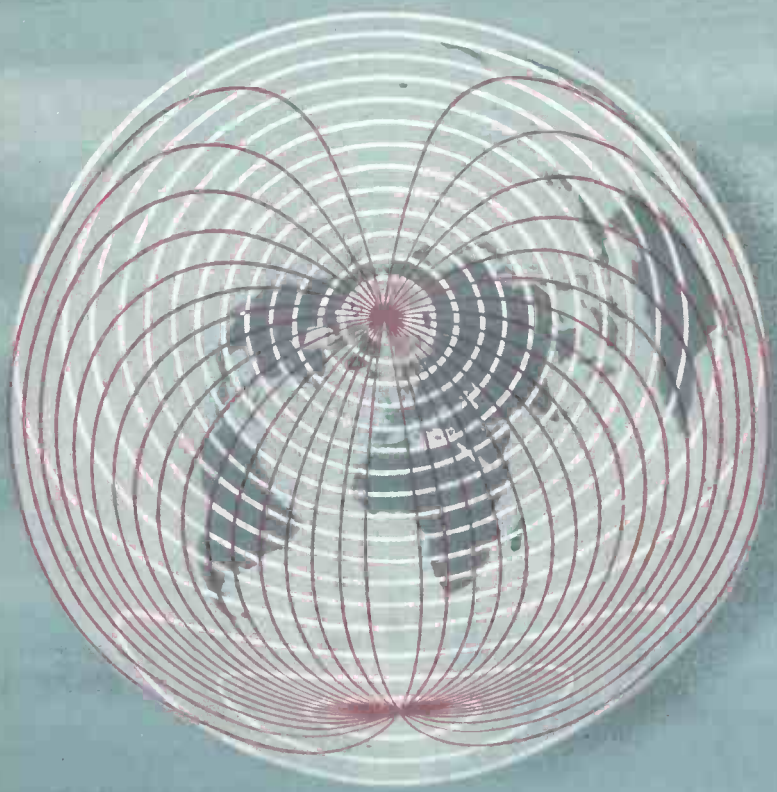
JULY 1955

TWO SHILLINGS

Wireless World

Radio · Electronics · Television



FORTY-FIFTH YEAR OF PUBLICATION

The *improved*

EDISWAN

STABILISED POWER SUPPLY UNIT TYPE R.1103A

PRICE REMAINS UNALTERED AT £57. 0. 0 NETT.

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 EDISON SWAN ELECTRIC COMPANY LIMITED

Member of the A.E.I. Group of Companies

155 Charing Cross Road, London, W.C.2 and Branches *Telephone: Gerrard 8660. Telegrams: Ediswan, Westcent, London*

S.P.116

Wireless World

RADIO, ELECTRONICS, TELEVISION

Managing Editor:
HUGH S. POCOCK, M.I.E.E.

Editor:
H. F. SMITH

JULY 1955

In This Issue

VOLUME 61 NO. 7
PRICE: TWO SHILLINGS

FORTY-FIFTH YEAR OF PUBLICATION

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VALVES, TUBES & CIRCUITS

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.

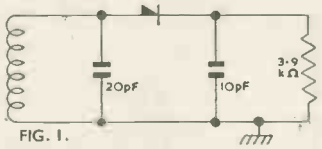


FIG. 1.

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.

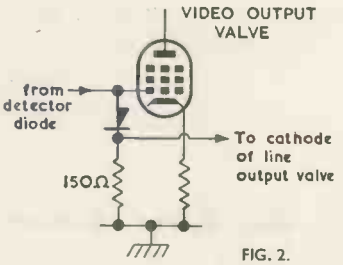


FIG. 2.

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.

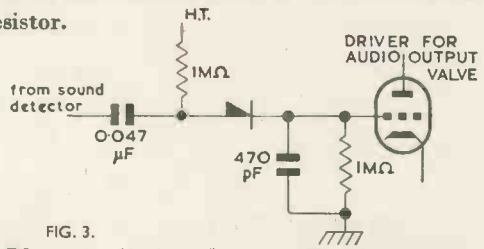


FIG. 3.

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.

Wireless World

JULY 1955 VOL. 61 No. 7

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.

Impedance and Admittance

Reactance and Resistance in Series and Parallel on the Slide Rule

By FRANCIS OAKES, M.Inst.E., A.M.Brit.I.R.E. and E. W. LAWSON, A.M.I.E.E.

CALCULATION 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

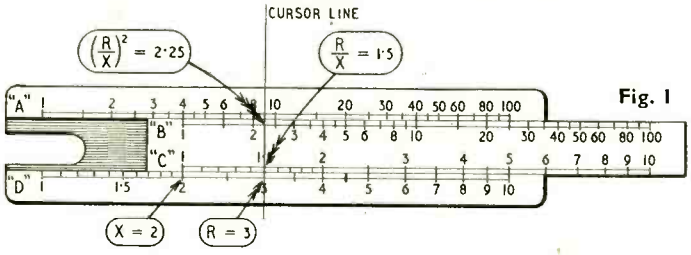


Fig. 1

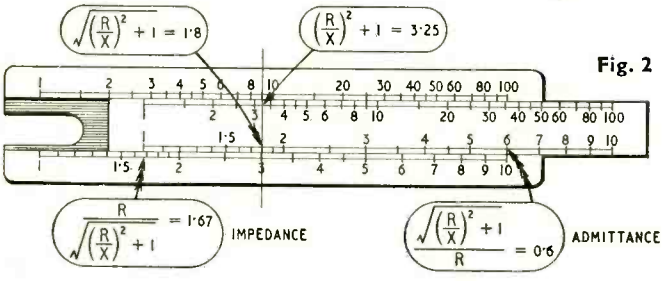


Fig. 2

PARALLEL COMBINATION

Set "C"1 (or 10) over "D"X. (Fig. 1, one arrow.)

Set cursor over "D"R. (Fig. 1, two arrows.)

Note cursor reading on "B" (Fig. 1, four arrows) and add 1.

Move slide to bring ("B" + 1) under cursor. (Fig. 2, one arrow.)

Read impedance under "C"1 (or 10). (Fig. 2, three arrows.)

Read admittance above "D"1 (or 10). (Fig. 2, four arrows.)

SERIES COMBINATION

Set "C"1 (or 10) over "D"X. (Fig. 1, one arrow.)

Set cursor over "D"R. (Fig. 1, two arrows.)

Note cursor reading on "B" (Fig. 1, four arrows) and add 1.

Move cursor over ("B" + 1). (Fig. 3 one arrow.)

Read impedance on "D" under cursor, (Fig. 3, three arrows) or move slide to bring "C"1 (or 10) under cursor. (Fig. 4, one arrow.)

Read admittance above "D"1 (or 10). (Fig. 4, two arrows.)

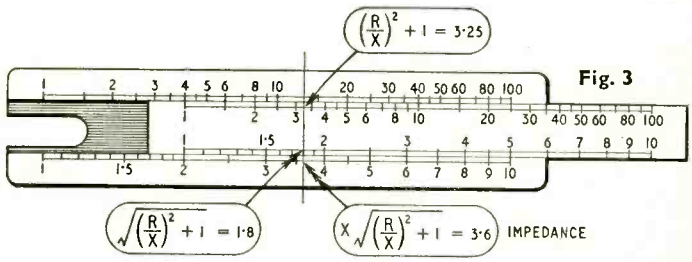


Fig. 3

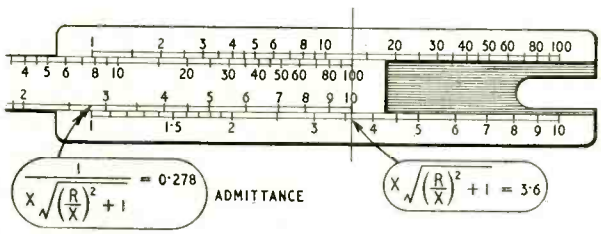


Fig. 4

Calculations

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

$$|Z| = \frac{R\,X}{\sqrt{R^2 + X^2}} \quad \text{as} \quad |Z| = \frac{R}{\sqrt{\left(\frac{R}{X}\right)^2 + 1}}$$

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, $\left(\frac{R}{X}\right)^2$ 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 $\left(\frac{R}{X}\right)^2 + 1$, instead of $\left(\frac{R}{X}\right)^2$, under the cursor line (Fig. 2, one arrow). This, of course, also brings $\sqrt{\left(\frac{R}{X}\right)^2 + 1}$ (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 $|Z| = \sqrt{R^2 + X^2}$, which can be converted to $|Z| = X\sqrt{\left(\frac{R}{X}\right)^2 + 1}$. 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, $\left(\frac{R}{X}\right)^2$ is read off (Fig. 1, four arrows). But this time;

(2) Instead of moving the slide, the *cursor* is moved to $\left(\frac{R}{X}\right)^2 + 1$ 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 $\sqrt{\left(\frac{R}{X}\right)^2 + 1}$ on the slide (Fig. 3, three arrows), thus, $X\sqrt{\left(\frac{R}{X}\right)^2 + 1}$, 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—to wit, the root of the sum of the 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 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; Redifon 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.

BOOKS RECEIVED

Precision Electrical Measurements. Proceedings of a symposium held at the National Physical Laboratory in November, 1954, covering capacitance and dielectrics, inductance and magnetics, electrotechnics, high-voltage measurements and impulse testing techniques. Pp. 345; Figs. 147. Price £1 7s 6d. Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.

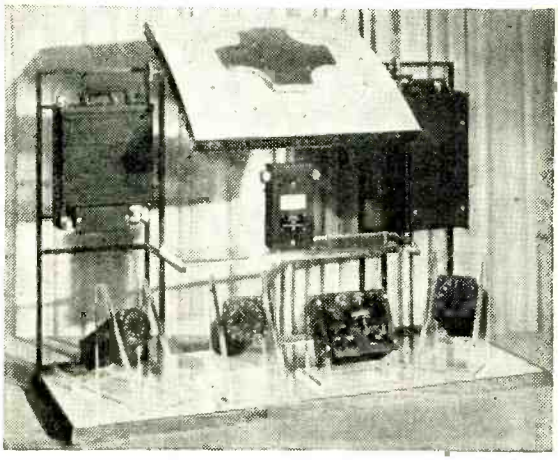
The Physics of the Ionosphere. Collection of papers presented at a conference under the auspices of the Physical Society at the Cavendish Laboratory, September, 1954. Pp. 406; Figs. 167. Price 40s. The Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.

Defects in Crystalline Solids. Report of the conference held at Bristol in July, 1954, including papers on semiconductors. Pp. 429; Figs. 324. Price 40s. The Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.

Calibration of Temperature Measuring Instruments. Description of methods employed at the National Physical Laboratory, covering electrical and non-electrical instruments. Pp. 47; Figs. 27. Price 2s. Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.

Radio Research 1954. Report of the Radio Research Board on the work of the year, which included the application of back-scatter technique to propagation research, investigations of semi-conductors and ferromagnetic materials. Pp. 47; Figs. 8. Price 2s 6d. Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.

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.

Proceedings of the National Electronics Conference, Vol. X. Collection of papers covering a wide range of subjects including microwaves, servo-mechanisms, solid-state devices and information theory. Pp. 808+XIV; Figs. 447. Price $5. National Electronics Conference, 84E, Randolph Street, Chicago, 1, Illinois, U.S.A.

Technique et Applications des Transistor by H. Schreiber. Physical principles, methods of construction and circuitry of point and junction types, with an analytical appendix treating the transistor as a four-pole network. Pp. 157; Figs. 182. Price Fr.720. Editions Radio, 9, rue Jacob, Paris, 6.

Principles for Television Advertising. Code of standards based on recommendations of the Advertising Advisory Committee for the guidance of prospective advertisers on television. Pp. 15. Price 1s. Independent Television Authority, 14, Princes Gate, London, S.W.7.

Staging TV Programmes and Commercials by Robert J. Wade. Illustrated treatise on the stagecraft of television programme production. Materials and methods of scene painting and lighting. Pp. 216. Price 48s. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2.

Specialized Tape Recorder Manual, Vol. 1. Collection of American manufacturers' service data on popular models made since 1950. Pp. 286, profusely illustrated. Price $4.50. John F. Rider, Publisher, 480, Canal Street, New York, 13.

From the Electron to the Superhet by J. Otte, Ph. F. Salverda and C. J. van Willigen. Course of instruction for training servicemen, in 42 lessons, with questions and model answers. The authors are in the Service Department of Philips, Eindhoven. Pp. 700; Figs. 733. Price 55s. Cleaver Hume Press, Ltd., 31, Wrights Lane, London, W.8.

Photo-electric Handbook by G. A. G. Ive. Practical guide to the installation, operation and maintenance of equipment incorporating photo-emissive cells. Pp. 152; Figs. 108. Price 17s 6d. George Newnes, Ltd., Southampton Street, London, W.C.2.

Zilveren-Jubileumboek K.V.I.V. Report of the International Technical-Economic Congress held under the auspices of the Royal Flemish Engineers Association at Antwerp in June, 1954, containing eighty-five papers on civil, mechanical and electrical engineering developments ranging from harbour works to automatic process control. Pp. 644; profusely illustrated. Price 1,000 Belgian francs. Technisch-Wetenschappelijk Tijdschrift, Torengebouw VIII, Schoenmarkt 31, Antwerp.

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-aiding 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.

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.

