current does not occur in the latter. Apart from this, therefore, the representation of Fig. 4 must hold for Fig. 2 as well as for Fig. 3.

We can take care of the discrepancy of there being no negative current by supposing an ideal diode to be in series with R and V', as in Fig. 5. This would represent exactly the ideal characteristics of Fig. 2. The resistance R of Fig. 5 is clearly equivalent to the a.c. resistance r_a of the ideal valve and the battery voltage V' governs the position of a line.

For V_a = 0, this battery voltage is clearly V'_a (Fig. 2) the intercept of the zero grid-volts line with the zero-current axis. For any other grid voltage, it has a value dependent on the grid voltage. The amplification factor of a valve is normally defined as

\[ \mu = -\frac{\delta V_a}{\delta V_g} \]

for constant anode current. The quantity \( \delta V_a \) is the change of anode voltage needed to maintain the anode current unchanged when the grid voltage is altered by the amount \( \delta V_g \). In spite of the minus sign, \( \mu \) is a positive number for, if \( \delta V_a \) is itself positive \( \delta V_g \) is necessarily negative and vice versa.

With the ideal characteristics shown in Fig. 2, it is clear from the geometry that the spacing of the intercepts on the V_a-axis of the lines for various values of V', is \( \mu \) times their spacing in terms of V_a. It follows that the value of V' for any line is

\[ V' = V_a - \mu V_g \]

The minus sign is required because a positive value of V_g reduces the value of the equivalent battery, while a negative value increases it.

**Complete Equivalent Circuit**

The equivalent circuit of the valve with its load resistance R_a and h.t. supply E_{hT} thus takes the form shown in Fig. 6. It is an exact equivalent of Fig. 1 if the valve used in Fig. 1 has the ideal characteristics of the dotted lines in Fig. 2. If one could have such a valve, it would not be possible to distinguish Figs. 1 and 6 by any measurements on these circuits.

With a practical valve, the equivalence is valid only in so far as the approximation of the dotted straight lines to the real valve curves is a good one. The equivalent circuit is thus useful only when V_g, V_a and I_a are restricted to values for which the approximation is good. This usually means that the anode current must not be too small. If we restrict the use of the circuit to these conditions, the anode current will always be positive and so the diode in Fig 6 is unnecessary. This was only put in to prevent negative current from flowing with an unrestricted range for V_a and V_g and, with a restricted range, it is no longer required.

We can, therefore, redraw Fig 6 as Fig 7. Here we have, as well as omitting the diode, replaced V_g by \( v_g - E_{UB} \) in accordance with equation (1). The valve is thus equivalent to \( r_a \) in series with the offsetting voltage \( V'_a \) of Fig. 2, a voltage \( \mu E_{OB} \) and a generator \( \mu v_g \) which represent in the anode circuit the effect of \( E_{OB} \) and \( v_g \) of Fig. 1 in the grid circuit.

The total voltage acting around the circuit of Fig. 7 is

\[ E_{hT} = \mu v_g - \mu E_{OB} - V'_a \]

The symbols here all represent the magnitudes only of the voltages when the polarities are as indicated in the figures.

The equation for current is thus

\[ I_a = \frac{E_{hT} - \mu E_{OB} - V'_a + \mu v_g}{R_a + r_a} \]  \[ \ldots (3) \]

and V_a is given by equation (2).

The voltage is made up of two components, \( \mu v_g \), an alternating voltage, and \( E_{hT} - \mu E_{OB} - V'_a \), a steady voltage. As the circuit is a linear one, within the limits of our approximation, we can similarly express the current \( I_a \) as the sum of an alternating current \( I_{am} \) and a direct current \( I_{am} \) and we can separate the a.c. and d.c. components of equation (3) and so get

\[ I_a = \frac{\mu v_g}{R_a + r_a} \]  \[ \ldots (4) \]

and

\[ I_{am} = \frac{E_{hT} - \mu E_{OB} - V'_a}{R_a + r_a} \]  \[ \ldots (5) \]

We can do the same thing for equation (2) and re-
ward \( V_a \) as the sum of an alternating component \( v_a \) and a steady component \( V_{an} \). This gives

\[
v_a = -\nu F R_a \quad \cdots \quad \cdots \quad (6)
\]

and

\[
V_a = E_{HT} - (E_{HT} - \mu E_{OB} - V_{a}) R_a \quad \cdots \quad (7)
\]

Equations (5) and (7) are the d.c. ones and apply to Fig. 7 if the generator \( \mu v_a \) is absent. Equations (4) and (6) are the a.c. ones and apply to Fig. 7 if all the batteries are removed, leaving \( \mu v_a \) only. The a.c. equivalent circuit thus takes the form shown in Fig. 8(a) and is the one with which we are all familiar. Some people prefer to draw it in the modified form of Fig. 8(b) in order to show \( v_a \) itself, but this form means exactly the same thing.

In Fig. 8, the restriction on the direction of current flow has disappeared. Current flows in both directions, on alternate half-cycles. This is because it now represents only the a.c. condition and it is implicit in the derivation that the peak value of current shall not exceed the mean direct current in Fig. 7, otherwise a reversal of current in Fig. 7 would be required and this cannot be allowed. To put it another way, in Fig. 7 \( I_a \) must always be less than \( I_{an} \) and usually a good deal less for the approximation behind the whole equivalence to be reasonably good.

Exactly the same form of representation is valid for a pentode valve. The full-line curves of Fig. 9 are typical of a pentode and the dotted lines indicate an ideal approximation to them. The voltage \( V'_{a} \), which settles the position of the zero grid-volts line is very large and negative for a pentode, whereas it is small and positive for a triode. The battery \( V_{a} \) in Fig. 7 thus reverses its polarity with a pentode.

If one wishes to determine \( V'_{a} \) from a graphical construction it is awkward to do so directly with a pentode, because \( V'_{a} \) is so large. It is much easier to determine it indirectly from the value of \( r_a \) and the current \( I_{a} \), at which the ideal zero grid-volts line cuts the current axis, and compute it from \( V'_{a} = -I_{a} r_{a} \).

It will probably surprise many that it is possible to represent the d.c. conditions of the valve by an equivalent circuit in this way. The equivalent circuit is valid and precise only in so far as the ideal straight lines approximate to the real valve characteristics and the anode current must never be permitted to become negative.

Some people object to the a.c. representation of Fig. 8 on the grounds that it depicts the valve as having an internal source of e.m.f. and the real valve has not. These people will presumably object even more to Fig. 7, which shows not only an a.c. generator but batteries within the equivalent valve.

The real justification for Fig. 7 is this. The equivalent circuit comprises an assembly of real practical elements. It would be possible to assemble it from real components. If one did so and boxed it up, as it is shown boxed in Fig. 7, it would not be possible to distinguish its contents from a real valve by any external measurements as long as the resulting voltages and currents were kept within the limits necessary for the validity of the representation. If they were allowed to stray outside those limits, of course, it would be easy enough to distinguish between them.

In practice, it is the a.c. equivalent circuit that is nearly always the one to be used. There are occasions, however, when the d.c. circuit is useful. Provided one keeps within the linear range, it is helpful in d.c. amplifier design and in some time-base circuits, where a capacitor is charged through a valve.

By means of Norton's theorem, the a.c. equivalent circuit of Fig. 8 can be changed to the form of Fig. 10, in which a constant-current generator \( \mu v_a \) replaces the constant-voltage generator \( \mu E_{OB} \). Here \( \mu_{m} \) is the mutual conductance and equals \( \mu r_a \). This is a very common and convenient form of circuit, especially for pentode valves, for which \( r_a \) is usually very high in value.

(To be continued)

**CLUB NEWS**

**Barnsley.**—The use of mobile equipment will be discussed by T. Foster (G3GAFH) at the meeting of the Barnsley and District Amateur Radio Club at 7.0 on July 22nd at the King George Hotel, Peal Street, Barnsley. Sec.: P. Carbutt (G2AVF), 33, Woodstock Road, Barnsley, Yorks.

**Birmingham.**—J. Missen, of the G.E.C. Research Laboratory, will be speaking about transistors to members of the Midland Amateur Radio Society at their July meeting. Visitors are welcome to the Club's meetings which are held at 7.15 p.m. on the third Tuesday of the month at the Birmingham and Midland Institute, Paradise Street, Birmingham. Sec.: D. Hall, 144, Hill Village Road, Sutton Coldfield.

**Chelmsford.**—"Test Gear for Amateur Television" is the title of the lecture to be given by R. Martyr at the next meeting of the Chelmsford group of the British Amateur Television Club. It will be held on July 14th at 10, Baddow Place Avenue, Grt. Baddow, Essex. Sec.: D. W. Wheele, 4, Bishop Road, Chelmsford, Essex.

**Downham (Kent).**—The Ravensbourne Amateur Radio Club (G3HEV) meets on Wednesdays at 8.0 in the Science Room, Durham Hill School, Downham. Courses are run in preparation for the Radio Amateurs' Examination under the club instructor, G. V. Haylock (G2DHV). Sec.: J. Wilshaw, 4, Station Road, Bromley, Kent.

**QRP Contest.**—The QRP Society is holding a portable amateur radio equipment contest (open to non-members) which is to be judged in four classes—hand and mobile communications gear, transmitter sets and test gear. Rules for the contest, entries for which must be received by September 30th, and information regarding the Society are obtainable from the secretary, John Whitehead, 92, Rydens Avenue, Walton-on-Thames, Surrey.
Compact Tape Recorder

MANY INGENIOUS FEATURES IN THE NEW PHILIPS "RECORDERGRAM"

OPERATING with a fixed tape speed of 3\(\frac{1}{2}\) in/sec the Philips Type AG8105 tape recorder gives a total of 1 hour's playing time from the two tracks of a 600ft (5 inch) reel of standard tape. It conforms to the B.S. convention of left-to-right motion of the tape, using the top track with the active side away from the observer.

For a complete recording machine it is remarkably compact 13\(\frac{1}{2}\)-in x 7\(\frac{1}{2}\)-in x 10in) and weighs only 21 lb. It bristles with ingenious ideas and one of the most obvious is the centralized control knob giving a choice of seven functions. For fast running—either forward or in reverse—the knob is depressed through a safety gate; the other functions are selected by rotation, with a subsidiary check to prevent accidental erasure when passing from the playback to the recording positions.

If desired the internal amplifier can be used for reproducing gramophone records. Another very convenient feature is that when tapes are being played back, a voltage output appears at the pickup terminals and can be applied to an external amplifier and loudspeaker system of greater power-handling capacity.

The internal loudspeaker continues to function as a monitor. There are only two valves in the main amplifier, a double triode and an output pentode. There is also a cathode-ray level indicator and, of course, a power rectifier. Although the available voltage amplification appears to be less than normal it should be borne in mind that the coercivity and saturation levels of modern tapes are high, and that by accepting a moderate power output, sufficient for the small internal loudspeaker, a perfectly satisfactory performance is obtained without danger of overloading the tape.

The loudspeaker incidentally is fitted with a ceramic ("Magnadur") magnet.

Tape Mechanism.—A dynamically-balanced high-speed induction motor drives a large flywheel through
an intermediate friction wheel, which is disengaged in the "off" position through a link mechanism from the central control knob. The supply and take-up spool spindles are driven at constant speed by a round spring belt from a groove in the flywheel. On each spindle are mounted a pair of concentric discs, carrying felt pads in their upper surfaces. The discs are connected by a flexible diaphragm, rather like a loudspeaker dustproof centring device, which permits relative vertical movement between the planes of the felt pads. Resting on one or other of these pads is the spool turntable which is provided with a bronze-bushed polythene centre boss and is free to rotate on the spindle.

When the control is set for recording or playback the inner, small-diameter pads are highest and engage the underside of the polythene centre boss, giving just sufficient friction (in opposite directions), to take up

the slack in the tape without imposing too much load on the capstan drive. There is always some slip between the turntables and their spindles. When the control is depressed for fast forward wind or for re-wind, one or other of the centre felt rings is retracted, allowing the outer felt pads to engage the turntable on a much larger diameter, giving a more positive drive with slip only during the speeding-up process.

The tape gate is a hinged die casting which carries the pinch roller, pressure pads and a segment of high-permeability alloy which closes behind the tape and completely screens the record/playback head except for the two narrow slots to pass the tape.

To prevent trouble from "sticky" tapes, a deflector is mounted close to the capstan on the exit side.

Circuit.—When used for recording from a gramophone pickup or microphone the two triode stages provide the few milliwatts of audio power required by the recording head. Feedback is applied through a frequency-dependent R-C circuit to give a relative rise at low frequencies. In the microphone position of the control switch, the cathode resistor of the first stage is shunted to reduce feedback and increase gain. The output pentode is used as bias oscillator in a Colpitts circuit, with the erase head itself as the frequency-determining inductance and the output transformer primary as the parallel feed impedance. A resistor of a few ohms is inserted at the earthy junction of the tuning capacitors and the filament of the tuning indicator is connected across it. Thus the level indicator also shows that bias and erase current is being generated.

On playback the head is tuned by a parallel capacitor to a frequency of 6 kc/s to give top lift. The bass lift feedback circuit used for recording stays in circuit for playback to give overall compensation for the 6-db/octave slope inherent in magnetic recording.

Performance.—Although the nominal frequency range is only 350 c/s to 6 kc/s, two recordings give the impression of a much wider response, and a test confirmed that the full compass of the piano can be recorded without any noticeably wooden tone in the treble and with a full

—William D. H.
round tone at three octaves below middle C where "the book" says the fundamental should be 33 c/s!

The piano is one of the severest tests that can be applied for wow and flutter, and one must not expect the performance in this respect to achieve the standard of studio equipment costing hundreds of pounds. In the machine tested there was a flutter at higher than capstan speed and some tape whistle, which we understand has now been remedied by a modification to the pressure pad. Neither of these faults was sufficient to detract from the value of the recorder as a medium of musical self-criticism.

Of the hundred and one uses to which this machine will be put it is safe to say that ninety-nine will prove entirely satisfactory. Speech quality is very good and some excellent records of bird song were included in the many samples taken of familiar sounds.

The expected difficulties arising from the small number of valves did not materialize. All one had to do was to work in the top third of the level control range rather than in the middle to avoid bringing up the hum level; there were fewer spoilt recordings due to overloading the tape during the initial stages of learning to handle the controls.

No trouble was experienced with the tape transport system, and a special word of praise is due to the fast winding mechanism and the sweet action of the turntable brakes, which combine to make the finding of any given part of the tape a much less frustrating operation than in the majority of tape mechanisms.

At £36 15s the "Recordergram" is excellent value for money, and the makers, Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2, are to be congratulated on the ingenuity of their response to a growing popular demand.

**TRANSISTOR RESTORATION**

**Re-forming a Damaged OC51**

During a series of experiments with an OC51 point transistor in a simple frequency-changer stage excessive current was allowed to flow due to the inadvertent reduction to zero of the variable resistance in the emitter circuit. This resulted in the transistor being damaged to such an extent that, when inserted in a simple detector stage, it refused to function and no collector current was taken.

Subsequent tests showed that the transistor, when in the same circuit with the supply disconnected, operated as a crystal detector. This, coupled with the fact that, when a meter and 1.5-volt battery were connected between the emitter and collector, an open-circuit was shown, led to the conclusion that the transistor was operating as a double diode. So, on the basis of nothing ventured nothing gained, an attempt at re-forming the collector was made.

The methods of forming home-made transistors were studied and the damaged transistor subjected to the recommended "shock treatment," consisting of discharging a 0.1 µF capacitor between the collector and base connections. The first discharge was from a capacitor charged at approximately 200 volts and the transistor was then inserted into a simple receiver circuit incorporating a meter in the collector supply. On connecting the supply, the meter was observed to flicker, thereby proving that the treatment was having effect.

The transistor was then subjected to further shocks, at the same voltage. Between each discharge it was replaced in the receiver circuit and the collector current observed to rise slowly. When the current was still below that normally drawn by a good transistor and further rise unobtainable, the voltage was increased to 250 volts and the procedure repeated. After approximately four such discharges the current approached that of a good transistor and it was decided to test the transistor's operation by connecting the aerial to the receiver circuit employed to measure the current during the re-forming operations.

It was found that the re-formed transistor now operated quite well as a detector on the medium wave band and reaction could be obtained. When the voltage was increased to that normally employed before the damage and reaction applied, the transistor oscillated violently and the collector current rose rapidly, but on decreasing the reaction normal operation was possible.

The next test was in an amplifier stage and the transistor performed quite normally with no tendency to oscillate. Operation in an r.f. stage was tried next, but with poor results, due to violent oscillation, which appeared to be caused by the fact that the value of emitter bias was now critical and the transistor a little unstable.

It appears that the transistor is now operating on a slightly different characteristic to normal, but as the re-forming of the collector has been successful, this, for certain applications, need not be discouraging.

R. T.
Valve Curve Diagrams

Last month, in discussing cathode followers, I made use of certain valve curve diagrams. It has occurred to me that there may have been readers who quickly shied off at that stage, or, seeing the diagrams in advance, were non-starters. Others, though less easily deterred, may through unfamiliarity have found them somewhat baffling, notwithstanding the clues I scattered as freely as space permitted.

The first thing that has to be explained, perhaps, is why it is considered necessary to use up a lot of paper and drawing effort in this way instead of dealing with valve problems in a neat equation or two. The reason is that valves do not behave in ways that can be represented accurately by neat equations. They are not like resistors and capacitors and air-core inductors. Oh, I know there is such a thing as an "equivalent generator" by which certain valve calculations can be reduced to simple algebra, but (a) that method takes account only of signal currents and voltages, so is no use at all for finding the best working conditions, such as grid bias voltage, and (b) it doesn't even deal with the signal part accurately, because it ignores the curvature or non-linearity of valves. In any case, certain types of mind are more brightly illuminated by a graphical diagram than by a row of equations.

In equations, quantities such as voltage and current are represented by letters or numbers (depending on whether their values are being dealt with in general or particular). On diagrams they are represented by distances on the paper. I am assuming it is well known how two such quantities are represented by distances respectively horizontal and vertical. Even tired business men understand this, when the two quantities are such things as time and commission on sales. But while we may all understand how it applies to voltage and current (for example, anode current and grid voltage), what may not be quite so clear is how resistance, conductance and power can also be represented on the same diagram, or how several different voltages in a circuit can be shown.

If one were to repeat Ohm's original experiment, plotting the current passing through a piece of wire, against the voltage between its ends, the resulting graph would be the kind of thing shown as Fig. 1—a straight line passing through the "origin" (0). Of course Ohm himself knew nothing about volts and amps, but we might as well make use of our modern units.) The information conveyed by this line could be presented with much less effort as an equation: $V = 3I$. Except for the number, the equation would be the same for different pieces of wire; a shorter length of the same wire would give a smaller number than 3, and vice versa. If "$V$" is being used to denote the potential difference in volts, and "$I$" the current in amps, the number is the resistance in ohms. The smaller the resistance, the steeper the line in the graph. If that fact is not obvious, try one or two different lines, and consider why the slope of the line is connected with the resistance in this way. The reason, of course, is that resistance in ohms can also be regarded as volts per amp. So the resistance represented by a line on a current/voltage graph is equal to the number of volts it slopes along the voltage scale for each amp up the current scale. In other words, resistance is the ratio of voltage to current, and on a graph the slope or gradient of a line is the ratio of vertical movement to horizontal movement or in this case current to voltage.

The easiest figures for finding the resistance in this example are 3 volts and 1 amp, but because the line is straight—representing a linear resistance—the differences in volts and amps between any two points on the line would do. If the resistance were not linear, the slope of the line, and the resistance, would vary with current (or voltage).

So not only the value of a resistance but also whether or not it is linear, is clearly shown on a current/voltage graph.

And because conductance is the ratio of current to voltage, it is shown too; the steeper the slope the greater the conductance. The mutual conductance of valves is, in fact, often called slope.

Representing Power

How about power? It is current multiplied by voltage. Horizontal distance multiplied by vertical distance gives the area enclosed by the vertical and horizontal lines at each end. For example, the power released in our wire when 1 amp flows through it (i.e., 3 watts) is represented by the shaded area. With a shorter piece of wire, only 1 volt might be needed to

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pass 1 amp, and the corresponding area would be one-third the size, representing \(1 \times 1 = 1\) watt. Equal powers in different resistances are represented by equal areas of different shapes.

Incidentally, if the voltage in Fig. 1 were doubled, from 3 to 6, the area would obviously be four times as big. The diagram helps the weaker brethren to visualize the fact that (with a linear resistance) the power dissipated is proportional to the square of the voltage (or current).

Our Fig. 1 line represents a certain resistance or conductance, but does not by itself reveal the actual current flowing in it. That depends on the voltage, which we do not know. It might be anything. What the line does show is that if 3 volts were applied the current would be 1 amp. Suppose we don't know the voltage applied to this 3-ohm resistance, but we do know the total voltage applied to it and another known resistance in series. With linear resistances it is a simple exercise in Ohm's law to calculate the voltage across each resistance and the current through both. With non-linear resistances, to which Ohm's law doesn't apply, we would probably be stuck—if we didn't have the graphical method to fall back on. But before taking a non-linear example, let us first try a linear one, which we can check by calculation.

**Two Resistances**

Suppose 8V is applied to our 3Ω in series with 10Ω. We know that the resulting state of affairs must be represented by a point somewhere on the resistance line in Fig. 1. It must also simultaneously be on a line representing the 10Ω. If we were to draw a 10Ω line through 0, that would be the only point common to both lines, and of course it would not represent the situation at all. The clue is the fact that the voltage applied to the 3Ω is 8V minus whatever is dropped in the 10Ω. The voltage dropped in the 10Ω is, then, from the point of view of the 30, a negative one, beginning at 8V. So we draw the 10Ω line as shown dotted in Fig. 2. To emphasize that there is nothing wrong about putting the zero-current point at 8V, I have added a second voltage scale to apply to this resistance. The dotted line shows on this scale the voltage to be deducted from 8V to give the voltage across the rest of the circuit, whatever the current.

The point \(p\), where the two lines cross, is the only one common to both, and indicates that the current through both must be 0.615A, the voltage across the 3Ω must be 1.85, and across the 10Ω, 6.15. Having checked this by calculation, we can have some faith in the graphical method and go on to apply it to situations where calculation fails.

But before we do that, let us see how Fig. 2 can be used to answer different kinds of questions. If we knew the value of the current but not \(R_2\), it could tell us what \(R_2\) would have to be. Try it for \(R_2 = 3\) and \(I = 0.5\). In this case the point on the \(R_2\) line is fixed by the fact that \(I = 0.5\), so what we have to do is lower the slope of the \(R_2\) line to make it pass through that point and then find what resistance it represents.

Or suppose we are told to find the value of \(R_2\) that results in 2 watts being dissipated in \(R_2\). That means...
drawing a constant-power line. A power of 2W can be made up of 2V, 1A, or 4V, 0.5A, or 5V, 0.4A, or 8V, 0.25A, and any number of such combinations. The 2-W line can be obtained by plotting a few of them and drawing the smoothest curve through the points, as in Fig. 3. This fixes a point on $R_\text{L}$, through which the $R_\text{L}$ line can be drawn to the applied voltage mark on the voltage scale as before, and the value of $R_\text{L}$ follows. Alternatively, if $R_\text{L}$ is known, a line of the corresponding slope is drawn through the $R_\text{L}$-P intersection, and where it crosses the $I=0$ axis it indicates the total voltage that has to be used.

A rather more difficult problem would be: Given $R_\text{L}$, and the total voltage, find the value of $R_\text{L}$, in which maximum power is developed. One way of doing this is to draw several different power curves for $R_\text{L}$. This means that they have to be drawn with reference to the "volts across $R_\text{L}$" scale, as in Fig. 4. The point on the $R_\text{L}$ line corresponding to the highest power is $q$, somewhere between 5 and 6 watts (actually 5 1/2), and if the diagram has been drawn well enough it will tell us that $R_\text{L}$ for this condition is 3Ω. As we probably knew all the time, it would invariably be equal to $R_\text{L}$, whatever that was, because a well-known and important circuit theorem says so (the Maximum Power or Load Matching theorem).

**Diode Characteristic**

I should think that's about enough for linear resistances, for all the problems so far (except possibly the last) can be solved more easily and neatly without graphs. A diode valve is a simple example of non-linear resistance. As Fig. 5 shows, regarded as a resistor it has several features not according to Ohm. First, a negative voltage does not cause a negative current; i.e., one in the opposite direction to that which flows with a positive voltage. (This is not strictly true, but one has to have a very super-sensitive micro-ammeter to discover it.) On the contrary, the current when the negative voltage is small is positive. Next, the slope of the line (which is visually, as well as mathematically, a curve) increases as the voltage increases positively, which means that the resistance decreases. Near zero it decreases very rapidly from infinity, but at higher voltages than shown here it is practically linear and therefore constant. This is where the beginner may get confused. The ordinary "d.c." way of reckoning resistance is the ratio of applied voltage to current flowing. At point $a$, the voltage is 2.8 and the current 3mA, so the resistance is $2.8/0.003 = 930\Omega$. This resistance is equal to that represented by a straight line joining $a$ to $0$. It is not equal to the resistance represented by the slope of the valve curve at $a$. This slope resistance is sometimes called the a.c. resistance, being the resistance to small alternating currents superimposed on the steady 3mA at $a$. The reason they are supposed to be small is that the bit of curve involved by them should then be as near straight as makes no matter. Both these kinds of resistance are significant; the d.c. kind when considering the "working point" of a valve (anode voltage, bias, and so forth), and the a.c. kind when considering signals being handled by it. At $a$ there is not a great deal of difference between them, but at $b$ the d.c. resistance is zero, whereas the a.c. resistance is far greater than at $a$.

A diode is normally used as a rectifier, and rectifiers are always more difficult than you think, so despite the apparent simplicity of the diode I am going to hurry past it to the triode. The anode current in a triode depends simultaneously on two voltages—anode and grid—and so really needs a three-dimensional diagram, for the making of which one would have to employ a sculptor, and the Editor would object to the expense. So, although a triode's current/voltage characteristic is really a 3D surface, for economy and convenience it is usual to make do with a series of cross-sections of this surface in two dimensions. Which two depends on what one wants to show most clearly. Sometimes they are anode current ($I_a$) and grid voltage ($V_g$), at a number of evenly-spaced values of anode voltage ($V_a$); and sometimes $I_a$ and $V_a$ at values of $V_g$. The latter (Fig. 6) are the more generally useful.

**Forbidden Areas**

The shape of the $I_a/V_a$ curves is very like the diode one. The effect of making the grid negative is, roughly, to push the curve bodily along to the right. What the effect of making the grid positive is, one does not usually bother to find out for ordinary receiving valves, because grid current flows and greatly complicates the.
situation, as well as spoiling the valve for most of its uses. So the whole of the area to the left of the "\(V_a = 0\)" curve is reckoned as out of bounds. In fact, as Fig. 5 shows (for the grid and cathode of a triode together equal a diode) the forbidden area may have to extend to \(V_a = -1V\), or even a little farther, to make sure that no appreciable grid current flows.

Next, again assuming that distortionless amplification is wanted, it is advisable to fence off the sharply curved part at the foot of the diagram, marked "Bottom Bend Area." The remaining parts of the curves are not dead straight, but are tolerably so, and can be made much straighter by negative feedback, as we saw last month.

The ceiling is imposed by the valve makers' "maximum anode dissipation"—the maximum power, \(V_a \times I_a\), that it is safe to inflict on the anode. Suppose in this case it is 6 watts. Then we draw a 6W curve on the diagram as shown, to rule off what can be called the Overheating Area.

Lastly, the valve maker usually specifies a maximum anode supply voltage (\(V_a (\text{max})\)). This must not be confused with the maximum anode working voltage (\(V_a (\text{max})\)) which is the voltage between anode and cathode when no signal is coming through, or the average when it is. When there is a resistance coupling, this anode voltage is less than the supply voltage—by the amount dropped in the resistance. But it is a voltage that is liable to get at the anode occasionally, as signal peaks or while the cathode is heating up. A vertical line should be drawn at this voltage (say 400 for example) to close up the remaining gap in the boundary.

Power into the Load

We now have a clearly defined area in which to play. But we should remember that there may be a section of it on the right that is only allowed for transient occupation—not for lingering in. That is, if there is a \(V_{a (\text{max})}\) lower than the \(V_a (\text{max})\). On the other hand, momentary trespassing across the "overheating" boundary is permitted, so long as the working point itself is not outside.

If we were aiming at the maximum power output from this valve we would put the working point actually on the 6W boundary at \(V_a (\text{max})\), which (let us say) is 250V. And if the load were to be a resistance, fed from the maximum supply voltage (400) it would be represented by the sloping line through O and 400V/0mA, as in Fig. 7. From its slope we find it is 6,250Ω. We note that the working point is on the "\(V_a = -15\)" curve, so that is the bias. And if we allow the signal input to swing the grid right up to 0 and down to −30, the load line shows that the corresponding \(V_a\) swing is between 140 and 350 (−210 peak-to-peak) and \(I_a\) is 41.6 and 8 (−33.6 peak-to-peak). The voltage amplification is therefore 210/30 = 7. The power output (into the resistance) is equal to the r.m.s. signal voltage multiplied by the r.m.s. signal current, and since an r.m.s. value is \(\sqrt{2}\) times a peak value, which was not so high as the overheat peak value, this power is equal to peak-to-peak \(V_a \times I_a\) divided twice by \(\sqrt{2}\), that is to say by 8. So it is \((210 \times 0.0336)/\sqrt{2} = 0.88W\).

Voltage Amplification Line

From a practical point of view all this is rather absurd. Is it voltage amplification or power output we are trying to get? We have adopted a usual method for voltage amplification—a resistance coupling—but the valve is clearly unsuitable for this and is intended for power amplification. However, what we gained by the output for just now is a quick understanding of graphical technique for valves, and I hope I haven’t confused you by explaining two things at once. The procedure just described, if applied to a suitable high-mu valve, is correct for voltage amplification. One would not actually bother about a maximum power curve, however; the aim would be to slope the line as little as possible, even perhaps into the bottom-bend area, so that the resistance was not so high as to be too much by stray capacitance at the top signal frequency. The working point would be fixed where it gave equal positive and negative grid swings within reasonable limits of distortion.

For a power amplifier, on the other hand, one wants to get the power out into some external load, such as a loudspeaker, not waste it all in a resistance coupling. The coupling is done by a transformer, which has very little—perhaps negligible—d.c. resistance, but considerable signal-frequency resistance. The usual procedure would be to place the working point as already done in Fig. 7, and then draw from it to the voltage scale a line representing the d.c. resistance of the transformer or choke coupling. Being such a low resistance, the line would be almost vertical, and the resulting \(V_a (\text{ind})\) indicated by where it cuts the \(V_a\) scale would be only slightly more than the working \(V_a\).

The a.c. load line need not touch the \(V_a\) scale at any particular point such as \(V_a (\text{ind})\); it should be swung round O as a pivot until it indicates the maximum output. The output power is represented by one-eighth of the area of the rectangle of which the load line is a diagonal. If the load line slopes too little, this rectangle is too flat to have much area; if the line slopes too steeply the rectangle is too narrow. The length of the load line diagonal must be equal in both directions from its pivot at O, and must not go beyond the grid-current or bottom-bend boundaries. The 6,250Ω line in Fig. 7 is unlikely to give the largest area because an input signal limited at its positive peak by grid current leaves quite a lot of useful space between its negative peak and the bend boundary. A more promising line would be steeper, indicating a lower load resistance; drawn, in fact, from the point

[Fig. 7. The Fig. 6 curve sheet with load line added, through the working point (encircled).]
where \( V_e = -30 \) cuts the bottom-bend boundary. In practical design there is vastly more to it than this; all I have been attempting to do is show what the various lines and things on this kind of diagram mean, and how it is that they mean them. If I have succeeded in making this clear, then perhaps you would like to turn back to last month's treatise and note how the ordinary valve curves can be used to derive another set of much straighter curves that represent the behaviour of a valve combined with negative feedback. Then, of course, there are pentodes. Their curves have quite different shapes, but except in detail the methods are the same.

At least one whole book has been written on the subject, and the users included in the Radio Designer's Handbook would almost make another book. So there is plenty of scope for follow-up.

*Graphical Constructions for Vacuum Tube Circuits, by A. Preismann. (McGraw Hill.)*

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**Manufacturers' Products:**

**Ground-to-Air Transmitter**

A NEW v.h.f. transmitter for ground-to-air communications, rated at 20 W output, has recently been introduced by Ekco Electronics to replace an earlier model. The new set, Type CE91, can be operated on any crystal-controlled spot frequency in the band 100 to 156 Mc/s, channel changing being effected by fitting the appropriate crystal and realigning the circuits. All the controls are readily accessible from the front panel but protected against accidental misalignment by easily removable cover plates.

New Ekco ground-to-air v.h.f. transmitter, Type CE91.

Particular attention has been given to the suppression of spurious emission, a matter of some importance now that the 200-Mc/s band is likely to become a highly populated one before long. The inclusion of bandpass and lowpass filters in the circuit contribute, no doubt, to the "clean" performance claimed for this transmitter. The set, including the power supply, weighs 75 lb and fits into the standard 19-in rack. It is made by Ekco Electronics, Ltd., Southend-on-Sea, Essex.

**Ferrite Rod Aerials**

TWO directional rod aerials are now available from the Teletron Co., Ltd., 266, Nightingale Lane, London, N.9.