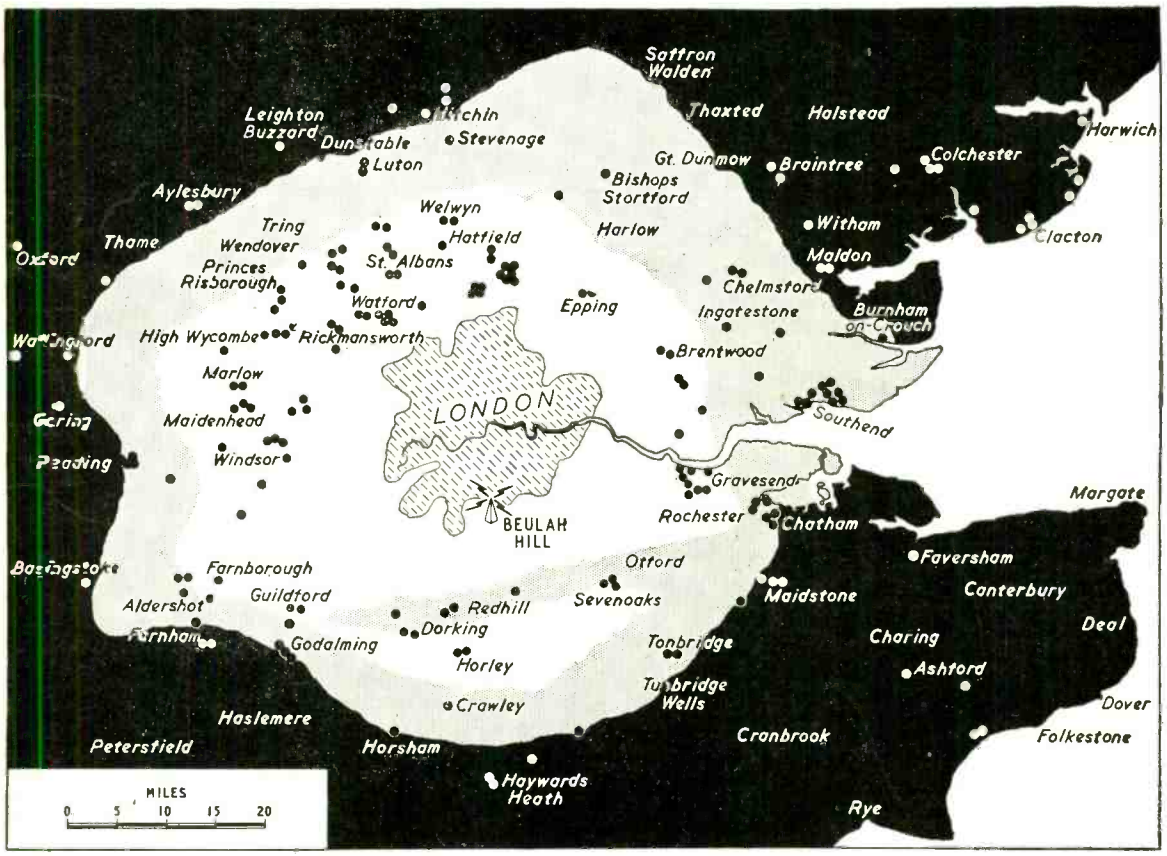
Improvements can also be effected in the end-products, and the increased heat resistance of irradiated polythene is already engaging the attention of cable makers.

In our own field it has been found* that irradiation of transistors can reduce the recovery time and increase 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.

* Florida, C. D., Holt, F. R. and Steven, J. H. *Nature*, February 27th, 1954, Vol. 173, p. 397.

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 Croydon 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.

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 1,450ft 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 had 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 depositing of flock, from timing loom 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.

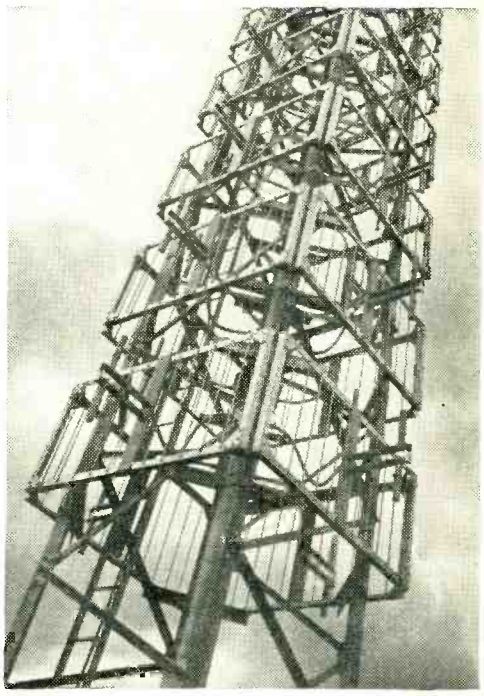
Swedish Television

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 outset, 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.



I.T.A. AERIAL. Part of the 8-stack aerial array built by Marconi's for the I.T.A. Croydon station.

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 Kompfner, 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 Birmingham University), and in 1944 went to the Clarendon Laboratory of Oxford University 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 Shepperton, 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, formerly 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 Metrovick 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 Airmec, Ltd., and the English Electric Company, he went to Canada in 1952 and returned to this country at the end of last year. Mr. Cattanes has twice been a member 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 was working 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. Clemow.**

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:—

Hugh K. Grey, head of the communications department, Foreign Office (C.B.E.).

F. Neil Sutherland, general manager, Marconi's Wireless Telegraph Company (C.B.E.).

Philip H. Spagnoletti, director and general manager, Kolster-Brandes, Ltd. (O.B.E.).

Harold W. Cox, E.M.I. Engineering Development, Ltd. (M.B.E.).

Richard W. Lewis, chief chemist, Burndept, 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 Telephony 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 was 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 associateships of the College were awarded. Among those to whom associateships 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 Appointments Bureau** (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 (Pye) as president. Frank Jones (Marconiphone) 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.B.U. Bulletin*, the German television set manufacturers 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-per-week 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 Engineering 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 a club. Requests should 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, Cadogan Street, Glasgow, C.2 (Tel.: Central 3633).

Winston Electronics Limited have moved from Hampton Hill to their new factory and offices in Govett 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 radio equipment for forty 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 Wigmore 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.

EXPORTS

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.

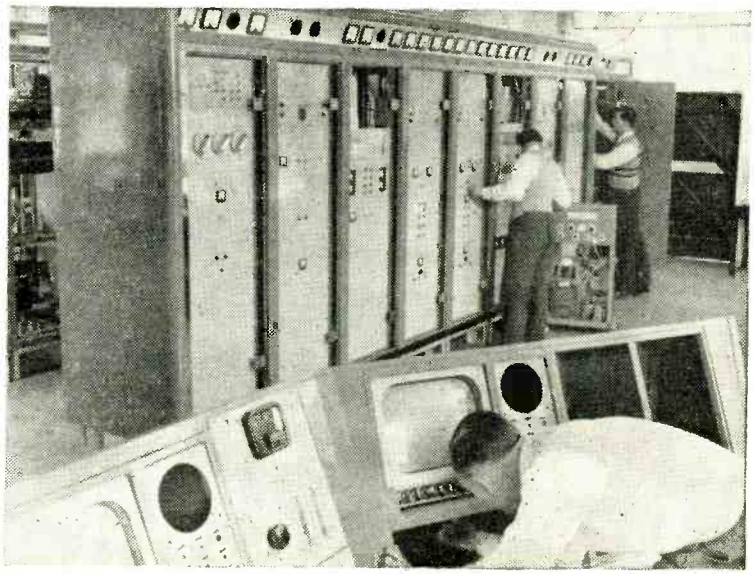
The Companhia Telephonica Brasileira (Brazil's telecommunications organization) has placed contracts for the supply of equipment for a cable and radio network for multi-channel telephony with **Standard Telephones and Cables, Limited,** through the associated company Standard Electrica S.A., of Brazil. 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 Compania Shell de Venezuela, in Caracas, a console control desk providing for four microphone inputs and eight line inputs and a transportable 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.



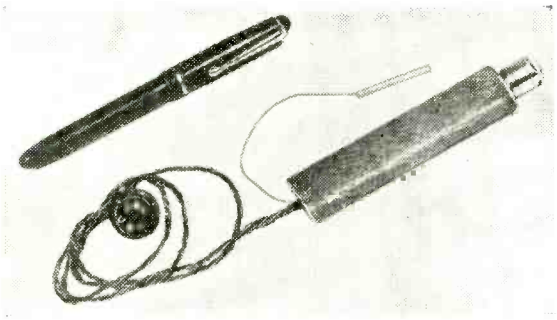
I.T.A. MIDLAND TRANSMITTER.—This is the Pye equipment to be installed at the I.T.A. Midland television station to be built at Common Barn Farm, Hints, some five miles south-east of Lichfield, Staffs. It is estimated that its service area will extend as far south as Gloucester, to Chesterfield in the 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.

Developments in Sound Reproduction

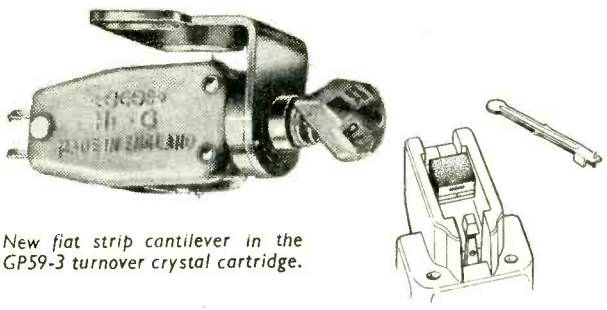
NEW PRODUCTS AND TRENDS AT RECENT EXHIBITIONS

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 $4\frac{3}{4}$in × 1in × $\frac{1}{2}$in and can be clipped into the breast pocket, when the $\frac{3}{8}$-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 1μV.



Leevers-Rich "Radiovoyce" transmitter-microphone.



New flat strip cantilever in the GP59-3 turnover crystal cartridge.

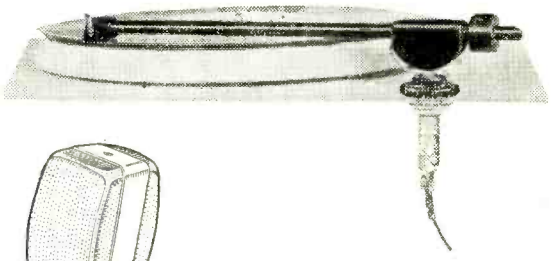
Another unobtrusive microphone, this time of normal direct-connected type, is the Model LFV59 "Full Vision" made by Lustraphone. This has been designed for singers and other artists and measures only about 1in in diameter. It is of the moving-coil type and is suitable for hand or stand use.

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 $2\frac{1}{2}$in and $1\frac{3}{8}$in in diameter and make use of semi-flexible tubing instead of swivel joints for adjusting the angle of the head.

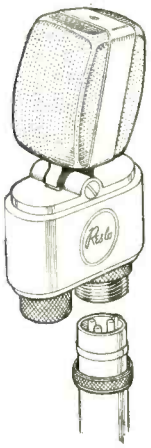
The Reslo ribbon microphone is now available in a redesigned screen with matching transformer in the base. The ribbon is 2 microns in thickness and is die formed to a shape which gives visual indication when the designed tension has been applied. This microphone, and the Reslo miniature moving coil, 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 $33\frac{1}{3}$ 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.

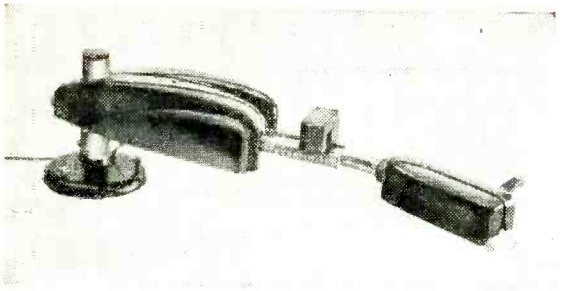
In a new Cosmocord high-output turnover crystal pickup, replaceable flat strip cantilevers are used for



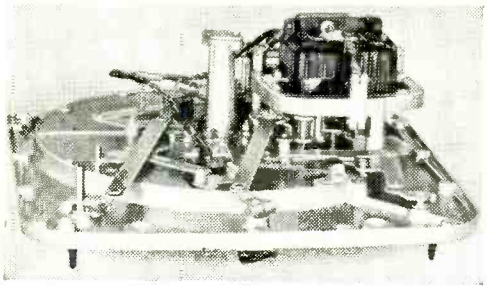
Leak "Dynamic" moving-coil pickup.



Reslo ribbon microphone.



Goldring transcription pickup arm.



Underside of Garrard "301" transcription motor.

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" pick-up arm developed by Goldring. No springs are used and the counterbalance is effected by variable leverage.

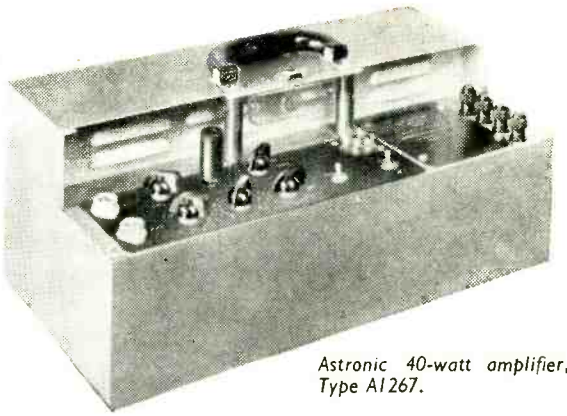
A new record for the testing of fine-groove (33⅓ r.p.m.) pickups is available from the British Sound Recording Association, 295, Regent's Park Road, London, N.3. It carries fourteen frequencies between 50 c/s and 10 kc/s and the lateral velocities conform within 0.5 db to the CCIR standard combining a 450μsec bass cut with a 50μsec 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 Connoiseur (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.



Astronic 40-watt amplifier, Type A1267.

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 S5E/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 × 4in × 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 converter. 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 20 kc/s. It is designed to work with most high-quality amplifying equipments.

Detail improvements in the Rogers range of ampli-

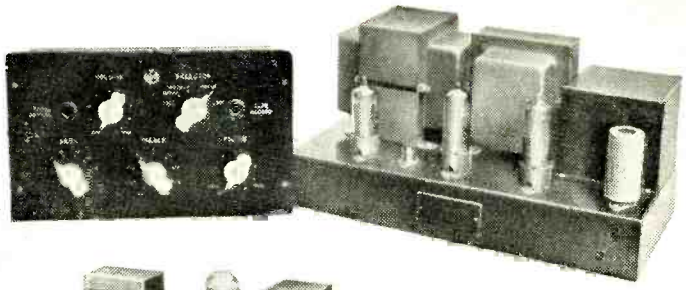
fiers include an "ultra-linear" output stage and provision for a radio input in the Mk. III version of the RD Minor. The RD Junior amplifier/control unit has a specification which meets most domestic requirements with an output of 8-10 watts, and the RD Senior with 25 watts is suitable for schools and 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.

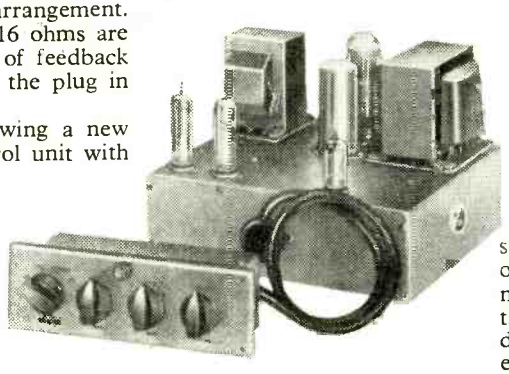
In the control circuit of the new Armstrong A10 amplifier, a worthy effort has been made to rationalize the chaotic pick-up equalization situation. Four principal response characteristics cover all the main British, Continental and American recording characteristics, which are listed and grouped. Minor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



Rogers RD Junior amplifier and control unit.



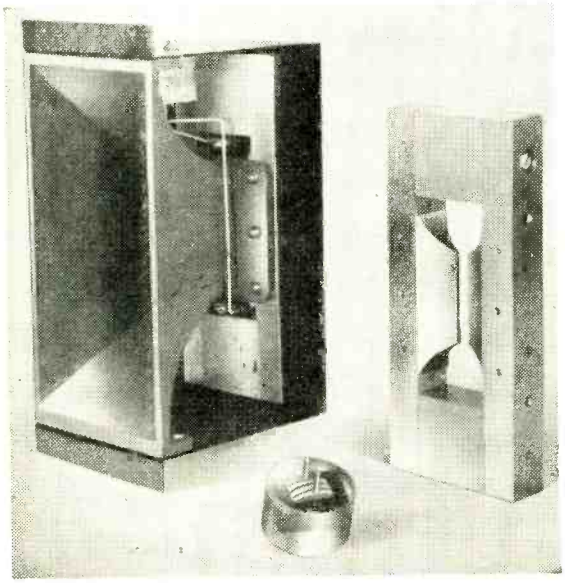
Left: Whiteley Electrical 12-watt high-quality amplifier.

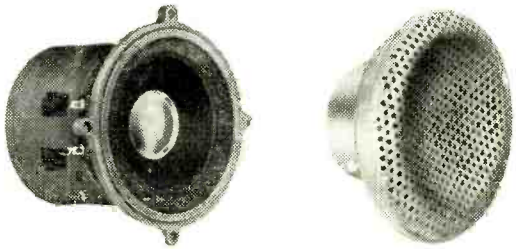
set the standard for other items of sound reproduction equipment as far as harmonic distortion is concerned. H. J. Leak demonstrated a high-frequency electrostatic unit of the new type in conjunction with a 15-in moving coil with a cross-over at 700 c/s, and the prototype of a wide-range all-electrostatic 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 4×10^7 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.

Reslosound, 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 $1\frac{1}{4}$ 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.





Left: Kelly Acoustics ribbon loudspeaker, with de-mounted magnet system and coupling transformer. Centre: Wharfedale "Super 3" tweeter. Right: Plessey 3-inch inset loudspeaker.

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.

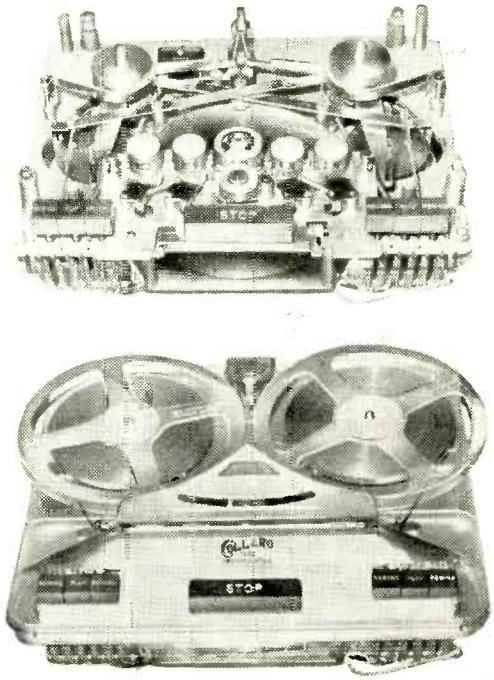
Two-speaker combinations of any of the units comprising the Goodmans range moving-coil loudspeakers can be arranged in a simple cross-over network using standardized 4.5 mH chokes. Pairs of these chokes for constructing the cross-over unit are available from Goodmans at 37s per pair.

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.

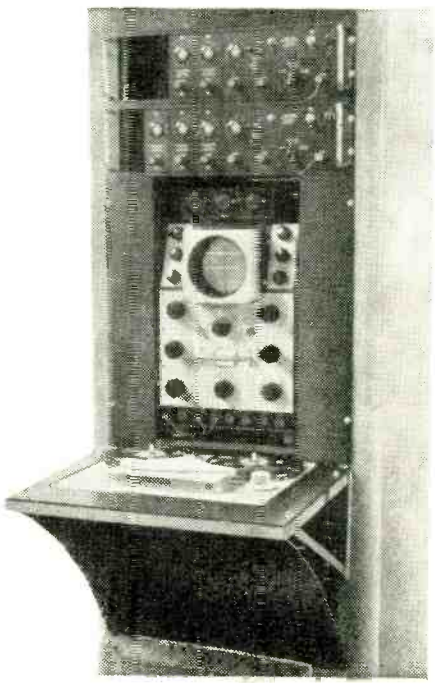
Magnetic Recording.—An event of considerable importance, particularly to owners of portable recorders with limited spool capacity, is the introduction by the Minnesota Mining and Manufacturing Company of a new thin tape ("Scotch Boy" Type 190M) giving a 50% increase of playing time from any given size 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.

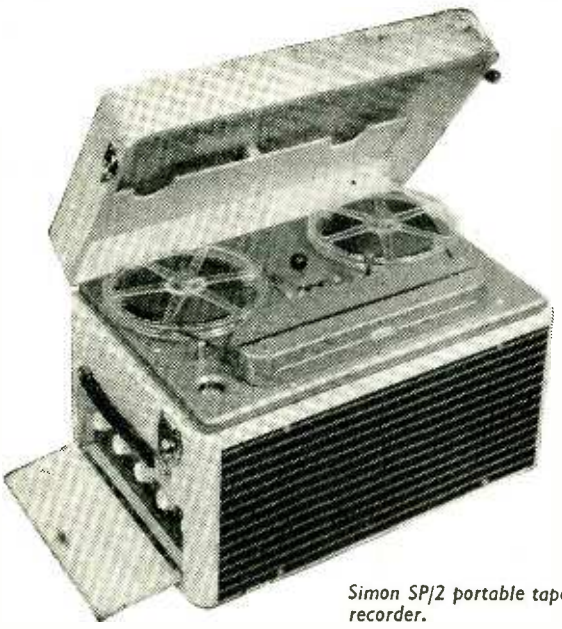
Special equipment has been developed by the M.S.S. Recording Company for routine examination of tape production and for the analysis of faults. The tape is driven at 30 in/sec and 10 kc/s is recorded and played back at the full width of the tape. After passing through a 2-kc/s wide bandpass filter the 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 1½in/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



Collaro "Transcripter" tape recording mechanism with and without top cover.



Equipment used by M.S.S. Recording for routine testing of magnetic tape.



Simon SP/2 portable tape recorder.

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 $6\frac{3}{4}$-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.

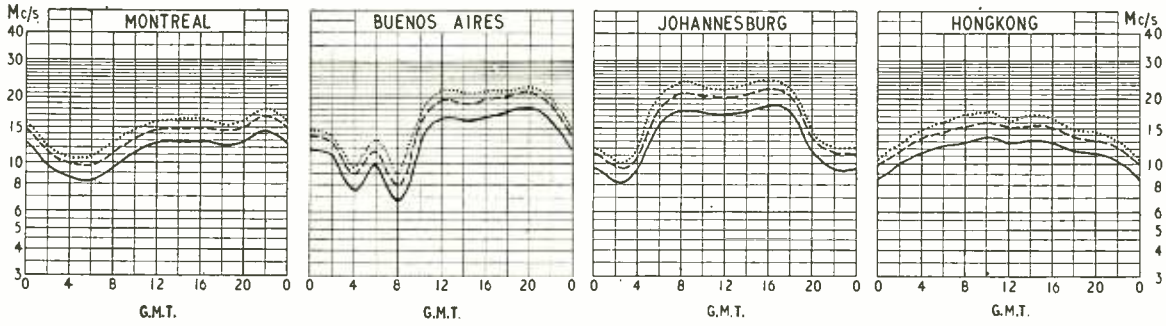
Grundig were showing a "Specialist" version of their tape recorder with a stated frequency range of 50-9,000 c/s at $3\frac{3}{4}$ in/sec and 40-14,000 c/s at $7\frac{1}{2}$-in/sec. Track changing is by press-button without changing spools. Wide-angle distribution of sound on playback is achieved by 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.

SHORT-WAVE CONDITIONS

Predictions for July



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.

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 was never greater. 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"[1] 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.

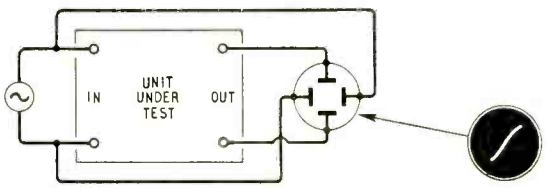


Fig. 1. In this c.r.o. method of measurement the cause rather than the effect of the distortion is seen—the non-linearity of the transfer characteristic.

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[2] and elaborate[3] 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) a single figure, viz., total harmonics expressed as a percentage of the whole output[5]. This total is the r.m.s. voltage of all the harmonics together, and the distortion figure is therefore

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

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[6] 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

$$100\sqrt{\frac{V_2^2+(\tfrac{3}{2}V_3)^2+(2V_4)^2+\ \ldots}{V_1^2+V_2^2+V_3^2+V_4^2+\ \ldots}}$$

In 1950 D.E.L. Shorter[7] produced evidence to show that this linear weighting is not drastic enough and that aural assessment is fitted more closely by a square law:

$$100\sqrt{\frac{V_2^2+(\tfrac{4}{3}V_3)^2+(4V_4)^2+\ \ldots}{V_1^2+V_2^2+V_3^2+V_4^2+\ \ldots}}$$

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 13th. But Shorter suggests that the fact that his weighting gives a figure related 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 were given long ago[6].

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.[1, 8, 9]. 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.[1] 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.[8, 10]. Or given the

* But unless the distortion is more than about 10%, the denominator $\sqrt{V_1^2+V_2^2+V_3^2+V_4^2+\ \ldots}$ can be replaced, with negligible error, by V_1.

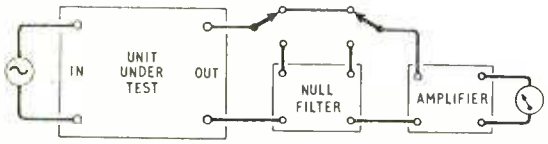


Fig. 2. Block diagram of the usual arrangement for measuring total harmonic distortion.

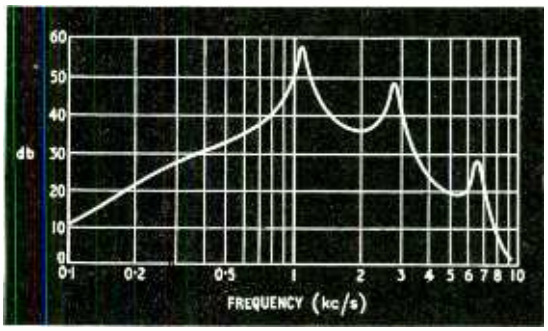


Fig. 3. Example of a frequency characteristic in which wide divergences between different methods of estimating distortion are to be expected.

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.[11, 12, 13] 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 that intermodulation data line up well with listening tests whereas harmonics do not.[8, 14-20]

From these many references let us take two examples. The first is by H. E. Roys.[15] 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[17] 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

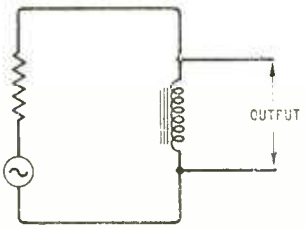


Fig. 4. A simple frequency-discriminating system, representing a typical output stage, in which the ratio of intermodulation to harmonic distortion is very different from that calculated for systems with level frequency characteristics.

quite invalid for non-linearity as generally understood.

The second example[18] 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[11,13] 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

TABLE I

Order of Distortion	Harmonic		Intermodulation	
	Frequency	Percentage	Frequency	Percentage
3rd	180	8.0	520	3.3
5th	300	2.3	640	0.67
7th	420	1.7	760	0.67

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 I.