"Teletron" Type FRD ferrite rod aerial.

In Type FRM, which is 4in long, a single wave-wound coil at one end, of 165-sH inductance, covers 180-500 metres when tuned by a 500-pF variable condenser. The Q at 1 Mc/s is stated to be 205.

Type FRD has an additional winding at the other end of the rod giving a combined inductance of 2.2 mH to cover wavelengths up to 2000 metres. The length of this rod is 8in. Rubber grommets are provided for mounting, and a fibre disc, secured to each coil former, facilitates adjustment when moving the coil on the "Ferroxcube" rod coil.

The price of Type FRM is 8s 9d and of Type FRD 12s 9d.

**Commercial Literature**

Marine V.H.F. Radiotelephones, a range of six models giving 10 watts output and covering 40-185 Mc/s with 10 or 20 channels. Available for a.m. f.m. or combined a.m./f.m. Brochure from Redifon, Broomhill Road, London, S.W.18.

Soldering Irons by Hydrel of Switzerland with pointed or hammer-shaped copper bits claimed to withstand oxidation. Elements from 45 to 500 watts, lengths 121/2 to 171/2 in, weights 7 oz to 21 lb. Leaflet from the sole distributors, A. B. Hobbs & Co., 214, Hatfield Road, St. Albans, Herts.


**High-voltage Control Valve**, triode Type TV501. With 70 kV on the anode, the anode current (max. 1.5 A) can be cut off to 100 µA by application of -400 V to the grid. Details and characteristics in a brochure fromSolus Electronic Tubes, 15-18, Clippington Street, London, W.1.

Microwave Frequency Meter, 2,400 to 10,200 Mc/s, and other waveguide components and test instruments described in an illustrated catalogue from the Narda Corporation, 66, Main Street, Mineola, N.Y., U.S.A.


**Radio Control of Models.** Ex-Government equipment for this and other purposes listed in a new mail order catalogue (No. 12) from Arthur Sallis Radio Control, 91, North Road, Brighton, Sussex; price 1s 6d including postage.

**Mobile Television Units** in motor vans for outside broadcasting, with cameras, control equipment, centimetre-wave transmitters, etc. Diagrams and photographs showing facilities available in a booklet from Marconi's Wireless Telegraph Company, Marconi House, Chelmsford, Essex.
**U.H.F. Television Broadcasting**

*Study of Propagation Conditions: Geographical Separation of Stations Using Common Frequencies*  

The advance of broadcasting (sound and television) services to increasingly higher frequencies has given rise to a need to understand in considerable detail the manner in which radio waves at the frequencies in question are propagated over the ground in urban and rural areas and through the lower atmosphere. The subject is of both national and international interest and has two distinct aspects so far as the station design and planning engineer is concerned. In the first instance, since the bands allocated for broadcasting purposes have to be shared between the various national operating administrations, it is essential to understand under what conditions and at what geographical separation two transmitters may operate on the same frequency without their broadcast services suffering intolerable mutual interference. Information designed to assist in this matter has been incorporated in curves published by the International Radio Consultative Committee (C.C.I.R.) following the Plenary Assembly held in London in 1953. These curves show the field strength likely to be exceeded for 1% and 10% of the time at distances between 100 and 700 km (60 and 430 miles) from a transmitter radiating one kilowatt on frequencies between 30 and 200 Mc/s.

The second aspect of the wave propagation problem concerns the determination of the area around a transmitter (usually much less than 100 km radius), over which the field strength received is sufficient to provide a satisfactory service. In this case, it is the nature of the terrain over which the radio waves travel that determines the received field strength, and there are frequently marked differences observed between a relatively open rural area and the built-up area conditions encountered in large towns.

In a recent contribution, one of the present authors (J. A. S.) has considered the effect of irregular terrain with the aid of the results of an experimental field-strength survey conducted on frequencies in the region of 100 and 600 Mc/s respectively and out to distances of 100 km (60 miles). The present paper is intended to carry the subject a stage further by considering more closely the possibilities of the ultra high frequencies (u.h.f.) for broadcasting purposes with special reference to television transmissions in Bands IV and V (470 to 585 and 610 to 960 Mc/s respectively).

Although the characteristics of propagation at frequencies above a few hundred megacycles per second, and particularly in densely built-up areas, are not yet completely understood, such evidence as exists from American and British field-strength surveys suggests that it will be possible to serve adequately a relatively restricted area, for example, a large city and its suburbs, with a transmitter operating at an ultra high frequency. It is already appreciated that a single u.h.f. transmitter cannot serve as large an area as a broadcasting or television transmitter in the v.h.f. bands, bearing in mind the radio frequency powers and aerial gains it may be feasible to use in the two frequency ranges. We shall, therefore, discuss some points which should be borne in mind when comparing the relative usefulness of u.h.f. and v.h.f. for television transmission.

**Power of Transmitters.**—The effective radiated power (e.r.p.) at present available in Band I (41 to 68 Mc/s) is of the order of 100 kW, and the greatest e.r.p. envisaged in the immediate future for this band is about 500 kW. It is possible that effective powers of a similar magnitude may ultimately be achieved for Band III (174 to 216 Mc/s).

The order of actual radio frequency power likely to be obtained in Bands IV and V is somewhat uncertain, but a value in the region of 10 to 50 kW seems reasonable for the next few years; and the prospects of a further increase are not out of the question. The degree of aerial gain and directivity it may be practicable to use in Bands IV and V will depend to some extent upon the nature of the area to be covered, and whether the transmitter is located centrally or to one side of the area; greater gain and directivity should be possible in the latter case, and a gain of, say, 20 db—giving a possible e.r.p. of 1,000 to 5,000 kW—might not be unreasonable. It is already envisaged by the U.S. Federal Communications Commission that the e.r.p.s to be used in Bands IV and V in the U.S.A. will be ten times those permitted in Band I.

**Sensitivity of Receivers.**—At present the overall noise factors (including average effects of cosmic noise) of u.h.f. receivers are 6 db or more worse than those of v.h.f. receivers; it is probable that future progress may lead to a reduction in this difference. In this connection, electrical interference, and in particular that arising from ignition systems, sometimes limits the range of satisfactory reception; but such interference is likely to be less serious at the higher frequencies.

**Wave Polarization.**—Whilst vertical polarization may offer some advantages over horizontal polarization in Band I (for example in the field strength obtained in fringe areas and in shadows) there would appear to be little to choose between the two polarizations for

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Bands III, IV and V (and particularly IV and V) from the point of view of the field strength provided generally within the service area. It is possible, however, that the locations of aerial design (both transmitting and receiving) may lead to a preference for one kind of polarization. For instance, a high-gain transmitting aerial (with omnidirectional characteristics in azimuth) using horizontal polarization can conveniently be obtained with a cylindrical array of vertical slots.

**Field Characteristics.**—It has been demonstrated that, for typical urban and rural areas of the kind found in the midland and southern regions of England and the eastern seaboard of the U.S.A., the median field strength (i.e., that exceeded for 50 per cent of receiving locations) is, to a first approximation, independent of frequency over Bands I to V for a given radiated power. The variation about the median value varies with frequency, however, and in Bands IV and V the field strength exceeded at 90 per cent of receiving locations may be some 5 to 10 db less than the corresponding value in Band I. These fields obtain in general where there is not a clear line of sight from the transmitting to the receiving aerial. When direct inter-visibility is possible it may be that at times a field strength approaching the free-space value will occur, although it is also possible that, even in the range of inter-visibility, multi-path transmission may produce interference effects giving very low field strengths. Such effects may occur more frequently in Bands IV and V than in Band I. In practice, however, it is likely that some diffracting obstacles—buildings or trees—will intervene between the transmitter and receiver, under which conditions the statistical distribution of field strength will be as indicated above. The experimental surveys also show that the median field strength at u.h.f. in densely built-up areas may be at least 10 db less than the overall median for an area embracing both urban and rural conditions: a similar effect, though less pronounced, exists in Band I.

**Diffraction Effects.**—An important factor in comparing the coverage to be obtained at v.h.f. and u.h.f. is the intensity of the shadows cast by diffracting obstacles. The general effects of such diffraction, often occurring repeatedly over a given transmission path, are embraced by the statistical evaluation of field strength described above. A more direct comparison of diffraction effects at various frequencies can, however, be made when a single obstacle is involved. At the frequencies in question it is a reasonable approximation to estimate such shadow effects from the principles of Fresnel diffraction theory. On this basis it can be shown that, when the diffraction loss is appreciable, the ratio of the field in the shadow to the undisturbed field above the obstacle is inversely proportional to the square root of the frequency. When the field at a point in the shadow is 1/500 of that above the obstacle, the frequency must be over 100 Mc/s, and almost certainly so for frequencies in Bands IV and V, under which conditions any signal received behind such a building is due to diffraction over and round it.

The attenuation of Band I transmissions in passing through wooded areas is not very great: the order of attenuation in a thick, continuous wood is about 0.03 db/metre, and there is evidence that greater attenuation occurs with vertically than with horizontally polarized waves—typical figures being 0.04 db/m as compared with 0.02 db/m. In Band III, the attenuation through woods may amount to 0.07 db/m; whilst in Bands IV and V values of 0.2 to 0.3 db/m may be reached. At u.h.f. there is less dependence upon wave polarization than at lower frequencies. Trees in leaf, and particularly when wet, produce more attenuation than when leafless and dry.

**Field Complexity and Performance of Receiving Aerials.**—On any receiving site, where the field may be influenced by diffraction and reflection at local obstacles, large fluctuations in field strength can occur over distances comparable with the wavelength: this is true at both v.h.f. and u.h.f. The actual spatial variations of the field strength in Bands IV and V is less than in Band I, and a range of variation of at least 20 db will not be uncommon on a typical receiving site.

It may well be that in some locations it would appear desirable if possible to achieve a gain of 10 db or more with a receiving aerial, but the performance of a directive aerial in fields of the complexity likely to arise in practice is not yet known, and it is possible that the gain to be expected in a uniform field will not be realized. It has in fact been suggested that, if the energy at a given point arrives predominantly after scattering from numerous obstacles within a certain zone near to the receiving aerial, the input signal to the receiver may be more if a non-directive rather than a highly directive aerial is used. This, however, is a portion of the subject requiring much more investigation.

**The Use of High-Gain Transmitting Aerials.**—If a transmitting aerial is designed to have a gain of 20 db, and to radiate uniformly in a horizontal plane, the beam width in the vertical direction will be quite small—not more than 1 or 2 degrees—and, as a result, receiving locations near to the transmitter, i.e., up to a few kilometres if the transmitting aerial is at, say, 200 metres above ground level, may suffer from a "skip" effect. It has been shown that, with an aerial having a gain of about 20 db (at 850 Mc/s), when the beam was tilted down from the horizontal position by 1.3 degrees, an increase of 11 db in the median field strength was obtained for distances of 1 to 8 km. Thus if very directive transmitting aerials are to be used the advantages of tilting the radiated beam downwards, either by electrical or mechanical means, should be borne in mind: in fact such tilting will be necessary at full power to secure the aerial gain to be realized. For serving a limited area it might be better to locate the transmitter outside the area rather than centrally; it would not then be necessary to provide all-round horizontal coverage, and the required degree of gain could be achieved with a greater beam width in the vertical plane.

**Statistical Assessment of Relative Coverage at U.H.F. and V.H.F.**—With so many variable factors to contend with, and the limited amount of knowledge so far available, it is not easy to give an assessment of the absolute performance of a u.h.f. system, but a comparison of what may be expected at u.h.f.
and v.h.f. may be attempted. For this purpose, and by way of example, we may compare the ranges at which equivalent services (i.e., the same signal-to-noise ratios, S/N) can be provided at frequencies of 50 and 500 Mc/s.

Let it be assumed that the overall noise factor of a receiver at 500 Mc/s is 6 db worse than one at 50 Mc/s (although future improvements in this figure might be expected), and that any difference in feeder loss at the receiving station for the two frequencies may be ignored.

In the first place we know19 that the median field strength (at 50 per cent of locations) at a given distance for a mixed urban and rural type of terrain is approximately independent of frequency for constant e.r.p.; so that for identical aerials (e.g., half-wavelength dipoles) the input voltage to the receiver at 500 Mc/s is 20 db below that at 50 Mc/s, and the S/N ratio is therefore 26 db worse. Suppose that at 500 Mc/s a receiving aerial gain of 10 db is achieved, and that an average gain of 2 db is allowed for aerials used at 50 Mc/s; it will then be seen that at a given distance (for constant e.r.p.) the S/N ratio is 18 db worse at the higher than at the lower frequency. From this it may be deduced19 that ranges‡ of 60 and 30 km at 50 Mc/s will be reduced to 30 and 12 km respectively at 500 Mc/s, the e.r.p. being the same at the two frequencies. If a predominantly urban area is to be served, these latter ranges will be reduced to 25 and 10 km because the median field strength at 500 Mc/s in densely built-up areas may be 10 db below the overall median as opposed to only 4 db at 50 Mc/s.

Now consider the situation if the e.r.p. at 500 Mc/s is ten times that at 50 Mc/s and if the field strength

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‡ At these ranges, median field strengths of about 2 and 10 mV/m respectively are obtained from a transmitter of 100 kW, e.r.p.

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**Fig. 1.** Field strengths for frequencies between 50 and 800 Mc/s; (a) over smooth ground, (b) over irregular terrain. Effective transmitted power 1 kW, transmitter aerial height 300 ft, receiver aerial 30 ft approx. (Courtesy Proc. I.E.E.)

**Fig. 2.** Effect of ground contour on received field strength. Two different paths are shown. Effective radiated power 1 kW. (Courtesy Proc. I.E.E.)
exceeded at 90 per cent of receiving locations is used as the basis for comparison. In this case the field strength at 500 Mc/s will be of the order of 5 db more than at 50 Mc/s;° and, following the argument given above, the S/N ratio at a given distance will be 13 db worse at the higher than at the lower frequency. From this it would appear that ranges of 60 and 30 km at 50 Mc/s will be reduced to 36 and 18 km respectively at 500 Mc/s in the general case, and to about 30 and 12 km in built-up areas. The corresponding ranges in Band III (about 200 Mc/s) will be intermediate between those referred to above for Bands I (50 Mc/s) and IV (500 Mc/s); whereas near the top of Band V (about 900 Mc/s) the ranges will perhaps be three-quarters of those attainable in Band IV.

Conclusions.—The results described above are summarized in Tables I and II from which the estimated ranges to be expected for the various conditions assumed can be clearly seen.

TABLE I
Comparative ranges in Bands I and IV for equal e.r.p. and based on median field strengths.
(Noise factor for receiver 6 db worse in IV than in I)

<table>
<thead>
<tr>
<th>Frequency Mc/s</th>
<th>Conditions</th>
<th>Range in km</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Mixed urban and rural</td>
<td>30 60</td>
</tr>
<tr>
<td>500</td>
<td>Mixed urban and rural</td>
<td>12 30</td>
</tr>
<tr>
<td>500</td>
<td>Mainly urban</td>
<td>10 25</td>
</tr>
</tbody>
</table>

TABLE II
Comparative ranges in Bands I and IV with e.r.p. in IV ten times that in I, and based on field strengths exceeded at 90% of receiving locations.
(Noise factor for receiver 6 db worse in IV than in I)

<table>
<thead>
<tr>
<th>Frequency Mc/s</th>
<th>Conditions</th>
<th>Range in km</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Mixed urban and rural</td>
<td>30 60</td>
</tr>
<tr>
<td>500</td>
<td>Mixed urban and rural</td>
<td>18 36</td>
</tr>
<tr>
<td>500</td>
<td>Mainly urban</td>
<td>12 30</td>
</tr>
</tbody>
</table>

* Range 1 corresponds to field strength of 10 mV/m in Band I.
† Range 2 corresponds to field strength of 2 mV/m in Band I.

While examples of this type could be multiplied, their usefulness is rather limited in the absence of much more experimental evidence. More knowledge is required at ultra high frequencies concerning the nature and complexity of the field at typical receiving locations, and the performance of directive receiving aerials in such fields. Especially in densely built-up residential areas is there a need for an experimental investigation of the receiving conditions where both the height and small changes in position of the receiving aerial may have a marked influence on the results obtained in television reception.

The substance of this paper was presented by the United Kingdom delegation at a meeting of C.C.I.R. Study Group XI (Television) held in Brussels in March/April, 1955, and it is to be expected that the resultant international discussion may stimulate further research in this subject in different countries.

The work described above was carried out as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research.

REFERENCES

"WIDE-RANGE ELECTROSTATIC LOUDSPEAKERS"

The third installment of this article, which began in the May issue, is unavoidably held over. In the meantime it should be pointed out that in Part 2 (June issue) the last sentence of the second paragraph (p. 265) should read: "In practice the compliance will be considerably less than the electrical negative compliance. . . ."

Line 23, left-hand column, p. 266, should read "velocity of motion will vary inversely with frequency"; and in line 2, right-hand column, p. 267, "f/" should be "f."
FM/AM Tuner

Eddystone Model 820 Embodying a Foster-Seeley Discriminator

With so many f.m. tuner units and receivers having almost standardized circuitry it is refreshing to encounter one that is in any way different. The Eddystone Model 820 tuner can perhaps claim this distinction on two counts. In the first case it has a Foster-Seeley discriminator, and secondly it provides the choice of two pre-selected stations in the medium waveband and one in the long. A further distinction is that provision is made also for feeding-in a gramophone output, although there is no actual audio amplification provided.

All three forms of entertainment, f.m. and a.m. broadcasting and records are selected by a single five-position switch.

The tuner has exceptionally high sensitivity and is capable of giving a very satisfactory performance outside the normal service area of a v.h.f. broadcast station.

Following accepted practice the "820" has an r.f. amplifier and all the three associated r.f. circuits, aerial, inter-valve coupling and oscillator, are tuned by a tiny three-gang capacitor designed especially for this unit. It is fitted with a single glass ball-bearing at the rear end of the rotor shaft and this novel innovation has been adopted in order to eliminate loop couplings in the capacitor.

The r.f. valve, (V1), is a 6AM6 r.f. pentode choke-capacitance coupled to the tuned inter-valve circuit and followed by a double-triode 12AT7, (V2), functioning as mixer and local oscillator for f.m. reception. The i.f. output from the mixer, which is at 465 kc/s, is fed via the f.m./a.m. switch to the grid of the hexode section in an ECH42, (V3), normal frequency changer. For f.m. reception this section functions as the first i.f. amplifier and its accompanying triode is inoperative.

For a.m. reception the hexode section of the ECH42 becomes the mixer with its triode functioning in the usual way as a local oscillator. For this condition of operation an i.f. of 465 kc/s is employed. I.F. transformers of 10.7 Mc/s and 465 kc/s are connected in series in the anode circuit and automatically select, without switching, the correct i.f. signal according to the mode of operation, e.g., as first i.f. at 10.7 Mc/s or mixer at 465 kc/s. Following the ECH42 is another 6AM6, (V4), functioning as second i.f. on 10.7 Mc/s or first i.f. on 465 kc/s as required.

The 10.7-Mc/s signal passes from V4 to another 6AM6, (V5), which is operated at relatively low anode and screen voltages, and behaves as a limiter. Under working conditions the limiter stage has quite an appreciable amount of grid bias derived from a 0.27-MΩ grid resistor. This negative d.c. voltage is used also to operate an EM80 magic-eye tuning indicator, (V7), on f.m. and supplies an a.c. voltage to the input grids of V3 and V4.

The 10.7-Mc/s discriminator transformer is in the anode circuit of the limiter, (V5), and is followed by a double diode 6AL5, (V6), arranged as a typical Foster-Seeley discriminator, its a.f. output going via a de-emphasis network and f.m./a.m. switch to an output volume control.

For a.m. reception the i.f. signal stops short at the anode of the 6AM6, (V4), following the ECH42, (V3), and there rectified by a crystal diode and the audio output taken, via the f.m./a.m. switch to the aforementioned output volume control.

The d.c. voltage derived from the

The large scale window with controls below characterizes the Model 820 f.m./a.m. tuner as an Eddystone product.

Viewed from the back the positions of the valves, i.f. and mains transformers are clearly seen. Also seen is the tuning mechanism.

Wireless World, July 1955
crystal current is used for a.g.c. This a.m. grid-bias (or a.g.c. voltage) is not applied to the tuning indicator which is not operative on the pre-set a.m. stations.

The tuner has its own a.c. power supply unit and this comprises a double-wound mains transformer, an E241 full-wave h.t. rectifier, (V8), a 500-ohm smoothing resistor and two 32-μF smoothing capacitors.

A coaxial socket is provided at the back of the unit for a 70-ohm feeder from the v.h.f. aerial and a screw terminal for a random-length aerial for a.m. reception. Two other coaxial sockets are included at the back; one is the a.f. output, the other is for a gramophone input. There is also an earth terminal.

The tuning control is delightfully smooth and free of backlash and the “sponginess” sometimes associated with cord drives. Actually the cord drive in the “820” tuner operates the pointer only and the gang capacitor is driven through a combination of spring-loaded gears and friction discs giving an overall reduction of about 76 to 1. A heavy flywheel smooths out any little irregularities in the system.

The tuning scale is just over 6in long and is traversed by a long pendant pointer. It is directly calibrated and covers 85 to 101 Mc/s with points at every megacycle and figures every 5 Mc/s. Viewing is made easy by employing white for figure markings and the pointer and a chocolate-coloured background.

The tuning indicator is viewed through a cut-out in the background plate and is enclosed by the scale window. This measures 8½ x 2¼ in and takes up the whole of the top half of the front panel. The three controls: AM/FM/PU switch, tuning and volume/on-off, in this order from left to right, are spaced out equidistant below.

The a.m. side of the tuner has been rather ignored so far, but it is well up to the performance of a mixer-i.f.-detector combination. In the MW1 position of the switch any station between 960 and 1,550 kc/s can be set up and in MW2 position the range is 610 to 960 kc/s. The range on long waves is 150 to 250 kc/s.

Since the f.m. side provides the three main programmes, Light, Home and Third, the stations set up on the pre-tuned circuits could with advantage be a regional which sometimes has a programme of local interest, or one's favourite Continental stations.

The tuner is supplied in chassis form as illustrated and measures 11 x 6½ x 8¾ in. The front is a sturdy light-alloy casting and forms a rigid support for the chassis which is braced by side members giving good mechanical rigidity; this rigidity is essential for good frequency stability. High praise can be given to the “820” tuner in this respect as the drift from cold to working temperature is comparatively small for v.h.f. equipment, while the long-term stability is very good indeed. After any initial correction has been made—and this is only necessary if the station is tuned-in immediately the set is switched on—no further attention is needed unless one wants another programme.

The tuner is supplied with all necessary fixing screws, coaxial sockets and trimming tools, and the price is £28 10s, plus £9 10s U.K. purchase tax.

The makers are Stratton and Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31.
Prize-winning entries in the B.S.R.A. competition. (Right) J. W. Dix's four-channel tape recorder, and (left) S. H. Bryant's mixer unit.

B.S.R.A. AMATEUR COMPETITION

In the competition for amateur constructors of sound recording and reproducing equipment, held in connection with the British Sound Recording Association's annual exhibition, the President's Trophy and the Wireless World prize were won this year by J. W. Dix of Nuneaton with a four-channel tape recorder intended primarily for sound effects in theatrical performances. The tape mechanism is designed to handle 3-inch as well as standard 1-inch wide tape at speeds of 7½ or 15 in/sec. Up to four tracks, with individual plug-in pre-amplifiers, can be used for stereophonic effects. In all there are seven heads.

The runner-up was S. H. Bryant, who was awarded the Committee Prize for a 3-way mixer unit.

(A description of new items of commercial equipment for sound reproduction shown at the B.S.R.A. exhibition is included in the report on p. 312 of this issue.)

RADIO TELEARCHICS: Two Recent Applications

On the left is a French Railways electric locomotive and four coaches photographed while travelling under radio control, without driver or passengers, on the main line between Paris and Le Mans. Orders to control the brakes and motors were given verbally by radio telephone from a railway travelling alongside and were received at a point about halfway along the route. From here control signals were transmitted to the locomotive on 1.9 metres. The jet fighter aircraft on the right was flying under control of a new precision U.H.F. radio guidance system designed by the U.S. Air Force and the Sperry Gyroscope Company. This system for automatic take-off and landing with control of climb, descent, and other manoeuvres. If the radio carrier is cut off for any reason an automatic control system takes over.

The TRIX tradition of quality has been established by an unswerving allegiance to the highest standards of sound engineering. TRIX Sound Equipment has been developed and produced to give faithful and lasting service anywhere in the world.

WIRELESS WORLD, JULY 1955

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LONDON, W.1
Tel: MUSEUM 5817
Grams: TRIXADIO, WESDO, LONDON

TRIXADIO, WESDO, LONDON

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Model T.635, 30-watt Amplifier.
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**RANDOM RADIATIONS**

By “DIALLIST”

**Timely Hints**

Some work is going ahead—or at any rate on the verge of going ahead—on the I.T.A. Midland station at the quaintly named Hints in Staffordshire. A pity there isn’t a suitably situated village called Tips to be the Independent Television centre of some other area! Hints, anyhow, seems well chosen, for it is 500ft above sea-level and in the middle of the thickly peopled midland area bounded by Shrewsbury, Chesterfield, Mansfield, Market Harborough and Gloucester. At the moment of writing I haven’t seen a map showing the expected service area. I thought at first sight that the one for the Croydon station was a trifle on the optimistic side. However, even the 1-kilowatt signal from the Belling and Lee test transmitter has been quite well received in not a few places which were expected to be in the fringe areas.

**Beyond Expectations**

The B.B.C. has always been wise in drawing its expected service area maps very conservatively, for it’s far better to give pleasant surprises than to raise false hopes and dash them later. The temporary Norwich transmitter at Tacolneston (pronounced Tackleston, I’m told on the best local authority) is a case in point. I’m writing these notes at a place well outside the predicted service area of the station; but really good and consistent pictures are received here on 3-element yagis consisting of dipole, reflector and director. One sees a few of the 4-element type, but for most homes the smaller array does all that’s needed.

**Bits and Pieces**

Is Kent a specially windy county? I don’t know, for until recently I’ve seldom done more than pass through parts of it on the way to somewhere else. I ask the question because when I was moving about Kent in March and April this year I saw more damaged TV aerials than I’ve ever noticed anywhere before. Driving one day from Tunbridge Wells to Wrotham one saw all over the place “Hs” which had lost one half of the reflector and “Xs” whose directors had been injured in the same way. In several cases the lower part of the dipole was missing. I even noticed once whose upper half had gone; somehow, I don’t think the owner could be getting a very good picture!

**The War of the Bands?**

As I write there are signs of a hard-fought struggle to come over the still unallocated channels in Band III. The I.T.A. had apparently taken it for granted that the whole of Band III would be its own particular stamping ground, when along came the B.B.C. with an order for two pairs of Band III transmitters for delivery in the latter part of next year. One side says that it must have all the eight channels if it is to provide country-wide coverage; the other lays claim to some of them for the development of its second programme. So far, the Postmaster General has “lain low and said nuffin’”; but his decision can’t be long delayed if planning is to go ahead. What a pity it is that there aren’t enough channels for both the B.B.C. and the I.T.A. to have all they want. With three vision programmes to choose from, there should be something to suit all tastes at most times and the £3 licence would be a magnificent bargain—if it remains at £3. I wonder whether it’s at all possible that with the world-wide spread of television, some widening of Bands I and III may come about by international agreement? If that doesn’t happen, it might be a tough problem to satisfy the B.B.C., the I.T.A. and the viewer.

**Quarts into Pint Pots**

Come to think of it, though, the B.B.C. has already shown in Band I, that wide geographic separation of transmitters and intelligent choice of horizontal or vertical polarization can do something very like fitting quarts into pint pots. The present plan is for eighteen stations in the five channels of Band I. A dozen or more are already working and (except possibly during certain freak conditions) mutual interference doesn’t appear to cause any headaches. For equal aerial heights and output ratings one would expect Band III transmitters to have shorter ranges than those using Band I. Though this means smaller service areas and therefore more stations to cover the whole.

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**“WIRELESS WORLD” PUBLICATIONS**

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<th>Title</th>
<th>Net Price</th>
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<tr>
<td>RADIO LABORATORY HANDBOOK</td>
<td>M. G. Scroggie, B.Sc.</td>
<td>25/-</td>
</tr>
<tr>
<td>STUDIO ENGINEERING FOR SOUND BROADCASTING</td>
<td>B.B.C. Engineering Training Manual by members of the B.B.C. Engineering Division. General Editor W. Godfrey</td>
<td>25/-</td>
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<tr>
<td>WIRELESS WORLD TELEVISION RECEIVER MODEL II: Complete constructional details with notes on modernizing the original design</td>
<td>3/6</td>
<td>3/9</td>
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<td>RADIO INTERFERENCE SUPPRESSION as Applied to Radio and Television Reception</td>
<td>G. L. Stephens, A.M.I.E.E.</td>
<td>10/6</td>
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<tr>
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<td>30/-</td>
</tr>
<tr>
<td>FOUNDATIONS OF WIRELESS</td>
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<td>18/-</td>
</tr>
</tbody>
</table>

A complete list of books is available on application. Obtainable from all leading booksellers or from ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1.
country, it should also mean, one would think, that stations using the same frequency could be sited closer together than on Band I without causing interference. If these assumptions are right, it should be possible to fit quite a lot of television stations into the eight channels which will eventually be available in Band III.

F.M. Quality

WITH amplitude modulation volume compression is a necessity. Were it not used, listeners at close quarters to a high-power transmitter would be liable to be deafened by fortissimo orchestral passages while others in distant parts might find their loudspeakers silent when a soloist was playing or singing very softly. But it needn't be done to anything like the same extent with f.m., for the transmitter radiates at full power all the time. So long as the signal is sufficient to work his limiter, the distant listener gets all that it has to give and hears the softest passages, and the close-quarter listener has only to adjust his receiver properly in order to ensure against its being over-loaded by the loudest. I haven't been able yet to listen to Wrotham since it came into regular service; but in the days when I regularly received its experimental transmissions it seemed that there was much less volume compression than on the medium and long waves. If compression can be used sparingly and lightly with the v.h.f. programmes listeners will be delighted to find wireless music something very much more like the real thing.

An Essential

So far, I haven't had the chance of handling or hearing any of the f.m. receivers that are being manufactured for domestic use. There used to be an idea that f.m. wouldn't suit the man or the woman in the street because very accurate tuning is needed if horrid distortion is to be avoided. When the B.B.C. was making its prolonged tests on the original Wrotham station part of its programme was to discover whether this was true or not. Some entirely non-technical folk were lent receivers and, after being instructed in how to work them, were left to get on with it. They got on very well indeed. The sets were provided with automatic frequency control and I understand that investigations at a later date showed that their users found them no more difficult to handle than their own medium-wave sets.
UNBIASED

Service with a Smile

LIKE all other rabid radiotics I do my own running repairs. I was more than a little vexed therefore—in fact I was livid, as the ladies say—when I returned from a brief business trip to Paris recently and found that Mrs. Free Grid had called in the local radio dealer to attend to a fault in the TV set.

Without casting aspersions on hard-working radio dealers I always regard my set—which is, of course, of my own design—with the same possessive pride as a mother does her child and have always thought that nobody but myself could properly tend it in sickness. I was surprised, therefore, when Mrs. Free Grid told me that the set was doing its stuff better than it had ever done before. I replied angrily that obviously some simple bread-and-butter fault had developed which nobody but a fool could miss.

I will freely confess that I was quite wrong in every respect. Investigations showed me that quite a complicated fault had developed and it had been repaired in a masterly manner. When Mrs. Free Grid told me that the serviceman had been trim and efficient-looking girl I was frankly incredulous and hurried round to the local dealer.

He gave me a cordial welcome and took great pride in presenting his service staff to me—all of them girls on the proper side of 25. He explained to me that he employed them instead of men not because of the greater nimbleness of their fingers but because their womanly intuition enabled them to diagnose the trouble and remedy the fault rapidly during the time when a mere man would still be fumbling with a lot of expensive and time-consuming instruments.

He said that as a result of experience he only trained married girls with at least one child as he found that they not only had intuition but also had acquired valuable “know-how” in trouble tracing by listening to the outlandish noises made by a baby in distress. To the average man bawling babies are bedlam but to an experienced mother no two bawls are alike, one indicating the need for nourishment, another for nappies and so on.

I can only say that I came away with a new respect for radio dealers—or at any rate for this particular one. On thinking things over it occurs to me that the only way that male service technicians can dodge the dole is for them to get married, for surely fathers are equally as experienced in getting up in the middle of the night to attend to a baby with a faulty grid leak.

Living Literature

I HAVE during the past few months been making taped recordings of the B.B.C. “Book at Bedtime” feature in which an installment of a popular novel is read late in the evening. I have sometimes prized the books which the B.B.C. has chosen but I have always been filled with admiration for the skill with which they are read. The readers put real dramatic skill into their work and even the dullest book seems to live; perhaps this is no more than would be expected as some of them are well known in the theatrical world.

One thing I cannot stand, however, is a serial story, more especially at bedtime. I am worked up to a fever of excitement wondering what the villain is going to do to the heroine when “psyche mad “e” receives a fearful jolt by the anti-climax of the announcer butting in with the B.B.C., equivalent of the old-fashioned Jane’s Journal’s “another gripping instalment next week.”

I, therefore, arrange for the instalments to be taken down on tape, using a special rigged-up receiver, recorder and timer switch for this purpose. Eventually when the book is finished I am enabled to sit back and listen to the story in comfort.

Now I derive so much more pleasure from listening with my eyes closed to these beautifully read books than I do from reading them for myself that I venture to prophesy that in a few years publishers will be burning their printing presses into tape recorders and we shall buy our books by the reel, the value of the recording being enhanced by the fame of the artist engaged by the publisher to do the reading. There will, in fact, be as much competition among publishers to sign up famous actors for these readings as there is among recording companies to sign up famous vocalists and instrumentalists.

To a limited extent the sort of thing I envisage is already available in the well-known talking books for the blind which are now on offer. Will I should imagine eventually be on tape.* An obvious extension of this idea which would help to put this “living literature” on the map would be to provide such a service to hospital patients. Many hospitals are now provided with multi-channel broadcasting whereby each patient can choose his radio programme by means of a switch at his bedside. Why not reserve one of these a.f. distribution channels for book reading either from a tape reproducer or the lips of a dulcet-toned nurse of the type whose voice sends your temperature up every time you hear it?

Caledonian Carefulness

FOR some odd reason the word parsimony has come to be associated with Scotland—probably due to vulgar and unfounded music-hall jokes made by comedians who have never travelled farther north than Wigan.

My own experience of “Caledonia, stern and wild” is that it is a land of unbounded generosity. I have not been there since quite my youth and I recollect riding in a Glasgow tram in the ’thirties and being asked to pay only a halfpenny fare when the minimum south of the border was a penny. For my humble bawbee I was carried quite a considerable distance. If this be parsimony, give me more of it!

In actual fact, of course, the Scots are not parsimonious but are “careful” and believe in getting—and giving—full value for money. This is only another way of saying they avoid waste and wantonness and I came across a remarkable example of this recently when browsing through the carbolic pages of the Nursing Mirror.

It appears that in a hospital in Paisley there has been installed a “pillowphone” system for distributing radio programmes. Hundreds of Sassenach hospitals must have done the same thing and then realized that their laurels; not so the canny Scots. Desiring to install also a system whereby a patient could summon a nurse they remembered the high price of copper and did not wantonly and extravagantly install a duplicate system of wiring but made the pillowphone system serve two purposes and operate in both directions; unfortunately the Nursing Mirror failed to give technical details of the modus operandi.

*(A description of a talking-book tape reproducer, was given in our Jan., 1954, issue.—Ed.)
Produced in response to a demand for a high sensitivity version of the world-famous Universal AvoMeter, this model incorporates the traditional design features of its predecessors, so highly valued for simplicity of operation and compact portability.

It has a sensitivity of 20,000 ohms per volt on all D.C. voltage ranges and 1,000 ohms per volt on A.C. ranges from 110 V. upwards. A decibel scale is provided for audio frequency tests. In addition, a press button has been incorporated which reverses the direction of current through the moving coil, and thus obviates the inconvenience of changing over test leads when the current direction reverses. It also simplifies the testing of potentials, both positive and negative, about a common reference point. A wide range of resistance measurements can be made using internal batteries, separate zero adjustment being provided for each range.

It is of importance to note that this model incorporates the "AVO" automatic cut-out for protection against inadvertent overloads.

<table>
<thead>
<tr>
<th>D.C. VOLTAGE</th>
<th>D.C. CURRENT</th>
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<tr>
<td>2.5V</td>
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<td>2,500V</td>
<td>100μA</td>
<td>2,500V</td>
<td>1μA</td>
</tr>
</tbody>
</table>

£23 : 10s.

Size 8½" x 7½" x 4½"  
Weight 6½lbs. (including leads)

The Automatic Coil Winder & Electrical Equipment Co. Ltd. 
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What's this thing between us, George, that prevents our seeing eye to eye?

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You mean that 'one-track mind' of theirs?

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Further details of the OC70 and OC71 and the economies they can effect in your power supply and space requirements are readily available from the Communications and Industrial Valve Department at Mullard. Write today . . . and watch these announcements for Transistor News.

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All LABpak resistors are carded in ohmic value, rating and tolerance, colour indexed and tabbed for easy selection.

THE RADIO RESISTOR COMPANY LIMITED
50 ABBEY GARDENS, LONDON, N.W.8 - Telephone: Maida Vale 5522
Response is not all the story

The Ferrograph was the first portable Tape Recorder to be designed and wholly manufactured in Britain. To-day the bewildered buyer may well hesitate when confronted with a choice of so many makes offered. But if he is serious — and not lightly choosing something for his casual enjoyment — he would do well to ponder the following fact.

Frequency response is often popularly quoted in advertisements as 50-12,000 c.p.s. This, of itself, means nothing in evaluating the excellence or otherwise of a recorder. Two other interdependent factors must be regarded, viz.—signal/noise ratio and distortion, if the true worth of the instrument is to be gauged.

Furthermore, the limits in which the response is held must be given or the statement is again valueless. The Ferrograph frequency response is guaranteed to be within ±3 db up to 10,000 c.p.s. at 7½ i.p.s., although the response does, of course, extend much beyond this.

No exaggerated claims are made for the Ferrograph since its established reputation makes such claims unnecessary. Simple conservatism has always been a feature of Ferrograph publications and advertisements, and experience has shown the discerning user prefers it that way.

**MODEL 2A/N**
3½ and 7½ i.p.s.
76 gns.

**MODEL 2A/NH**
7½ and 15 i.p.s.
86 gns.

**Ferrograph**

**BRIEF SPECIFICATION**

- Twin Track (to International standards)
- Playing British and American pre-recorded tapes
- Playing Time with 1,750 ft. Reel: 45 minutes per track at 7½ i.p.s. (otherspeeds pro rata)
- Quick Rewind in less than 60 seconds
- Signal Level Meter giving positive reading
- Frequency Response ±3 db 50/10,000 c.p.s. at 7½ i.p.s.
- "Wow" and Flutter less than 0.2% at 7½ i.p.s.
- Signal to Noise Ratio Better than 50 db, 200/12,000 c.p.s. Unweighted, including hum, 45 db.
- Longterm Speed Stability Less than ±5% variation
- Output Power 2½ watts into 15 ohms

Dealerships in several of the principal towns are still open and applications are invited.

WRIGHT & WEAI RE LTD
131 SLOANE STREET - LONDON - SW1 Tel: SLOane 2214/5 & 1510
Output Level Stabilised to $\pm \frac{1}{2}\text{db}$

OVER THE FULL FREQUENCY RANGE OF 10 kc/s – 10 Mc/s

To the established features of the Wayne Kerr Video Oscillator has been added, at the suggestion of the B.B.C., a 50 cycle Square Wave for the examination of the low frequency characteristics of Video networks. This output is achieved by interrupting a stable D.C. Source with a polarised relay energised from the mains. The rise time of the square wave is better than 0.02µ sec.

Specification

<table>
<thead>
<tr>
<th>FREQUENCY RANGE:</th>
<th>10 kc/s – 10 Mc/s, in 6 ranges, and 50 cycle Square Wave.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stability:</td>
<td>Better than 1 in 10⁴ in one hour.</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>1%.</td>
</tr>
<tr>
<td>OUTPUT RANGE:</td>
<td>+40 db to –50 db on 1V p-p.</td>
</tr>
<tr>
<td>Level:</td>
<td>Constant to $\pm 0.5$ db at any Frequency [setting].</td>
</tr>
<tr>
<td>Impedance:</td>
<td>75 Ω.</td>
</tr>
<tr>
<td>TOTAL HARMONIC CONTENT:</td>
<td>Less than 1%.</td>
</tr>
</tbody>
</table>

In transportable case £155, or for standard 19' Rack mounting £148.

THE WAYNE KERR LABORATORIES LIMITED · NEW MALDEN · SURREY · MALDEN 2202
**VOLTAGE STABILISERS**

Cold cathode gas-filled voltage stabilisers manufactured by English Electric Valve Co. Ltd. provide a sensibly constant output voltage from a source of supply liable to fluctuation, satisfying all requirements for reliability and conforming to British Service specifications. Whether your needs are for General, Rugged or High Stability type Stabilisers and Reference Tubes, your requirements can be adequately met from our range which is the most extensive provided by any manufacturer in Great Britain. Send for full technical data.

<table>
<thead>
<tr>
<th>Type</th>
<th>C.V. No.</th>
<th>Base</th>
<th>Length mm.</th>
<th>Diameter mm.</th>
<th>Sticking Voltage (Maximum)</th>
<th>Operating Voltage</th>
<th>Ignition Voltage (Maximum)</th>
<th>Ignition Electrode (Mphase)</th>
<th>Maximum Current (Amp)</th>
<th>Minimum Tube Current (Amp)</th>
<th>Regulation over Range (Volts)</th>
<th>American Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>QS. 75/20</td>
<td>CV. 284</td>
<td>B7G</td>
<td>54</td>
<td>19</td>
<td>110</td>
<td>75</td>
<td>20</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>OD3</td>
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<tr>
<td>QS. 75/60</td>
<td>CV. 434</td>
<td>B8G</td>
<td>80</td>
<td>30</td>
<td>117</td>
<td>75</td>
<td>60</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>OD3</td>
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<tr>
<td>QS. 92/10</td>
<td>CV. 188</td>
<td>4-PIN</td>
<td>85</td>
<td>32</td>
<td>140</td>
<td>92</td>
<td>30</td>
<td>1</td>
<td>5</td>
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<td>5</td>
<td>OD3</td>
</tr>
<tr>
<td>QS. 95/10</td>
<td>CV. 286</td>
<td>B7G</td>
<td>54</td>
<td>19</td>
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<td>75</td>
<td>150</td>
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<td>10</td>
<td>45</td>
<td>5</td>
<td>5</td>
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<tr>
<td>QS. 108/45</td>
<td>CV. 422</td>
<td>B8G</td>
<td>80</td>
<td>30</td>
<td>120</td>
<td>108</td>
<td>150</td>
<td>0.1</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>QS. 150/15</td>
<td>CV. 287</td>
<td>B7G</td>
<td>54</td>
<td>19</td>
<td>170</td>
<td>150</td>
<td>240</td>
<td>0.25</td>
<td>15</td>
<td>5</td>
<td>5</td>
<td>5</td>
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<tr>
<td>QS. 150/40</td>
<td>CV. 216</td>
<td>I.O.</td>
<td>105</td>
<td>39.5</td>
<td>180</td>
<td>150</td>
<td>40</td>
<td>5</td>
<td>5</td>
<td>5.5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>QS. 150/45</td>
<td>CV. 395</td>
<td>B8G</td>
<td>80</td>
<td>30</td>
<td>170</td>
<td>150</td>
<td>200</td>
<td>0.1</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>QS.1201</td>
<td></td>
<td>FLYING LEADS</td>
<td>80</td>
<td>19</td>
<td>110</td>
<td>75</td>
<td>15</td>
<td>2</td>
<td>4.5</td>
<td></td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>QS.1202</td>
<td></td>
<td>FLYING LEADS</td>
<td>80</td>
<td>19</td>
<td>133</td>
<td>108</td>
<td>15</td>
<td>2</td>
<td>4.5</td>
<td></td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>QS.1203</td>
<td></td>
<td>FLYING LEADS</td>
<td>80</td>
<td>19</td>
<td>180</td>
<td>150</td>
<td>15</td>
<td>2</td>
<td>4.5</td>
<td></td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>QS.1204</td>
<td></td>
<td>B7G</td>
<td>54</td>
<td>19</td>
<td>133</td>
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<tr>
<td>QS.1205</td>
<td>CV. 3798</td>
<td>I.O.</td>
<td>105</td>
<td>39.5</td>
<td>105</td>
<td>75</td>
<td>40</td>
<td>5</td>
<td>6.5</td>
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<td>OA3</td>
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<tr>
<td>QS.1206</td>
<td>CV. 686</td>
<td>I.O.</td>
<td>105</td>
<td>39.5</td>
<td>133</td>
<td>105</td>
<td>40</td>
<td>5</td>
<td>5.5</td>
<td></td>
<td>OC3</td>
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<tr>
<td>QS.1207</td>
<td>CV. 1832</td>
<td>B7G</td>
<td>67</td>
<td>19</td>
<td>185</td>
<td>150</td>
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<td>5</td>
<td>2.0</td>
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<td>OA2</td>
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<tr>
<td>QS.1208</td>
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<td>67</td>
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<td>5</td>
<td>2.0</td>
<td></td>
<td>OB2</td>
<td></td>
</tr>
</tbody>
</table>

**HIGH STABILITY TUBES**

<table>
<thead>
<tr>
<th>Type</th>
<th>C.V. No.</th>
<th>Base</th>
<th>Length mm.</th>
<th>Diameter mm.</th>
<th>Sticking Voltage (Maximum)</th>
<th>Operating Voltage</th>
<th>Ignition Voltage (Maximum)</th>
<th>Ignition Electrode (Mphase)</th>
<th>Maximum Current (Amp)</th>
<th>Minimum Tube Current (Amp)</th>
<th>Regulation over Range (Volts)</th>
<th>American Equivalent</th>
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<tbody>
<tr>
<td>QS. 83/3</td>
<td>CV. 449</td>
<td>B7G</td>
<td>54</td>
<td>19</td>
<td>125</td>
<td>83</td>
<td>5</td>
<td>1</td>
<td>0.6</td>
<td>5651</td>
<td></td>
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<tr>
<td>QS.1200</td>
<td>CV. 2225</td>
<td>B7G</td>
<td>54</td>
<td>19</td>
<td>180</td>
<td>150</td>
<td>15</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conservation

This pretty and ingenious 17th century attempt at complete conservation of energy didn't work, and to this day perpetuum mobile may make fine music, but it remains moonshine in the technical sense. The perversity of nature (and the second law of thermodynamics in particular) still demand some residuum of loss on every process. Nevertheless, the Suflex Polystyrene Capacitor reduces this energy loss to refreshingly small limits, and the familiar old hysteresis loop for the Suflex capacitor is such a slender, graceful, little thing.

Suflex Polystyrene Capacitors
- Low dielectric loss
- High Q
- Good stability

A quality component which may be economically used in commercial equipment

SUFLEX LONDON
35 BAKER STREET, LONDON W1
Telephone: WELbeck 0791 Cables: Suflex London
There's a difference between Packing & PROTECTION

A product can be packed yet not protected. Even when it has been made secure against external damage, it can still be open to other risks.

EXPORT PACKING SERVICE LIMITED designs packs to give protection against the hazards of corrosion, distortion, deterioration, structural weaknesses, incompatibility of materials, etc., in addition to providing external cover.

It does this by scientific study of the product to be packed and of the dangers likely to be met with; by the most modern testing methods, and by expert production-packing craftsmanship. All that Research and Planning can bring to bear on packing problems is forthcoming from E.P.S.

An officially approved pack for Aircraft Transmitter/Receivers


Fully conversant with J.A.N. and M.I.L., and other U.S. packaging specifications.

EXPORT PACKING SERVICE LTD
IMPERIAL BUILDINGS, 56 KINGSWAY, LONDON, W.C.2.

Telephone: CHAncery 5121-2-3

and at Cardiff, Banbury, Merthyr Tydfil, Sittingbourne
NEW...from start to finish...

The NEW SIMON Model SP/2 Tape Recorder is designed and built to top standards. Years of specialist experience in the field of sound-recording engineering and techniques have been combined to produce an entirely new equipment which is faultless in performance and appearance. The SP/2 provides superb recording and reproduction facilities. Ask your dealer to show you the new SP/2 now...

The inside story...

Ask for a copy of the new booklet — “Affairs of Tape”, free of course. Brings you up to date on Tape Recording — gives you the inside story of the SP/2.

Simon is Sound recording

SIMON SOUND SERVICE LTD.
46-50 GEORGE STREET, LONDON, W.1. WELbeck 2371 (5 lines)
THE OSCILLOSCOPE TYPE 723 is a general purpose instrument with a flat frequency response from D.C. to 5 Mc/s. Special features include an Automatic Brilliance Control, adjustable E.H.T. voltages, Time Base speeds up to 10 cms per microsecond, automatic synchronisation limiting, instantaneous shifts, and a versatile Auxiliary Amplifier.

The instrument utilises a vertical cathode ray tube with a 4in. flat screen, viewed through a surface-aluminised mirror. For recording purposes the Oscilloscope Camera Type 758 is mounted permanently above the Oscilloscope, and photographs are taken by withdrawing the viewing hood and photographing directly downwards through an aperture thus exposed in the top of the instrument.

Y Plate Amplifier:
- Balanced, Unbalanced or Differential.
- Frequency Response: ±2 db from D.C. to 5 Mc/s.
- Overload: Over 5 cms at 4 kV. E.H.T. voltage.
- Time Base: 0.5 second to 1 microsecond.
- Range: Repetitive or Triggered.
- Operation: 1, 2 or 4 kV.
- Dimensions: 19in. wide, 21in. high and 8½in. deep.
- Price: £160.

THE OSCILLOSCOPE CAMRA TYPE 758 is designed specifically for use with Airmec Oscilloscopes. It may be used for single shot photography or continuous recording, and a motor with variable speed gearing is included for the latter purpose. The cassettes will accommodate 100 feet of 35 mm. film or paper and a footage indicator shows the amount of film used.

Film: Standard 35 mm film or paper.
Film Speed: 0.5, 1.5 and 4.5 ft. per second.
Lens: The camera employs an f/3.5 lens.
Dimensions: 19in. wide, 7in. high and 8½in. deep.
Writing Speed: Using a fast film and an E.H.T. voltage of 4kV on the Oscilloscope Type 723, the maximum writing speed is approximately 20 kilometres per second.
Power Supply: The camera operates from 200-230 volt, 50 c/s mains.
Price: £100.

Full details of these or any other Airmec instruments will be forwarded gladly upon request.

AIRMEC LIMITED

HIGH WYCOMBE - BUCKINGHAMSHIRE

Telephone: High Wycombe 2060 Cables: Airmec, High Wycombe
STAR FEATURES

★ Heats up from cold in 6 seconds—by a light thumb pressure on the switch ring.

★ When not in use, current is automatically switched off—thus greatly reducing wear of copper bit. Electricity consumption is correspondingly reduced.

★ It is 10" long, weighs 3½ ozs., can be used on 2.5 to 6.3-volt supply. 4-volt transformer normally supplied.

★ More powerful than conventional 150-watt irons and equally suitable for light wiring work or heavy soldering on chassis.

★ Simple to operate, ideal for precision work. Requires minimum maintenance at negligible cost. Shows lowest operating cost over a period.

★ Can be used from a car battery.

★ It is by far the most efficient and economical soldering iron ever designed for test bench and maintenance work.

STAR APPLICATIONS

Designed on an entirely new principle, this light-weight, versatile iron is eminently suitable for soldering operations in the RADIO, TELEVISION, ELECTRONIC and TELECOMMUNICATION industries, particularly for all SERVICE work. For general purpose work the Superspeed Iron is the ideal stand-by soldering tool.

The Superspeed soldering iron is available NOW

Write for full particulars, including guarantee terms and free trial facilities, to the sole concessionaires in this country—

ENTHOVEN SOLDERS LIMITED
(Industrial Equipment Division), 89 Upper Thames St., London, E.C.4. Telephone: MANsion House 4533
They say we make a perfect pair...

To be exact, this is the 12 pin version of the Multi-Way Plug and Socket range, which covers 4, 8, 12, 20 and 28 ways. The range features unusually low insertion pressures, and embodies considerable experience in meeting humid conditions. Designed to overcome as far as possible the difficulties encountered when using this type of connector in rack mounting applications, they have greater latitude in matching up than any comparable product, and are in use throughout the world in Radio, Television and Telecommunications equipment by such renowned firms as:— Messrs. Marconi’s Wireless Telegraph Co. Ltd., The English Electric Co. Ltd. and Messrs. Standard Telephones & Cables Ltd.
The Electronics Dept., of Ferranti Ltd., manufacture a wide range of Valves and Cathode Ray Tubes for Radio and Television receivers. Valves for domestic use include BVG and BVA miniatures, Octal and Loctal based types. Television Cathode Ray Tubes are produced in all the popular sizes, up to 21in. rectangular. Enquiries to Electronics Dept., Moston, Manchester, 10.

FERRANTI LTD - FIELDS NEW ROAD - CHADDETON - OLDHAM

London Office: KERN HOUSE, 36 KINGSWAY, W.C.2
We are proud of the vast number of our loudspeakers incorporated in radio and television receivers used throughout the world. Their quality of reproduction and unfailing performance have been amply proved over many years in every climate and condition of service.

Rola Celestion Ltd

FERRY WORKS, THAMES DITTON, SURREY
TELEPHONE: EMBerbrook 3402/6
Twenty five years ago

... our present Managing Director founded R. & A. with little capital but unbounded enthusiasm and with the enthusiasm went resolve—resolve to specialise upon the design and production of one main product and to base every action of the Company upon engineering and trading integrity.

Though we now make as many reproducers in a week as we made in the whole of our first year, our philosophy remains unchanged; we have grown and today there are more enthusiasts, but there is no less individual enthusiasm. We are happy that our policies and our products have brought us 25 years of enjoyable business relationships with Customers, Suppliers and Employees.
The brilliantly versatile combination of the PYE PF91/91A Amplifier and Remote Control Unit is acclaimed by enthusiast and engineer alike as the heart of any top quality Hi Fi system. For realistic reproduction from record player, tape recorder, microphone and radio tuner inputs, it stands supreme. Both units are beautifully designed and compactly proportioned, and are supplied with four feet of linking cable for easy, practical mounting in the widest variety of Hi Fi installations. Please write for a fully illustrated booklet to Pye Ltd., Box 49, Cambridge.

PYE LIMITED · CAMBRIDGE · ENGLAND
- Pye (New Zealand) Ltd., Auckland C.I., New Zealand. · Pye Canada Ltd., Ajax, Canada.
- Pye (Ireland) Ltd., Dublin, Eire. · Pye-Electronic Pty., Ltd., Melbourne, Australia.
- Pye Corporation of America, 270, Park Avenue, New York.
- Pye Radio & Television (Pty.) Ltd., Johannesburg, South Africa.
Precision Relays

The world-renowned specialists and manufacturers of all types of relays

An extensive range of standard types always available for prompt delivery

Special types designed to suit your needs

ELECTRO METHODS LTD
OF STEVENAGE

Now FREE to all!

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Regardless of whether your relay problem is simple or complex, the fact remains that the only reliable solution is that which entirely eliminates risk.

We therefore respectfully invite you to avail yourself of the wide resources of technical knowledge and practical experience possessed by the specialist technicians of our Relay Division.

Electro Methods Ltd. 12-36 Caxton Way, Stevenage, Herts. Phone: Stevenage 780
It pays
to use

'Cyldon'  

VARIABLE
Capacitors

and Inductance Tuners

for TELEVISION and AUTO-RADIO

SYDNEY S. BIRD  
& SONS LTD.

Designers and users of radio and electronic equipment know that they can rely implicitly on the efficiency and dependability of "Cyldon" Capacitors and Tuners. They know too that the exceptionally wide variety of types in the standard "Cyldon" range covers most day-to-day requirements, but that when special types are needed the full resources and specialised experience of the manufacturers are entirely at their disposal.

Equipment manufacturers are invited to write for literature covering Cyldon "Teletuners" (Catalogue TV.1953) and Cyldon Trimmers (Catalogue T.1951), together with details of our complete range of Variable Capacitors and list of Agents for Home and Overseas.
AN Ediswan Mazda aluminized picture tube gives a picture 60% brighter and more contrasty than is possible with an ordinary tube. In addition, Ediswan aluminizing protects the screen from ion burn and, with the new Ediswan ion trap tetrode gun to protect the cathode, tube life is increased.

Ediswan production methods, which include the special in-line vacuumizing system, ensure a higher, more uniform standard of lasting efficiency. For complete satisfaction demonstrate and recommend Ediswan Mazda aluminized picture tubes.

EDISWAN
MAZDA
ALUMINIZED CATHODE RAY TUBES
THE EDISON SWAN ELECTRIC COMPANY LIMITED,
155 Charing Cross Road, London, W.C.2 and Branches.
Member of the A.E.I. Group of Companies.

This
ALUMINIZED
Picture tube gives

60% brighter pictures
more contrast
extra tube life

WITHOUT ALUMINIZING
Without aluminizing, tubes waste half their light (see diagram above). To counteract this the brilliance must be increased and the tube life is shortened.

WITH EDISWAN ALUMINIZING
Ediswan aluminized tubes have a mirror backing to the screen. All the light is thus thrown forwards giving brighter, clearer pictures and extra life.

NATION WIDE SERVICE
6 fully equipped cathode ray tube service depots provide better, quicker tube testing should the need arise. Stocks of tubes are available in 26 Ediswan Offices. Only Ediswan give such complete backing to the Trade.
The Automatic Frequency Monitor (20 Mc/s) is but one of a series of high grade monitors now in course of manufacture for the accurate measurement of frequency.

Employing hard valve techniques throughout, it will measure any frequency in the range 10 c/s to 20 Mc/s to an accuracy within ± 1 part in 10^6.

The result, in decimal notation, is presented on eight panel mounted meters each scaled from 0 to 9 and the unknown frequency is automatically remeasured every few seconds.

This new equipment presents a considerable advance in frequency measuring techniques and apart from normal laboratory applications, is ideally suited for incorporation in production testing routines.

Full technical information on this and other frequency measuring equipment is available on request.

SALES AND SERVICING AGENTS:
Hawnt & Co. Ltd., 59 Moor St. Birmingham, 4
Atkins, Robertson & Whiteford Ltd., 100 Torrisdale Street. Glasgow, S. 2
F. C. Robinson & Partners Ltd., 122 Seymour Grove, Old Trafford, Manchester, 16
Improved beam focus and picture positioning with minimum effect on scan coils and ion trap assemblies.

- Fitted with latest type dual "Magnadur" sintered Oxide Magnets.
- Magnets DO NOT ROTATE during adjustment.
- Friction damping ensures smooth positive movement without backlash.
- Rapid and easy adjustment of focus and picture position.

RETAIL PRICES IN U.K.

- Type FD12/90 (Low flux) .................. 22/6
- Type FD13/90 (Medium flux) ............. 23/-
- Type FD14/90 (High flux) ............... 25/-
USE OUR TECHNICAL ADVISORY SERVICE

If you are faced with a winding problem please ask for assistance; BICC technicians are always willing to give you the benefit of their experience. For most winding wire jobs the Publications listed will provide the data you require. They are available on request.

BRITISH INSULATED CALLENDER’S CABLES LIMITED

No. 266 Insulated Winding Wires and Strips.
No. 295 "Bicaloc" Winding Wires (Self Bonding).
No. 303 Enamelled Oil Base Winding Wires.
No. 322 "Bicalex" Winding Wires (Synthetic Enamel).
No. 328 "Fifty - Three" Enamelled Winding Wires.
B.C.C. V.H.F. COMMUNICATIONS EQUIPMENT PROVIDES
CONTINUOUS CONTROL
IMMEDIATE ACTION
UNRESTRICTED MOBILITY

B.C.C. COMMUNICATIONS EQUIPMENT FEATURES:
* OUTSTANDING PERFORMANCE
* RELIABILITY
* EASE OF MAINTENANCE
* ECONOMY OF OPERATION

BRITISH COMMUNICATIONS CORPORATION LIMITED
SECOND WAY, EXHIBITION GROUNDS
WEMBLEY, ENGLAND
TELEGRAMS: BEECEECEE
Building your own recorder?

BURGOYNE

TWO-SPEED TAPE DECK

Here is the heart of your Tape Recorder. If you are building or modernising your own equipment, you MUST have the BURGOYNE Tape Deck giving 2 speeds, designed for building into complete recorders, and IDEAL for PRE-RECORDED TAPES.

BRIEF SPECIFICATION

☆ 2 HOURS’ PLAYING TIME ☆ Automatic speed change ☆ Drop-in tape loading ☆ Instantaneous and positive braking ☆ Minimum wow and flutter ☆ Frequency range 50/10,000 c/s at 7fin./sec. ☆ Powered by 3 high-grade motors ☆ Twin-track high impedance heads ☆ Fast forward and rewind without unloading tape ☆ Overall size 11fin. x 14fin. ☆ For 200/250 v. A.C.

THE EDITOR TWO-SPEED

Easy to carry—easy to look at, the “Editor” is the smallest mains-operated fully automatic two-speed recorder with 7fin. spools. Twin track heads; INDEPENDENT BASS AND TREBLE controls for recording and playback; two hours’ playing time at 7fin. per sec. Amplifier may be used independently for high quality record reproduction. IDEAL FOR USE WITH PRE-RECORDED TAPES. Fitted in handsome two-tone case with attractive gilt fittings. For 200/250 v. A.C. mains.

£13.19.6

Or on Easy Terms

... or looking for a complete unit?

WE CAN OFFER FROM STOCK
ANY OF THESE POPULAR RECORDERS

THE EDITOR SUPER

The de luxe version of the “Editor” two speed. Incorporates mixing and monitoring facilities and single knob control super tape deck. Fitted in padded simulated crocodile case.

Complete with microphone and tape

£45.00

Or on Easy Terms

THE PLAYTIME PLUS

The smallest lightweight COMPLETE Tape Recorder giving a FULL HOUR’S PLAYING TIME. Complete and ready to use with a self-contained wide range amplifier and high flux elliptical loudspeaker. Simple to operate—joystick control for all operations. Fitted in elegant two-tone suitcase only 12fin. x 10fin. x 5fin.—total weight less than 20 lb. For A.C. mains. Additional Facilities for use as an Amplifier.

35 gns.

Complete with microphone and tape

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BUY ON THE M.O.S. PERSONAL CREDIT PLAN

Send 15 per cent deposit with your order, with remainder spread over any period up to 18 months. All proprietary brands of equipment advertised in this Journal are available from us under the M.O.S. Personal Credit Plan.

E. & G. MAIL ORDER SUPPLY CO.

The Radio Centre
33, Tottenham Court Road London · W.I · Tel. MUS 6667
The **SCALAMP** Range

**GALVANOMETERS · FLUXMETERS · ELECTROSTATIC VOLTMETERS**

The illustration above shows the operator 'balancing the coil' of a "SCALAMP" GALVANOMETER — one of the final operations in its construction. This instrument, available in a range of sensitivities and incorporating a built-in four-position shunt, is one of the most versatile instruments of its kind. Housed in a robust dust-proof plastic case, it can be operated from mains or battery supply. Two new features, namely a slow-motion drive to the zero control, and an automatic self-shorting foot have recently been incorporated.

The truly functional design of the case with built-in lamphouse, transformer and scale renders it adaptable to other instrument types. A FLUXMETER of exceptional performance and a series of ELECTROSTATIC VOLTMETERS (ranges 1-5, 3-10 and 5-18 kV) have already been introduced and a MEGOHM-PER-VOLT VOLTMETER is under development.

Details of the "SCALAMP" range will gladly be sent on request.

**STANDARD EQUIPMENT IN MANY LEADING LABORATORIES**

**SCIENTIFIC INSTRUMENTS**

W. G. PYE & CO. LTD. GRANTA WORKS · CAMBRIDGE · ENGLAND
PAINTON "MULTICON" PLUGS AND SOCKETS

COMMERICAL RANGE
2 pole 4 pole 6 pole
8 pole 12 pole 18 pole
24 pole 33 pole and 10-in-line unitor.
Voltage Rating: 500 volts.
D.C. or A.C. Peak.
Current Carrying Capacity:
5 amps. D.C. or A.C. (R.M.S.) per contact.
Average Contact Resistance:
Less than 0.005 ohm.
Single-piece moulding ensures satisfactory operation under severe tropical and climatic conditions.

SERVICES RANGE
6 pole 12 pole
18 pole 24 pole
Voltage Rating, Current Carrying Capacity and Average Contact Resistance are the same as for the Commercial Range.
Two-piece die-cast cover enables soldered joints and cable-clamping arrangements to be inspected easily.
Single-piece moulding ensures tropical and climatic performance in accordance with RCS.321 standards.

PAINTON
Northampton England
These versatile resins have a remarkable range of characteristics and uses. They combine excellent adhesion with insignificant shrinkage on setting, flexibility with toughness, outstanding electrical properties with resistance to chemicals and exposure.

They are used:
- for bonding metals and ceramics
- for potting and sealing electrical components
- for producing glass cloth laminates
- for producing jigs, fixtures, patterns and tools
- as fillers for sheet metal work
- as protective coatings for metal surfaces

Full details will be sent gladly on request. Redd. trade mark.

Aero Research Limited
Duxford, Cambridge
HIGH-STABILITY
Magnetic Amplifiers

SINGLE-STAGE OR PUSH-PULL
An extensive range of standard types always available for prompt delivery
SPECIAL TYPES DESIGNED TO SUIT YOUR NEEDS

THE WORLD-RENNOWNED SPECIALIST DESIGNERS
AND MANUFACTURERS OF MAGNETIC AMPLIFIERS

Now FREE to all!

THE E-M TECHNICAL ADVISORY SERVICE
Regardless of whether your magnetic amplifier problem is simple or complex, the fact remains that the only reliable solution is that which entirely eliminates risk.

We therefore respectfully invite you to avail yourself of the wide resources of technical knowledge and practical experience possessed by the specialist technicians of our Magnetic Amplifier Division.