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,[8–11, 15, 20, 21] 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 "total harmonic distortion" measurement, for it makes no distinction between products of different order.* And because the kind of non-linearity that generates nth harmonic also generates intermodulation of the nth order, it is not surprising if, in general, the unpleasantness increases with the order of intermodulation[14]. 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[12], 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.[17, 22] This can be investigated with the help of ref.[13] We assume that a signal $v = V\cos\omega t$ is applied to an element having a single non-linear term kv^n 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 whether $V\cos\omega t$ is the only signal present or not. If next the signal applied is $v = V_1\cos\omega_1 t + V_2\cos\omega_2 t$, column 3 shows the ratio of the coefficient of the nth order intermodulation product, $\cos(\omega_2 t - n\omega_1 t) + \cos(\omega_2 t + n\omega_1 t)$, to V_2. 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, $V_1 = 4V_2$ 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[13]; and these alter the ratios tabulated for second and third order, the tendency being to

* An intermodulation product of frequency $pf_1 \pm qf_2$, 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

1	2	3	4	5	6	7
Order of distortion, n	**Relative harmonic amplitude**	**Relative intermod. amplitude**	**Intermod./ harmonic ratio, R**	**R when $V = V_1$**	**R when $V = V_1 + V_2$**	**2R when $V = 5V_2$ $V_1 = 4V_2$**
2	$\frac{kV}{2}$	$\frac{2kV_1}{2}$	$\frac{2V_1}{V}$	2	$2\Big/\left(\frac{V_2}{V_1}+1\right)$	3.20
3	$\frac{kV^2}{4}$	$\frac{3kV_1^2}{4}$	$3\left(\frac{V_1}{V}\right)^2$	3	$3\Big/\left(\frac{V_2}{V_1}+1\right)^2$	3.84
4	$\frac{kV^3}{8}$	$\frac{4kV_1^3}{8}$	$4\left(\frac{V_1}{V}\right)^3$	4	$4\Big/\left(\frac{V_2}{V_1}+1\right)^3$	4.08
5	$\frac{kV^4}{16}$	$\frac{5kV_1^4}{16}$	$5\left(\frac{V_1}{V}\right)^4$	5	$5\Big/\left(\frac{V_2}{V_1}+1\right)^4$	4.08
6	$\frac{kV^5}{32}$	$\frac{6kV_1^5}{32}$	$6\left(\frac{V_1}{V}\right)^5$	6	$6\Big/\left(\frac{V_2}{V_1}+1\right)^5$	3.92

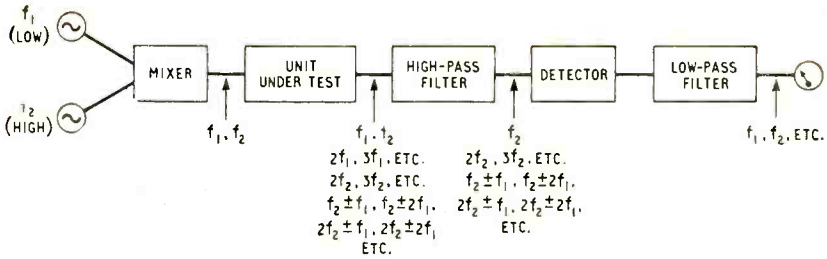


Fig. 5. Block diagram of the usual arrangement (S.M.P.E.) for measuring total intermodulation.

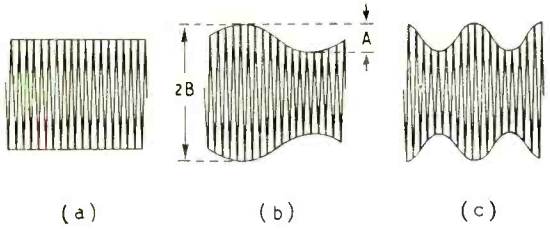


Fig. 6. Typical modulation envelopes showing (a) no distortion, (b) second-order distortion, (c) third-order distortion.

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[17], named after Le Bel but basically the same as that described much earlier by Bartlett[23], 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[24]. 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, 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[25, 18]. 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[26] 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[10, 15, 21]; for hearing aids both these methods are regarded as useless and the C.C.I.F. method strongly advocated[16].

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—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.?% it should

TABLE III

Order of modulation product	Frequency of weak signal when strong signal frequency is:			
	65 c/s	800 c/s	3,000 c/s	12,000 c/s
1 (fundmtl.)	1,320	1,320	1,320	1,320
2	1,385	2,120	4,320	13,320 (or (10,680)
3	1,450	2,920	7,320	
4	1,515	3,720	10,320	
5	1,580	4,520	13,320	
6	1,645	5,320	16,320	
7	1,710	6,120	19,320	

be sufficient to give the percentages of second and third at two suitable frequencies. Some substantial improvement on present practice need not therefore be completely unpractical.

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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, Manchester. V. MAYES.

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. Maurice and R. J. H. Slaughter 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_{K-d}/V_{a-d}. 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_{K-d}/V_{a-d} follows *faithfully* the original audio modulation. This is only true when second and higher orders of small quantities are neglected.

Malvern, Worcs. F. L. MORRIS.

I FAIL to understand why Messrs. Amos and Johnson should choose the ratio detector for their f.m. receiver[1]. 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 Roddam's circuit[2]? 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 contractor companies (Associated-Rediffusion, Ltd.), I wrote

[1] Amos & Johnstone; *Wireless World*, April 1955.
[2] Roddam; *Wireless World*, July 1948.

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 can cover an area at least 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.

It 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 concerned and specially the dislocation that would be caused to existing television installations, on balance it may be best 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 plan 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 augmentation of their second programme services.

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 off-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 up overnight. I had always understood that except for long-haired grey beards, the cylinder-type machine "died" before the First World War, and I wonder if the Gamage'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. Leak, who states that whilst foil 0.005in 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.

Kelly Acoustics, Ltd., London, N.3. S. KELLY.

CORRECTIONS

IN referring to the **Solartron square-wave generator, Type G0511**, 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.

Spurious Radiation from Wrotham

A Problem in Co-sited Transmitters

By J. R. BRINKLEY*

A RECENT issue of *Wireless World* contained an article[1] 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 unwise; 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.[2, 3]

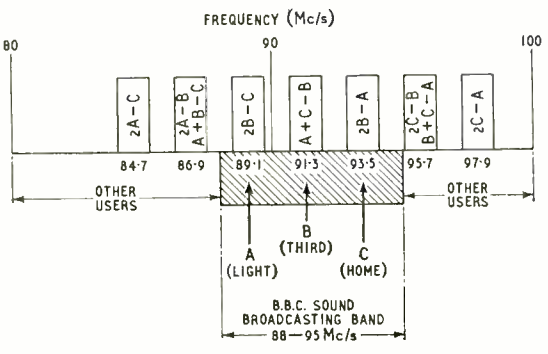
That transmitters which have any mutual coupling and are closely spaced in frequency can combine to produce spurious products is well known.[4] The phenomenon is due to the fact that each transmitter output stage as "seen" by the others is a non-linear device in which the separate carriers mix and produce 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 intermodulation experienced from this cause when operating several v.h.f. sets simultaneously aboard warships became known as "rusty bolt effect."[4]

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 65db 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 ±225kc/s and the total sideband spread approximately ±300kc/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.

* Pye Telecommunications, Ltd.



Third-order intermodulation products radiated from Wrotham.

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

[2] "Wrotham Aerial System," by C. Gillam. *Wireless World*, June/July, 1951, p.p. 210-214, 279-282.

[3] "Wide Band Folded—Slot Aerials," by G. D. Monteath. *Journal I.E.E.*, Vol. 97, Pt. III, 1950, p. 414.

[4] "External Cross-Modulation in the 100 mc/s Band," by K. W. Blake. *Journal I.E.E.*, Vol. 94, Pt. IIIa, 1947, p. 659-662.

Design for a

By D. H. W. BUSBY

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[1]. 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%.

Fig. 1. Complete circuit diagram of pre-amplifier.

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[1], 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

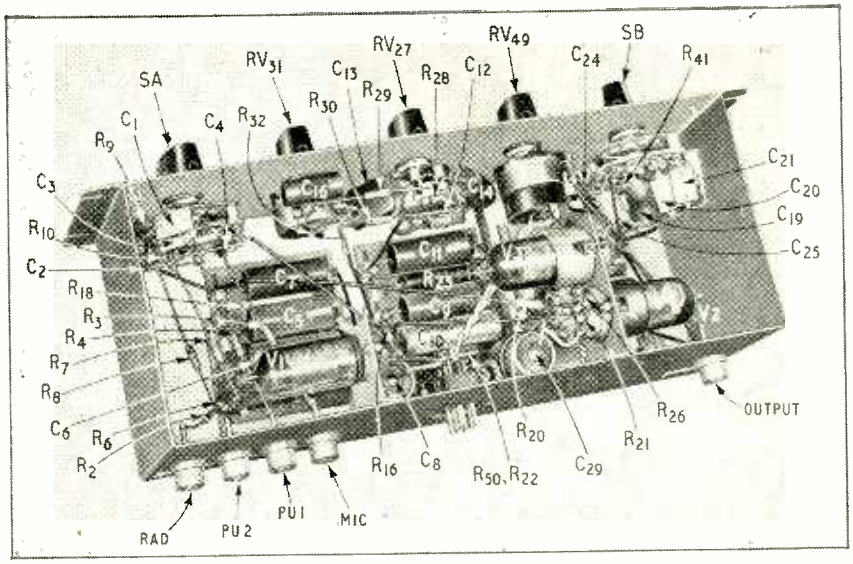
* Mullard Valve Measurement and Application Laboratory.
† Society of Motion Picture and Television Engineers. See also "Electronic Measurements" by Terman and Pettit (McGraw Hill).

Pre-Amplifier

For Use with a 20-watt High-quality Amplifier

of the pre-amplifier it follows that the stated signal-to-background ratio will be maintained at all settings of the gain control.

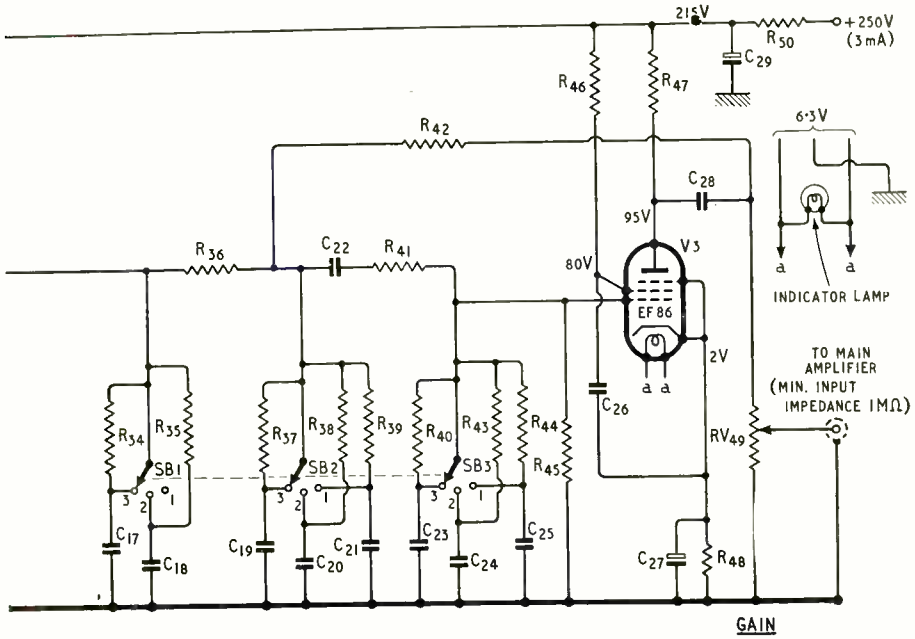
Layout. — Considerable thought has been given to layout, since many difficulties may be encountered when working at such high sensitivity, and the proposed layout was found to be very suitable from all considerations. In general with pre-amplifier circuits it is essential to adhere closely to the suggested 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.



Underside of chassis showing positions of most of the components.

In order to obtain the required line voltage of 250 V in conjunction with the 20-watt power amplifier[1], 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 R_{20} in the grid of V2 minimizes interaction between this stage and the input stage

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 not 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

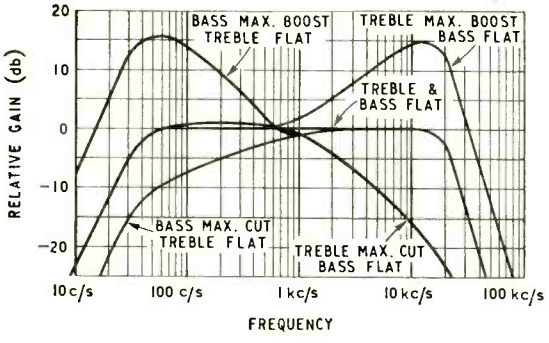


Fig. 2. Tone control frequency response characteristics.

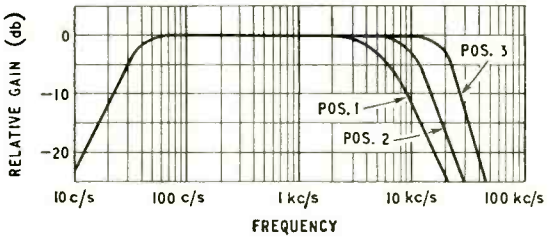


Fig. 3. Response with high-pass and low-pass filters.

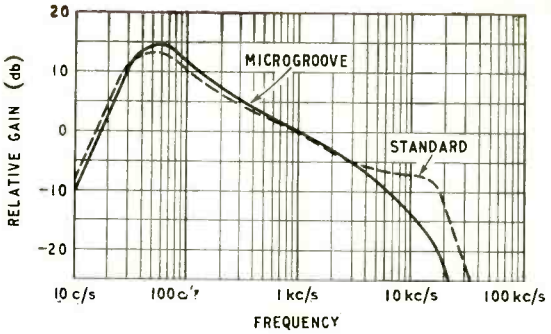


Fig. 4. Record playback characteristics adopted in the pre-amplifier.

filtering and feedback[2] 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 overloading the system, and to cut 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 comparatvely 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.[3] 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,[4] 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

[1] "Design for 20-watt High-Quality Amplifier," by W. A. Ferguson, *Wireless World*, June, 1955.
[2] Gramophone and Microphone Pre-amplifier, by P. J. Baxandall, *Wireless World*, January, 1955.
[3] Record Industry Association of America, Inc., "Radio Electronics," May, 1954, p. 63.
[4] "The Pursuit of High Fidelity," booklet by E.M.I., Ltd.