ELECTRO METHODS LTD, 12-36 CAXTON WAY, STEVENAGE, HERTS. Phone: STEVENAGE 780

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12-36 CAXTON WAY, STEVENAGE, HERTS. Phone: STEVENAGE 780
The Invisible link with the Isolated Community

V.H.F. RADIO TELEPHONE

* No Change in Normal Telephone Operating Procedure
* Mains or Battery Operation
* Signalling Units for All Types of Circuit

The V.H.F. link provides the most practical means of direct communication between isolated communities in all areas where the nature of the terrain or distance involved preclude the use of open wires for junction or subscribers' lines. Dialling facilities can be employed, and the radio equipment can be interposed in a standard line circuit in any part of a telephone system without modification to switching equipment.

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.

AT14511-Bx107
We are now specialising in the supply of units
Our Chief Engineer, who is operating a Technical
No. 1 "SYMPHONY" AMPLIFIER is a 3-channel
Manufacturer-to-Consumer policy saves you at least one-third cost!
Scratch-Cut is
and opposite to the resultant curve of the other items in
Full provision and power for Tuner. Output tapped 3, 7.5
113/4/2 respectively.
No. 2 "SYMPHONY" AMPLIFIER as No. 1 but with
SCRATCH-CUT is a non-reflective negative-feedback
circuit employed. The Amplifier can accommodate a wide
variety of records from old 78s to new L.P.s.
This flexibility of control is far more impor-
tant than mere nominal linear response of the amplifier,
as the pickup, speaker, etc., are not linear. Independent
Scratch-Cut is 10/14/-, or with two separate high fidelity
heads respectively.
 immediate delivery at present.
NOW ROUND THE CORNER.
Highly efficient AM/FM TUNING and COIL
ASSEMBLY with I.F. Transformers and Discriminator
Model No. 1 is suitable for building AM/FM Radio
Receiver or Tuner. (Complete circuits supplied.)
WONDERFUL THINGS TO COME!
ENIETS for the AXIOM 150 Mark
Goodmans.

CURRENT GARRARD, COLLARO & B.S.R. PRODUCTS
AVAILABLE FOR IMMEDIATE DELIVERY FROM
STOCK AT PRESENT.
MODEL TA 3-speed unit, with plug-in turnover head
Type G.C.C., £10/16/-. or with Acos HGP 33 or 37 heads,
£11/16/- or £12/17/-. Unique light heads, £8/11/-. post 2 Heads, £4/2/-.
MODEL TB as above, but with long pickup arm. Less
heads, £8/11/-. post 2/6.
Head to fit Detonator Mark II, Deca XMS, 54/6, Deca Crystal,
30/,-, Garrard Standard Magnetic, 30/-, Garrard
Magnetic high impedance, 38/-. post on heads 1/,-.
MODEL RC5M AUTOCHANGER. We recom-
Endow the Deca XMS, 54/6, Deca Crystal, 30/,-, Garrard
Standard Magnetic, 30/-, Garrard
Magnetic high impedance, 38/-. post on heads 1/,-.
MODEL RC8BM AUTOCHANGER. We recom-
Endow the Deca XMS, 54/6, Deca Crystal, 30/,-, Garrard
Standard Magnetic, 30/-, Garrard
Magnetic high impedance, 38/-. post on heads 1/,-.
MODEL PC8 PICKUP AND HEADS. Studio
Transcription Pickup Arm, 13/10. Studio Pickup head type "O" or "P"
with bronze escutcheon provided. £3/10/-.
Pickup complete £3/14/7. Studio Transcription
Pickup Arm with Studio "P" head, £4/11/9. Disc with
Transcription head, £6/2/5.
COLLARO 3-SPEED SINGLE RECORD UNIT AC35
COLLARO 3-SPEED MIXED DESIGN AUTOCHANGER RC54. Both above fitted with
either Type "O" or "P" pickup heads with permanent sapphire styli. Price £8/18/4 and
£13/4/2 respectively. Transcription cartridge 6/9 extra.
COLLARO 3-SPEED SINGLE RECORD UNIT AC35
MK. I, £13/9/6. Model 2010, including Transcription
pickup and PX cartridge, £11/12/-. Carryage 5/-
either case. This model is ideal for the W.E. HF 102 (See "The
Gramophone" review March).
TREBLE BALEFF veneered to match, optional extra 5/-.
CONSOLE AMPLIFIER CABINETS. 33in.
high, consists of fully cut-in, thick, heavy insulating
non-resonant patent acoustic box, deflector plate, felt,
screws, etc., and full instructions. 8in. speaker model,
£9/4/-. 10in. speaker model, £10/15/-. Price £5/7/6. The design is the final result of extensive research in
to sound waves and complete absence of background
acoustic results. Carriage 7/6. Ready built, 10/- extra.
SYMPHONY BASS REFLEX CABINET KITS
High, consist of fully cut-in, thick, heavy insulating
non-resonant patent acoustic box, deflector plate, felt,
screws, etc., and full instructions. 8in. speaker model,
£9/4/-. 10in. speaker model, £10/15/-. £5/7/6. The design is the final result of extensive research in
to sound waves and complete absence of background
acoustic results. Carriage 7/6. Ready built, 10/- extra.
SYMPHONY BASS REFLEX CABINETS. Fully finished in figured walnut, oak or mahogany to
our own design and to match our Console Amplifier
Cabinets, enabling the housing of a whole equipment in a
two-piece suite: cost: 12in. speaker model, £11/10/1-
10in.: £11; 8in.: £10/10/-. Carriage according to area.
The 10in. model ideal for the W.E. HF 102 (See "The
Gramophone" review March).
TREBLE BALEFF veneered to match, optional extra 5/-.
CONSOLE AMPLIFIER CABINETS. 33in.
high, consists of fully cut-in, thick, heavy insulating
non-resonant patent acoustic box, deflector plate, felt,
screws, etc., and full instructions. 8in. speaker model,
£9/4/-. 10in. speaker model, £10/15/-. £5/7/6. The design is the final result of extensive research in
to sound waves and complete absence of background
acoustic results. Carriage 7/6. Ready built, 10/- extra.
L』"SYMPHONY" RADIO FEEDER UNITS
No. 1 "SYMPHONY" TUNER A T.R.F. model designed for the
latest version to take
22 Ens.
price 13/- a card.

"SYMPHONY" RADIO FEEDER UNITS
No. 1 "SYMPHONY" TUNER A T.R.F. model designed for the
latest version to take
22 Ens.
price 13/- a card.
The GFT.560/2 is a 2-3 kW channelised transmitter with a frequency range of 1.5-30 Mc/s. It consists of three basic cabinets—r.f. unit, modulator unit, and power supply unit—combinations of which can be used to provide multi-frequency working as well as a number of different types of emission. The wave change facilities of the transmitter are both rapid and reliable—a valuable asset when the operating frequency is changed many times each day. The GFT.560/2 is fully tropicalised, and its unit construction facilitates future expansion of the initial installation, should the need arise.

For use in conjunction with the GFT.560/2 there are ancillary units that enable the transmitter to be remotely controlled over a two wire telephone circuit: operational adjustments are dialled to the transmitter.

The versatility and reliability of this new Mullard transmitter make it particularly suitable for h.f. en-route, ground-to-air services and point-to-point communication networks. A team of Mullard communication engineers is available to advise on the use of the GFT.560/2 in such applications.

**ABRIDGED DATA**

- **Frequency Range**: 1.5-30 Mc/s
- **Frequency Stability**: To Atlantic City 1947 standards
- **Power Output**: 3kW, c.w., 2kW m.c.w. or r/t
- **Types of Emission**: c.w., m.c.w., telephony, frequency shift A1, A2, A3, F1
- **Output Impedance**: 600 ohms balanced twin feeder
- **Power Supply**: 400V, 50-60 c/s, 3-phase
THE
Concertone
for
Incomparable
perfection ★
and
fidelity ★
in
TAPE RECORDING

Meticulously recording every tonal facet with complete mastery, the "Concertone" tape recorder will give you the ultimate listening pleasure that comes from superb music faultlessly recorded and reproduced.

The "Concertone" will re-create, in the home, the true image of the original performance. Whether it be Solo Violin or Oboe, or a Full Organ with its demanding power and range, the "Concertone" with its wide frequency response, and extended dynamic range, will satisfy the connoisseur of fine music.

Simple, absolutely reliable, rugged, compact, lightweight, and easily portable, the "Concertone" will, wherever there are sounds to be recorded, serve faithfully, earning, justly, unqualified praise for its faultless performance.

Manufactured by the company in its own precision machine shop, the tape mechanism employs three motors and a special design servomatic brake. The brake not only locks the spools securely during transit but, of greater importance, it is completely free from fade, being self-compensating for wear. Unique is the provision of a mechanical interlock which prevents faulty operation.

Entirely Manufactured by
FISHER ELECTRONICS COMPANY LTD.

70 BREWER STREET · LONDON · W.1
TELEPHONE · GERRARD 3376
The contents include:

- Barretters
- Cathode ray tubes
  (instrument and special types)
- Electrometer valves
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- Photoelectric cells
- Photoelectric industrial aids
- Semi-conductors
- Voltage stabilisers

Write to

OSRAM VALVE AND ELECTRONICS DEPT. FOR

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2
This Pye VHF Fixed Station is designed for service anywhere in the world. Robust, simple to operate and of small dimensions, it is specially suitable for point-to-point Radio Links or for mobile schemes. In the aeronautical band it provides a most efficient ground-to-air control station. The equipment can be supplied with or without remote control facilities.
Whatever the recorder
Choose—

MAGNETIC RECORDING PAPER BASED TAPE

- MANUFACTURED BY ONE OF THE COUNTRY’S LEADING POWDER METALLURGICAL LABORATORIES
- MIRROR SMOOTH FINISH DESIGNED TO REDUCE FRICTION AND WEAR ON HEADS
- EMBODYING QUALITIES FOUND IN THE MORE EXPENSIVE TAPES
- 7" DIA. IMPROVED UNIVERSAL SPOOL CONTAINING 1,200 FEET
- LET THIS NEW TAPE “SPEAK FOR ITSELF”

RETAIL PRICE £1 WITH FULL TRADE DISCOUNT

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PEEL WORKS • SILK STREET • SALFORD 3 • LANCs
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A Subsidiary of THE GENERAL ELECTRIC COMPANY LTD. OF ENGLAND
The answer, of course, is when it’s a UNISTOR ... from that useful range of asymmetric resistors made by Standard. SenTerCel Unistors have a wide field of application in electronic circuits, particularly those associated with digital computers and other equipments of a similar nature.

Four current ratings are at present available... 0.25 mA, 1.5 mA, 7 mA and 10 mA at various D.C. voltages between 20 and 100V.

Here are some specimen data.

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SenTerCel UNISTORS

(asymmetric resistors)

Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, W.C.2

RECTIFIER DIVISION: Edinburgh Way - Harlow - Essex

Telephone: Harlow 26811

Telegrams: Sentercel, Harlow
RCA's new design sets Tomorrow's standard for radio telegraph transmitters

NEW RCA ET-18 15KW radiotelegraph transmitter uses latest multigrid tubes for self-neutralization. Ideal harmonic suppression (no interference with TV or other signals); exceptional circuit stability.

Revolutionary Advance in Frequency-Shift Telegraphy—RCA's years-ahead ET-18 15KW transmitter—efficient, reliable, versatile. A modulator is available to convert it for 10KW broadcasting, AM telephony, or single sideband telephone and telegraph transmission. The ET-18 provides full power output over the entire 3.2 to 24 mc range. There are only three radio-frequency power stages between the 2-watt frequency-shift keyer and full power output; and all power amplification is at operating frequency.

Lowest cost. Self-contained and factory-wired except for one external power transformer, the entire unit occupies only 25.8 sq. ft. of floor space—may be located in existing building without expensive alterations. With minimum instruction, non-technical personnel can operate the ET-18. It requires attention only when frequency is to be changed. And the total number of components has been decreased, reducing your replacement problems. Difficult-to-service mechanisms have been eliminated.

As a long-range investment, the ET-18 has no peer. For complete information, see your RCA distributor or write:

RCA INTERNATIONAL DIVISION
RADIO CORPORATION OF AMERICA
RCA BUILDING
30 ROCKEFELLER PLAZA, NEW YORK N.Y., U.S.A.
Illustrated are 5 of the 16 new aerials now available for the reception of Band 3 transmissions in Channels 8 or 9 and at prices that reflect the careful planning and thought that has gone into their construction! Our wide experience gained from AntifERENCE factories on the American continent has played a large part in the development of this completely new range of aerials designed for efficiency—with economy. All the fine features of the AntifERENCE Band 1 range are incorporated in these models; they are easy to install, being fully pre-assembled and aligned for peak performance on the Band 3 frequencies.

When ordering, please quote Channel for which aerials are required.

E.g., CAT. No. 350/2D/... (quote Channel reference here).

The complete ANTIFERENCE range includes aerials for Band 1, Indoor and Outdoor, Band 2, Indoor and Outdoor, and several “Addex” Units for converting existing Band 1 aerials to dual Band reception.
The Advance type B4 is a tried and proven generator which is essentially simple to use. One special feature is the accuracy of the R.F. output over the entire frequency range, achieved by the use of a crystal voltmeter and the subsequent elimination of all circuits having poor frequency characteristics.

MODEL A 100 kc/s—80 Mc/s in six bands
MODEL B 30 kc/s—30 Mc/s in six bands
Calibration accuracy of both models is ±1%

ADVANCE TYPE B4
Nett price in U.K. £60.0.0

Full technical details in Folder W11

Advance signal generator
GOODMANS are manufacturers of the widest and most versatile range of loudspeakers in the World. The units in the “commercial” range, some of which are shown above, are made to the same high standards of quality and excellence of design which have for so long been associated with Goodmans tradition of excellence.

GOODMANS INDUSTRIES LTD.
AXIOM WORKS - WEMBLEY - MIDDX - WEMBLEY 1200

U.S.A. AGENTS: ROCKBAR CORPORATION INC.
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SPECIALIZE

in equipment for the DEAF
and for PHYSIOTHERAPY

The MINUET

ALL-TRANSISTOR HEARING AID

This 4-stage Resistance Capacity Coupled Transistor Amplifier has a crystal microphone and is powered by the small Mallory cell Type RM625. It is, we believe, the lightest, slimmest and most elegant 4-stage Hearing Aid in existence.

★ Weighs only 1 oz. complete.
★ Can be worn by ladies in the hair; by men, behind a coat lapel or necktie.
★ The single battery lasts approx. 200 hours. NO high tension battery required.
★ Two-position Tone Control; ample volume for the majority of the hard-of-hearing.

Inquiries should be addressed to
MULTITONE ELECTRIC CO. LTD.
PIONEERS IN SOUND AMPLIFICATION

HARTLEY-TURNER

SOUND EQUIPMENT

Over the past few months we have devoted our space in this journal to an item by item description of our major products.

Whether you require a complete sound reproduction equipment including everything from the pick-up to the loudspeaker, or whether you require only one item, whether you require your old radiogram cabinet to be fitted with up-to-date equipment, or whether you require a long-play record in mint condition, we are always at your service.

Why not write today for details of our sound reproduction equipment and our long-playing record postal service?

Full details and illustrated literature sent free and post free on request to:

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152, HAMMERSMITH ROAD,
HAMMERSMITH, LONDON, W.6.

Telephone: RIVerside 7387

Special Note for Overseas Dealers:
If you require any items of communication equipment and are not already served, our Purchasing and Export Departments can help you. Let us know your requirements.
new world-beating
‘SCOTCH BOY’
extra-play
magnetic recording tape
190m

THE FINEST BASE-FILM EVER MADE
The astonishing new polyester base-film for ‘Scotch Boy 190M,’ is so much stronger than other tape bases that it can be made 33⅓% thinner—and still be stronger. This means you get 50% more length—and 50% EXTRA PLAYING TIME—on the same-sized reel. Polyester film is a naturally limp and flexible material, and is little affected by temperature and humidity changes. ‘Scotch Boy 190M’ tape conforms snugly to recorder heads, is easy to handle, winds trimly, and tracks smoothly. It has an indefinite life in storage, and is an ideal tape for archive purposes.

NEW THIN COATING
The new and potent oxide coating of ‘Scotch Boy 190M’ tape gives clear, crisp reproduction of every frequency in the audible range. High-frequency response shows a specially notable improvement. Output variations from reel to reel and within each reel are remarkably small and, as with all Scotch Boy tapes, background noise is negligible.

THE WORLD’S FINEST TAPE
‘Scotch Boy 190M’ has been developed and produced in Britain by the 3M Company. Its appearance in Britain is its first appearance in the world. This is a landmark in the development of tape recording.

‘SCOTCH BOY’ 190m
MAGNETIC RECORDING TAPE
with polyester base

MINNESOTA MINING & MANUFACTURING CO. LTD.
LONDON, BIRMINGHAM, MANCHESTER AND GLASGOW.
CORDIALLY INVITE ALL HIGH-FIDELITY ENTHUSIASTS TO 
visit our Regent Street showroom

★ We can offer direct, comparative demonstrations—under identical conditions—of the accepted best in high quality audio amplifiers and loudspeakers.

Demonstrations of high fidelity equipments:
Daily 10.30 a.m.—1.30 p.m.
Saturday 10.30 a.m.—12.30 p.m.

B. K. PARTNERS LTD.
229, REGENT STREET, LONDON, W.I. (ENTRANCE HANOVER STREET) Phone: REG 7361

A SOUND TIE UP

★H.P. TERMS AVAILABLE

“WILLESDEN” TRANSFORMERS
for all
ELECTRONIC & TELECOMMUNICATION REQUIREMENTS

WILLESDEN TRANSFORMER CO. LTD., 2a, FRITHVILLE GARDENS, SHEPHERDS BUSH, LONDON, W.12. Telephone: SHE 5819, 2714.
ICI proved filtex units with Ferroxcube pot cores

1 High performance combined with small size and light weight.
2 Designed and built to customers' individual requirements.
3 Long term stability, even under conditions of temperature variation.

High quality electrical filter units built around Ferroxcube cores can now be supplied to communications equipment designers' individual specifications. These filter units have significant advantages over comparable types designed without the use of Ferroxcube, particularly in the frequency range 300 c/s to 500 kc/s. For audio frequencies the use of Ferroxcube cores permits the winding of compact coils with very high inductances. This results in a considerable reduction in the size and cost of the associated condensers and hence of the filter unit as a whole. The high Q values obtained for a given volume, especially above 10 kc/s, enable sharp cut off characteristics and low pass-band losses to be achieved, while negligible stray flux facilitates the production of compact and mechanically robust filters. Electrical filter units are among a number of high quality components now being made available by Mullard. Full details of the complete series of components will be gladly supplied upon request.

Mullard

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SOLDER INSTRUMENTS
for MINIATURE and
SUB MINIATURE WORK
by

ADCOLD
(Regd. Trade Mark)

SPECIAL FEATURES
1. Traditional British quality.
2. Designed temperatures.
3. Weight 2 oz. (excluding flex)
4. Length 8in.
5. 18 watts.
6. Practical temperature for high class solder jointing.

Illustrated
ListNo.70
(Actual Size)

Supplied in all volt ranges

Models to cover all fields of the Radio, TV, and Electronic Industry.

For all Soldering Instruments and Allied equipment,

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an open
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Deaf Aids
Private Telephone Installations
Amplifiers
D.C. Power Units
Spot Welding Equipment
Test Gear
Magnetisation Equipment

You are invited to regard the TECHNICIANS at DALY as a part of your own technical staff. Non-standard components are invariably a source of worry, therefore the Electrical Industry find the DALY "made-to-measure" service for individual requirements specially helpful and a great time-saver.

For URGENT problems a telephone request will bring us post haste to your factory for consultation without obligation—and you will find our readiness to help both valuable and economic.

DALY ELECTROLYTICS for ELECTRONICS and COMMUNICATIONS... MOTOR START... RADIO and T.V. are in great demand throughout the world; send for appropriate pamphlet.

DALY ELECTROLYTIC CAPACITORS
CONDENSER SPECIALISTS FOR OVER 20 YEARS
DALY (CONDENSERS) LTD., WEST LODGE WORKS, THE GREEN, EALING, LONDON, W.5
Phone: EALing 3127-8. Cables: DALYCON, LONDON
JUST RELEASED!

Taylor TV Sweep Oscillator
Model 92A
For Band III and F.M. Alignment
Covering Band III
Frequency-modulated oscillator designed for the rapid and accurate alignment of TV receivers. Also suitable for checking band pass amplifier and for alignment of F.M. receivers.
Frequency range: 5-250 Mc/s.
Frequency deviation: Continuously variable to approx. 15 Mc/s.
Output: 40 microvolts to 2 millivolts continuously variable.
Freq. Mod. Substantially linear to 6 Mc/s.
sweep width—less than 10% max. sweep.
Sweep: Sweep voltage continuously variable to a max. of 300 v. R.M.S.
Cash Price £30/- Prompt Delivery
AVAILABLE ON ADVANTAGEOUS H.P. TERMS

NEW TAYLOR VALVE TESTER
Model 45c
A Comprehensive valve tester which may be used to measure the mutual conductance of most types of British, American and Continental receiving valves. Measures for over 4,000 different valves.

TESTING FACILITIES
Mutual Conductance. Two ranges: 0-3 m A/V and 0-15 m A/V.
Cathode Leakage. Tests for Heater/Cathode insulation up to 10 megohms, with heater hot. Emission. Rectifiers and Diodes may be tested for emission.
Inter Electrode Shorts. Short circuits between electrodes are shown on the meter. Heater Continuity. Meter indicates continuity of heater or filament.
Gas Tests. Press button "gas" tests shows abnormal positive or negative grid current. TV tube adaptor to check most tubes can be supplied separately.
Price £27-10-0 Prompt delivery
AVAILABLE ON ADVANTAGEOUS H.P. TERMS.

See them all on STAND 27. Block A. British Instrument Industries Exhibition (June 28-July 9).

Separate leaflets giving full technical details available. All other Taylor Instruments available on H.P. Write for catalogue and details of H.P. terms.

ELECTRICAL INSTRUMENTS LTD.
THE A.10 AMPLIFIER
Output: 10-12 watts Ultralinear.
Distortion: 0.1% total harmonic at 5 watts.
Frequency Response: within 1 dB 15-20,000 cps.
CONTROLS
1. Input — 4 position.
2. Equaliser — 4 position.
3. Treble-Lift and cut giving ± 15 dB continuously variable.
4. Treble-Lift and cut giving ± 15 dB continuously variable.

THE F.M. 56 TUNER
Coverage: 85-90 m.c.s.
Image Rejection: 26 dB.
I.F. Rejection: 60 dB.
Output: 3 volts r.m.s.
Circuit: a low noise triode R.F. stage is coupled to a high stability frequency changer. This is followed by two I.F. stages and a triple diode triode ratio detector and A.F. stage.
Values: The latest type Mullard EXT 55, EF 85, EABC 80, EM 84.

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For full information on the Reflectograph Range write to the Manufacturers
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<tr>
<th>Mod.</th>
<th>Consumption</th>
<th>Voltage</th>
<th>Bit Diameter</th>
<th>Weight</th>
<th>Price</th>
<th>Spare Bits</th>
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<tbody>
<tr>
<td>12</td>
<td>12 watts</td>
<td>6, 12, 24 or 50</td>
<td>3/16in. (4.8 mm.)</td>
<td>0.5 oz.</td>
<td>25/-</td>
<td>2/-</td>
</tr>
<tr>
<td>9</td>
<td>8.3 watts</td>
<td>6, 12 or 24</td>
<td>5/32in. (4 mm.)</td>
<td>0.25 oz.</td>
<td>25/-</td>
<td>1/8</td>
</tr>
<tr>
<td>6A</td>
<td>6 watts</td>
<td>6 only</td>
<td>3/32in. (2.4 mm.)</td>
<td>0.25 oz.</td>
<td>25/-</td>
<td>1/8</td>
</tr>
<tr>
<td>6</td>
<td>6 watts</td>
<td>6 only</td>
<td>1/16in. (1.6 mm.)</td>
<td>0.25 oz.</td>
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(Actual sizes shown)

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Max. cathode current 800mA

The Ediswan Mazda 13.E.1 is a new beam tetrode with a high slope and good power handling capacity for use as either a series or shunt control valve in stabilised power supplies. It is also eminently suitable for servo control motor systems.

In either of these functions the 13.E.1 can usually be used in place of two or three smaller valves thereby saving space and simplifying wiring because multiplicity of connections, grid and anode stopper resistors etc., are avoided, and this, in turn, gives the additional advantage of improved circuit stability.

The 13.E.1 has a B.7A. all glass base and is intended for vertical mounting. All maximum ratings shown below are absolute values, not design centres.

<table>
<thead>
<tr>
<th>RATING</th>
<th>BASE CONNECTIONS = B.7A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vh</td>
<td>26.0 v 13 v</td>
</tr>
<tr>
<td>Ih</td>
<td>1.3 A 2.6 A</td>
</tr>
<tr>
<td>Va max</td>
<td>800 V</td>
</tr>
<tr>
<td>Vg2 max</td>
<td>300 V</td>
</tr>
<tr>
<td>Vg1 max</td>
<td>-100 V</td>
</tr>
<tr>
<td>Wa max</td>
<td>90 W</td>
</tr>
<tr>
<td>Wg2 max</td>
<td>10 W</td>
</tr>
<tr>
<td>Ia Max</td>
<td>800 mA</td>
</tr>
<tr>
<td>Vh/k max. (cathode+VE)</td>
<td>300 V</td>
</tr>
</tbody>
</table>

Pin 1 h
Pin 2 h tap
Pin 3 gl
Pin 4 k
Pin 5 g2
Pin 6 a
Pin 7 h

EDISWAN
MAZDA
VALVES AND CATHODE RAY TUBES
THE EDISON SWAN ELECTRIC CO. LTD.
Member of the A.E.I. Group of Companies
Why juggle with corrections?

OUR NEW B.800 INCREMENTAL INDUCTANCE BRIDGE

operates under working conditions and frequencies
50 mH to 500 H
at any frequency from
25 c/s to 3 Kc/s
with superimposed d.c. from
0 to 1.5 A

Variable a.c. excitation measured across the component under test.
Direct reading of L and Q.
Logarithmic multi-range null indicator.
Selective amplifier ensures sharp balance free from waveform error.

Furzehill Laboratories Ltd.

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Every seagoing vessel in this electronic age relies on Marine Communication Equipment.

Our contribution is a specialised range of reliable Headphones which provide ships' operators with the clearest possible reception of all signals—Morse or speech.

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Telephone: Watford 7241.

GOODSELL LTD.

Type PFA Pre-amplifiers
The latest PFA unit is built especially for use with our range of Williamson Amplifiers. Separate bass and treble control in equaliser section. Low noise—high gain. 5 mv. input, 6 valves.

Price £20.

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From £13.17.6 plus Tax.

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Tel.: Brighton 26735
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36 SPECIALISTS

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Address

Occupation

Your Signature

(Or your Parent’s Signature if under 21)

RTRB 25
The NEW

PREMIER TELEVISOR

SUITABLE FOR USE WITH ANY POPULAR WIDE ANGLE TUBE

Brief Technical Details are as follows:

- 20 valves (plus tube) Superhet Receiver, tunable from 40-68 MHz, without coil or core changing. Wide Angle scanning Flyback EHT giving 14 kV. Duomag Focaliser, permanent magnet focusing with simple picture centering adjustments, suitable for any wide angle tube.
- VISION CIRCUIT: Common RF Amplifier, single valve frequency changer, two IF stages, Video Detector and Noise Limiter followed by special type of Video Output Valve. ALL COILS PRE-TUNED ASSURING ACCURATE ALIGNMENT AND EXCELLENT BANDWIDTH.
- SOUND CIRCUIT: Coupling from anode of frequency changer, two IF stages, Double Diode Triode detector and first LF Amplifier. Diode Noise Limiter and Beam-type Output Valve, feeding a 10 in. Speaker. ALL COILS PRE-TUNED.
- TIME BASES: 2 valve sync. Separator, giving very firm lock and excellent interlace.
- LINE TIME BASE: Blocking Oscillator using a pentode driving a high efficiency output stage comprising Ferroxcube Cored Output Transformer with Booster Diode.
- FRAME TIME BASE: Blocking Oscillator driving a Beam Output Valve coupled through a Transformer to the high efficiency FERROX-CUBE Cored Scanning Coils.
- POWER PACK: Double wound Mains Transformer supplying all L.T. and H.T. using two full-wave Rectifiers.

The Televisor may be constructed in 5 easy stages:
1. Vision
2. Time Base
3. Sound
4. Power Pack
5. Final Assembly

Each stage is fully covered in the Instruction Book, which includes layout, circuit diagrams and point-to-point wiring instructions.

Instruction book 3/6, Post Free.

MULTI-CHANNEL TUNER AVAILABLE SHORTLY — SEND FOR DETAILS

CONSOLE CABINETS

For 14", 16" and 17" Televisors

A handsome Walnut Cabinet that will be a fitting housing for a first-class Televisor. Folding doors are fitted to cover the Cathode Ray Tube when not in use. A flap is provided which gives access to the preset controls on the front edge of the Chassis. A baffle board suitable for a 10 in. Loudspeaker and all the necessary Tube and Chassis bearers are included. The overall dimensions of the Cabinets are the same: Height 38 in. Width 19 in. Depth Top 19 in. Depth Bottom 21 in.

TUBE ESCUTCHEONS

- 17in. White Moulded
- 17in. Bronze Moulded, complete with Protective Lid
- 14in. Black Moulded
- Dark Screen Filler suitable for 14in. Tube
- Dark Screen Filler suitable for 16in. and 17in. Tubes
- Polystyrene Mask for E.E.T.901
- Rubber Ring (Anti-Corona) for E.E.T.901
- Polystyrene Shield for E.E.T.901

Price £13-10-0

TERMS OF BUSINESS: Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-, 1/6 under 40/-, unless otherwise stated.
The New
"PREMIER PORTABLE"
TAPE RECORDER
USING THE NEW LANE 2-SPEED TAPE UNIT MARK 6
COMPLETE 39 GNS CASH
(Packing & Carriage 1/-)
(Including Reel of Scotch Boy Tape and Microphone)

H.P. Terms: Deposit £10.4.9 and 12 monthly payments of £2.16.11.
or Complete Kit including All Parts, Valves, Speaker Cabinet, Tape Unit, Reel of Scotch Boy Tape, Rewind Spool and Microphone at £37.4.0 plus pkg. & carr. 15/-.

H.P. Terms: Deposit £9.6.0 and 12 monthly payments of £2.11.9.

SPECIFICATION
* TWO SPEEDS 7½in. AND 9in. * 7-VALVE HIGH QUALITY PER SECOND AMPLIFIER.
* THREE ESPECIALLY DESIGNED RECORDING MOTORS.
* 1.5000FT TAPE REELS PRO-VISION PLAYING TIMES OF 1 HRS. AND 5 HRS.
* DROP-IN TAPE LOADING.
* EASY FORWARD OR REVERSE WIND WITHOUT REMOVING TAPE.
* ONE KNOB DECK OPERATION.

RECTIFIERS

<table>
<thead>
<tr>
<th>Type</th>
<th>E.H.T. Factual Type S.T.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>K</em>33/3</td>
<td>600 v. 1 ma.</td>
</tr>
<tr>
<td><em>K</em>33/4</td>
<td>550 v. 3 ma.</td>
</tr>
<tr>
<td><em>K</em>33/6</td>
<td>450 v. 6 ma.</td>
</tr>
<tr>
<td><em>K</em>33/8</td>
<td>250 v. 8 ma.</td>
</tr>
<tr>
<td><em>K</em>33/10</td>
<td>200 v. 10 ma.</td>
</tr>
<tr>
<td><em>K</em>33/12</td>
<td>150 v. 12 ma.</td>
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</table>

H.T. Type S.T.C.

<table>
<thead>
<tr>
<th>Type</th>
<th>150 v. 16 ma.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>R</em>41</td>
<td>250 v. 10 ma.</td>
</tr>
<tr>
<td><em>M</em>31</td>
<td>200 v. 7 ma.</td>
</tr>
<tr>
<td><em>R</em>44</td>
<td>150 v. 5 ma.</td>
</tr>
</tbody>
</table>

L.T. Type Full Wave

| 12 v. 1 amp. | 10 v. 2 amp. | 7 v. 4 amp. |

A RANGE OF BAND 3 AND F.M. AERIALS IS NOW AVAILABLE

Teletron Ferrite Rod Aerials, Medium Wave 8½, Medium/Long Wave 12/9.

Corner Reflex Cabinet for Goodmans Avox 150 to specification £12/10/0, pkg. and carr. 15/–.

ALUMINIUM CHASSIS 18½ in. x 9½ in. x 7½ in.

Substantially made from Bright Aluminium with four sides.

<table>
<thead>
<tr>
<th>7 x 8 in.</th>
<th>6 x 8 in.</th>
<th>5 x 8 in.</th>
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<tbody>
<tr>
<td>1½ in.</td>
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ALUMINIUM PANELS 18½ in. x 9½ in.

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<th>7 x 8 in.</th>
<th>6 x 8 in.</th>
<th>5 x 8 in.</th>
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<tbody>
<tr>
<td>1½ in.</td>
<td>1½ in.</td>
<td>1½ in.</td>
</tr>
</tbody>
</table>

CABINETS—PO RTABLE

Model PC/1
Brown Rexine covered. Overall dimensions 16½in. x 13½in. x 9½in. Clearances under lid 1½in., when closed 3½in. Hire purchase terms, Deposit £10.4.9 and 12 monthly payments of £1.2.9.

Model PC/2
Grey Lexan Rexine covered. Overall dimensions 16½in. x 13½in. x 9½in. Clearances under lid 1½in., when closed 3½in. Hire purchase terms, Deposit £10.4.9 and 12 monthly payments of £1.2.9.

All the above Cabinets are supplied with Panel, Carrying Handle and Clips.

PACKING AND POSTAGE 2/6.

FREQUENCY MODULATION
V.H.F. Tuning Unit type U740 permeability tuned, coverage 88-103 Mc., stage gain Aerial to output of fast I.F. (contained in Unit) approximately 300. Maximum frequency drift 0.70 degrees centigrade 10 kc. Radiation less than 30 microvolts per metre, price £9/5/1 including excise. Valves UC586.

I.F. type U.F.376 inter-stage, 9.7 Mc. Gain 40/50, coupling factor unity plus, 7%. Baffle Filter type UBF377 Q1-72, Q2-110, price 2/0/6.

Overall bandwidth of the above Units 150 kc.

Complete Handbook containing full details of construction and potentiometer wiring diagrams including also details of F.M. Aerials 2/6 post free.

QUALITY CRYSTAL PICK-UP ROTHER-MEL TYPE U48 2/6. - Plus 1/6 Pig. and Carr.

SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW.—
Amplifier (built, wired and tested with Speaker). £14/15/-, plus postage and carriage 7/6.
Hire purchase terms, Deposit £3/13/9 and 12 monthly payments of £1/9/6.
Amplifier Kit (including Speaker). £11/1/- plus packing and carriage 5/-.
Hire Purchase terms, Deposit £2/15/0 and 9 monthly payments of £1/9/7.
New Lane 2-speed Tape Unit Mark 6. £18/10/0 plus packing and carriage 7/6.
Hire Purchase terms, Deposit £4/12/6 and 12 monthly payments of £1/3/9.
Portable Cabinet (rexine covered). £4/19/6, plus postage and carriage 5/-.
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Instructioon Booklet. 2/6. Post free.
WIRELESS WORLD

WILLIAMSON AMPLIFIER KIT 15 m.s.

Full Scale Internal External Movement
2.5 A. 25 Mfd. 6 Mfd. 100 cycles
20 A. 25 Mfd. 3 Mfd. 1250 cycles
40 A. 30 Mfd. 1 Mfd. 1500 cycles
100 mA. 15 Mfd. 1 Mfd. 700 cycles
20 mA. 10 Mfd. 1 Mfd. 400 cycles
5 mA. 10 Mfd. 1 Mfd. 300 cycles
1 mA. 10 Mfd. 1 Mfd. 150 cycles

WILLIAMSON CHokes
12/110 m.A. Fully shrouded 19/6
30/10 m.A. Fully shrouded 11/9

BUILD THESE NEW PREMIER DESIGNS

3-BAND SUPERHET RECEIVER

MAY BE BUILT FOR £7.19.6

The circuit is the latest type TRF using 3 valves and Metal Rectifiers for operation on 200/250 A.C. mains. Waveband coverage is 180-350 metres, medium wave and 800-2000 metres on long wave. The dial is illuminated and the Valve line-up is 6K7 H.F. Pentode 617 Detector and 6V6-Output. The attractive Cabinets to house the Receiver size 12in. long, 6fin. high, 5fin. deep, can be supplied in either WALNUT or IVORY BAKELITE or WOOD. Instruction Book 1/- post free, which includes Assembly and wiring diagrams, also a detailed stock list of priced components.

DECCA MODEL 33A RECORD PLAYER

Adaptable for STND. or LP. The turntable is adjustable to play 10in., 12in. and 78 r.p.m. records. No. of speeds: 12. A wide choice of covers is available. Cloth or Vinyl - 6d., 1/-, 1/6.

Miniature Tuning Condensers 6,000 mfd. with trimmers.

MINIATURE TUNING CONDENSERS

MAY BE BUILT FOR £5.15.0

MAY BE BUILT FOR £7.8.0

TRF RECEIVER

In all models, the choke core is of heavy gauge enamelled wire. Rectifiers: E.E.T. 11/-, Power Transformer 25/-, Filter Cells 2/-.

MICROPHONES

Crystal Microphone - Othermel 2AD56, High Impedance Ball Type, 2E/101. Ronette Crystal Microphone Incorp. the Filter Cell Insert; 221151. Special Offer £1.20.

LOW NOISE ELITEPIA.


MINIATURE TUNING CONDENSERS

LIST PRICE

Sound Anything else that beats this, please send 4/- stamp for our 1955 CATALOGUE

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-250-350 volts, mains 40-100 cycles. All primaries are screened.

E.H.T. primary 210 v., 230 v., secondary 1.75 Kv., 2-3 a., 25/-.
E.H.T. TRANSFORMER, primary 210, 230 v., secondary 1.75 Kv., 2.5 A.
M.AINS TRANSFORMERS SP425A

WILLIAMSON OUTPUT TRANSFORMER

Author's Specification 3.6 ohms secondaries

M.E.H.T. TRANSFORMER, primary 210, 230 v., secondary 1.75 Kv., 2.5 A.

DEALER'S SPECIAL OFFER

MAINS NOISE ELIMINATOR KIT

A two-way transformer, one input and two outputs. The transformers are specified for all mains voltage and for all power frequencies. The transformer is guaranteed to meet the demand for an efficient variable noise eliminator and to provide a very simple installation. The transformer is guaranteed to give a noise reduction of 90% at mains frequency. The transformer is fully adjustable and is supplied complete with a noise eliminator, a noise reduction transformer, a noise eliminator, a noise reduction transformer, a noise eliminator, and a noise reduction transformer, a noise eliminator, and a noise reduction transformer.

BATTERY PORTABLE RADIO RECEIVER

4 miniature Valves in a Superhet Circuit covering medium and long waves. Receiver covered Cabinets 11fin. x 10in. x 5fin. in two contrasting colours. Wines with Grey Panel, or Blue with Grey Panel, please state choice when ordering. THE SET MAY BE USED EVERYWHERE WHERE home, office, car or holidays. Instruction Book 1/- (Post Free) which includes Assembly and wiring diagrams, also a detailed Stock List of priced components.
PREMIER RADIO COMPANY

LIMITED QUANTITY RADIOGRAM CHASSIS PUSH-PULL OUTPUT

PRICE £11-19-6


SELECTION OF H.P. ITEMS

GRUNDIG TX111. Cash price £6/10/- Deposit £3/4/- 12 monthly payments £7/1/6. Postage and packing 1/-.

TRUMOVX T10. Cash price £6/10/- Deposit £3/4/- 12 monthly payments £7/1/6. Postage and packing 1/-.

LEAK TL10 AMPLIFIER AND PREAMPLIFIER. Cash price £3/1/6 Deposit £1/6/- 6 monthly payments £1/1/6. Postage and packing 1/-.

TRUMOVX T11 DECK. Cash price £5/1/9/- Deposit £3/6/- 12 monthly payments £1/1/6. Postage and packing 1/-.

ELPICO TUNER UNIT MODEL RP700. Cash price £1/15/- Deposit £1/6/- 12 monthly payments £1/1/6. Postage and packing 1/-.

CABINET available for above Chassis in figured walnut lined with white sycamore, size 2ft. wide, 2ft. 6in. high, 1ft. 6in. deep, £15/1/11. Or on Hire Purchase Terms, deposit £4/1/9 and 12 monthly payments of £1/1/11. Packing and Carriage extra.

PORTABLE TAPE RECORDER CABINETS

All Rexine covered

TAPE DECK AMPLIFIER TYPE PRICE

Lace Mk. VI Premier Mk. VI £4/19/6
Truvox Mk. III H.P. £4/4
Truvox Mk. III Truvox C £4/4
Truvox Mk. III Premier £4/4

Plus Postage and Packing 5/-

We carry a comprehensive stock of components by all leading Manufacturers.

AND NOW . . .

A VASTLY INCREASED RANGE OF MOULDED KNOBS

The finest range in the country—and all from one source! These attractive knobs are available in many sizes and colours, with a choice of AN ENGRAVING FOR EVERY PURPOSE

All styles shown will accept 3in. diameter spindles. Prices are competitive, and delivery in the main is prompt. If you are a user of control knobs you should contact us right away for details. Attractive quantity rates will be quoted to bulk buyers. The full factor's preferential discount is applicable.

UNCLES, BLISS & CO. LIMITED

139, Cherry Orchard Road, East Croydon, Surrey. Telephone: Croydon 3379/6390.
Here is a brilliant new high-fidelity single record player which brings top quality reproduction within the reach of all record lovers.

The Regent HF.100 is built to the same high standard as the Monarch Autochanger. It plays all records, all speeds, all sizes. Its many features include: a new lightweight pickup incorporating a high-fidelity turnover crystal cartridge with dual sapphire styli; a concealed automatic stop which operates on all records, irrespective of run-off groove diameter; powerful constant-speed 4-pole motor ensuring smooth power and the well-known "Rotocam" speed change.

We shall be pleased to send you literature on request.

BIRMINGHAM SOUND REPRODUCERS LTD., OLD HILL, STAFFS
Managing Editor:
HUGH S. POOCOCK, M.I.E.E.
Editor:
H. F. SMITH

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Advertisement No. 30 in this series compared the germanium point-contact diode with the more familiar thermionic type, and discussed the significance of its characteristics. It was said that the main classification of germanium diodes was into low and high current types, which have, respectively, high and comparatively low reverse breakdown voltages. In the present advertisement typical applications of these two contrasted types of germanium diode are illustrated.

Reprints of these advertisements, supplemented by data for Mullard diodes, are issued free.

High Current Applications

A typical application is given in Fig. 1, which shows a video detector circuit using a Mullard OA70. The circuit operates at 30Mc/s, therefore the available recharging time for the capacitor is short, and the diode must have a low forward resistance which will pass a substantial charging current. The reverse resistance requirement is of rather less consequence. The value must be significantly greater than the 3.9kΩ resistor in order to prevent the capacitor discharging back through the diode. A value of 20kΩ is sufficiently high.

The OA70 fulfils these requirements. It has a low forward resistance (a typical diode will pass about 8mA for a voltage drop of 1 volt); and its reverse resistance is of the order of 100kΩ. The OA70 also satisfies another requirement which results from the high operating frequency: the completion of each rectification action in the diode must be rapid. This property (which is known as minimum hole storage) is comparable with rapid deionisation time in a thyratron. The OA70 is rated for use at frequencies up to 100Mc/s.

Fig. 2 shows a grid circuit limiter which is intended to prevent overload of the receiver during the warming-up period. The diode requirements are high forward current, a capacitance which is sufficiently low to avoid deterioration of the video frequency response, and a reverse resistance which is much greater than the forward resistance. The OA70 satisfies these requirements.

Low Current Applications

A low current type, such as the Mullard OA71, has, necessarily, a more negative turnover voltage and a higher reverse resistance than a high current type. This last characteristic is essential in some applications. For example, in a sound detector circuit the 3.9kΩ load resistor of Fig. 1 would be replaced by, say, 47kΩ, and the choice of diode lies between the OA70 (reverse resistance 100kΩ) and the OA71 (1MΩ), depending on the peak inverse voltage which will be encountered and on the value of the load resistor.

The noise limiter shown in Fig. 3 requires a diode with a high reverse resistance. A small current flows through the chain of 1MΩ resistors and holds the diode in its conducting region. The diode therefore provides a path for normal audio frequency signals. Interference, however, drives the diode into its reverse current region where the high reverse resistance virtually open-circuits the signal path.
Another first from BRIMAR—still another natural choice for the manufacturer who is looking for the finest. Here's a tube designed to be the finest. Here's a tube tested (and re-tested) at every stage of manufacture to meet the exacting demands of equipment manufacturers.

These are the features that have contributed to the Brimar success.

- Rectangular shape with maximum viewing area.
- Flat-faced to give wide-angle viewing.
- Aluminised screen for extra bright pictures.
- Highly efficient ion trap to minimise burns.
- External conductive coating.

Brimar by constant research and the use of modern manufacturing techniques will continue to meet the ever changing demands of electronic and radio engineers, by producing the efficient cathode-ray tube that the public demands.

Consult BRIMAR — the people who know — for your future equipment requirements.

Standard Telephones and Cables Limited
FOOTSCRAY • SIDCUP • KENT.
Telephone: FOOTSCRAY 3333
Bring your equipment up to date with

REPLACEMENT PICK-UP HEADS

If you already own a fine radiogram or record-player you now have the opportunity of rejuvenating it—of bringing it right up to date for a quite modest sum. Acos Hi-g crystal pick-ups are now available in a range of specially designed "plug-in" models to suit most famous makes of record reproducing equipment. These Acos "Hi-g" pick-ups, you will find, represent a truly phenomenal advance in pick-up design—with regard to both reproduction and tracking characteristics (so important with many of the new microgroove recordings). Ask your Dealer!

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HGP 37-I</td>
<td>A Hi-g pick-up head incorporating the HGP 37-I turnover cartridge with cantilever sapphire stylus.</td>
</tr>
<tr>
<td>Collaro</td>
<td>Ask for Data Sheet No. 4800.</td>
</tr>
<tr>
<td>HGP 37-I</td>
<td>A Hi-g pick-up head incorporating the HGP 37-I turnover cartridge with cantilever sapphire stylus.</td>
</tr>
<tr>
<td>Garrard</td>
<td>Ask for Data Sheet No. 4800.</td>
</tr>
<tr>
<td>HGP 39-I</td>
<td>Hi-g pick-up heads incorporating cantilever sapphire stylus. Separate heads for standard and microgroove records. Will fit the Acos GP 20 pick-up arm and the Garrard C type adaptor.</td>
</tr>
<tr>
<td></td>
<td>Ask for Data Sheet No. 4400.</td>
</tr>
<tr>
<td>HGP 35-I</td>
<td>Separate plug-in type Hi-g heads for standard and microgroove records; fitted with cantilever sapphire stylus. The crystal unit is identical to that of the HGP 39-I above. Can be used on Garrard units RC 75M; RC 80M; RC 90; RC 111; and the TA player.</td>
</tr>
<tr>
<td></td>
<td>Ask for Data Sheet No. 4000.</td>
</tr>
<tr>
<td>HGP 41-I</td>
<td>Separate Hi-g plug-in type heads for standard and microgroove records incorporating the crystal unit as used in the HGP 39 pick-up head. Will fit Collaro units RC 532; AC 534; AC3/534; 3RC 532. Available in cream or walnut.</td>
</tr>
<tr>
<td></td>
<td>Ask for Data Sheet No. 4500.</td>
</tr>
<tr>
<td>HGP 45</td>
<td>Separate Hi-g pick-up heads for either standard or microgroove records. The crystal unit is identical to that used in the HGP 39-I head. Will fit Garrard units RC 80; RC 72A; RC 75A; and the Model M player. Can be used on any unit which at present uses the Garrard C adaptor with GP 19 heads.</td>
</tr>
<tr>
<td></td>
<td>Ask for Data Sheet No. 4600.</td>
</tr>
</tbody>
</table>

... always well ahead

Acos devices are protected by patents, patent applications and registered designs in Great Britain and abroad.

Goscocord Ltd. Enfield Middx. Enfield 4022

PRICE 32/6 (Plus 10½ P.T.)
for all types except
HGP 39 models which are 32/- (Plus 10½ P.T.)
**"BELLING-LEE" NOTES**

"Belling-Lee"

Experimental Transmitter

Now that the "Belling-Lee" experimental band III transmitter at Croydon has settled down, we are able to give "Wireless World" readers some additional general data about the station.

**Location:**
South Norwood Hill, S.E.25.

**Grid reference:**
332696

**Height above sea-level:**
350 feet

**Vision carrier: frequency:**
194.75 Mc/s.

**Vision peak white E.R.P.:**
50 W. (approximately)

**Vision carrier: frequency:**
191.27 Mc/s.

**Sound carrier E.R.P.:**
1 kW. (approximately)

**Type of sound aerial:**
Four bays of folded dipoles, each bay consisting of four folded dipoles arranged in turnstile fashion.

**Type of vision aerial:**
Quarter-wave folded unipole and four radial earth plane elements.

**Mean height above ground level:**
Vision aerial, 85 feet, Sound aerial, 92 feet

**Hours of transmission (B.S.T.), public and Bank Holidays excepted:**
Weekdays: 10.30-12.30
14.00-16.00

**Nature of transmission:**
Continuous radiation of the standard G9AED test card

**I.T.A. estimated coverage Map**

It will be remembered that the I.T.A. published a map showing the approximate coverage for their Croydon temporary station. With their permission we have enlarged this map and have fixed a red spot for every reliable reception report received—and there are hundreds. We have written to every dealer we know of within the area covered by the map, sending them a postcard questionnaire, and on receipt of a report we send a Q.S.L. card. We feel that no matter how bad the reception, provided it is possible to lock a picture with G9AED on 1 kW., a useful picture will be obtained from the I.T.A. transmitter on 60 kW. Some of the reports really are remarkable, e.g., Clacton is 60 miles from Croydon but pulls in a good picture any day. We feel that the last few miles across the estuary of the Blackwater is providing a measure of recovery which is very useful. This feature may be responsible for the remarkable reception in the Isle of Wight; here again there is just about 12 miles of water at the end of a 70 mile journey. Whoever the individuals were who drew up the map showing the estimated coverage for the I.T.A. Croydon temporary station—they should be congratulated. If the writer presumed to criticise in any way it would be on the grounds of over cautiousness. To the north-east good reports have been received from Chelmsford, Braintree, Witham, Colchester, Clacton, Wivenhoe, Malden, Burnham-on-Crouch and Southend. One-fifth of the reports received are in the shaded portion of the map or beyond but such a statement may be misleading. The pattern within the shaded portion is fairly even with the greatest density in the centre, just north of the river. We are always being asked what type of aerial should be used in such and such a district. Short of making an individual survey which would be expensive, we can only recommend—as your dealer. He is anxious to get on with band III modifications and aerial installations; he knows the district and its peculiarities. So much depends on whether an outdoor or an indoor aerial is possible or required, or if you are situated on the remote side of a hill.

So far as our transmissions are concerned we had a few enquiries relating to the vision/sound ratio. This is certainly very low, 20:1 in fact, whereas we believe the normal is in the region of 4 or 5:1. Originally G9AED was vision only and we were pleased to be able to add even a low power sound transmission.

**Advertisement of BELLING & LEE LTD**
Great Cambridge Rd., Enfield, Middx.
Written 24th May, 1955

**NOTES**

**Nature of transmission—Vision**
Continuous radiation of the standard G9AED test card

**Sound**
Radiation of a 600 c.p.s. (approx.) tone interrupted at 15 minute intervals from the hour by a short telephonic announcement of identity.

**Contact Resistance—**less than 2 milliohms per pole.

**Working Voltage:** 150 v. d.c. or a.c. peak.

**Insulation Resistance:**—60,000 megohms at 500 v. d.c. between contacts and from contacts to housing.

**A range of lightweight plugs & sockets**

"SCREENS" for instrumentation, etc.

These non-reversible, screened connectors accommodate cables up to 0.24 in. overall diameter and are available for 1 to 3 ways. Points to note:—A spring-loaded locking ring is now incorporated giving vibration-proof locking; resilient skirt maintains screen contact even if locking ring is left undone; contacts assembled on moisture resistant, nylon-filled, phenolic moulded insulant; rubber cable support to minimise wear at clamping point; housing designed so that the moulded inserts can be interposed, i.e., fixed or free plug, etc.; flange permits use on panels of any thickness.

New type plugs (L.788, L.789 or L.790 range) will mate with old type sockets (L.722, L.625 or L.715 range) locking as formerly, and old type plugs will mate with new type sockets but will not lock in as the ring is left undone; contacts assembled on moisture resistant, nylon-filled, phenolic moulded insulant; rubber cable support to minimise wear at clamping point; housing designed so that the moulded inserts can be interposed, i.e., fixed or free plug, etc.; flange permits use on panels of any thickness.

**BELLING & LEE LTD**
Great Cambridge Road, Enfield, Middx., England
Marconi Broadcasting Transmitters

The greatly differing needs of broadcasting systems and stations call for many types of transmitters. Marconi's make ten types as standard, and these can be modified to provide for variations in requirement. Equipment for paralleling transmitters offers advantages in continuity of transmission while dealing with faults, and Marconi's have evolved a system which introduces an isolating circuit of nearly infinite impedance between transmitters whilst allowing output signals to pass into a common load. This system may be arranged for efficient and economical operation at half power.

Shown above is the MF Unattended 2 kW Type BD210C with the combining, aerial matching, and drive units housed in the left hand cabinet, the remainder being the transmitter units, which are combined in parallel. The 600 W Type BD210A and 1 kW Type BD210B utilise one or two transmitter units respectively. This series has been designed to serve the recent trend in technique which calls for unattended transmitters set up at a predetermined frequency and thereafter completely remote-controlled.

The first advertised radio programme was broadcast from Marconi's Chelmsford transmitter in 1920. Today 75% of the countries in the world rely on Marconi broadcasting equipment.

Lifeline of communication

MARCONI

Complete Broadcasting and Television Systems

MARCONI'S WIRELESS TELEGRAPH CO. LTD., CHELMSFORD, ESSEX
Partners in Progress with The 'ENGLISH ELECTRIC' Company Ltd.
LEARN THE PRACTICAL WAY

Specially prepared sets of radio parts with which we teach you, in your own home, the working of fundamental electronic circuits and bring you easily to the point when you can construct and service radio sets. Whether you are a student for an examination; starting a new hobby; intent upon a career in industry; or running your own business—these Practical Courses are intended for YOU—and may be yours at very moderate cost.

EASY TERMS FROM 15/- A MONTH

With these outfits, which you receive upon enrolment, you are instructed how to build basic Electronic Circuits (Amplifiers, Oscillators, Power Units, etc.) leading to complete Radio and Television Receiver Testing and Servicing.

BEGINNER'S RADIO OUTFITS — For carrying out basic practical work in Radio and Electronics, from first principles and leading to the design and building of simple Receivers.

ADVANCED RADIO OUTFITS — With this equipment, you are instructed in the design, construction, testing and servicing of complete modern TRS. Superhet Radio Receivers.

TELEVISION Outfit No. 3 — With this equipment you are instructed in the design, construction, servicing and testing of a modern high-quality 15" Television Receiver.

OTHER COURSES WITH EQUIPMENT INCLUDE:

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E.M.I. INSTITUTES The only Postal College which is part of a world-wide Industrial Organisation
ANNOUNCEMENT

FM RECEIVER ALIGNMENT
GENERATOR MODEL 1324

This Alignment Generator will be available later this year to provide the Service Engineer with a compact test set with which all essential alignment procedures on FM Broadcast Receivers may be undertaken.

Accurate trimming for correct overall and IF response curves is easily carried out and facilities will be provided for discriminator alignment and checks on its sensitivity and distortion.

Watch for the release date and price.

C O S S O R
Model 1322

Telecheck and Marker Generator
for Bands I and III

Model 1322 — used in conjunction with a cathode ray oscillograph — provides equipment for the display, measurement and correct adjustment of RF and IF response curves of television receivers. This entirely new instrument comprises a swept oscillator covering the Television BANDS I and III (5-75 Mc/s. and 155-255 Mc/s.) and a frequency marker oscillator so that precise calibration of the oscillograph display may be made; accuracy of the frequency of the marker pips being verified by reference to an internal crystal. The alignment oscillator is set to the video carrier to which the receiver is tuned and the sweep (either 1 Mc/s. or 10 Mc/s.) is automatically derived from the time base voltage of the display oscillograph. The response of the “strip” under test to the frequency band applied is then presented on the screen of the cathode ray tube. The RF output of Model 1322 is available at 75 ohms and is adjustable from a maximum of 40 millivolts to a minimum of 10 microvolts through a coarse and fine attenuator.

TELECHECK CONVERTER FOR BAND III

Model 1321

This adaptor provides owners of Model 1320 “Telecheck” with an extension of the frequency range of the original instrument into the BAND III television channel. Thus, alignment procedures adopted for BAND I RF/IF “strips” are available also for BAND III receivers. A selection of the desired BAND is made by means of a switch. Pattern generator facilities for picture time base linearity checks have been retained.

Model 1321 Adaptor is designed for permanent attachment to the standard “Telecheck” providing a neat, light and compact unit. Mounting is effected by four screws and the inter-connecting wiring is carried in a single insulating sleeve.

COSSOR INSTRUMENTS LIMITED

Write for illustrated leaflets about both these instruments:

COSSOR INSTRUMENTS LIMITED (Dept. 1) Highbury Grove, London, N.5.

Reception on six spot frequencies in the HF band and continuous tuning throughout the entire range, plus broadcast reception

MARCONI RECEIVER
TYPE CR 150/6

The performance of this receiver is of the highest order and meets the requirements of commercial telecommunication working in all climates and conditions. It is of double superhet design and incorporates special filters, a noise limiter and a built-in, crystal controlled calibration oscillator. H.T. voltages are stabilised to overcome mains fluctuations.

SPECIAL FEATURES
- Crystal control on any six spot frequencies throughout the band with continuous tunable L.C. oscillator in addition.
- Double crystal band-pass filters giving extremely good adjacent channel protection.
- Built-in 500 kc's crystal oscillator facilitates calibration checking.
- De-sensitising circuit enables full or partial muting when working with an associated transmitter.
- Power supply circuits in separate unit to avoid temperature changes.
- Suitable for cabinet or rack mounting, with easy servicing access.

Over 80 countries now have Marconi equipped telegraph and communications systems. Many of these are still giving trouble-free service after more than twenty years in operation.

Lifeline of communication

MARCONI
COMPLETE COMMUNICATION SYSTEMS
Surveyed, planned, installed, maintained

MARCONI'S WIRELESS TELEGRAPH CO. LTD., CHELMSFORD, ESSEX
Partners in Progress with The 'ENGLISH ELECTRIC' Company Ltd.
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With many courses we supply actual equipment thus combining theory and practice in the correct educational sequence. The equipment, specially prepared and designed, remains your property. Courses include: Radio, Television, Electronics, Draughtsmanship, Carpentry, Photography and Commercial Art, Amateur S.W. Radio, Electricity, Languages, Mechanics, etc.

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NAME

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SUBJECT(S) OF INTEREST
(We shall not worry you with personal visits)

JULY 1955
Why Ediswan Clix P.T.F.E. Valveholders are widely used in B.B.C. Television equipment

Large quantities of Ediswan Clix P.T.F.E. Valveholders are used in B.B.C. Television equipment. Only the combination of the finest insulation—P.T.F.E., the most efficient contact material—Beryllium copper—and Ediswan Clix design and manufacture can match the requirements of efficiency and reliability in this and all other stringent valveholder applications. Ediswan Clix P.T.F.E. Valveholders are fully type approved for Services Grade 1, Class 1 conditions. Full details of these valveholders and other components in the Ediswan range are given in catalogue CR.1681. Manufacturers and Development Groups may have a copy on request.
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panel instruments

Both round and rectangular models of moving iron, moving coil, A.C. rectifier and H.F. thermocouple types are offered. In the range of rectangular instruments, which have been introduced to give the advantage of long, easily-read scales and to harmonize with rectangular panels, certain models are available with illuminated dials. Full particulars of types and ranges available are to be found in leaflets List Nos. W.1 and W.2, copies of which are available on request.

Larger instruments, both round and rectangular and for switchboard or panel mounting are also available. These have scale lengths of 6" and 6½" respectively.

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PHASE INVERTER SPEAKER

"For months I have been scanning small advertisements for a Phase Inverter Speaker for sale—no luck. Now I have just obtained a new one and know now why there are no second-hand ones. Nobody who buys one is ever fool enough to get rid of it!"

"For many years, as money allowed, I have been trying to improve my record reproduction. I am not a technically minded "Hi-Fi" specialist but I think your claims for the Phase Inverter too modest. What I most like is the true coloration and separation of instruments, the real 'hit-of-the-stomach' thump given by a drum roll and the real edgy bite of trumpets. I find your speaker can handle more power than my set can give it without any trace of distortion so I have only one more step to make now—when the bank balance is out of the red!

That is to replace my wireless set by your "A-Z" amplifier and F.M. Tuner—when that is done my goal will be reached.—H. Radford, Thrapston."

Price £14.10.0 complete with cabinet

"Manufacturers of all A-Z Products ('A-Z' Regd. Trade Mark)"

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Extracts from two of many letters received—"HESWALL—A truly excellent instrument." "THRAPSTON—It is indeed its own best advertisement as everybody who comes to our house has to hear it!"
VORTEXION TAPE RECORDER

The amplifier, speaker and case, with detachable lid, measures 8\(\frac{1}{4}\)in. x 22\(\frac{1}{4}\)in. x 15\(\frac{1}{2}\)in. and weighs 30 lb.

**PRICE**, complete with WEARITE TAPE DECK $84 0 0

- The total hum and noise at 7\(\frac{1}{2}\) inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.
- The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.
- A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.
- The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.
- A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20 ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.
- The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.
- A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.
- The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

POWER SUPPLY UNIT to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE** £18 0 0.

FOUR CHANNEL ELECTRONIC MIXER

is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording. It is recommended by a number of tape recorder manufacturers for this purpose. Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced. The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.

The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes. An internal screened power pack and selenium rectifier feed the five low noise non-microphonic valves. Used in many hundreds of large public address installations and recording studios throughout the world.

**PRICE** £36 15 0.

Manufactured by

VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIberty 2814 and 6242-3

Telegram: “Vortexion, Wimbledon, London.”
Why I bought a **GRUNDIG**

People like myself are inveterate listeners. For us, music and other pleasures of the mind—drama, discussion, verse—are as necessary as food. In my case I found a need to "capture and keep” the memory of things that delighted my ear—to record the peerless performance or the subtle interchange between accomplished speakers.

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Intended for outstanding Science sixth-formers who are capable of training into future team leaders in scientific applications. Final qualifications are B.Sc. and City and Guilds Full Technological Certificate in Telecommunication Engineering. Next course commences on 4th October, 1955.

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The College associated with a world-wide electronics industry, including "His Master's Voice," Marconiphone, Columbia, etc.
Sales up 300%!

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27 GNS COMPLETE
A price made possible only by WORLD-WIDE SALES

The handsome gold escutcheon plate contributes to the elegant appearance, and blends with all woods.

Pickup
The pre-amplifier will operate from any pickup generally available in the world. A continuously variable input attenuator at the rear of the pre-amplifier permits the instantaneous use of crystal, moving-iron and moving-coil pickups.

Radio
The radio Input sockets at the rear permit the connection of the LEAK V.S. tuner unit. An Input attenuator is fitted. H.T. and filament supplies are available from the pre-amplifier.

Distortion
Of the order of 0.1%.

Hum
Negligible, due to the use of recently developed valves and special techniques.

Treble
Continuously variable, - 9 db to + 15 db at 10,000 c/s.

Bass
Continuously variable + 12 db to - 13 db at 40 c/s.

Volume Control and Switch
The switch controls the power supply to the TL/10 power amplifier.

Tape Recording Jacks
An exclusive feature. Readily accessible jacks are provided on the front panel for instantaneous use with Tape Recorders which have built-in (low level) amplifiers.

★ Write for leaflet W ★

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Telegrams : Sinusoidal, Eolux, London
Cables : Sinusoidal, London

From long experience and by extreme attention to design details during development work on the pre-production models, we enable our labour force to achieve a high output per man-hour. The labour costs thus saved offset the increased costs incurred for high-grade materials, components and finishes, and this together with quantity production (made possible only by a world-wide market) explains how quality products may be sold at reasonable prices. The results obtainable with the new Leak TL/10 and "Point One" are indistinguishable from those obtained with the TL/12 model—a fact easily proved by an instantaneous changeover test. The new TL/10 has been used since its introduction for all our public demonstrations, including those at the New York Audio Fair. These are some of the reasons why sales of the TL/10 and "Point One," since their introduction in April last year, are three times as great as for the famous TL/12 in the corresponding months of 1953—and why the size of our factory has been more than doubled to cope with this increased demand.

TL/10 POWER AMPLIFIER
This 10 watt amplifier maintains, in every respect, the world renowned Leak reputation for precision engineering, fine appearance and fastidious wiring.

SPECIFICATION
Circuitry
A triple loop feedback circuit based on the famous TL/12. The output transformer is the same size as in the TL/12.

Maximum power output: 10 watts.
Frequency Response: ± 1 db 20 c/s to 20,000 c/s.
Harmonic Distortion: 0.1%, 1,000 c/s, 7.5 watts output.
Feedback Magnitude: 26 db, main loop.
Damping Factor: 25.
Hum: -80 db referred to 10 watts.
Loudspeaker Impedances: 16 ohms, 8 ohms, and 4 ohms.

ELECTROSTATIC LOUDSPEAKERS
Reprints of the article by H. J. Leak, reviewing the latest advances in Electrostatic Loudspeakers, can be obtained from us on request, free of charge.

★ Make this THE HEART of your HI-FI EQUIPMENT

and this is why...
**BAND III AERIALS**

**AERIALS**

**BAND III Aerials**—These aerials have quick-fitting elements all alloy tube construction and polythene low-loss insulators.