PRE-AMPLIFIER UNIT—LIST OF COMPONENT VALUES

Resistors

R_1	82kΩ	10%	0.25W
R_2	68kΩ	10%	0.25W
R_3	680kΩ	10%	0.25W
R_4	82kΩ	10%	0.25W
R_5	8.2kΩ	10%	0.25W
R_6	27kΩ	10%	0.25W
R_7	82kΩ	10%	0.25W
R_8	100kΩ	10%	0.25W
R_9	5.6MΩ	5%	0.25W
R_{10}	6.8MΩ	5%	0.25W
R_{11}	20MΩ	5%	0.25W
R_{12}	120kΩ	5%	0.25W
R_{13}	680kΩ	5%	0.25W
R_{14}	390kΩ	5%	0.25W
R_{15}	680kΩ	5%	0.25W
R_{16}	2.2MΩ	10%	0.25W
R_{17}	1.5MΩ*	10%	1W
R_{18}	270kΩ*	10%	1W
R_{19}	3.9kΩ*	10%	1W
R_{20}	220kΩ	10%	0.25W
R_{21}	470kΩ	10%	0.25W
R_{22}	18kΩ	10%	0.25W
R_{23}	470kΩ*	10%	1W
R_{24}	100kΩ*	10%	1W
R_{25}	1.2kΩ*	10%	1W
R_{26}	8.2MΩ	10%	0.25W
RV_{27}	250kΩ	logarithmic (10% law)	
R_{28}	47kΩ	10%	0.25W
R_{29}	39kΩ	10%	0.25W
R_{30}	68kΩ	10%	0.25W
RV_{31}	250kΩ	logarithmic (10% law)	
R_{32}	6.8kΩ	10%	0.25W
R_{33}	82kΩ	5%	0.25W
R_{34}	10MΩ	20%	0.25W
R_{35}	10MΩ	20%	0.25W
R_{36}	68kΩ	5%	0.25W
R_{37}	10MΩ	20%	0.25W
R_{38}	10MΩ	20%	0.25W
R_{39}	10MΩ	20%	0.25W
R_{40}	10MΩ	20%	0.25W
R_{41}	47kΩ	5%	0.25W
R_{42}	820kΩ	5%	0.25W
R_{43}	10MΩ	20%	0.25W
R_{44}	10MΩ	20%	0.25W
R_{45}	470kΩ	5%	0.25W
R_{46}	1.5MΩ*	10%	1W
R_{47}	270kΩ*	10%	1W
R_{48}	3.9kΩ*	10%	1W
†RV_{49}	100kΩ	logarithmic (10% law)	
R_{50}	12kΩ	10%	0.25W

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

Capacitors

C_1	820pF	Silver mica	5%
C_2	470pF	Silver mica	5%
C_3	120pF	Silver mica	5%
C_4	120pF	Silver mica	5%
C_5	0.1μF	Paper	350 V d.c. wkg.
C_6	50μF	Electrolytic	12 V d.c. wkg.
C_7	0.1μF	Paper	350 V d.c. wkg.
C_8	8μF	Electrolytic	350 V d.c. wkg.
C_9	0.1μF	Paper	350 V d.c. wkg.
C_{10}	50μF	Electrolytic	12 V d.c. wkg.
C_{11}	0.1μF	Paper	350 V d.c. wkg.
C_{12}	560pF	Silver mica	5%
C_{13}	8200pF	Silver mica	5%
C_{14}	0.05μF	Paper	150 V d.c. wkg.
C_{15}	2200pF	Silver mica	5%
C_{16}	0.02μF	Paper	150 V d.c. wkg.
C_{17}	180pF	Silver mica	5%
C_{18}	270pF	Silver mica	5%
C_{19}	180pF	Silver mica	5%
C_{20}	470pF	Silver mica	5%
C_{21}	1800pF	Silver mica	5%
C_{22}	820pF	Silver mica	5%
C_{23}	220pF	Silver mica	5%
C_{24}	390pF	Silver mica	5%
C_{25}	560pF	Silver mica	5%
C_{26}	0.1μF	Paper	350 V d.c. wkg.
C_{27}	50μF	Electrolytic	12 V d.c. wkg.
C_{28}	0.01μF	Paper	350 V d.c. wkg.
C_{29}	8μF	Electrolytic	350 V d.c. wkg.

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 78	Input impedance 100 kΩ	5.0 mV
PU2 LP	Input impedance 100 kΩ	50 mV
PU2 78	Input impedance 100 kΩ	60 mV
Microphone	Input impedance ½ MΩ	1.5 mV

Distortion

Total harmonics better than 0.1% on all positions at approximately 200 mV 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 (PU2 o/c) L.P.:—(— 53 dB).
PU1 input socket short-circuited (PU2 o/c) 78:—(— 54 dB).
PU2 input socket loaded with 50 kΩ (PU1 o/c) L.P.:—(— 55 dB).
PU2 input socket loaded with 50 kΩ (PU1 o/c) 78:—(— 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

Testing Point	D.C. Voltage (V)	Meter Range
C_{29}	215	1000 V d.c.
C_8	210	1000 V d.c.
Anode V3	95	1000 V d.c.
Screen grid V3	80	1000 V d.c.
Cathode V3	2	10 V d.c.
Anode V2	90	1000 V d.c.
Screen grid V2	100	1000 V d.c.
Cathode V2	1.8	10 V d.c.
Anode V1	90	1000 V d.c.
Screen grid V1	80	1000 V d.c.
Cathode V1	2	10 V d.c.

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

Power Supply

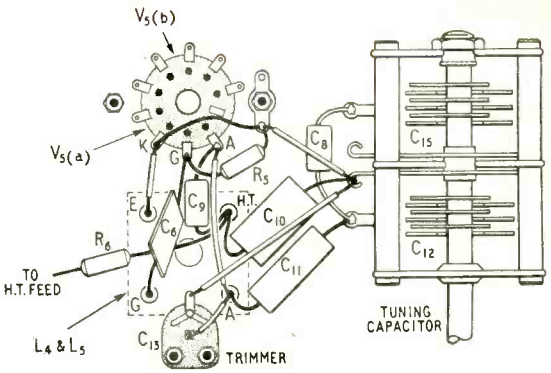
High tension	250 V at 3 mA.
Heaters	centre tapped 6.3 V at 0.6 A.

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.)



Underside view of the chassis immediately surrounding the oscillator showing exact relative position of all components in this circuit. Note that the oscillator coil has been turned through 180 degrees.

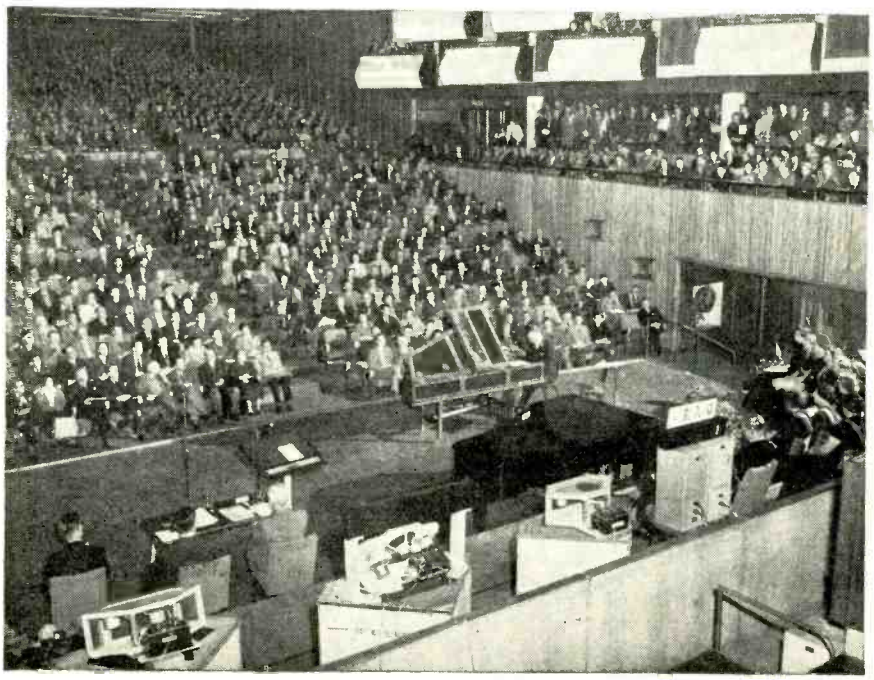
SINCE the publication of the articles on the f.m. tuner in the April and May issues letters received have indicated that further information concerning the layout of the oscillator components may be desirable and the accompanying diagram has been prepared to help constructors. This is an underside view 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_9 enclosed in the screening can of the inductor L_4, 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_9 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 $\frac{1}{3}$in in length before soldering the component in position. In order to accommodate C_9 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,

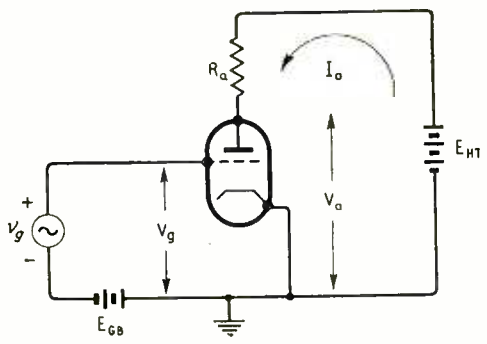


Fig. 1. Basic triode valve circuit.

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

$$V_g = v_g - E_{GB} \quad .. \quad .. \quad .. \quad .. \quad (1)$$

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

$$V_a = E_{HT} - I_a R_a \quad .. \quad .. \quad .. \quad .. \quad (2)$$

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_g, V_a and I_a depend upon the valve itself and can be measured for any specimen. We can, for instance, keep V_g at some fixed value and measure the current I_a for a series of values of V_a. We can then change V_g 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_a, V_g 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_g, 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 δ 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.

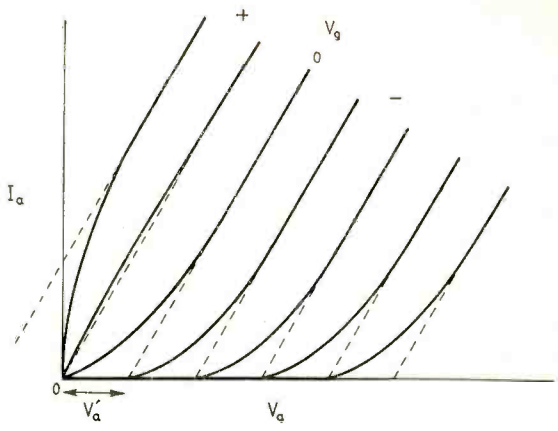


Fig. 2. Typical triode characteristics are shown by the full-line curves and an idealized approximation to them by the dotted lines.

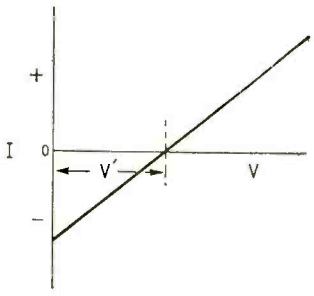


Fig. 3. Single characteristic similar to any dotted line of Fig. 7, but extended to negative current

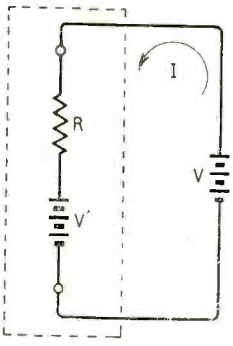


Fig. 4

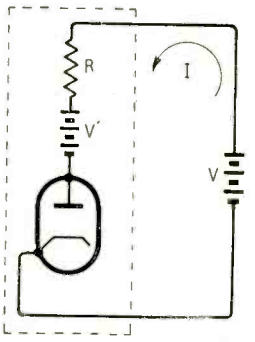


Fig. 5

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 chracteristic like a dotted line of Fig. 2.

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

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 $V_g = 0$, 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

$$\mu = -\delta V_a / \delta V_g$$

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 δV_g. In spite of the minus sign, μ is a positive number for, if δV_a is itself positive δV_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_g, is μ 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.

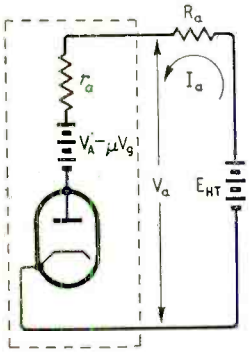


Fig. 6

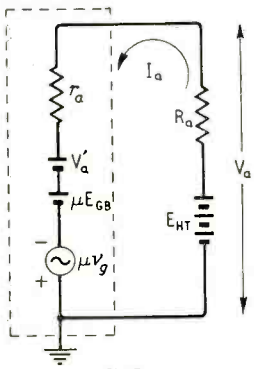


Fig. 7

Fig. 6. This is the same circuit as Fig. 5, but the internal battery is changed to represent Fig. 2.

Fig. 7. This circuit is an equivalent of Fig. 1, valid for a.c. and d.c. conditions as long as the voltages are such that the dotted-line approximation to the real valve curves in Fig. 2 is a good one.

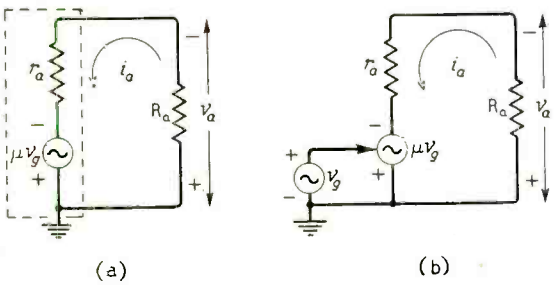


Fig. 8. Here the a.c. equivalent circuit alone is shown, the d.c. elements being dropped out. The usual form is (a) but the generator is sometimes drawn as in (b).

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_g and V_a 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 $v_g - E_{GB}$ 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 μE_{GB} and a generator μv_g, which represent in the anode circuit the effect of E_{GB} and v_g of Fig. 1 in the grid circuit.

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

$$E_{HT} + \mu v_g - \mu E_{GB} - V'_a$$

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

$$I_a = \frac{E_{HT} - \mu E_{GB} - V'_a + \mu v_g}{R_a + r_a} \quad .. \quad .. \quad (3)$$

and V_a is given by equation (2).

The voltage is made up of two components, μv_g, an alternating voltage, and $E_{HT} - \mu E_{GB} - V'_a$, 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_a and a direct current I_{am}, and we can separate out the a.c. and d.c. components of equation (3) and so get

$$i_a = \frac{\mu v_g}{R_a + r_a} \quad .. \quad .. \quad .. \quad .. \quad (4)$$

and

$$I_{am} = \frac{E_{HT} - \mu E_{GB} - V'_a}{R_a + r_a} \quad .. \quad .. \quad (5)$$

We can do the same thing for equation (2) and re-

gard V_a as the sum of an alternating component v_a and a steady component V_{am}. This gives

$$v_a = -\mu v_g \frac{R_a}{R_a + r_a} \quad .. \quad .. \quad .. \quad (6)$$

and

$$V_a = E_{HT} - (E_{HT} - \mu E_{GB} - V'_a)\frac{R_a}{R_a + r_a} \quad .. \quad (7)$$

Equations (5) and (7) are the d.c. ones and apply to Fig. 7 if the generator μv_g is absent. Equations (4) and (6) are the a.c. ones and apply to Fig. 7 if all the batteries are removed, leaving μv_g 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_g 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_{am} 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,

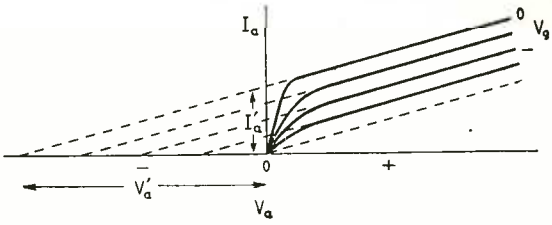


Fig. 9. Typical pentode characteristics are shown by the full-line curves and an idealized approximation by the dotted lines.