Arrays

<table>
<thead>
<tr>
<th>Model</th>
<th>6-element</th>
<th>5-element</th>
<th>4-element</th>
<th>3-element</th>
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<tr>
<td>7003X</td>
<td>45/- each</td>
<td>60/- each</td>
<td>75/- each</td>
<td>90/- each</td>
</tr>
<tr>
<td>7020C</td>
<td>65/- each</td>
<td>72/- each</td>
<td>76/- each</td>
<td>82/- each</td>
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</table>

**Aerials Components**

<table>
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<tr>
<th>Model</th>
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<th>4-element</th>
<th>5-element</th>
<th>6-element</th>
</tr>
</thead>
<tbody>
<tr>
<td>7025C</td>
<td>77/- each</td>
<td>80/- each</td>
<td>85/- each</td>
<td>93/- each</td>
</tr>
</tbody>
</table>

**THIN PAXOLIN PANELS**

- Size 8in. x 5in.
- Price 3/- doz.
- Post 6d.
- Ref. 3J2.

**CONNECTING WIRE SNIP**

- P.V.C. insulated 23 A.W.G. copper wire in 100ft. rolls, 2/6 each.
- Various copper phones available separately for 10/-.

**H.T. RECTIFIERS**

- Famous Selenium "Senterge".

- All are this year's stocks—higher voltages joint two or more in series.
  - R.M.1: 120-v. 60 mA.
  - R.M.2: 120-v. 120 mA.
  - R.M.3: 125-v. 150 mA.
  - R.M.4: 200-v. 250 mA.

**SERVICE DATA**

- 100 service sheets, covering British receivers which have been sold at high quantities, and which are therefore used for service work. The following makes are included: Aerostar, Ailsa, Blues, Cross, Elek, G.E.C., General Electric, General Electric, G.E.C., Quad, Pye, Plessey, R.C.A., Regency, Telefunken, Televes,Victor, etc.

**BAND III DOWNLEADS**

- Protected five core construction ensures maximum air to polythene ratio around the conductor high performance.

**A SIGNAL AND BAR PATTERN GENERATOR COMPLETE WITH CALIBRATION EQUIPMENT, 25/- POST FREE.**

With the inception of Band III the home constructor is working on new ground and accurate checking instruments are a MUST.

**THE "ELPREQ" BAND III SIGNAL GENERATOR** is the very efficient and inexpensive answer. It:

1. Will provide the signal for tuning to any Band III station.
2. Can be used as a grid-dip meter for checking the frequency of Band III T.V. aerials, Colls, etc.
3. Can be made to give a pattern to any T.V. Receiver screen.
4. Can be accurately calibrated with included equipment.

All the parts including valves, tuning condenser and metal chassis are available as a Kit at 25/- post free. Constructional data free with Kit or available separately price 2/-.

**BE READY FOR THE NEW COMMERCIAL T.V.**

**BUILD YOUR OWN CONVERTOR**

The Elpreq Band III Converter has given very satisfactory results from the experimental Band III station. It may be noted, however, that it is not at all difficult to make and can be lined up with the simple 2G Instrument designed by PAX.

Price for all the components including constructional data is 20/-—data available separately price 2/-.

**10 VALVE 1 ½ METRE SUPERHET**

Designed to receive 200 mc/s transmission, the receivers should be ideal for conversion to the Commercial T.V. Band. These contain 6 valves type SP61, and one each RL16, RL16, and EA50. Six IF transformers 12 Mc/s, band, and hundreds of other useful components. Price 5/-, plus 5/- packing 7/6. These receivers are unused.

**THE ELPREQ F.M. UNIT**

In the ELPREQ F.M. Toner four valves and two crystals are used. The last valve acts as a limiter so reducing the necessity of extra tuning and at the same time improving interference rejection. Crystals are used in the radio detector to avoid hum troubles inherent in some comparatively unmanned valve radio detectors. Stability in extremely good and tuning most simple. The tuner draws its power supplied from the set or amplifier, its valves housed are not connected to earth.

With only a simple indoor aerial made by pasting the ends of ordinary flexible cable this tuner works very well at Eastbourne (over 60 miles from London) and we await reports from even greater distances.

Cost of all parts including valves is £2/12/6, data is included free with the parts or available separately price 2/-.

**CABINETS 19/6**

You can make an excellent portable PA cabinet, with a suitable amplifier, less than the cost of a similar portable cabinet. The cost of all parts including valved is £2/12/6. data is included free with the parts or available separately price 2/-.

**COMPLETE TOOL KITS**

**THE ELECTRICIAN'S**

This is an illustrated and contains 36 fine tools arranged on 3 trays in an automatic tool-box. The top opened to show the pressure of the hand and close automatically when lifted. The tools are all that a practical electrician needs, including lenox saw, radiate block, back-saw, chisels, etc., for wood, brick and steel, pliers, side cutters, screwdrivers, side and straight wrenches, hammers, spanners, and socket wrenches, hand-drill, B.A. drills, etc. Price 21/3/10/-, or 37/3/ deposit and 19 payments of 20/-.

**RADIO ENGINEER'S**

This again is fitted into an automatic tool-box and contains 30 tools including pliers, side cutters, screwdrivers, side and straight wrenches, hammers, spanners, and socket wrenches, hand-drill, B.A. drills, etc. Price 21/3/10/-, or 37/3/ deposit and 19 payments of 20/-.

**1 in. MICROMETER**

Exceptional purchase enables us to offer a 1 in. precision micrometer at the very low price of 10/-.

**TRANSFORMER 100 WATTS**

These transformers are equipped with a wound primary, tapped to allow for secondary. There is a simple window fitting, however, for the hand winding of secondaries to suit your own requirements.

The taps, taken out will depend upon volts, e.g., 20 taps at 10 volts, 10 amps at 5 volts, etc. Price 10/-, plus 5/- packing 2/-.

**RESISTORS**

50 assorted 1 and 1 watt resistors. Range between 10 and 10 megohm. (Our selection.) Price 5/-, $a. 10 and 1 watt. 5/-.

**PUSH BUTTON UNIT**

9 ways. Price 2/-, Post 6d.

**CONDENSERS**

High voltage. 0.05 MFD. 5 K.V. 5in. x 1in. dia.

Price 4/6, Post 6d.

Ref. 21969.

**CORNER CONSOLE**

A massive cabinet but being corner fitted is not out of place even in a modern small living room. Overall dimensions of this cabinet are 47in. wide x 31in. (deep to corner) 50in. high. Made to house 15in. Television, Radio Unit, Amplifier, Tape Deck, etc. Originally £18. Our Price £10 plus 30/- carriage.

**IMPORTANT TO POSTAL SHOPPERS**

In order to improve our postal service, we are centralising this at our Eastbourne Depot and all post orders will have to be addressed to: E.P.E. Ltd., Dept. E, Bourne House, Queen Road, Eastbourne.
BENDIX RA-IB COMMUNICATIONS RECEIVER

Originally intended for the American Forces this fine receiver, (a small quantity of which has been released by the Ministry of Supply) is available to you on pro forma basis. Designed to receive C.W. or B.T. it uses probably the finest Verrier tuning and baked impedance arrangement possible, it covers the following bands—

Band 1 .13 to .35 mc.
Band 2 .32 to .60 mc.
Band 3 .60 to 1.1 mc. (i.e. 1 Fredericks)
Band 4 1.1 to 3.7 mc.
Band 5 3.7 to 7.5 mc.
Band 6 7.5 to 15.9 mc.

The sensitivity is 4 micro volts for full output. It uses 8 valves and operates from battery (12 or 24vols) or from the mains through a power pack. It has built-in output stage with a jack socket for phones.

Conclusively, all of which are brought to the front panel, include aerial switch, aerial compensating condenser, main tuning condenser, band selector, C.W. switch, power on/off switch, and volume control.

This is a robust well finished cabinet. These sets are most highly recommended and in perfect working order—special price this month. £1/11/- deposit, balance over 12 months carriage and insurance 10/-.

ORDER now to avoid disappointment. Circuit diagram and component list available to-day. Mains Power Pack for Bendix RA-IB, £1/10/-. Post free.

CABINETS FOR ALL

We confidently believe we carry the best stock of cabinets in London. The one illustrated is The Bureau, a really beautiful cabinet elegantly veneered in walnut, polished to perfection. The control board is revealed when the front is dropped. Both the radio board and motor board are left uncut and in perfect working order. Price £16/10/-, carriage 3/6d. We have many other types in stock. Pay a visit, or send for Cabinet List.

RECORD PLAYER BARGAIN

3-speed record player with pick-up using the famous Acoo "Hi-O" turntable crystal—motor also by a famous maker—speed selection is by Bakelite knob. All on unit board ready for installation.

A wonderful bargain at £6/10/- plus 5/- carriage—Hire Purchase 1/- deposit.

TERRY'S FOLDING SPANNERS

2BA, 3BA, 6BA. Price 4/- doz. sets. Post 9d. Ref. 2F75.

MULLARD AMPLIFIER "$10"

A High Quality amplifier designed by Mullard engineers. Robust high fidelity with a power output exceeding 10 watts and a harmonic distortion less than 4%, at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 30,000 C.F.R.―three controls are provided and the whole unit is very suitable for use with the Gallery Studio and many other good pick-ups. The price of the unit completely made up and ready to work is £12/10/- or deposit, plus 10/- carriage and insurance. Alternatively, if you wish to make up the unit yourself we shall be glad to supply the components separately. Send for the Mullard amplifier shopping list.

TERRY'S FOLDING SPANNERS

2BA, 3BA, 6BA. Price 4/- doz. sets. Post 9d. Ref. 2F75.

CONDENSORS

High voltage.
.05 mf. plus .05 mf. x 2.... £.341
14m. dia. Price 3/- 6d. Post 6d. Ref. 2B81.

CONDENSORS

High Voltage
.001 x 4kV, 24in.
.01 x Lin. dia. Price 2/6. Post 6d. Ref. 2B83.

WIRING CLEATS

Vitreous porcelain; two groove 1/4 per doz., three groove 2/9 per doz.

CHARGING CUT-OUT

Bakelite case, suitable 6, 12 or 24 volts.

TRIMMER

Post 3d.

SAPPHIRE TIPPED GRAMophone NEEDLE

Straight or half-taper type.

TLV=E.H.T. GENERATOR

69/6

Post 3d.

GRAMOPHONE NEEDLE

Post 3d.

SAPPHIRE TIPPED GRAMophone NEEDLE

Straight or half-taper type.

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TRIMMER

Post 3d.

SAPPHIRE TIPPED GRAMophone NEEDLE

Straight or half-taper type.
POTTED MAINS TRANSFORMERS

Three of these units, each rated at 5000 watts, are fitted in cast metal cases and are enclosed by a strong, effectively ventilated steel box. All are upward mounting and have metal back plates, 300 mm. x 500 mm. x 150 mm., and fully screened primary, secondary and earthed case. All units are Type SF5, 2500 v. a. m. a., 6.5 x, at 7 amperes; 4.4 x at 5 ampere; Price £55; surface and packing 26/3.

Type SF5, 2500 v. a. m. a., 6.5 x, at 7 amperes; 4.4 x at 5 ampere; Price £55; surface and packing 26/3.

Type SF5, 2500 v. a. m. a., 6.5 x, at 7 amperes; 4.4 x at 5 ampere; Price £55; surface and packing 26/3.

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Type SF5, 2500 v. a. m. a., 6.5 x, at 7 amperes; 4.4 x at 5 ampere; Price £55; surface and packing 26/3.

POPPED CHOICES

These choices are in line with the most popular cases and are included with other transformers. Type SP4, 5 x at 2500 watts. Price 10/-, surface and packing 26/3.

Type SPB, 10 x at 150 watts. Price 12/6 per post and packing 26/3.

RELAYS P.O. 3500 TYPE

Ref. 5A1, 2,000 ohm, slow close plu contacts, one break, two make. Price 2/6 each.

Ref. 5A2, 2,000 ohm, standard coil, one break, two make. Price 12/6 per post and packing 26/3.

WELD TYPE WIRE JOINER

This machine welds the ends of the metal wire to the connecting wire. It is available in two sizes, one suitable for 10 mm. and another for 12 mm. It is not intended to replace theolder wires but it is ideal for making joints that have, for instance, to withstand heat, vibration, chemical action, etc.

In many cases this method is faster than soldering and there can be a considerable saving of current. Price 1/- each. Order with umbers marking transformer 26/2.

HIGH POWER TRANSFORMERS

For R.F. Heaters, transmitters, etc., etc.

Type SP7, 1000 at 5 000 v., 35/-; 500 v., 18/-; 250 v., 10/-; 125 v., 6/-; for relays, etc., 22/-, plus 3/- carriage and packing 3/6.

Type SP6, 1000-3000 E at 500 v. and 4 v. at 4 x; Price £7/10/-, carriage and packing 3/6.

Type SP3, 372-375 at 250 v. and 4 v. at 4 x; Price 27/10/-, carriage and packing 3/6.

Type SP8, 1000-2500 E at 500 v. and 6 v. at 5 x, 45/-, carriage and packing 3/6.

WIRELESS WORLD

WIRELESS WORLD

PAGE OF SPECIAL EQUIPMENT

UNITS FOR ROTATING HEAVY AERIALS

We have broad new, still in original unopened packing cases and shipped by all rail to London and fully screened primary, secondary and earthed case. All units are Type SF5, 2500 v. a. m. a., 6.5 x, at 7 amperes; 4.4 x at 5 ampere; Price £55; surface and packing 26/3.

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Type SF5, 2500 v. a. m. a., 6.5 x, at 7 amperes; 4.4 x at 5 ampere; Price £55; surface and packing 26/3.

The equipment described on this page is not available at our normal regular prices as at our sales department address as below. Orders and enquiries should also be addressed to WIRELESS WORLD.

E.P.E. LTD. SPECIAL SALES DEPT., BOULME HAVILAND, GROVE ROAD, EASTBOURNE, SUSSEX.
MORE SPECIAL EQUIPMENT

HEAVY DUTY POWER PACKS

The VARIABLE 500/1,000 v.
The conventional alternator is now available throughout and all components are simply proportioned to permit substantial saving on loading. A master switch controls the whole unit and whenever the output is required it is automatically supplied to the customer's annoyance, thus keeping them at the same time in the equipment state. The H.T. transformer is supplied from the primary of the equipment transformer, and the smaller switch being via an overload switch, and a tapped choke. The variable switch controls the H.T. and the tapped choke in conjunction with its extractor switch gives the correct combinations of power to 'low' power' to 'high' power.

The unit has a series heated cathode- grid -wave output which is smoothed by a 10 Henry choke and 4 mfd. condenser. A bleeder resistor connected across the output serves as a dummy load, and also discharges the smoothing condenser once the output is below a certain value of output ohms.

The continuous rating of the power pack is 1,000 watts at 100 millamp (500 watt). But the proportions of the various components are such that 300 per cent. overloading can be allowed for pulse work or other intermittent operations. The size of the power pack is approximately 16in. x 13in. x 13in. and its weight is approximately 87 lb. Price: Kit of parts £17/10/0, or made up ready as £37/0/0.

The VARIABLE 250/2,000 v.
The maximum continuous rating of this is 250 milliwatts at 2,000 volts. Rectification is half wave. Specification otherwise as for the variable 500/1,000 v.

The VARIABLE 250/2,000 v.
The continuous power rating of this is 250 milliwatts at 2,000 volts. But the tapped choke and selector switch enables this to be reduced in steps. Weight approximately 190 lb., size 16in. x 13in. x 13in. Price £37/10/0 - in kit form, or made up ready as £77/10/0.

The VARIABLE 1,000/1,000 v.
The maximum continuous rating of this is 1 amp. at 1,000 volts. Rectification is full wave, and output in the same size as 1,000/1,000 v. Price £37/10/0 - in kit form, or £47/10/0 made up ready for work.

FIXED MODELS

Any of the models mentioned above can be supplied without the tapped choke and selector switch. The prices are as follows:

Fixed 500/500 v. £25/10/0 - in kit form, or £55/0/0 made up.
Fixed 500/2,000 v. £35/10/0 - in kit form, or £50/0/0 made up.
Fixed 2,000/2,000 v. £50/0/0 - in kit form, or £85/0/0 made up.

All prices quoted are ex Works.

SPECIAL PURPOSE VALVES

Triode Type CV1098 - This is a high-power air-cooled triode. Specification of which is as follows: Plate voltage 1,000 volts, filament current 25 amps., anode dissipation 700 watts. Maximum anode voltage 22 kV.

This valve is very suitable for R.F. heating at high frequencies and two or three in push-pull under Class C conditions gives a total wattage of approximately 5 kilowatts. Brand new, still in original shockproof packing, price £15 each.

TETRODE TYPE VT13

This is a high-power air-cooled tetrode. Specification of which is as follows: Heater voltage 115 v., heater current 8 amp., maximum anode voltage 20 kV., anode dissipation 250 watts, size approximately 14ins. long and 6ins. across the body. Identified quantity only at £6 each, still in original packing.

HIGH CYCLE MOTOR ALTERNATOR

TYPE P1. Has a motor 250 v., 50 cycle single phase 500 r.p.m., coupled to a generator output 250 v., 1,728 cycles at 42 amps. Good condition, with wiring diagram. Price £21/0/0 plus £10/0/0 carriage.

TYPE 2. Has a motor 500 v., 50 cycle single phase, coupled to an alternator output 250 v., 625 cycles at 42 amps. Price £29/15/0 plus £10/0/0 carriage.

IONS-RED SENSITIVE LAYER FLUORESCENT SCREEN

UNITED STATES OF AMERICA

These are sometimes known as boleros, and when they are worn at night, are said to be a good protection against snake bites. But they are not recommended for use in daytime, as they are likely to attract animals that are otherwise harmless. They are also very uncomfortable to wear.
TOWARDS PERFECTION...

demands constant research and development

25,110 gauss, average gap flux!

YES that is the new amazing magnetic performance of our latest P.M.4 drive units. Undoubtedly the most efficient drive unit in the world.

Fitted to the Lowther-Hegeman reproducer or the P.W.1 Corner Horn housing.

Recent reviews on Lowther Units:

T.P.1. "Record News" (May issue). "This is without doubt one of the finest speakers obtainable."

P.M.4. Radio People, Ltd., Hong Kong. "The crowd unanimously voted for the P.M.4."


Further details of this and other Lowther quality products gladly forwarded upon request.

LOWTHER MANUFACTURING COMPANY, LOWTHER HOUSE, ST. MARK’S ROAD, BROMLEY, KENT

Telephone: RAVensbourne 5225

HIGH VACUUM applied to METALLIC MICRO-FILMS

Micro-thin films of metal and their compounds are vital to many developments in electronic devices, but their maximum effectiveness depends upon the critical control of quality and thickness. HIGH VACUUM COATING ensures users of thin films a high standard of precision and control with a simplicity of deposition possible by no other method. EDWARDS vacuum coating units are available from 6” diameter work-chamber for laboratory or large scale production. Illustrated is an 18” model.

. . . FOR BETTER VACUUM SERVICE

EDWARDS HIGH VACUUM LTD.

MANOR ROYAL - CRAWLEY - SUSSEX
CRAWLEY 1500 (10 lines) EDCOHIVAC CRAWLEY

BRANCHES: GLASGOW & TORONTO
AGENTS THROUGHOUT THE WORLD
Specialists in Tropicalisation and Inter Services Jungle Finish
Conforming to A.I.D. and C.I.E.M. standards
PROTOTYPE Relays made to specification.
POST OFFICE TYPE KEYS supplied to specification.
Speedy Deliveries—Enquiries Invited

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Manufacturers of
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MAGNETIC RELAYS
3,000 and 600
Contractors to:
H.M. GOVERNMENT AND
LEADING MANUFACTURERS
COILS up to 80,000Ω.
CONTACTS up to 8 amps.
INSULATION up to 5 kv.

Z & I AERO SERVICES LTD.,
OFFER THE FOLLOWING GUARANTEED EQUIPMENT:
BONDING TESTERS, A.M. Ref. No. SG/2126,
COMPLETE WITH MATCHED LEADS WITH SPIKES
GENERAL RADIO TYPE 804 U.H.F. SIGNAL GENERATORS: Range 7.5 to 330 mc. in three bands. Output voltage up to 20 mV. Power supplies 115/230 v. A.C.
COLLINS TCS RADIO RECEIVING AND TRANSMITTING EQUIPMENT, 1,500-12,000 kc., output 20 watts on voice and 40 watts on C.W., completely rebuilt and fully guaranteed.
RECTIFIER POWER SUPPLY UNITS, Type RA-62C, for SCR522 Radio Sets. Input: 110/220 v. Rated output: HT—300 v., 260 mA; GB—150 v., 8 mA; LT—13 v., 3.9 mA. Overhauled and in perfect operating condition
LARGE VARIETY OF LABORATORY EQUIPMENT, e.g., Signal Generators, Waveformers, Oscillators, etc., completely overhauled and fully guaranteed.

Please write for full Catalogue to:
Z & I AERO SERVICES LTD.,
19, Buckingham St., London, W.C.2
Telephone: TRAfalgar 2371/2
Please offer us your surplus Radio Equipment.

L-R’S
Estd. 1925
EASY TERMS
QUALITY EQUIPMENT
for the Connoisseur
If you want the Finest Quality Reproduction together with Workmanship of the Highest Order your choice must be LEAK.
AS USED BY BROADCASTING CORPORATIONS THROUGHOUT THE WORLD.
LEAK "TL/10" AND "POINT ONE" PRE-AMPLIFIER. Cash Price £38/7/- or sent for £41/10/- Deposit and 18 monthly payments of 30/-, carr. and crate free.
LEAK TL/10 AND VARI-SLOPE MK. II PRE-AMPLIFIER. Cash Price £34/13/- or sent for £6 Deposit and 18 monthly payments of 35/-, carr. and crate free.
LEAK DYNAMIC PICK-UP Complete with two detachable diamond heads and transformer. Cash Price £20/19/9 or sent for £3 Deposit and 10 monthly payments of 40/-.

Delivery of all the above is from stock. We can also supply Wharfedale, Goodmans and Tannoy loudspeakers, etc., Connoisseur Variable 3-speed Motors and all other Quality Equipment on EASY TERMS.
Please let us have your requirements.

14 DAYS FREE TRIAL
with the SUPERB NEW REMINGTON '60'
ELECTRIC SHAVER
will convince you
that it really does shave quicker and smoother than any other method. The extra long shaving heads are slightly arched to fit easily into those hard-to-shave spots.
SEND DEPOSIT OF ONLY 5/- FOR IMMEDIATE DELIVERY
(Returned if not satisfied)
Balance after 14 DAYS FREE TRIAL 15/- and 8 monthly payments of 24/-.
Cash Price £5.17.11.

• WE WILL ALLOW YOU FOR YOUR OLD ELECTRIC SHAVER if you decide to keep the REMINGTON after trial.
SEND FOR FREE BROCHURE

The L. R. SUPPLY Co. Ltd.
BALCOMBE : SUSSEX
Phone 234
Boulton Paul Electronics

This Stabilised Power Unit, covering the lower voltage range, is extremely portable, weighing only 16½ lb. While it has been specifically designed to replace the troublesome H.T. battery, it has the added advantage of a built-in BIAS and L.T. SUPPLY. These facilities, coupled with its superior performance, make this unit an essential item in the laboratory or on the test bench.

All these attractive facilities are provided for the very modest price of: £38.0-0

Write today (mentioning this journal) for leaflets describing our range of Stabilised Power Units.

BOULTON PAUL ELECTRONICS
Boulton Paul Aircraft Ltd., Wolverhampton, England.
Tel.: Fordhouses 3191 Ext. 99. Telegraphic address “Aircraft Wolverhampton.”

VHF/FM BROADCAST RECEIVER
TYPE CB4

Constructed to VHF standards throughout. Covers the band 2 with RF Mixer, 2-IF, and ratio detector stages. Provision is made for single or push pull output, or added Short Waveband. Although “hand built” in small quantities, an attractive price is maintained.

Model "A." FM tuner. A popular and small unit, with good sensitivity. These are in use from Bognor to Ely, and little changed since first described by Amos and Johnstone in the Wireless World. New “hammer” finish front plate and tuning scale carries a magic eye; this and power unit are optional.

The "Mullard" S-10 amplifier. Our version is condensed to only 12 x 3 in. plan, with symmetrical front layout. With FM, a truly high fidelity outfit is possible under £35.

CB4 FM/4W feeder unit, mains driven: £21 0 0
CB4/3, with push pull output: £26 0 0
"A" basic tuner: £11 17 6
"A" tuning scale, magic eye: £3 0 0
"A" power unit: £3 0 0
"Mullard" amplifier, our version: £14 10 0

Welcome to MARLBOROUGH YARD, N.19, evening demonstrations also arranged.

TRY the new PRIMAX for SOLDERING 70'- Post free

now in the sensational UNBREAKABLE CASE

NEW MODEL can now be used ALMOST CONTINUOUSLY without overheating. Improved easily replaceable switch. Weighs only 24 oz. Loop for hanging now provided.

The ideal tool for any RADIO - TV - TELEPHONE mechanic or amateur.

Welcome to MARLBOROUGH YARD, N.19, evening demonstrations also arranged.

Boultone Paul Aircraft Ltd., Wolverhampton, England.
Tel. : Fordhouses 3191 Ext. 99. Telegraphic address “Aircraft Wolverhampton.”

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Boultone Paul Aircraft Ltd., Wolverhampton, England.
Tel. : Fordhouses 3191 Ext. 99. Telegraphic address “Aircraft Wolverhampton.”
Letter from CANADA

The outstanding performance of the Super 12/CS/AL speaker is primarily due to the magnet. High flux density (17,000 lines) gives excellent transient response and sensitivity with wide frequency range.

Price of Speaker £17.10.0 tax free.

Wharfedale
WIRELESS WORKS LTD.
IDLE, BRADFORD, YORKSHIRE
Tel. Idle 1235/6

My dear Mr. Briggs:

About three months ago, to complete my high-fidelity assembly, I purchased from the Electro-Voice people in Toronto one of your Super 12/CS/AL speakers—Serial No. 2034, to be exact.

I thought you might have some interest as to its performance and am glad to say that this has pleased me very much. The speaker has a soft, mellow, bell-like tone that I particularly like, and is happily free from the somewhat harsh driving stridency noticeable in many so-called hi-fi loudspeakers. It has been most favorably commented upon by friends who have heard its performance, so, all in all, I certainly don't regret my choice—which wasn't arrived at in a hurry.

The radio unit is a Fisher 6-control AM-FM tuner; the amplifier a Radio Craftsmen of Chicago Williamson-type 15-watter; the record-player an RC 80 Garrard with General Electric variable-reluctance diamond-and-sapphire cartridge, while the speaker enclosure is a heavily-constructed Jensen-type back-loading folding horn, so your product isn't consorting with too bad company. I quite appreciate and realize that the performance of the best electronic equipment can be no better than the speaker it feeds, so it is a pleasure to tell you that the resultant sound from the above-described expensive hardware suits my particular pair of ears just fine.

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PRINTED CIRCUITS (by T.C.C.) for the MULLARD 5/10 and OSRAM 912 AMPLIFIERS now available.

THE MULLARD 5/10 AMPLIFIER KIT
Uses 1 each 6SL7, 6V6, 5Z4. All components, chassis, valves, output transformer, mains transformer, L.N. and shopping list, 1/-, post free.

PRINTED CIRCUITS (by T.C.C.) for the OSRAM 912 AMPLIFIER KIT
Uses 1 each 6SL7, 6V6, 5Z4. All components, chassis, valves, output transformer, mains transformer, L.N. and shopping list, 1/-, post free.
F.M.!! (Frequency Modulation)

We are pleased to announce our complete Kit for the "Demo" F.M. Feeder Unit. This unit provides an A.F. output suitable for feeding into the audio section of a standard broadcast receiver where bridge/period output is available. Within an average of 30 miles from a V.H.F. transmitter one F.M. star should be adequate, but our complete Kit supplied includes all components and values for an extra F.M. stage if necessary, or if the unit is used at greater distances. Full constructional details, theoretical account and point-to-point wiring diagram can be supplied for 1/20 post free, so the complete Kit right down to the last cut and solder, is ready to go. This unit will be supplied if desired. 35/- post and packet. All new.

The Jason F.M. Tuner Kit!

This kit has been based on the book "Practising Modulation", price 21/- post free. Each book is supplied dividedly printed in large easy-to-read construction and alignment of this tuner are no more difficult than the normal medium wave tuner. It is highly sensitive and free from drift. Incorporates 4 valves type 16s and 2 specially graded G.E.C. Crystal tubes. The kit supplied includes drilled chassis with focusing condensers, scale calibrated to megacycles, and attractive bakkelite store manuallly mounted front plate already finished. Price 35/- each plus 6/- P. & P.

TELESCOPIC AERIAL MAST. Ex-R.D.S. diagonal adjustable mast, total length when extended 17ft. Collapses into two sections each 8½ ft. complete with base fixings, lightweight aluminium construction, diam. at longest point 3½ in., 1½ oz. approx., tip to tip. New condition. 12/- F. & P.

TRANSISTORS. Mulfair Type OGI available from stock, 6/- post free.

THE JASON F.M. TUNER - ADIMINISTRATION

Data Sheet type 16S2/12, 6-3 volt 2 1/2 amp. 200 watts. Complete with 4 metal rectifiers each 250 v. 250 ma. Complete with 4 metal rectifiers each 250 v. 250 ma.

METERS

P.D.S. Size Type Fitting

50 microamps D.C. 2½ in. R.P.

100 microamps D.C. 2½ in. R.P.

500 microamps D.C. 3½ in. R.P.

1 mamp D.C. 3½ in. R.P.

10 mamps D.C. 3½ in. R.P.

100 mamps D.C. 3½ in. R.P.

1 amp D.C. 3½ in. R.P.

3 amperes D.C. 3½ in. R.P.

10 amperes D.C. 3½ in. R.P.

50 amperes D.C. 3½ in. R.P.

100 amperes D.C. 3½ in. R.P.

200 amperes D.C. 3½ in. R.P.

300 amperes D.C. 3½ in. R.P.

500 amperes D.C. 3½ in. R.P.

1000 amperes D.C. 3½ in. R.P.

1500 amperes D.C. 3½ in. R.P.

2000 amperes D.C. 3½ in. R.P.

3000 amperes D.C. 3½ in. R.P.

5000 amperes D.C. 3½ in. R.P.

10,000 amperes D.C. 3½ in. R.P.

50,000 amperes D.C. 3½ in. R.P.

100,000 amperes D.C. 3½ in. R.P.

200,000 amperes D.C. 3½ in. R.P.

300,000 amperes D.C. 3½ in. R.P.

500,000 amperes D.C. 3½ in. R.P.

1000,000 amperes D.C. 3½ in. R.P.

100,000,000 amperes D.C. 3½ in. R.P.

1,000,000,000 amperes D.C. 3½ in. R.P.

1,000,000,000,000 amperes D.C. 3½ in. R.P.

10,000,000,000,000 amperes D.C. 3½ in. R.P.

100,000,000,000,000 amperes D.C. 3½ in. R.P.

1,000,000,000,000,000 amperes D.C. 3½ in. R.P.

1,000,000,000,000,000,000 amperes D.C. 3½ in. R.P.

1,000,000,000,000,000,000,000 amperes D.C. 3½ in. R.P.


METER RECTIFIERS. 1 in. by G.E.C. at 6/-, also 5 in. by Westinghouse at 8/-.
THE R.E.F. ONE-VALVE BATTERY RECEIVER KIT. Single one-valve battery receiver for headphones, easily built in one evening. All required components including headphones, can be supplied at inclusive cost of 45s. post free. Operated by Ever Ready Bright 111 type battery.

COLLARO BRAZ PLAYER. Just released. Fixed keyboard, Leslie covered perforated cabinet, incorporates tone control, has 1/2 in. driver, Cream finish.

LATEST 3-SPEED AUTO-CHANGER. Latest model complete with C and D, high density leads. Limited quantities at £11/10/- plus 5/- F. & P. Terms available.

LATEST IMPORTED F.M. COMPONENTS.

The R.C. Gram Replacement Chassis Kit. To meet the very great demand for this type of receiver, we have produced this unit. For Long, Medium and Short Waves. Range: 300 m. to 10,000 m.


ARMSTRONG F.C.48. Their very latest high quality replacement chassis having provision for F.M. feeder unit, 8 valves, four wavebands. Independent treble and tumbler switches, crystal head switch used. Well adapted for use by £2/18/- plus 5/- F. & P. or £5/18/- deposit and 12 monthly payments at 3/3/-.

LATEST 3-SPEED AUTO-CHANGER. An all-new, all improved design from a famous manufacturer.

DELCO RADIO/RADIOGRAM CHASSIS. All latest models from £17/13/- and P.3 post-pur at reduced prices. Available for illustrated leaflet.

COLLARO 6010. Transcription motor with Studio Pick-up. £1/3/- 6/6. 10 in. and 12 in. sizes. Available for illustrated leaflet.