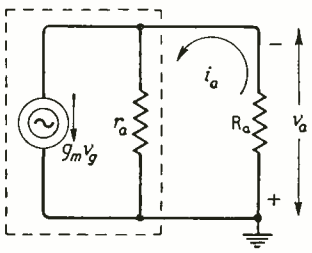


Fig. 10. Alternative form of a.c. equivalent circuit using a constant-current generator instead of a constant-voltage.

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 $g_m v_g$ replaces the constant-voltage generator μv_g. Here g_m is the mutual conductance and equals μ/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 (G3GAH) at the meeting of the Barnsley and District Amateur Radio Club at 7.0 on July 22nd at the King George Hotel, Peel Street, Barnsley. Sec.: P. Carbutt (G2AFV), 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, Gt. 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, transistor 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"

Accessories include a 600-ft reel of tape and a crystal microphone. A dummy socket is provided in the top left-hand corner of the lid to carry the mains plug.

Weighing only 21lb, the "Recordergram" can be carried without undue strain.

OPERATING with a fixed tape speed of $3\frac{3}{4}$ 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.

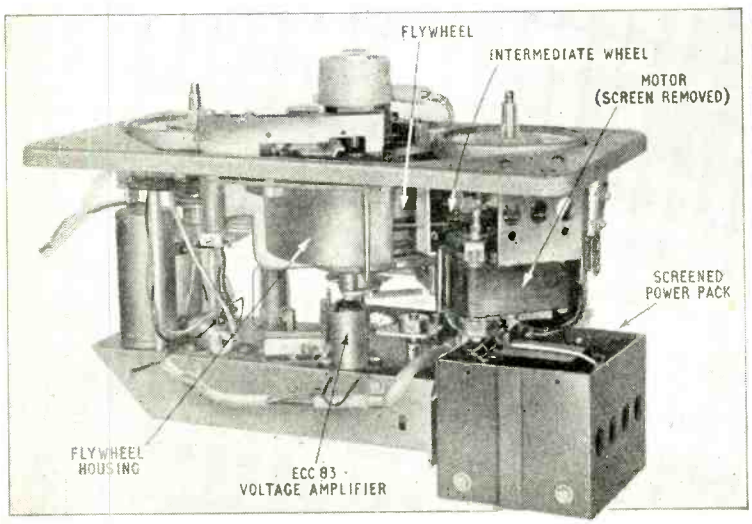
For a complete recording machine it is remarkably compact ($13\frac{3}{4}$in × $7\frac{1}{2}$in × 10in) and weighs only 21 lb. It bristles with ingenious ideas and one of the most obvious is the centralized control knob giving a choice of seven functions. For fast running—either forward or in reverse—the 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.

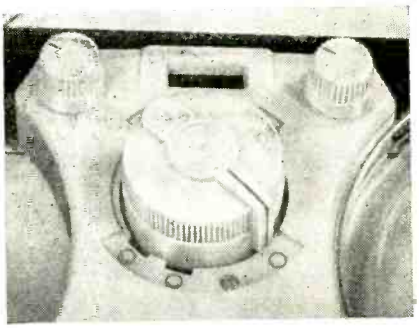
There are only two valves in the main amplifier, a double triode and an output pentode. There is also a cathode-ray level indicator and, of course, a power rectifier. Although the available voltage amplification appears to be less than normal it should be borne in mind that the coercivity and saturation 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



View of the chassis with screening removed to show the driving motor.



Above: Main control knob with seven positions:—(1) "off," (2) amplifier only, (3) fast forward, (4) fast rewind, (5) playback, (6) recording from inputs other than microphone, (7) recording from microphone. The two small knobs control separately the levels for recording and playback.

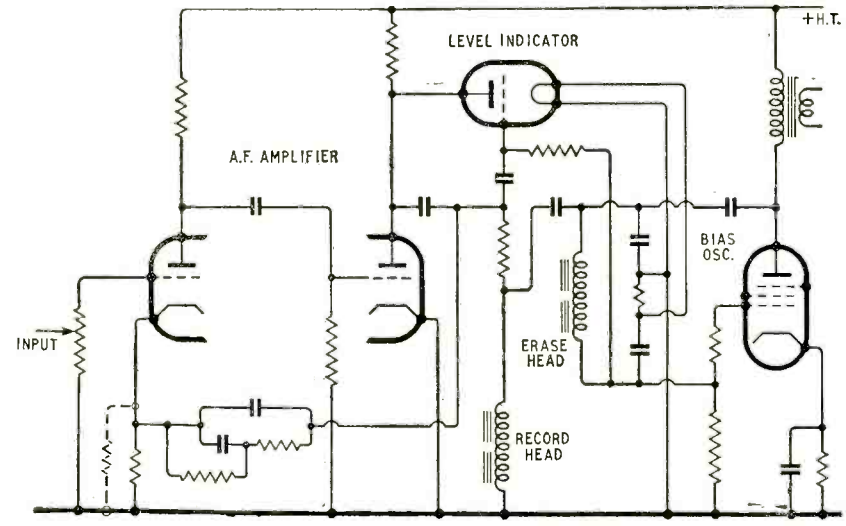
an intermediate friction wheel, which is disengaged in the "off" position through a link mechanism from the central control knob. The supply and take-up spool spindles are driven at constant speed by a round spring belt from a groove in the flywheel. On each spindle are mounted a pair of concentric discs, carrying felt pads in their upper surfaces. The discs are connected by a flexible diaphragm, rather like a loudspeaker dust-proof 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.

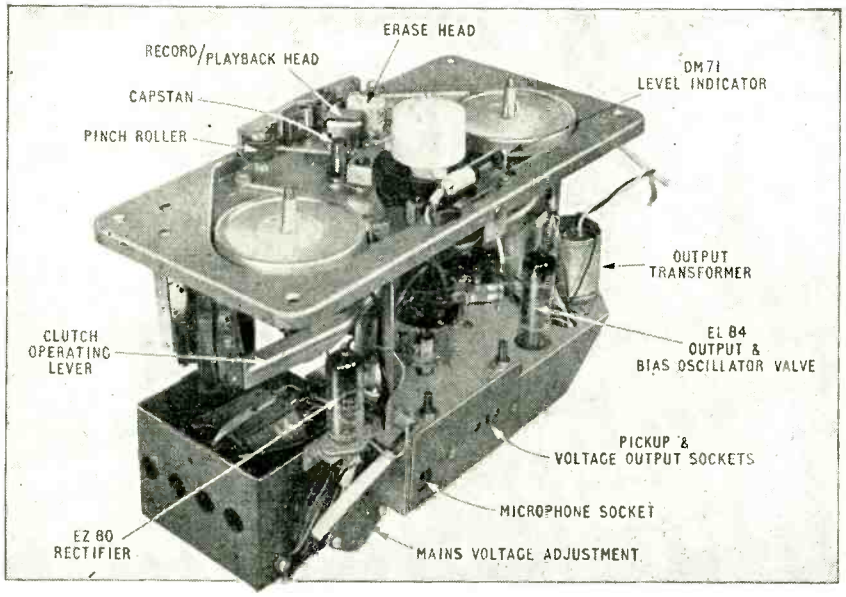
The tape gate is a hinged die casting which carries the pinch roller, pressure pads and a segment of high-permeability alloy which closes behind the tape and completely screens the record/playback head except for the two narrow slots to pass the tape.

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.



Simplified diagram showing essential features of the circuit when switched to "record."



The power pack (left foreground) is mounted separately from the main chassis, but is lifted by tags which engage in slots in the chassis when the "works" are extracted from the case.

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 100 c/s to 6 kc/s, live 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

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

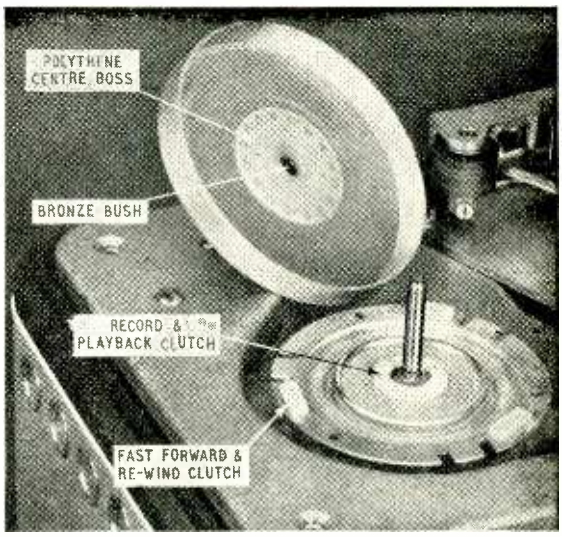
The piano is one of the severest tests that can be applied for wow and flutter, and one must not expect the performance in this respect to achieve the standard of studio equipment costing hundreds of pounds. In the machine tested there was a flutter at higher than capstan speed and some tape whistle, 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.



Turntable removed to show normal and fast-running felt friction pads.

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

Understanding the Significance of Load and Other Lines

By "CATHODE RAY"

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.

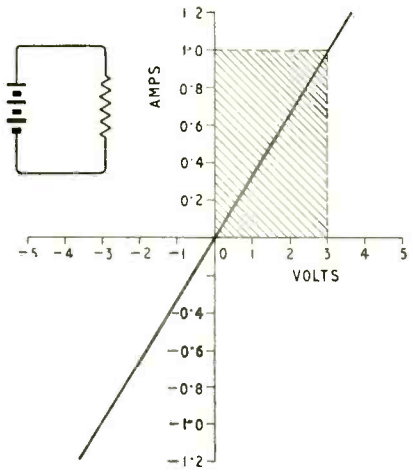


Fig. 1. Graph of current against voltage for linear resistance, represented by the diagonal line. The power used up in it when 1 amp is flowing is represented by the shaded area. Negative currents and voltages are in the reverse direction in the circuit.

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

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 3Ω, 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.

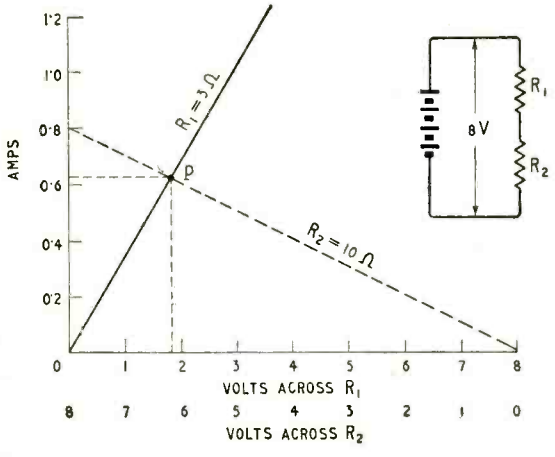


Fig. 2. A circuit with two resistances in series can be investigated by adding a second resistance line, sloping from the point representing the total voltage.

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 $R_1 = 3$ and $I = 0.5$. In this case the point on the R_1 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_1. That means

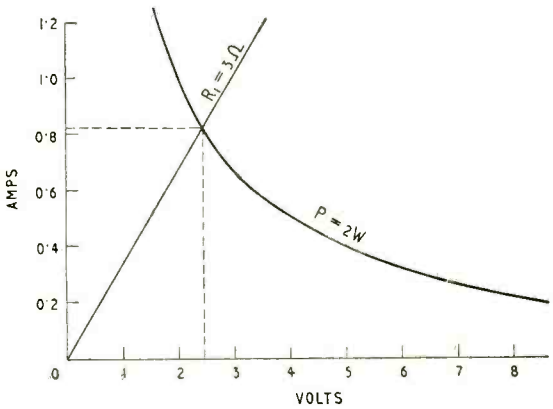


Fig. 3. The top right-hand corners of all the rectangles representing a given power (2 watts in this case) trace out a curve like this.

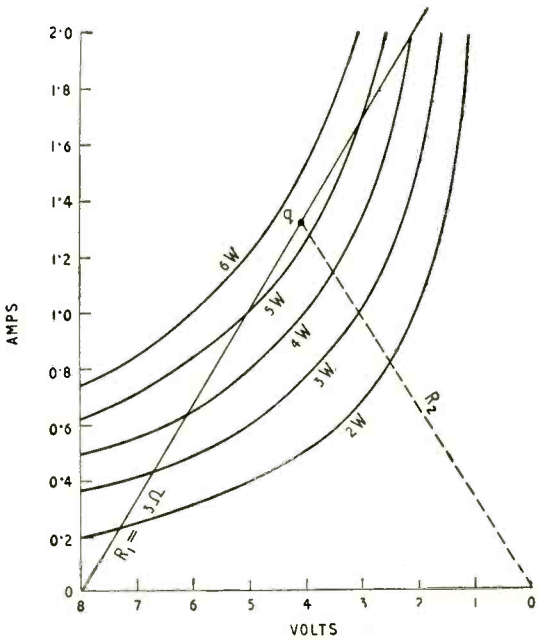


Fig. 4. Power curves can be used to find the value of R_2 receiving maximum power in the series circuit.

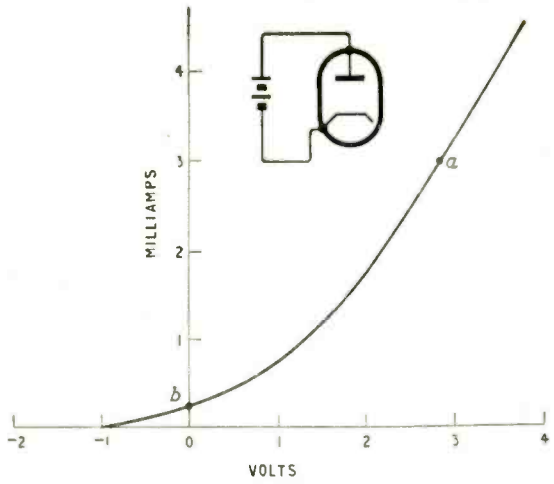


Fig. 5. Graph of a non-linear resistance—that of a diode valve.

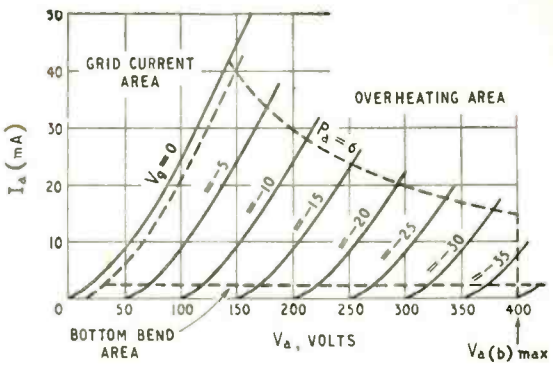


Fig. 6. Typical set of anode-current/anode-voltage curves for a small power triode, showing the areas that for various reasons are out of bounds.

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_1, through which the R_2 line can be drawn to the applied voltage mark on the voltage scale as before, and the value of R_2 follows. Alternatively, if R_2 is known, a line of the corresponding slope is drawn through the R_1-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_1 and the total voltage, find the value of R_2 in which maximum power is developed. One way of doing this is to draw several different power curves for R_2. This means that they have to be drawn with reference to the "volts across R_2" scale, as in Fig. 4. The point on the R_1 line corresponding to the highest power is *q*, somewhere between 5 and 6 watts (actually $5\frac{1}{3}$), and if the diagram has been drawn well enough it will tell us that R_2 for this condition is 3Ω. As we probably knew all the time, it would invariably be equal to R_1, 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 microammeter 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 new boy 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=930Ω. 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—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 "$V_g=0$" 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 $V_g=-1V$, 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 ($V_{a(b)\,max}$). This must not be confused with the maximum anode working voltage ($V_{a,max}$) 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, at 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 $V_{a,max}$ lower than the $V_{a(b)\,max}$. 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 $V_{a,max}$, 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 "$V_g=-15$" curve, so that is the grid 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 $1/\sqrt{2}$ times a peak value, which in turn is half the peak-to-peak value, this power is equal to peak-to-peak $V_a \times I_a$, divided twice by $2\sqrt{2}$, that is to say by 8. So it is $(210 \times 0.0336)/8 = 0.88W$.

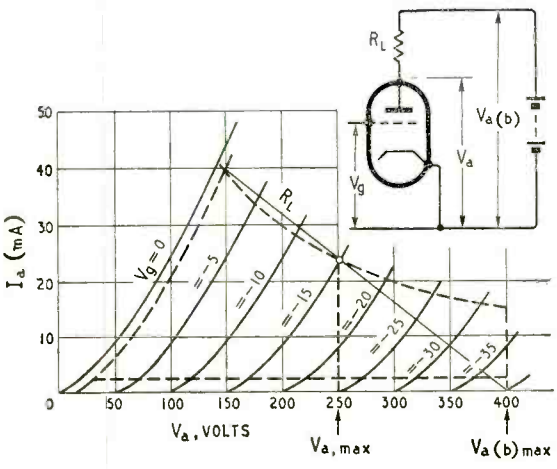


Fig. 7. The Fig. 6 curve sheet with load line added, through the working point (encircled).

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 are really out 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 long as the resistance was not so high as to be shunted 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 $V_{a(b)}$ indicated by where it cut 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 $V_{a(b)\,max}$; 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

where "$V_g = -30$" 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 uses 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. Preisman. (McGraw Hill.)

Manufacturers' Products: NEW EQUIPMENT AND ACCESSORIES

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.

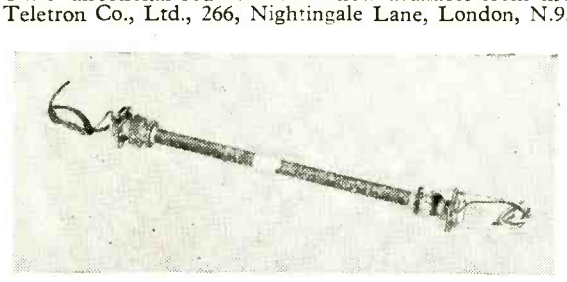
New Ekco ground-to-air v.h.f. transmitter, Type CE91.

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 μH inductance, covers 180-550 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 core.

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 12½in to 17½in, weights 7 oz to 2½ lb. Leaflet from the sole distributors, A. B. Hobbs & Co., 214, Hatfield Road, St. Albans, Herts.

Overtone Quartz Crystals, 17 Mc/s to 36 Mc/s, listed in a new easy-reference catalogue of Salford crystals from the General Electric Co., Magnet House, Kingsway, London, W.C.2. Also a booklet on selenium rectifiers, giving performance figures and curves for various circuits, and a leaflet on Gecalloy micropowder permanent magnets.

Waveguide Components and test instruments for centimetre and millimetre waves, with notes on automatic measuring instruments suitable for production testing. Illustrated catalogue from Elliott Brothers (London), Century Works, Lewisham, London, S.E.13.

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 from Solus Electronic Tubes, 15-18, Clipstone 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.

Selenium Rectifier Stacks for domestic sound and television receivers. A booklet with information on ratings, coding and polarity markings, dimensions, weights, and 45 pages of performance curves. From Standard Telephones and Cables, Rectifier Division, Edinburgh Way, Harlow, Essex.

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, 93, 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**

By R. L. SMITH-ROSE,
C.B.E., D.Sc., Ph.D., M.I.E.E.,
and
J. A. SAXTON,
D.Sc., Ph.D., M.I.E.E.

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[1]. 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[2], 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 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[3-10] 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 transmissions.

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 par-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

* Official communication from D.S.I.R. Radio Research Station, Slough.

† The V.H.F. band extends from 30 to 300 Mc/s and therefore includes broadcasting Bands I, II and III.

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 considerations 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[8, 9] 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.[11, 12] 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. Thus in going from 50 to 500 Mc/s the field at a point in the shadow behind an opaque diffracting obstacle will be 10 db less at the higher than at the lower frequency for the same field immediately above the obstacle.

Attenuation Effects.—Although the experimental evidence is perhaps somewhat scanty, there is little doubt that as the frequency increases through the v.h.f. and u.h.f. bands the attenuation of waves passing through buildings and trees increases; and it is not unreasonable to assume that any substantial brick building is opaque for frequencies exceeding about 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.[9, 13] The actual spatial variations are thus more rapid in Bands IV and V 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[5] 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[6] 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 if the full value of the aerial gain is 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 know[10] 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 deduced[10] 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

‡ 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.

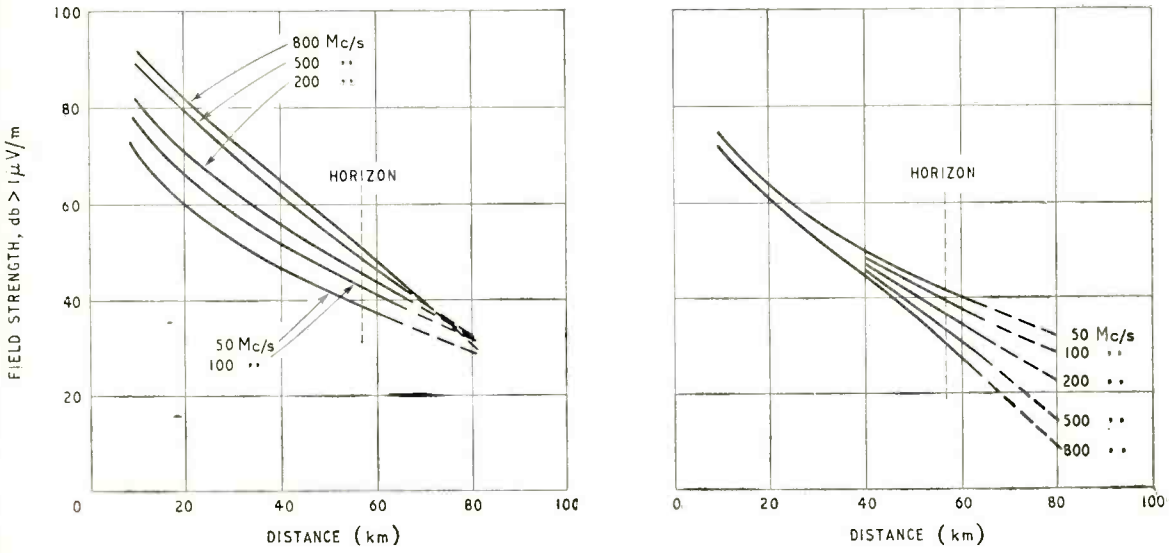


Fig. 1. Field strengths for frequencies between 50 and 800 Mc/s ; (a) over smooth ground, (b) over irregular terrain. Effective transmitted power 1 kW, transmitter aerial height 300ft, receiver aerial 30ft approx. (Courtesy Proc. I.E.E.)

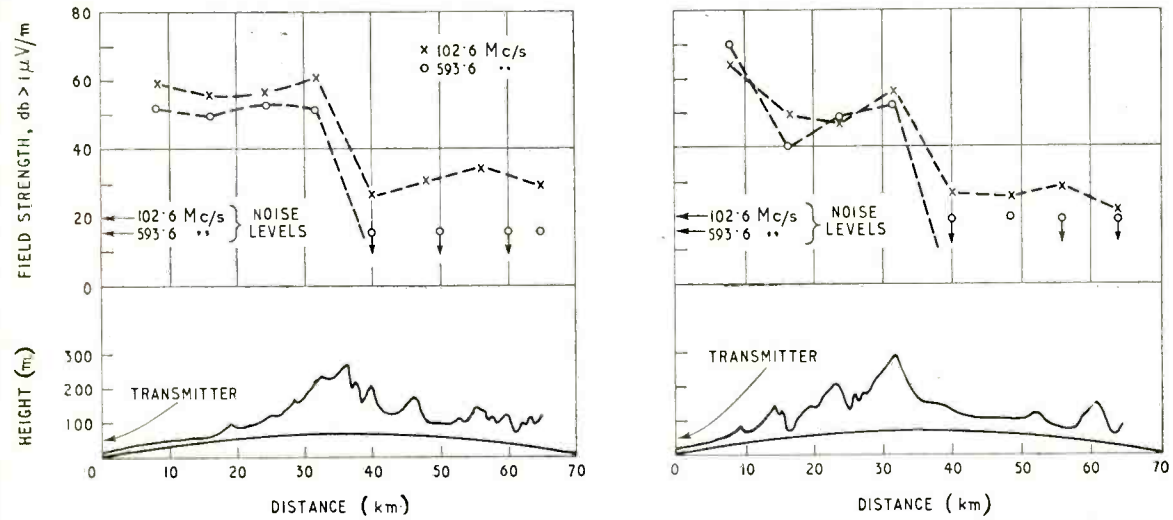


Fig. 2. Effect of ground contour on received field strength. Two different paths are shown. Effective radiated power 1 kW. (Courtesy Proc. I.E.E.)

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,[10] 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)

Frequency Mc/s	Conditions	Range in km	
		1*	2†
50	Mixed urban and rural	30	60
500	Mixed urban and rural	12	30
500	Mainly urban	10	25

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)

Frequency Mc/s	Conditions	Range in km	
		1*	2†
50	Mixed urban and rural	30	60
500	Mixed urban and rural	18	36
500	Mainly urban	12	30

* 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.

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"WIDE-RANGE ELECTROSTATIC LOUDSPEAKERS"

THE third instalment 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_2" should be "f^2."

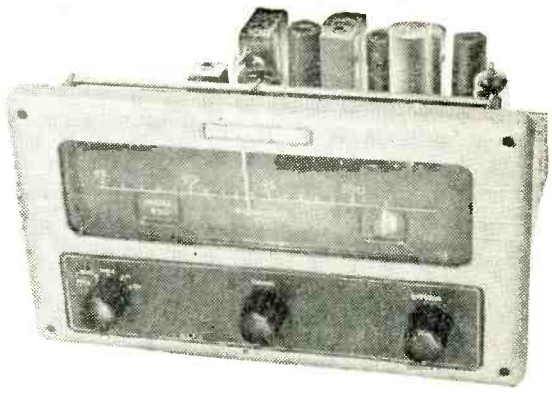
RETAIL RECEIVER SALES

THE "seasonal decline" in the sales of domestic receiving equipment is shown in this table from a retail market survey for the first four months of the year issued by the British Radio Equipment Manufacturers' Association. Fifty-five per cent of all the sales in April were credit transactions.

	Sound	Radiograms	Television
January	98,000	35,000	103,000
February	99,000	33,000	98,000
March	95,000	24,000	85,000
April	79,000	13,000	71,000

FM/AM Tuner

Eddystone Model 820 Embodying a Foster-Seeley Discriminator



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

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.