18, Tottenham Court Road, London, W.1.
SELENIUM RECTIFIERS

L.T. Types   H.T. Type H.W.
2/6 v. 1 a. a.w.b. 1/9 120-240 v. 80 ma. 3/11
6/12 v. 1 a. a.w.b. 2/9 250-500 v. 50 ma. 5/9
250 v. 80 ma. 5/9
50 v. 150 ma. 9/9
F.W. Bridge Types
6/12 v. 1 a. 4/11 250 v. 250 ma. 11/9
6/12 v. 2 a. 8/8 300 v. 275 ma. 12/11
CO-AXIAL CABLE, 75 ohms, 72. yard. Twin screened, feeder, 100. yard.

SILVER MICA CONDENSERS
5, 10, 15, 20, 25, 50, 75, 100, 150, 10, 200, 250, 300, 350, 400, 470, 500, 1,000 pod., (000UF), .002 mf. (2,000 pfd.). At all 5d. each, $0.90 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.15 a., 6/9 doz.; 6.5 v. 0.3 a., 6/9 doz.; 4.5 v. 0.3 a., 6/9 doz.

ELECTROLYTICS (current production). Not ex Govt.

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THE SKY FOUR T.F.R. RECEIVER

A design of a 3-Valve 200-250 v. A.C. mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. 11 regenerators valves 6K7, SP01, 6FG, and is specially designed for simplicity in wiring. Quality and quietness is well up to standard. Point-to-point wiring diagrams, instructions, and parts list, 2/3. This receiver can be assembled with a minimum of $4, plus switch, 2/9; with S.P. switch, 3/9; with louvred crackle finished case. Price with circuit, 23/9.

Mains Transformers
Primary 200-230-250 c. 0.5 a. 5 v. 5 a. 3 z.
Midget type, 21-3-3 in.

Triple Ended Transformers
250-250-250 v. 100 ma., 6.3 v. 4 z., 4 a. c., t. 4-5 v. 3 a.
250-250-250 v. 100 ma., 6.3 v. 6 a., 5 v. 5 a. 3 a.

COILS
6/12 v. 2,000, 0.15 a.
32 mfd. 500 v.
16 mfd. 350 v.
8 mfd. 250 v.
4 mfd. 150 v.
2 mfd. 100 v.
1 mfd. 75 v.
0.5 mfd. 50 v.
0.25 mfd. 25 v.

SMOOTHING CYCLES
250 ma., 3 h., 600 ohms 17/9
150 ma., 7-10 H. 350 ohms 11/9
80 ma., 16-18 H. 250 ohms 10/9
Carriage on any of above 5/- extra.

EX GOVT. MAINS TRANSFORMERS
All 230 v. 50 c/s. input
8.5 v. 4 a.
43 v. 1 a.
300-300-300 v. 5 a. 3 v. 3 a.
275-275-275 v. 100 ma.
101-22 v. 30 a.
16-18-20 v. 30 a.
Carriage on any of above 5/- extra.

EX GOVT. AUTO TRANSFORMERS
15-10-5-0-4-5-10-255-255 v. 500 watts 27/9
Double wound 10-0-200-240 v. to 10-0-275-0-200-240 v. 1,100 watts 69/6
Carriage on any of above 6/- extra.

EX GOVT. SMOKING CHOKES
250 ma., 10 H. 50 ohms 14/9
250 ma., 10 H. 50 watt inc. 14/9
250 ma., 10 H. 120 ohms 14/9
250 ma., 10 H. 1200 ohms 14/9

EX GOVT. BATTERY CHARGERS

OIL FILLED BLOCK CONDENSERS
(Byrce) 11-7 mfd. 500 v. New unused Govt. surplus, only 5/- each.

H.T. ELIMINATOR AND TRICKLE CHARGER
Mains Input 250-250 v. Output 120 v. 40 ma., and 2 v. a.
Price with circuit, 23/6.

R.S.C. BATTERY CHARGER KITS
For mains input 200-250 v. 50 c/s. To charge 6 v. accumulator at 2 amps, 25/9.
To charge 6 v. or 12 v. at 2 a. and 3/11.
To charge 6 v. or 12 v. at 4 a. 49/9.
ABOVE KITS CONSIST OF GREEN CRACKLE, LOUVRED STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSE, HOLDER AND CIRCUIT, CO-AXIAL CABLE. Any type assembled and tested for 6/- extra.
R.S.C. HIGH FIDELITY 25 watt AMPLIFIER A4

A NEW DESIGN FOR 1955
HIGH GAIN PUSH-PULL OUT-TURNED TUBE BUILT-IN PRE- AND TONE CONTROL STAGES. INCLUDES
7 valves, sectionally wound output transformer, block paper reservoir condenser, and reliable small components.
AN INPUT OF ONLY 20 millivolts IS REQUIRED FOR
FULL OUTPUT. THIS MEANS THAT ANY TYPE OF MICROPHONE OR PICK-UP IS SUITABLE.
Two separate inputs controlled by separate volume controls allow simultaneous use of "Mike" and Gram., or
Tape and Radio, etc., etc. Individual controls for Bass and Treble "lift" and "cut." Six
- to-point wiring diagrams. (appropriate for 23/19/- extra.
H.P. Terminals on assembled units. Deposit 2/- and 12 monthly payments of £1. Plus carr. 10/-.
Terms to include cover, mike, speakers, etc., on request. Cover as illustrated if required, price 17½/- extra.

A PUSH PULL 3-4 WATT HIGH GAIN
ASSEMBLED AMPLIFIER FOR £2/19/6.
For mains input 200-250 v. 50 c/a
Complete kit of parts including point-to-point wiring diagrams and instructions.
Amplifier can be used with any type of feeder unit or pick-up.
This is not A.C./D.C. with "live" chassis but A.C.
Only 250-400 V. 15-20 mA. H.T. required
Output is for 2-3 ohm speaker. (We can supply a suitable 16ohm unit for £3/17/6.) Fully ready for use in the amplifier.

H.M.V. LONG PLAYING RECORD TUNASTABLE
COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS).
Speed 2/53 c.p.m. BRAND NEW, Carr. £3/2/6. (Approx. half price. Carr. 3/- for 200-200 v. A.C. mains.)

GOLDRING MAGNETIC PICK-UPS. Due to a
fortunate purchase we can offer those popular high-
impedance pick-ups, brand new, boxed, at only 23/-.

R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER
TYPE A5

A highly sensitive 4-valve quality amplifier for the home.
A.C./D.C. with "live" chassis but A.C.
Only 250-400 V. 15-20 mA. H.T. required
Output is for 2-3 ohm speaker. (We can supply a suitable 16ohm unit for £3/17/6.) Fully ready for use in the amplifier.

R.S.C. MASTER INTERCOMM. UNIT, with provision
for up to 4 "Listen-Back" Talk-Back Units. Self-contained complete assembly, inc.
Three valves and Low Distortion
Cathode follower
Germanium Diode Detector.
Complete with table stand. Normal price 4 gns.
Price with circuit, 27/9. Complete with British High Fidelity
MICRO-PHONES. Type 252. Complete with British High Fidelity
Complete with circuit and instructions. DO NOT MISS THIS
SPECIAL SUMMER OFFER FOR ONE MONTH
This amplifier, whilst having sufficient output to fill a small
hall, is the ideal amplifier for the quality enthusiast who
knows that though the average listening level is less than
one watt it is necessary, for the very highest quality to
have an output of at least ten times this figure in order to
obtain completely distortionless reproduction of standard
high-fi recordings.

Large safety factors in every component A.C. and H.T.
Partly enclosed chassis, high gain and perfect at fraction of normal price.

This unit with self-contained Pre-amp. and Tone Control.

R.S.C. HIGH FIDELITY MICRAPHONE PICK-UPS.
High impedance type. Limited number, new, boxed, at only 23/-

DEFIANT RECORD PLAYING TUNASTABLE COMPLETE WITH MAGNETIC PICK-UP.
Pick-up is high impedance type unit is housed in a beauti-
lful solid veneered cabinet of attractive design for all
standard records (78 r.p.m.).
Limited number. Brand new, cartoned, 5/15/-.
Carr.: 7/-.
COLLAR HIGH FIDELITY MAGNETIC PICK-UPS.
High impedance type. Limited number, new, boxed, at only 23/-

AOS HIGH FIDELITY CRYSTAL MICRO-
PHONES. Type 252. Complete with table stand. Normal price 4 gns.

ALL DRY RECEIVER BATTERY SUPER-
SEDER KIT
All parts for an "All Dry" Battery. Eliminator Complete
with case. Completely replaces 1.4 v. and 90 v.
batteries wherever, normal
range supply made of 200-200 v. 50 c/a, is available.
Price with circuit, 23/-.
Only for use with 23/- extra. plus 3/- carr.

BATTERY SET CONVERTER KIT. All parts for con-
verting any type of battery receiver to all mains. A.C. 220-240
v. 50 c/a. Kit will supply fully smoothed B.T. of 220 v.
or 40 v. at up to 40 ma., and fully smoothed L.T. of 2
v. at 0.4 a. Price complete with circuit and instruc-
tions only 25/-.

Hum level 66 D.B. down. Certified total harmonic distortion of only
0.35% measured at 10 watts. Compare
with the best. Suitable for
SMALL HOMES OR LARGE HALLS, CLUBS,
GARDEN PARTIES, DANCE HALLS, etc., etc. For ELECTRONIC
OR ORGAN. OR GUITAR.

For STANDARD OR LONG RECORDING
RECORDS. Size 12 x 10 x 9 in. For mains A.C. 200-250 v. 50 c/s
Power consumption 175 watts. Outputs for 3 and 15 ohm speakers. The kit
is complete in every detail. Chassis is
fully punched. Easy to follow point-to-
point wiring diagrams. With EXTRA HIGH
SENSITIVITY, HIGHEST QUALITY:
Assembled read for use for 50/- extra. 9 Gns.

Radio Supply Co. (LEEDS) LTD.
22 THE CALLS.
LEEDS, 2.
Terms C.W.O. or C.O.D. No C.O.D. under £1.
Postage 1/- extra under 10/-, ½/- extra under £1, 1½/- extra under £2. Full Price List 6d. Trade List 5d.
Open to Callers: 9 a.m. to 5:30 p.m. Saturdays until 1 p.m.

W.B. "STENTORIAN" HIGH FIDELITY P.M.
SPEAKER. 8PO10, 12 in., 15 ohm (or 3 ohm) speaker.
Wears a really good quality speaker. The price is required to suit individual, recommended this unit
with an amazing performance. £3/17/6.
RECEIVER CHASSIS

Modernise your old Radiogram

COMPLETE RADIOGRAM EQUIPMENT—QUALITY AT LOW COST

STERN'S DESIGN FOR HOME CONSTRUCTORS

The "SUPER-SIX"

A compact and highly efficient superhet Radio-Radiogram chassis of outstanding quality.

YOU CAN BUILD IT FOR £10/7/6

Including the OCTAL VALVE LINE-UP (£12/7/6 with the miniature valves.)

Incorporating the new B.V.A. Miniature Valve Line-up. This receiver is designed to the very latest specification and provision is made to incorporate either the standard Octal Valve line-up or the new B.V.A. range of miniature valves.

Great attention has been paid to the quality of the reproduction of both Radio reception and Record playing, and excellent clarity of speech and music is obtained.

A few brief details:

- Covers 3 wavebands 16-50 metres, 190-550 and 900-2,000 metres.
- Equipped witharts valves having PULL-PULL for 5-watt output.
- Incorporates delayed A.V.C. on 3 wavebands and pre-selective feedback.
- Has independent mains supply socket for a Record Player.
- Size of Assembled Chassis 12in. x 7fin. x 6fin. high. Dial aperture 8fin. x 4fin.
- Provision for any A.O. mains 200-205 volts 50 cycles.
- Negative feedback and delayed A.V.C.
- For operation on A.C. mains 200-250 volts 50 cycles.
- Power supplies required 250 volts at 100 ma and 6.3 volts at 10 ma.
- A position Tone Control operates on all 3 wavebands.
- A push-pull stage drives into a 4-valve output stage, of which the 800-2,000 metre set has the dual output valves.
- They cover 3 wavebands 16-50 metres, 190-550 and 900-2,000 metres, and are for operation on A.C. mains 200-250 volts.

THE INSTRUCTION and INSTALLATION MANUAL is available for 6s. It contains very detailed practical line-ups and circuit diagrams and a complete Component Price List.

A BULK PURCHASE ENABLES US TO OFFER THIS "PULL-PULL" 7-VALVE SUPERHETERODYNE RECEPTOR FOR £12/19/6

For only

(Carr. & ins. 7/6 extra)

This receiver Models AW-3 are the latest models of manufacture and incorporate the latest Deren Valve Line-up of X79—W77—D177—H77—1T78 and two X79 in Push-pull for approx. 7 watts output. They cover 3 wavebands 16-50 metres, 190-550 and 900-2,000 metres, and are for operation on A.C. mains 200-250 volts.

WE CAN ALSO SUPPLY

(a) The GARRARD 3-SPEED CHANGER MODEL R.C.58.
(b) The GARRARD 3-SPEED CHANGER MODEL A.V. 7.
(c) The COLLARO 3-SPEED CHANGER MODEL R.C.54.
(d) The COLLARO 3-SPEED NON-AUTO MODEL 355.
(e) The B.S.R. 3-SPEED NON-AUTO MODEL HF100.

All of these are the very latest models. Send S.A.E. for details.

We recommend the W.B. "STENTORIAN" P.M. SPEAKERS

POWERS, LTD. have introduced a new P.M. Speaker. These units will auto-change on all 4 wavebands to give you the best in the American broadcast stations. They play MIXED 7IN., 10IN. and 12IN. P.M. Coils with the standard 7-inch P.M. Speaker.

WE CAN SUPPLY FROM STOCK

THE COLLARO 3-SPEED "TRANSCRIPTION" PLAYERS

MODEL 1010 with the NEW LIGHTWEIGHT "STUDIO P" CRYSTAL PICKUP.

PRICE £18 / 5 / 3 (plus 7/- carriage and insurance).

H.P. TERMS: Deposit ££/4/1.12 monthly payments of ££/4/5.

MODEL 2010 (few only) 3-speed unit only (excluding pick-up).

PRICE £13/6/6 (plus 7/- carriage and insurance).

H.P. TERMS: Deposit ££/3/7/6 and 12 monthly payments of ££/10/0.

THE NEW ARMSTRONG F.C. 48

A high quality reproduction Radio or Radiogram chassis with receive provision for an F.M. Feeder Unit.

PRICE ASSEMBLED AND READY FOR USE £23 / 18 / 0

(Plus 7/- Carr. and Ins.)

H.P. TERMS: Deposit ££/15/5. 12 monthly payments of ££/13/9/0.

OUTSTANDING FEATURES INCLUDE:

- 8 Valves including 2 double Triodes.
- 8 Wires output from push-pull triodes. Heavy negative feedback in used, resulting in negligible distortion and high degree of freedom.
- Provision for using FM adapter to receive the present high quality transmissions from Wrotham and the new B.B.C. V.H.F. stations.
- An accessible socket at rear provides the power supply for this unit.
- Independent controls gives BAS and TREVBLE lift and cut with unique Thermistor meter visual indicator.
- A standard socket for a wavechange switch.
- 4 Wavebands Coverage 16-51, 50-120, 190-550, 1,000-2,000 metres.
- Large iron-coloured illuminated dial.

WE HAVE THE NEW ARMSTRONG F.M. FEEDER UNIT


GREATLY REDUCED—WE OFFER THE ACOS "MIC 22-2" CRYSTAL MICROPHONE

This is a High Fidelity Mike incorporating the "Filtrele" Microphone and is normally retails at ££/4/- It is complete with Table Stand. (plus 7/- carr. & ins.)

STERN RADIO LTD.
**A COMPLETELY ASSEMBLED “HIGH FIDELITY” PUSH-PULL AMPLIFIER.** Supplied Complete with THE STERN'S DUAL CHANNEL TONE CONTROL PRE-AMPLIFIER UNIT FOR ONLY £13/13/- (plus 5/- Carr. & Ins.)

H.P. TERMS DEPOSIT £2/2/- and 12 monthly payments of £1/6/-.

We are able to offer this equipment at such an attractive price only because of a bulk purchase of FARMERS TRANSFORMERS, CHOKES, etc.

It is designed for really good reproduction, employing two 6F6's in push pull for approximately 10 watts output. A total of 7 valves are employed, the main Amplifier having 6F6s in push pull and incorporating negative feedback.

Price completely assembled excluding Power Supply £17/0/0

PRICES:

(a) The COMPLETE AMPLIFIER WITH PRE-AMPLIFIER, £28/7/- or £7/2/- Deposit and 12 months at £1/6/-.

(b) The 10/MAIN AMPLIFIER ONLY: £17/17/- or £4/7/- Deposit and 12 months at £1/5/4.

(c) The “POINT ONE” PRE-AMPLIFIER ONLY: £10/1/- or £2/0/- Deposit and 19 months at £1/6/4.

**THE DENCHE F.M. FEEDER UNIT INCORPORATING AN R.F. STAG**

A VALVE SUPERHETEROTYPE having a frequency coverage of 88 to 100 mks.

This F.M. Receiver is designed to operate with any type of Amplifier and most Radio Receivers. It incorporates a 2YF-7 Rectifier and two 6F6 Stages followed by a Radio Discriminator; the valve line-up being 6AK5—2H2B—at the G.B.A. and 9G4B. Overall size of assembled chassis 9.5 x 6.3 x 4.3 in. high. Price £17/13/6.

**SPECIAL PRICE REDUCTIONS**

**SELECT ANY TUNING UNIT and an assemblable AMPLIFIER, or a TUNING UNIT and RECORD PLAYER.** *Special price reductions are quoted to you at the time of your order.*

**STERN’S 12 WATT "HIGH FIDELITY" Push-Pull AMPLIFIER.**

A very high quality Unit attractively finished in deep gold, and on which the component clearly identified. The ideal amplifier for general home use and for small halls, etc.

**PRICE OF COMPLETE KIT:**

£10/13/- (plus 5/- Carr. & Ins.)

H.F. TERMS DEPOSIT £2/2/- and 12 monthly payments of £1/5/4.

We will supply it Completely Built or for 27/2/8 with Dial

**THE COMPLETE KIT IS AVAILABLE FOR**

£14/0/0

**THE COMPLETE UNIT ASSEMBLED AND READY FOR USE** £17/0/0

**THE NEW “LEAK” TL/10 AMPLIFIER AND “Point One” PRE-AMPLIFIER**

This Amplifier has a maximum output of 10 watts and maintains in every respect the world renowned LEAK reputation for precision engineering: the appearance and finish is outstanding. The Pre-Amplifier will operate from any type of pickup. A continuously variable input attenuator at the rear of the Pre-amplifier permits the instantaneous use of crystal, moving iron, and moving coil microphones, H.T. and L.T. supplies are available for a Radio Tuning Unit. An input attenuator is fitted. S.A.E. for descriptive leaflet.

**PRICES:**

(a) The COMPLETE AMPLIFIER WITH PRE-AMPLIFIER, £28/7/- or £7/2/- Deposit and 12 months at £1/6/4.

(b) The 10/MAIN AMPLIFIER ONLY: £17/17/- or £4/7/- Deposit and 12 months at £1/5/4.

(c) The “POINT ONE” PRE-AMPLIFIER ONLY: £10/1/- or £2/0/- Deposit and 19 months at £1/6/4.

**SPECIAL PRICE REDUCTIONS**

**STERN’S MODEL CP3G 3 WAVEBAND SUPERHET TUNING UNIT**

A highly sensitive tuning unit providing for excellent reception of station on the short wavebands (16-50 metres) medium waveband (140-540 metres) and long waveband (1600-5000 metres). We can supply this tuner correctly operate with each lef the Amplifiers.

**PRICE:** £17/13/6

H.P. TERMS Deposit £2/2/- Deposit Deposit 27 weeks at £1/5/4.

**SPECIAL PRICE REDUCTIONS**

**SELECT ANY TUNING UNIT and an assemblable AMPLIFIER, or a TUNING UNIT and RECORD PLAYER.** *Special price reductions are quoted to you at the time of your order.*

**STERN’S 8 WATT AMPLIFIER and the Model CP3G (or DENCHE F.M. TUNER) all assembled together for £17/2/- (plus 5/- Carr. & Ins.)**

H.F. TERMS Deposit £2/2/- Deposit 27 weeks at £1/5/4.

**SPECIAL PRICE REDUCTIONS**

**NEW M.S. MONARCH 3-SPEED CRANK**

For £20/0/0.

**SPECIAL PRICE REDUCTIONS**

**NEW M.S. MONARCH 3-SPEED CRANK**

For £17/2/-.

**SPECIAL PRICE REDUCTIONS**

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For £17/2/-.

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**NEW M.S. MONARCH 3-SPEED CRANK**

For £17/2/-.

**SPECIAL PRICE REDUCTIONS**

**NEW M.S. MONARCH 3-SPEED CRANK**

For £17/2/-.
YOU CAN ASSEMBLE

The

 TAPE

 RECORDER

 FOR ONLY £40

!! IT ONLY NEEDS CONNECTING UP!!

We are completely satisfied that this Tape Recorder, although supplied at a Genuinely
low price, provides absolute Fidelity Recordings and, in addition to being completely
dependable, has a performance at least equal to recorders marketed at a far higher
price. The actual assembly of the Tape Recorder is extremely simple and only
involves a few connections. The Truvox Tape Deck and the Quality Amplifier
are supplied tested and ready for use, and all that is required to complete the
Recorder is to connect the two together (a connection chart is supplied for this
purpose) and secure them by the screws provided into the Attache Case. The items
illustrated and described below form the complete equipment.

**WILL TAKE ALL STANDARD TAPES UP TO 1,200ft.**

**WILL PROVIDE 2 HOURS' PLAYING AT 3min. or 1 hour at 7min. per second.**

SEND S.A.E. FOR DESCRIPTIVE LEAFLET.

![Truvox Tape Deck](image)

**MODEL T.R.I./F. QUALITY AMPLIFIER**

This amplifier has been expressly designed to meet
the requirements of enthusiasts for fidelity repro-
duction and in particular to CORRECTLY
operate the above TRUVOX DECK. It is
supplied complete with a matched Elliptical 3 ohm P.M. Speaker, it incorporates an efficient
Tone Control arrangement and has a Magic
Eye Level Indicator (Operative on Record).
In addition it can be used as a general purpose
Amplifier for high quality reproduction of
gramophone records direct from a Gram Unit.

**GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS)**

**PRICE SUMMARY**

WE WILL SUPPLY ALL FIVE UNITS LISTED ABOVE, i.e., THE COM-
plete BUT UNASSEMBLED RECORDER FOR £40/-. H.P. Terms:
Deposit £10 and 12 monthly payments of £2/15/0 or in two parts as follows:—

<table>
<thead>
<tr>
<th>CASH</th>
<th>PRICE</th>
<th>DEPOSIT payments of</th>
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<tr>
<td><strong>TRUVOX Mk. TRU TAPE DECK</strong></td>
<td>£33 10 0</td>
<td>£8 10 0 £2 6 4</td>
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<tr>
<td><strong>AMPLIFIER WITH SPEAKER</strong></td>
<td>£14 14 0</td>
<td>£4 16 6 18 4</td>
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<tr>
<td><strong>ATTACHE CASE</strong></td>
<td>£5 0 0</td>
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<tr>
<td><strong>ACOS CRYSTAL MIKE &quot; 33-1.</strong></td>
<td>£1 10 0</td>
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<tr>
<td><strong>REEL OF TAPE 1,200ft.</strong></td>
<td>£1 15 0</td>
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NOTE: Please send 30/- to cover cost of packing, carriage and insurance. We will refund
£1 if the packing case is returned to us in tact.

**PORTABLE ATTACHE CASE**

This, as may be judged from the illustration
opposite, is a neat, compact and attractively
finished case, being covered with maroon
rexine and having an ivory coloured speaker
escutcheon. It contains concealed pockets to
accommodate the Microphone, Mains Lead
and a spare 1,200ft. reel of tape.

The greatly rising sale for the
assembled recorder enables us
to reduce the price and to offer
it complete and ready for use
for...

**SCOTCH BOY MAGNETIC RECORDING TAPE.** Supplied with a
1,200ft. reel of Scotch Boy plastic tape famous for
its true brilliant quality.

**STERN RADIO LTD.**
MAKE YOUR OWN PORTABLE RECORD PLAYER!!!

WE OFFER THE PORTABLE CASE ILLUSTRATED

CONTAINING A 3-VOLUME AMPLIFIER AND A P.M. SPEAKER FOR ONLY £7/17/6

Having been reduced from £8/17/6, this is a magnificent offer for your Microgram Record Player. It is robustly constructed and finished in good quality grey rexine. It will accommodate the COLLARO ID.C.4 3-SPEED AUTOCHANGER and any make of 3-speed Single Record Pick-up fitted together with a coloured indicator.

Case and Amplifier are available separately.
(a) Complete case (plus 10/- carriage and insurance) £7/6
(b) 3-VOLUME AMPLIFIER, with P.M. SPEAKER

WE CAN NOW OFFER THEM FOR £11/19/6

(combined with P.M. Speaker) as illustrated

WE OFFER THE PORTABLE CASE ILLUSTRATED

THREE VALVE AMPLIFIER, with P.M. SPEAKER

THE MINI TWO-THREE!

As a "Mini" High Quality Receiver of mid-size - 6in. x 4in. x 15in. designed to cover medium wave band 190-550 metres, with use of small trailer aerial.

The simple design of this Receiver is so arranged that either a single valve set or a 3-valve set (afterwards easily converted to the 3-valve) can be used.

Consists of a P.M. circuit using a regenerative detector with H.F. and a high gain output period. Valve line up TV-42-2F-114.

The 3-valve set can be completely built, for £2/3/6 (6in. case) and the 3-valve for £2/5/6 (6in. case). Each price includes valves, speaker, and drilled chassis.

Send 5/- for the assembly instructions; they include simple and complete practical component layouts and diagrams.

!! STERN'S AMAZING BARGAIN OFFER !!

WE HAVE BOUGHT THE ENTIRE STOCK OF THE FAMOUS MODEL B3PP RADIO OR RADIOGRAM CHASSIS

A 6 VALVE 3 WAVEBAND SUPERHET WITH PUSH-PULL OUTPUT

Thousands of these successful and very popular Receiver Chassis have been sold for £15/5/- each.

WE CAN NOW OFFER THEM FOR £11/19/6

PLUS 7/6 Carriage and Insurance. H.F. Terms, Deposit £3 and 12 Monthly Payments of 7/-.

GENERAL DETAILS

For use on A.C. mains 100/110 Volts and 220/250 volts.

Employes the latest Valves 6BE6, 6BA6, 6X5, two 6AK5 in push-pull and 6X4 for single detector.

It has a 3 inch socket on the chassis for connection to Grain unit.

Incorporates extension speaker and Pick-up.

Overall size of Chassis is 12in. x 4in. x 8in. high.

Dial size 81/2in. x 4in. high. Dial Escutcheon is available for 10/-.

THE IDEAL SET FOR USE IN CARAVANS, ETC. ! !

A DUAL-CHANNEL PRE-AMPLIFIER

Adaptively fitted to " Old Gold " and providing full control of R.A.M. TREMBLE in conjunction with a main volume control.

It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit allowing simple untuning for all types of pic-up, and all kinds of recordings, i.e., English, American and foreign, all playing perfectly without recourse to pick-up adjustment.

This extreme flexibility of the bass and treble control is such that the unit may be used with either small or large speakers and with the latest types of self-contained power supply and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position.

Price including drilled chassis, valves (60N7 and 12AC7) and 12 months at £1/8/2.

WILLIAMSON AMPLIFIERS BY GOODSELL

These Amplifiers have become the accepted standard in reproduction by which all others are judged. Two Models are available.

MODEL G.W.12. Uses slightly lower H.T. voltage to produce 10-12 watts output.

Price (P.M. Cartridge) £27/10/- and Insurance.

MODEL G.W.13. Does slightly lower H.T. voltage to produce 10-12 watts output, but otherwise it is built completely to specification.

Price (P.M. Cartridge) £27/10/- and Insurance.

THE MINI TWO-THREE AMPLIFIER

As a "Mini" High Quality Receiver of mid-size - 6in. x 4in. x 15in. designed to cover medium wave band 190-550 metres, with use of small trailer aerial.

THE MODEL P.F.A. TONE CONTROL UNIT

FACTORY REFURBISHED

This Control Unit has established a reputation for its excellent quality of reproduction, and ability to give adequate gain for any type of pick-up.

Price £20/0/- and Insurance.

THE MIDGET AND SUB-MIDGET AMPLIFIERS

As a "Midget" Microgram Receiver of 6in. x 4in. x 15in. designed to cover medium wave band 190-550 metres, with use of small trailer aerial.

These Receivers Chassis have undoubtedly proved to be amongst the most popular and successful yet offered. They are designed to the most modern specification with great attention having been given to the quality of reproduction which gives really excellent clarity of speech and music on both Radio and Gram.

They are the IDEAL REPLACEMENT CHASSIS FOR THAT " OLD RADIOGRAM "

All Chassis are BRAND NEW and GUARANTEED FOR 12 MONTHS (B.V.A.)

"PERSONAL SET" BATTERY ELIMINATOR

Complete Kit of parts to build a Midget All"thy Battery Eliminator, giving approx. 10 volts at 10 mA and 1-4 volts at 50 mA.

This Eliminator is for use on A.C. masts and is suitable for any valve Superhet Receiver, requiring H.T. and L.T. voltages as above, or approx. 10/9 volts. The Kit is quite easily and quickly assembled and is housed in a light-aluminium case size 6in. x 4in. x 31/2in. Price including complete Kit of parts to build a Midget All"thy Battery Eliminator, giving approx. 10 volts at 10 mA and 1-4 volts at 50 mA.

Send 5/- for the assembly instructions; they include simple and complete practical component layouts and diagrams.

109 and 115 FLEET ST. LONDON, E.C.4. Phone : CENTRAL 5812-3-4
**COMPLETELY BUILT SIGNAL GENERATOR**

Coverage 120 Kc.+ 320 Kc., 300 Kc.+ 100 Kc. 275 Mc. 27.5 Mcs. 8.5 Mcs., 6 Mcs.-28 Mcs., 16 Mcs.-56 Mcs., 24 Mcs.- 84 Mcs. Metal case 10 x 6 x 4 in. Size of scale 6 x 2 in. 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 milli volts. C.W. and mod. switch, variable A.F. output and moving coil output meter. Black crinkle finished case and white panel, Accuracy plus or minus 2%. 6/4/196 and 34/- deposit and 3 monthly payments 35/-, P. & P. 4/- extra.

**PATTERN GENERATOR**

40-70 Mcl. direct calibration, checks frame and line time base, frequency and linearity, vision channel alignment, sound channel alignment, and sound rejection circuits and vision channel band width. Silver plated coil, black crinkle finished. A.C. mains 200 volts. This unit will align any T.V. receiver, accuracy plus or minus 1%. Cash price 6/4/16 and 29/- deposit and 3 monthly payments of 61/-, P. & P. 4/- extra.

**FLEXIBLE WIRELESS BALLAST UNIT**

Frustrated export order, by very famous manufacturer, at an original cost of approximately £1. VERY LIMITED QUANTITY. Twin 40 watt, both of which are in parallel, can be used as one single 40 watt. The unit comprises 2 choke and power-factor condenser in metal case, size 13 x 3 x 21 in. Completely sealed and fully impregnated. Four lug fixing. A.C. mains 230/250 volts. Fully guaranteed. Post and packing 2/6 each, 15%.

20 watt A.C. or D.C. 200/250v. FLUORESCENT KIT comprising tube in white stoved enamel finish, two tube holders, starter and holder and barreter. Post and packing 1/9, 12/-.

**SPECIAL NOTE:** NO GOODS SENT WHERE CUSTOMS DECLARATION IS APPLICABLE

Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/6 post up to 10/-, 2/- up to 41/- and 2/6 up to £2. All queries please add 1/6 postage.

---

**RADIO TRADERS LTD.**

23 WARDOUR ST., LONDON, W.1. (Coventry Street end)

Phone No. GERard 3971/3

**R**adio Trade 3971/3

**SHEETS** 11 x 11, 31 x 11, 31 x 9, 31 x 7, 31 x 5, 31 x 3, 31 x 1, 31 x 1/2.

**SPECIAL OFFER**

Large assortment of tubular condensers.

**MIDGET MICA CONDENSERS**

-0000, 0001, 0002, 0003, 0004, 0005.... 3/6 each.

200 Assorted Mica Micas, Popular Values...

200 Assorted Silver Micas, Popular Values...

200 Assorted Carbon Resistors, £1.0 10.

**L**arge assortment of fuses.

**B**ig assortment of fuses.

**B**ig assortment of fuses.

**R**adio Trade 3971/3

**W**hole trade manufacturers' and export enquiries invited

**CASH WITH ORDER or C.O.D.**

**J**ones Plugs and Sockets.

**S**older Tags 2/6 per gross; Shakeproof Washers

**N**uts 9 BA 3/-; 6BA 2/6; 4BA 3/-; 2BA 4/- per gross

**S**ignal Lamp Holders, Panel mounting, complete with internal modulator, 1/9 each.

**N**uts 8 BA 3/-; 6BA 2/4; 4BA 3/-; 2BA 4/- per gross

**S**ignal Lamp Holders, Panel mounting, complete with internal modulator, 1/9 each.

**J**ones Plugs and Sockets.

**C**ash with order or all orders Dept. W.

**ALL ORDERS FOR LESS THAN 5/- ADD POSTAGE**

We invite your enquiries for the items not listed

Trade Counter open 9 to 6 Monday to Friday

Callers Welcome

Wholesale, manufacturers' and export enquiries invited
MAINS TRANSFORMERS
Primary, 260-300 v. P. 4.3/6.,
150 mA., 6.7 v. 2 amp.,
5 v. 3 amp., 4.9 v. 2 amp., 2.5 v. 2 amp.
Semi-Shrouded, tripod-mounted. 360-400
v. 2 amp., 2 amp., 2.5 v. 2 amp.
Dial Scale 200-300 v. 70 ma.,
6.5 v. 2.5 amp., 2.5 v. 2 amp.
Chassis mounted and fully shrouded. 80 mA., 6.3 v. 2 amp.,
5 v. 2 amp., 2.5 v. 2 amp., 1416.
280-350 v. 6.4 v. 2 amp., 4.5 v. 2 amp., 2.5 v. 2 amp.
Drop thru 270-320. 80 ma., 4.5 v.
3 amp., 4.5 v. 3 amp., 13/6.
Pan 280-300 v. 70 ma., 6.3 v.
3 amp., 2.5 amp., 2.5 v. 3 amp.

Silver coated, shielded, 400 ma., 6 v. 3 amp., 3.5 v. 3 amp., 2.5 v. 3 amp.,
2.5 v. 2 amp., 1416.

Semi-Shrouded,
Primary, 200-250 v.

4-pole
3-pole 4-way, 4-pole 3-way
3-way 3-way

PUSH-BACK

T.V. Coils, moulded former, iron-cored
3-gang .0005, with feet, size 4 x 4 x 3.

2-way, 3-way

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3-gang .0005, with feet, size 4 x 4 x 3.
METERS
LARGE AND VARIED STOCKS AVAILABLE FOR IMMEDIATE DELIVERY

EXAMPLES FROM OUR RANGE OF 2¼ FLUSH PATTERN MOVING COIL INSTRUMENTS (as Illustrated)

AMPERES D.C. 0-1, 2, 3, 5, 15, 20, 25, 30, 50

MILLIAMPS 0-1, 0-5, 10, 15, 20, 25, 30, 50, 100, 250, 500

MICROAMPS 0-50, 100, 200, 250, 500, 750, 1000

VOLTAMS 0-50, 100, 200, 250, 500, 750, 1000

WATTS 0-50, 100, 200, 250, 500, 750, 1000

We can supply meters with NON-STANDARD CURRENT and VOLTAGE RANGES to any specification. DELIVERY 7-14 days.

MOVING IRON, THERMO & ELECTROSTATIC INSTRUMENTS ALSO AVAILABLE.

ANDERS ELECTRONICS LTD.
91, HAMPTSTEAD ROAD, LONDON, N.W.1.
Telephone: EUSton 1639
Supplied to Government Departments, B.B.C., Leading Manufacturers & Research Laboratories.
RISS COMMUNICATION RECEIVERS. Individually tested in original transit cases, £11 19s. each. Brand new but shop-soiled, £9 19s. each. A combination of pack and audio output stage for A.C. mains, can be supplied with a receiver for an extra cost of 7s. 6d.

SMOOTHING CHOKES. Admiralty type, 9 henry 100 mA.; German shunted type, 10 henry 60 mA.; 3;- American shunted types, 10 henry 80 mA.; and, 3/-; American potted types, 10 henry 90 mA., 6/- 6d. Heavy duty type, 15 henry 275 mA., 10/6.

MIDGET REVERSIBLE MOTORS. For oscillators, 4, 12 or 24 volts, 2 fin., x 1 fin., spindle 3in. x 3in. x 3in. Ideal for model makers, locos, boats, etc., 10/6.

DEAF-AID VALVES. Brand new "Raytheon" type, CX 555AX equivalent to 6SK7, 2/6 each. DEAF-AID WAVES. Brand new "Raytheon" type, CX 555AX equivalent to 6SK7, 2/6 each.

3 independent 5-amp. switches, size 3f x 2 x 1, £9 19s. each.

GERMANIUM DIODES. 2 way, brand new, 4; 6 each.

HEADPHONES. FOR ALL RADIO BARGAINS

AMERICAN INSTRUMENT POTENTIOMETERS. Brand new and boxed. 10,000 ohms, 5fin. dia. Ideal for bridge, 2/6 each.

DEAF-AIDS. An exceptional offer of deaf-aid units, complete with three miniature valves, crystal mike, etc., but less outside bakelite case, only 1/- each. Miniature ear pieces, 3/6, or with lead and plugs, 4/6 each.


Transformer Type 2. Primary 230 volts 50 cycles. Secondary 5-0-5 v., 0-5-0 v., and 5-0-5 v., all at 3 amps. This will give any voltage between 5 and 30 volts in 5-volt steps at 5 amps. Supplied brand new, 59/6 each.

CRYSTAL MICROPHONE INSERTS. A sensitive high-quality crystal mike, ideal for tape recorders, amplifiers, etc., 7/6 each.

Transformer Type 3. Ex-Admiralty. 230 volts 50 cycle input. Secondary 2,000 volts, 5 mA. Ideal for "scope, etc., 14/6 each.

SPECIAL OFFER. PACKARD BELL AMPERIERS. These brand new American amplifiers are complete with a 6L5T and 2807 vacuum tubes, diaphragms, resisters, midget relay, pot and 8-way midget plug and socket, 12/6 each with circuit.

Transformer Type 4. Ex-Admiralty. Secondary 500 x 500 volts 250 mA. 4 volt 3 amp. C.T., 110 volts insulation, 22/6 each.

Transformer Type 5. Ex-Admiralty. Secondary 500 x 500 volts 250 mA. 4 volt 3 amp. C.T., 110 volts insulation, 22/6 each.

TEST SET TYPE 74A. "The ideal basis for an oscilloscope. Five vacuum tubes contain a VCR139 3in. CRT and 11 other valves. A complete A.C. 230-volt power pack giving A.C.T., H.T., and L.T., fully smoothed, potted condensers; withstand greed. Supplied tube tested, £41 19s. each.

P.O. Unisector Switches. 4 bank, double wipers, 25 position, brand new, 32/6.

Deaf-Aid Pots. A midget 1 meg. ohm. pot with switch, only 1/- each.


CERAMIC SWITCHES. 12 pole, 4 way, 4 bank; 10/6; 12 pole, 3 way, 3 bank; 6/6; 7 pole, 2 way, 1 bank; 6/6; 6 pole, 3 way, 2 bank; 4/6; 4 pole, 2 pole, 1 bank; 6/6; 4 pole, 1 bank, 6/6; 2 pole, 1 bank; 6/6; 4 pole, 1 bank, 6/6; 6 pole, 3 way, 2 bank; 6/6; 4 pole, 2 pole, 1 bank; 6/6; 6 pole, 3 way, 2 bank.

FILAMENT TRANSFORMERS. 220-240 volt input, 6.3 volt 1.5 amp., 59/6 each; 6.3 volt 3 amp., 99/6 each.

P.O. Key Switches. Double pole change-over, complete with knob, brand new, 2/9.

Tyne 45 meg. I.F. STRIPS. Complete television I.F. strip with 6 E50 valves. Finest strip ever produced, brand new and complete, 59/6 each.

RECORD AMPLIERS. A push-pull amplifier fitted for use on any output. For operation on 200-250 volts A.C. Standard gain input, output matched to 3 or 15 ohms. Tone and volume controls. Complete valve line-up, 6SN7, 6V6, 6V6, 524. Supplied in an attractive desk type cabinet, perfect working order, 66/10/- each.

METERS. All brand new and boxed. 0-50 mA., 2fin. square, P.M., Mic, 7/6; 0-100 mA., 2fin. round, P.M., Mic, 9/6; 0-150 mA., 2fin. square, P.M., Mic, 7/6; 0-200 mA., 2fin. round, P.M., Mic, 9/6; 0-200 volts, 2fin. round, P.M., Mic, 7/6; 200 ohm, 0.74 amp., 7/6; 200 ohm, 0.35 amp., 1/-; 1,000 ohm, 0.3 amp., 1/-; 0-300 volts, 5fin. projection, Mic, 5/6.

AMERICAN POWER HROSTATS. Brand new and boxed. 3 ohm, 3.3 amp., 1/6; 8 ohm, 2.5 amp., 7/6; 60 ohm, 1.3 amp., 9/6; 90 ohm, 0.74 amp., 7/6; 200 ohm, 0.35 amp., 1/-; 600 ohm, 0.15 amp., 1/6.

Multiway Toggle Switch Boxes. Fitted with 16 toggle type switches. Ideal for train or model control, brand new and boxed, 4/- each.

Hour Recorders. A time recorder for operation on 200/250 volts A.C. Range from 1/10-10,000 hours on five separate scales. Supplied brand new and boxed, 39/6 each.

P.40 POWER PACKS. Input 200/250 volts A.C. Output 175 volts 60 mA., and 12 volt 2.5 amp. Fully smoothed, 524 rectifier, 32/6.

APN4 RECEIVERS. Brand new and complete with valves, 14-17 watts, 6SN7, 1 of 6H6, 1 of 6AS7, 1 of 6UC1, 1 of 6B4, 1 of 6SK7, 2 of 2X2, 3 of 684, 4 of 6GSK, 5/-19s. each.

Battery Charging Equipment. Transformers. 200-250 volts input. Output 9 or 15 volts 1 amp., 9/6; 3.5, 9 or 17 volts 2 amp., 14/3; 3.5, 9 or 17 volts 4 amp., 16/6. Rectifiers, full wave and bridged. 12 volts 1 amp., 5/6; 12 volts 2 amp., 11/6; 12 volts 4 amp., 14/3.

Indicator Type 96. These brand new units contain a VCR97 CRT, 6 SP16, 1 VR3, 1/5 each, 1 EA50, thousands of components. Ideal for television, 45/- each.

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Ex-W.D. Power Packs. 230 volts A.C. input. Output 150 volts 60 mA., 6.3 volts 15 amp. Fully smoothed, metal rectifiers, 29/6 each.

Marcioni Direction Finding Receivers M.D.F.S. Battery operated. Frequency coverage 275 to 3,450 kc/s. Bakelite or plastic, or phone output. Perfect P.M., Mic. condition, 13/10 each.

HOURS OF BUSINESS: 9 a.m.-6 p.m. Thursday 1 p.m. Open all day Saturday.

Please print your name and address clearly, also include postage or carriage on all items.
TWO WONDERFUL BARGAINS

ELECTRO-VOICE MOVING
COIL MICROPHONES

No. 600.C. With built-in matching transformer for direct connection to grid of amplifier valve. These mikes are ex the famous BC.610 Transmitter and give perfect speech quality, they are all brand new with 9ft. screen lead and 3 pin plug, packed in original carton. Price £2, plus 1½/6 postage and packing.

We are offering AS NEW, COMPLETE TR.1196 TRANSCEIVERS, as illustrated. Outfit comprises, 6 valve Superhet, 3 Valve Transmitter, Power Unit and Relay Unit. All complete on Chassis. Present range 4-6.5 me/s. and output 2 watts. Can be easily converted to cover 1.5 me/s.-7 me/s. and power output up to 8 watts. It has a most versatile Receiver which can be easily adapted to cover any band of frequencies from medium broadcast to 30 me/s. The Transmitter range can also be easily extended and by simply adding 200 pf. condenser to tank circuit will cover 1.5 me/s. Circuit and conversion details included with each unit. Each outfit is despatched in transit case at the amazingly low price of £3/-/10/- plus carriage £1.6. If despatched without Transit Case, 42/-10/- plus carriage £8.6.

LARGE QUANTITIES OF OUR UN-USED COMPONENT BARGAINS STILL AVAILABLE AT PRICES BELOW MANUFACTURING COSTS.

- Ceramic Variable Condenser, split stator 15/15 Pf., 2/6 each.
- Ceramic Trimmers 22 Pf., 1/6 per doz.
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- Munding Pot 100 ohm. miniature wire wound, 2/- each.
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- Erie Resistors 47K 2 watt boxed in 50's, and 5's.
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We are able to offer for immediate delivery Sleeving in various grades, such as Permanoid, Micoflex Plastic and Tenaplas Silk covered. Prices are 20% below present trade. For example, various colours, 1 mm. and 1.5 mm. Permanoid, in coils of approx. 144 yds., 8/6 per coil.

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The "OCTAGONAL"
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This new cabinet, which works on the loaded port principle, is constructed in laminated soft woods. It was originally designed for the G.E.C. Metal Cone Speaker, but is equally suitable for any Bin. speaker unit. The model is available in polished veneered oak or walnut. Retail Price £12/10/-.

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During the past five years over ½ million "ACRU" Neons have been sold with not a single complaint about short life.

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BENDIX COMMUNICATIONS
RECEIVER TYPE RA-10DB

A superb 8 valve 4 band receiver covering 150-400 kc/s., 400-1100 kc/s., 2-5 M/cs., and 5-10 M/cs. Valve line up 6SK7 R/F, 6K8 F/C, Two 6SK7 IF Amplifiers, 6R7 Second Det. AVC and AF Amplifier, 6C5 BFO, 6K6 OP, 6H6 Sig. limiter diode.

Power supply 28 v. d.c. 2 A to internal motor generator. If desired this can easily be changed to a similar generator with either 6 or 12 V. input. Alternatively the generator may be removed and the space utilised for a converter. A circuit for a.c. mains conversion is available.

As a BOAT, TRUCK, CARAVAN or CAR RECEIVER it is UNEQUALLED in value; converted to a.c. operation for fixed station, it equals receivers selling for over five times the price we ask.

Full technical details, servicing data and circuit are supplied with every receiver.

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A MULTIRANGE AC/DC TESTMETER of well known American manufacture

This testmeter has a basic movement of 400 microamps and is calibrated for use on the following ranges:
- A.C. and D.C. Volts 0 to 5,000 V. in 6 switched ranges.
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Use as an OHMMETER (Resistance Measurements) 1 ohm to 1 megohm.

Decibels from −10 db to +15 db. For line load impedances from 5 to 1,000 ohms (directly calibrated for 500 ohm line).

This instrument is contained in a well finished polished wood case with leather carrying handle. Leads and test probes are housed in the case which measures 6½in. x 3½in. x 4½in.

All meters fully tested before despatch. Supplied complete with moulded test probes, full operating instructions and circuit diagram.

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Bridge Meggers, 250 V.
Made by Evershed & Vignoles, with integral Decade Box. 10-1M. In leather case 12in. x 9in. x 8in. In perfect order.

£10 plus 7½% carriage.

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Miniature Pocket Radio
Receiver converted from an ex-Government Hearing Aid.
Complete Kit of parts

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OPEN ALL DAY SATURDAY
The new LOWTHER T.P.10, 12 watts output, push pull EL 34's, 7 to 70,000 c.p.s. Motor control unit for above £4 0

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Leak V5S Long/Medium/Short wave tuner in perfect order ................................ £19 0 0
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Kelly range of
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Here is a radical advance in the development of high frequency reproducing units. It utilises an entirely new principle compared with conventional moving-coil "tweeters." It gives remarkably smooth response free from resonance throughout its exceptionally wide frequency range. The main characteristics are listed below—write for full details and recommendations.

LIST PRICE 12 GNS.
Response ................................ 3,000-20,000 c/s
Power Capacity ................................ 10 watts
Impedance ................................... 15 ohms
Flux ..................................... 10,000 Gauss
Dynamic Mass ................................ 0.000 grams
*Force/mass ratio .......................... 4 x 10^10 dynes/gm.
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*Equivalent moving-coil 3.000 dynes/gm.
units 5 x 10^9
Dimensions 8jin. x 5jin. x 4jin.
Weight ..................................... 8 lb.

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NEW APPARATUS FROM STOCK
Leak TL.10 amplifier with Point One preamp. 27 gns. cash or £6/15/- deposit and 25/7 monthly.
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Also full stocks of GARARD, LOWTHER, ACOUSTICAL, DECCA, and WHARFEDALE products.

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LINE OUTPUT TESTER
Essentially a special purpose oscilloscope, with a 1in. diameter screen, for checking damping of TV Line O.P. transformers. Uses the method of injecting a pulse into the primary, and inspecting the resulting wave train on screen. One shorting turn clearly shows on the screen. Finished in durable bronze hammer finish, with contrasting cream panel. Test leads may be wound round carrying handle. Measures only 6jin. x 4jin. x 3jin. 200-250 volts A.C. GUARANTEED 12 MONTHS. Indispensable to every Service Engineer!

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For facsimile transmission, doing spot telecope transmission and research involving low light-levels, 6-stage multiplier. Brand new and guaranteed, only £8 10/-, Special 12-pin base 50 Data sheets supplied.

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Input 12 v., output 200 v. @ 44 mA. £6 15/

Input 6 v. output 150 v. @ 20 mA. £3 10/

Vibrato Transformers 6 v. 150 v. 60 mA. £6 8/

Vibrato Transformers 12 v. 300 v. 60 mA. £12 15/

Vibrators 6 or 24 v. 4 pin. £6 5/

Vibrators 6 or 7 pin synchronous. £6 25/

Vibrators 12 or 7 pin synchronous. £12 10/

Vibrators 24 or 7 pin synchronous. £24 25/

**TRIUS RECEPTOR**

Receiver 27/12. This is a six-valve superhet receiver with 465 kc/s I.F., Complete with all valves—2 EF93, 2 M302, 1 EP103. In brand new condition with full conversion data. E82121.OFFER, 27/10 (plus 2/- carriage).

**NEON INDICATOR LAMP**

Sloane Type V120. Brand new 5/-, post free.

**INDICATOR UNIT TYPE 122A**

Unit contains V122A Cathode Ray Tube, complete with steel metal screen, 2 EP12, 4 EF93, 4 M302 and M303. Complete with 465 kc/s valve, input and output valves, machined image, faceplate for base of television (full pictures guaranteed) or Oscilloscope Bracket NEW (Two Miniature Units, Cased at 6/6. Plus 7/6 carr. "Radio-Construction" scope circuits included.

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Vibrato Transformers 6 v. 150 v. 60 mA. £6 8/

Vibrato Transformers 12 v. 300 v. 60 mA. £12 15/

Vibrators 6 or 24 v. 4 pin. £6 5/

Vibrators 6 or 7 pin synchronous. £6 25/

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Vibrators 24 or 7 pin synchronous. £24 25/

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Unit contains V122A Cathode Ray Tube, complete with steel metal screen, 2 EP12, 4 EF93, 4 M302 and M303. Complete with 465 kc/s valve, input and output valves, machined image, faceplate for base of television (full pictures guaranteed) or Oscilloscope Bracket NEW (Two Miniature Units, Cased at 6/6. Plus 7/6 carr. "Radio-Construction" scope circuits included.

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Coaxial Plugs
Standard Size Pots, 21in.

Special
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yd.

Mains Transformer
-121,11, 125 v., 60 to -A.

Ceramic
Ceramic Type -5 w., 15 ohms to 10K.. 119; 10 w., 20 ohm
Wire -Wound
ohms to 2 Meg -ohms.

Ceramic, 30, 50, 70 pf., 9d.

Tag Strips -2- or 3-way, 2d.; 4- or 5-way, 3d.; 6-way,
x 12in., 41-.

Voltage

Volume Controls
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Coaxial Plugs
Standard Size Pots, 21in.

Special
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4½; 4⅞; COILS. Bulletin giving IF's, 6/- each; Ratio discrirn. trans. MAXI-Q-DENCO F.M. FEEDER UNIT.

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remains the most popular and widely used relay of all.

THE OUTPUT MUST BE RESTRICTED

to maintain the waveform, so say all the books. But not so with the HATFIELD oscillator, nor is it necessary to work near the point of instability.

COMPLETE STABILITY, LESS THAN 0.2% of distortion, R.M.S.

output voltage 50% greater than the H.T. voltage, 1 valve, 1 coil, simple circuit.

Sounds, incredible, but it is GUARANTEED.

Send for copy of N.P.L. report and see our ad. in April issue of "W.W.W." The HATFIELD oscillator is now made with 3 output impedances to suit any Head on the market.

TAPE RECORDISTS! Are you Completely satisfied with your recordings? Bad waveform in an oscillator can cause DISTORTION due to intermodulation, NOISY BACKGROUND due to D.C. component in a symmetrical waveform and INTERFERENCE with radio due to harmonics beating with incoming signals. The fundamental cannot do this!

COIL, complete with circuit, 10/6 post free. Patent app. for.

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Even a small amount of bias frequency getting into the amplifier can cause a lot of trouble, and nearly all tape recorders need a rejector coil to prevent this.

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The HERGA recorder incorporates ALL the above items together with a fire-class crystal mike and one reel of SCOTCH BOY tape in an attractive two-tone portable cabinet, absolutely complete at 39 gns. Or £7 down and 12 payments of £3.

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First-Class openings for experienced television engineers and senior design draughtsmen who shall shortly become available with a firm of reputatate in the London area. Engineers able to undertake immediately development work on broadcast radio and television apparatus would be offered an attractive salary. The successful candidates will be eligible for company superannuation and insurance schemes. Please reply giving full details of experience, to Box 4812.

E. K. COLE, Ltd. (Malmesbury Division).
The Malmesbury Division of E. K. Cole is engaged in the development and production of radar and communication equipment associated with high priority defence projects. Vacancies exist in the Development Department for Project Engineers, Engineers and Assistant Engineers with training and experience in the following fields:
Pulse Generators.
Time Base Generators.
G.M. I. Engineering Development, Ltd.
Transformers design.

A vacancy has arisen at the Feltham laboratories of this active company for an engineer to work on transformer design and development. The person we are looking for will have at least ordinary national and preferably have had some experience in this field, this is not a pre-requisite for consideration. Applicants should have 4-6 years experience and a degree in science or engineering would be a distinct advantage; an attractive salary is proposed for this, and prospects in the Co., which is steadily expanding, are considerable.


E. M. I. Engineering Development, Ltd.
Micro-wave work.
AN engineer is required at the Company's Potters Bar laboratory to collaborate on micro-wave component design and to investigate problems arising from quantity manufacture of micro-wave components and aerials; applicants should have 4-6 years experience and a degree in science or engineering would be a distinct advantage; an attractive salary is proposed for this post, and prospects in the Co., which is steadily expanding, are considerable.


E. M. I. Engineering Development, Ltd.
Experienced valve engineers.
AN interesting vacancy has arisen at the Company's Feltham laboratory for a valve engineer with 4-6 years experience of both valves and microphone equipment; applicants who should be qualified, will have some knowledge of tube theory and in particular special purpose, will be able to design suitable valve equipment. Applicants should be able to design suitable valve equipment, all successful applications will be given the first opportunity at College, Knutsford, B.S.27, returnable within 14 days.

E. M. I. Engineering Development, Ltd.
Experienced valve engineers.
AN interesting vacancy has arisen at the Company's Feltham laboratory for a valve engineer with 4-6 years experience of both valves and microphone equipment; applicants who should be qualified, will have some knowledge of tube theory and in particular special purpose, will be able to design suitable valve equipment. Applicants should be able to design suitable valve equipment, all successful applications will be given the first opportunity at College, Knutsford, B.S.27, returnable within 14 days.

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Early delivery can be given of some quantities, and we will be pleased to quote for your specific requirements.
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12 x 8 in. x 2 in. - 13/6
8 x 6 in. x 2 in. - 13/6

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

ASSISTANT trials planner.

AN assistant is required for trials planning at the Company's Peakhurst Laboratory. The successful applicant will be responsible for the design, layout and construction of the installation.

Apply, Personnel Officer, Louis Newmark, Ltd., LOUIS NEWMARK, Ltd., have vacancies in Engineering Development, and WEY TELECOMMUNICATIONS, Ltd., Ditton College Works, Chertsey Road, Weybridge, S.E.19.

DUTIES in new development work on radio and television equipments, including supervision of work both in laboratory and the field. Must have wide experience in electronics design and some experience in the engineering field. Must have a knowledge of techniques and be able to pass the requirements of the Post Office. Must be a graduate in Electrical Engineering. Permanently appointed with pensionable and holding a position of distinction in the industry.

Applications from persons possessing B.Sc., V.H.F., microwave and recording equipments, would be especially welcomed.

APPLICATION forms from Mr. T. M. T. Mant, Human Resources Dept., A.W.R.E., W. 741A, 5 V. A. Ltd., Chichester, W. 741B, 6 V. A. Ltd., Chichester.

STEEL METER CASES WITH ALUMINIUM PANEL

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STEEL METER CASES WITH ALUMINIUM PANEL

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8 x 6 in. x 3 in. - 9/6
6 x 3 in. x 2 in. - 9/6

FULLY DRILLED ALUMINIUM CASES

4 x 3 in. x 1 in. - 8/6
3 x 3 in. x 1 in. - 8/6
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12 x 8 in. x 2 in. - 13/6
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(b) Engineering experimental units for use in the field.

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Senior Engineering experimental units for use in the field. Previous experience of the construction and testing of complex electronic equipment is essential. Successful applicants will be required to join the Authority’s Establishment’s contractors. Applicants had equivalent training in an appropriate trade.

Salary.

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Some experience in the construction and testing of electronic components will be desirable.

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109 RECEIVERS v.h.f. pack and skir. 85/-, P. A. P. £2.13.6.

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JULY, 1955
SITUATIONS VACANT

ULTRALIGHT LTD., Western Avenue, Aston, Longford, W.3. ANNOUNCE the following vacancies for ENGINEERING R.A.F.- (1) TELEVISION (a) SENIOR ENGINEERS required for TV receiver design; applicants should have good academic qualifications and experience of the design of video and RF circuits. They will design up to frequencies of the order of 200 Mc/s. (b) SENIOR ENGINEERS for time base development; applicants should have good academic qualifications and previous experience in the design of TV scanning circuits.

(2) RADIO DEVELOPMENT (a) SENIOR ENGINEERS required for development of radio receivers embodying the most advanced automatic frequency control. Full knowledge of the receiver design desirable.

(3) JUNIOR ENGINEERS required for receiver design; experience desirable but not essential for possessing H.N.C. or C. & G. (Telecoms.) Final Cert.

ELECTRONICS (a) SENIOR ELECTRONICS ENGINEER with experience of design for work in one of the following:

(i) Pulse techniques and general waveform circuitry.

(ii) Radar display.

(iii) Feedback techniques at video frequencies.

(b) JUNIOR ELECTRONICS ENGINEERS for work on one or more of the above subjects.

(1) TELECOMMUNICATIONS DEVELOPMENT (a) TEST EQUIPMENT DEVELOPMENT Engineer for the design and production test equipment for TV, radio or other telephone instruments requires H.N.C. or equivalent and good experience.

(b) JUNIOR ENGINEERS with some qualifications or preferably some experience.

(2) MEASUREMENTS SECTION LABORATORY ASSISTANT (m. or f.) with some technical knowledge of calibration and certification of electronic equipment. Applicants are required to write to the Personnel Manager, stating which of the post(s) desired and giving full details (in strict confidence) including age, experience and salary expected. Saturday morning interviews can be expected; Saturday afternoons may be advertised if necessary.

BURNDEPT., Ltd., have vacancies, due to expansion, for:

(a) VARIABLE capacitors.

(b) SWITCHES for radio or electrical appliances.

(c) U.H.F. or U.E.R. circuits and tuning mechanisms.

(d) KELAYS and vibrators.

(e) LOUDSPEAKERS and acoustics. A good salary and a progressive future are offered to men who can design components suitable for high production rates, while maintaining standards of quality and performance. There are also vacancies for qualified engineers and draughtsmen with less experience who will be taken on as apprentices, and be able to undertake responsible design work after a period in the laboratory. All posts are permanent and reasonable and a modern laboratory provides efficient and agreeable working conditions.


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Input 11½ v., Output 250 v. at 12.5 mA

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Input 11½ v., Output 490 v., 18 amp.

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with switch, popular values, long spindle 2½ each.

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WIRE WOUND POTS

2½ watts 30 k. NSF, 1½ in. spindle at 1½ each. 3,000 coils. 50ohm, 250 watts to carry 25 amps.

AMERICAN UB TUBE CONDENSERS

.001 600 v., oil filled 3½ in. x 1½ in. at 9½ each. 2,000 vac.-1800 ohms. .0001 2,500 v., test, at 1½ each. .01 2,000 vac.-1250 ohms.

WAXED TUBE CONDENSERS

1,200 vac.-1250 ohms. 100 vac.-800 ohms. 150 vac.-600 ohms. 200 vac.-500 ohms.

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(1½ em.) Post 1½ each. BELLING & LEE

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Please add post for orders under 1£.

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250 watts to carry 25 amps. Resistance 0.4 ohms. Suitable for charging board, etc. Size 9 x 4 x 6 in. High. Brand new. Price 10/6. Post 2½/.

Circulating Round grey heavy insulation, in 10m. lengths, 3½ in. dia. 16/0.4. Price per metre: 5½/. Post 2½/.

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Acknowledgements: These are the personal views of the writer, and not necessarily those of the Editor.
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(c) ELECTRO-MECHANICAL Engineer for design and development work to assist in the general mechanical construction of radio and electronic equipments. Applicants should have a good knowledge of model shop practice and should have A.M.I. Mech.E./A.M.I.E.E., together with proved experience.
(d) SENIOR Radio Engineer for design and development work in many new applications of electronics in communications and industry. Minimum requirements are H.N.C. or C. (Telecomm.). Final Certificate.
(e) MODEL Shop Mechanic conversant with work involved in electronic development work and able to fabricate from rough sketches. Drawings or circuit diagrams. There are also vacancies for sheet metal and machine operatives as well as welders.

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(2) MECHANICAL Engineers to be concerned with design problems arising from the high-speed rotation of discs and cylinders and possessing a sound knowledge of the problems arising in such structure due to heating and centrifugal effects and with high-precision work involved in over-precision engineering and balancing problems. A knowledge of small motor design would be an advantage.

(3) MAGNETIC Recording Engineer for investigations into special record heads and power supplies and methods of speed control for magnetic drums and for the design of synchronising circuits in co-operation with Computer Circuit Engineers. Permanent staff appointments with pension benefit. Application forms from Mr. T. J. Lunt, Blackpool Television, Ltd., Holland Wood, Lancs. Please quote reference CD (E) 1474 or P.

DRAUGHTSMEN required, electro-mechanical background, knowledge of circuitry an advantage—Apply ( quoting Ref. (1) ) to Personnel Manager, Ferranti, Ltd., Union Works, East Lane, Wembley. [Tel: 1474]

RAIDEN, Ltd., a reputable firm at Rochdale (Hydromite Ltd.), require an Electrical Engineer responsible by Bread, (Hydromite Ltd.), for many of the R.F. system—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., Wembley. [Tel: 10627]

SALERMAN required for radio and T.V. components, good prospects, permanent position, previous experience an advantage—Apply to Personnel Manager, Garrett Lane, Ltd., Mission Rd., W.11. [Tel: 14728]

QUALIFIED electronic engineers urgently required for the research division of a prominent London company; applicants should possess initiative and be accustomed to a high degree of responsibility—Write loa 1572.

HEARING all manufacturers, north-west, required experience instrumentation to work as a Special-Service personnel engineer from give fullest details of experience and salary required to Box 2729, The Times, London. [Tel: 14719]

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Applicants should have had both teaching and industrial experience, and a knowledge of electronic switching techniques would be an advantage.

Salary as for Senior Lecturer, Burnham Technical College. Commencing salary according to experience and qualifications.

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JULY, 1955

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Electrical engineer required for experimental work and electrical research, with experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering; complete experience of high voltage, electronics, atomic energy, state, and experience and knowledge of advanced engineering.
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1124 VHF Receiver with 6 valves, 3 watts output, 2.5-25 megacycles, 6 channel switching. Receives T.V. sound, police, fire and amateurs. 30.5 to 40 m.cps. 1/29 plus 2/6 post or 3/9 plus 2/6 post, including and conversion data free with each set.

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29/9 including L Speaker. 5 valve kit, 3/5 watt, A.C. mains complete, less valves. All used, tested, guaranteed. FREE draw from orders. Post 4/6. Knobs (set of four) 1/6 extra.

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2/9d stamp only for complete catalogue.
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Technical Assistants and Junior Engineers for Experimental Laboratory work on problems related to the application of Radio, Machine Frequencies, and Resistance Heating. Candidates must have had a full-time electrical or mechanical apprenticeship and present good academic qualifications. Draughtsmen, Seniors and Juniors for circuitry layouts, mechanical and electrical equipment associated with Radio, Machine Frequency, and Resistance Heating Applications. Candidates must have had a full electrical or mechanical apprenticeship and present good academic qualifications as well as a full-time electrical apprenticeship will be in accordance with age, qualifications, and experience.

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<table>
<thead>
<tr>
<th>Catalogue No.</th>
<th>Alloy</th>
<th>Tin Lead</th>
<th>S.W.G.</th>
<th>App. Length</th>
</tr>
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<tbody>
<tr>
<td>C 14014</td>
<td>6/40</td>
<td>14</td>
<td>21 feet</td>
<td></td>
</tr>
<tr>
<td>C 16016</td>
<td>60/40</td>
<td>18</td>
<td>55 feet</td>
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<td>15 feet</td>
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<td>C 1401340</td>
<td>40/60</td>
<td>16</td>
<td>38 feet</td>
<td></td>
</tr>
</tbody>
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