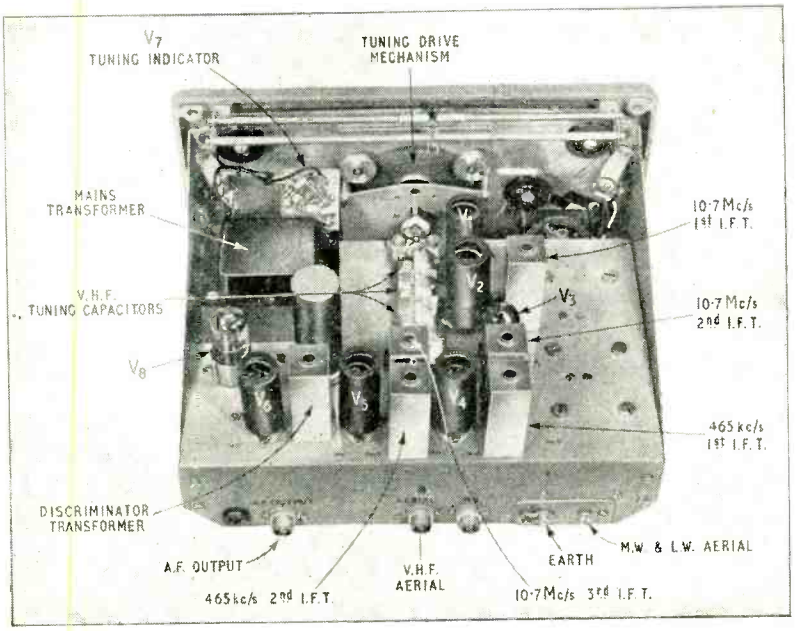
The r.f. valve, (V1), is a 6AM6 r.f. pentode choke-capacitance coupled to the tuned intervalve circuit and followed by a double-triode 12AT7, (V2), functioning as mixer and local oscillator for f.m. reception. The i.f. output from the mixer, which is at 10.7 Mc/s, is fed *via* the f.m./a.m. switch to 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.g.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 is 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

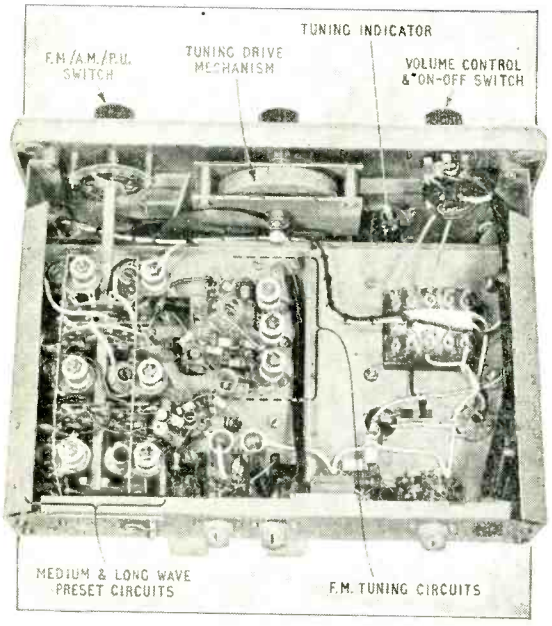


Viewed from the back the positions of the valves, i.f. and mains transformers are clearly seen. Also seen is the tuning mechanism.

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 EZ41 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 chassis has a metal base plate which when removed gives access to the tuning circuits, small components and wiring.

In view of the potential high sensitivity of the tuner, tests were carried out at some distance from Wrotham and in a rather poor location from the point of v.h.f. reception on the south coast. As the tuner was designed in Birmingham and reputed to put up a good performance there it was felt this would be a good way of testing its merits.

A further handicap was imposed by using a loft aerial, since no other of the right type was available at the time. It was a single dipole and the direct "line-of-sight" to Wrotham was interrupted by high ground up to 600 to 700ft about 3 miles away. The receiving aerial was just under 200ft above sea level.

The tuner put up a most satisfactory performance, signals being strong enough to give good limiting and entirely suppress the background and all but the most severe interference from passing motor cars.

Aircraft flying in the vicinity of the receiving site are a great nuisance on the v.h.f. bands and while the "820" put up a stout effort in resisting the greater part of the signal flutter they produced it could not cope with the worst kind. So severe can this be at times that it is doubtful if any f.m. receiver would cope with it under all conditions; however, it is possible a better aerial would make a great deal of difference. Provided the signal is maintained above the limiting level the audio output remains quite steady, despite quite violent "throbbing" of the magic-eye.

Used with a good amplifier and loudspeaker there is a crispness in the reproduction that is rarely possible on other bands owing to the necessity to restrict the receiver's bandwidth in order to keep out interference from stations on nearby wavelengths. Apart from this the most impressive thing about the reception, especially to anyone continuously plagued by whistles, "monkey chatter," and crackles of many kinds, that prevail almost anywhere south of London in the U.K., is the delightfully quiet background.

First impressions may be that not enough de-emphasis is provided, but this will generally prove groundless as greater familiarity is gained with f.m. reception. However, a little tone-correction can generally be applied in the audio amplifier if thought desirable.

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 $8\frac{1}{2} \times 2\frac{3}{8}$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 $11 \times 6\frac{1}{4} \times 8\frac{1}{4}$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 ½-inch as well as standard ¼-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 railcar travelling alongside and were received at a point about half-way 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 provides for automatic take-off and landing with control of climb, dives, orbiting and other manœuvres. If the radio carrier is cut off for any reason an automatic control system in the aircraft takes over.

RANDOM RADIATIONS

By "DIALLIST"

Timely Hints

SO 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 one 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 unallotted 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 widish 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

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 overloaded 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

By FREE GRID

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 a 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.

Radio trouble tracers

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 tape recordings of the B.B.C. "Book at Bedtime" feature in which an instalment of a popular novel is read late in the evening. I have sometimes criticized 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 my "psyche" or "ego" 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 specially rigged-up receiver, recorder and time 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 beat 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, originally on disc, 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 pre-war days but 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 carbolicky 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 rested on 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* fails to give technical data of the *modus operandi*.

[*A description of a talking-book tape reproducer was given in our Jan., 1954, issue.—ED.]

Transistor News from Mullard

JUNCTION TRANSISTORS FOR INDUSTRIAL ELECTRONICS

Audio Amplification heads list of economic applications

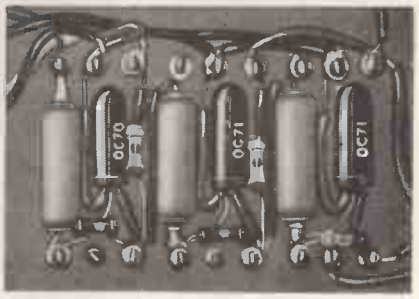
Now that Mullard Junction Transistors OC70 and OC71 are available in production quantities, the advantages of transistors can be brought to a long list of industrial electronic equipment. For low power audio applications, particularly amplifiers, these two transistors are recommended for their small size, instantaneous operation and simple power requirements—in a typical circuit only two or three volts "H.T." is required to operate telephones at full volume.

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.

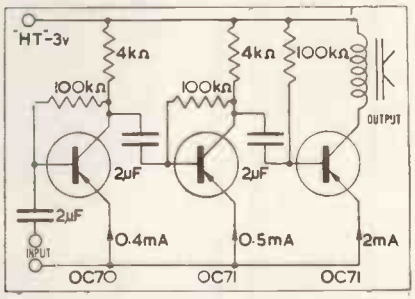
POTENTIAL APPLICATIONS OF THE OC70 & OC71

A.F. AMPLIFIERS IN TELEPHONE EQUIPMENT · LOW POWER OSCILLATORS FOR TEST GEAR AND FOR A.C. BRIDGES · NULL & BALANCE INDICATORS FOR A.C. BRIDGES · A.F. PRE-AMPLIFIERS · COMPUTING CIRCUITS · LOW POWER H.T. GENERATORS · BROADCASTING STUDIO & THEATRE PROMPT & CALL DEVICES · INDUCTIVE REMOTE CONTROL SYSTEMS · &c., &c.

TYPICAL AMPLIFIER



This is the actual size of a basic a.f. amplifier used for amplifying weak signals from a noise cancelling microphone to full telephone strength. The amplifier is sufficiently small to be fitted in the microphone casing of an ordinary hand set. Circuit diagram is shown below.



ABRIDGED DATA	OC70	OC71
Max. D.C. voltage (V)	5	5
Max. collector dissipation at 45°C (mW)	25	25
Max. ambient temperature (°C)	45	45
Typical current gain with grounded emitter	30	50

Mullard

COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT,
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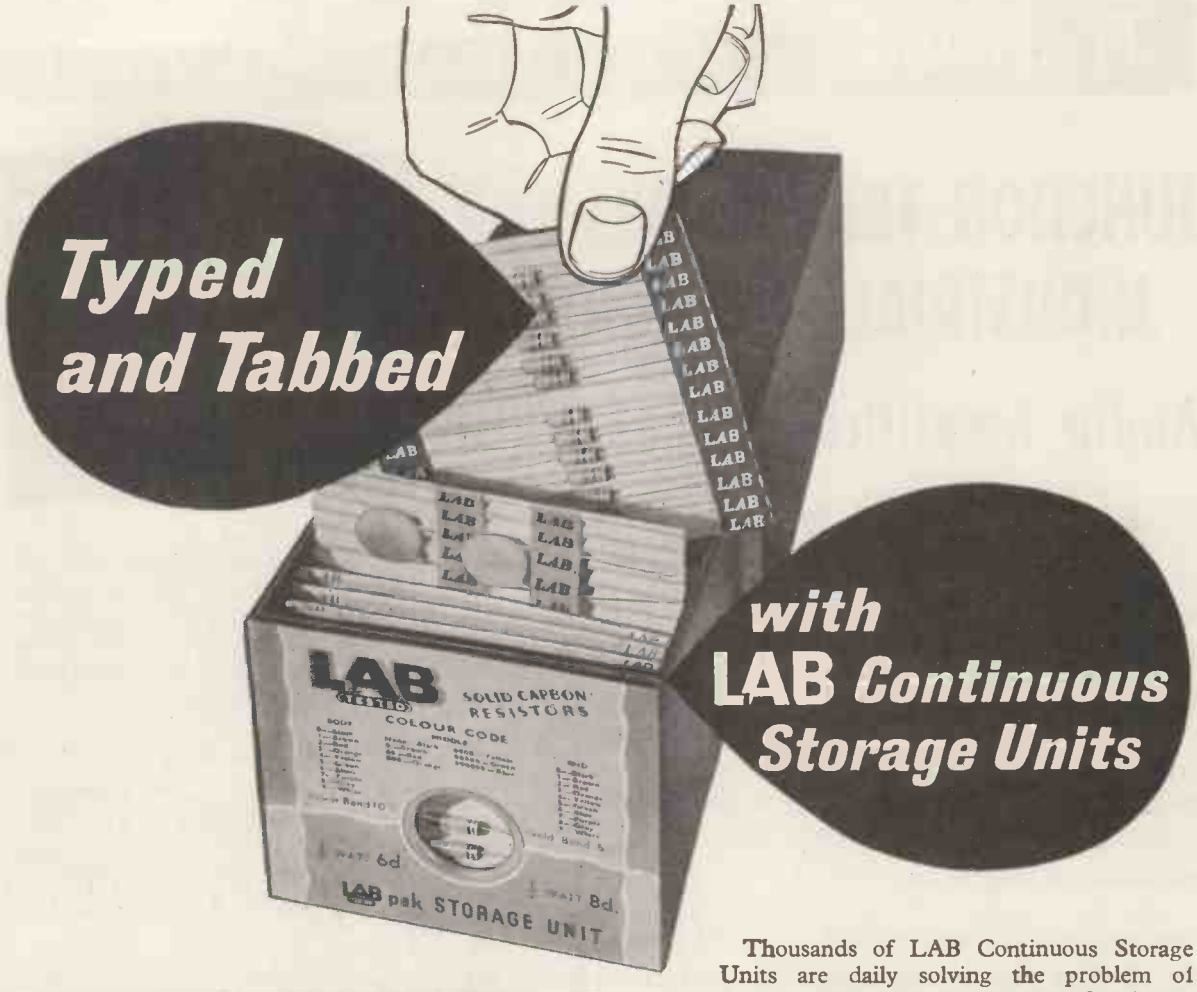
MVT176



REF.	WATTS	MAX. VOLTS	OHMS	MIN. ORDER FOR FREE UNIT	UNIT STORAGE CAPACITY
RESISTORS					
T	½	250	10 to 10M	240	720
R	1	500	10 to 10M	180	500
Tolerances available ±20% 10% 5%					
HIGH STABILITY RESISTORS					
HS3	½	750	1 to 500M	93	500
Tolerances available ±5% 2% 1%					
WIREWOUND RESISTORS					
LM	5 & 10	—	5 to 100K	72	300
LP	5 & 10	—	5 to 100K	72	300
CERAMICAPS					
CER	Tubular	500	3 to 470pf	141	500
HK	Tubular	500	470 to 5000pf	141	500
HKD	Disc	500	470 to 5000pf	141	500
Tolerances available ±2% 10%					

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Response is not all the story

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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
3¾ and 7½ i.p.s.
76 gns.

MODEL 2A/NH
7½ and 15 i.p.s.
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Ferrograph

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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. (other speeds 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

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2½ watts into 15 ohms

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Type	C.V. No.	Base	Length mm.	Diameter mm.	Striking Voltage (Maximum)	Operating Voltage	Ignition Electrode Voltage	Ignition Electrode Resistance (Megohms)	Maximum Tube Current	Minimum Tube Current	Regulation over Current Range (Volts)	American Equivalent
QS. 75/20	CV. 284	B7G	54	19	110	75	—	—	20	2	6	—
QS. 75/60	CV. 434	B8G	80	30	117	75	—	—	60	5	5	—
QS. 92/10	CV. 188 / CV. 1070	BRITISH 4-PIN	85	33	140	92	—	—	10	1	5	—
QS. 95/10	CV. 286	B7G	54	19	110	95	150	0.25	10	2	5	—
QS.108/45	CV. 422	B8G	80	30	120	108	150	0.1	45	5	5	—
QS.150/15	CV. 287	B7G	54	19	170	150	240	0.25	15	2	5	—
QS.150/40	CV. 216	I.O.	105	39.5	180	150	—	—	40	5	5.5	OD3
QS.150/45	CV. 395	B8G	80	30	170	150	200	0.1	45	5	5	—
QS.1201	—	FLYING LEADS	80	19	110	75	—	—	15	2	4.5	—
QS.1202	—	FLYING LEADS	80	19	133	108	—	—	15	2	4.5	—
QS.1203	—	FLYING LEADS	80	19	180	150	—	—	15	2	4.5	—
QS.1204	—	B7G	54	19	133	108	—	—	25	5	3	—
QS.1205	CV. 3798	I.O.	105	39.5	105	75	—	—	40	5	6.5	OA3
QS.1206	CV. 686	I.O.	105	39.5	133	105	—	—	40	5	5.5	OC3
QS.1207	CV. 1832	B7G	67	19	185	150	—	—	30	5	2.0	OA2
QS.1208	CV. 1833	B7G	67	19	133	108	—	—	30	5	2.0	OB2
HIGH STABILITY TUBES												
QS. 83/3	CV. 449	B7G	54	19	125	83	—	—	5	1	0.6	5651
QS.1200	CV. 2225	B7G	54	19	180	150	—	—	15	5	3	—

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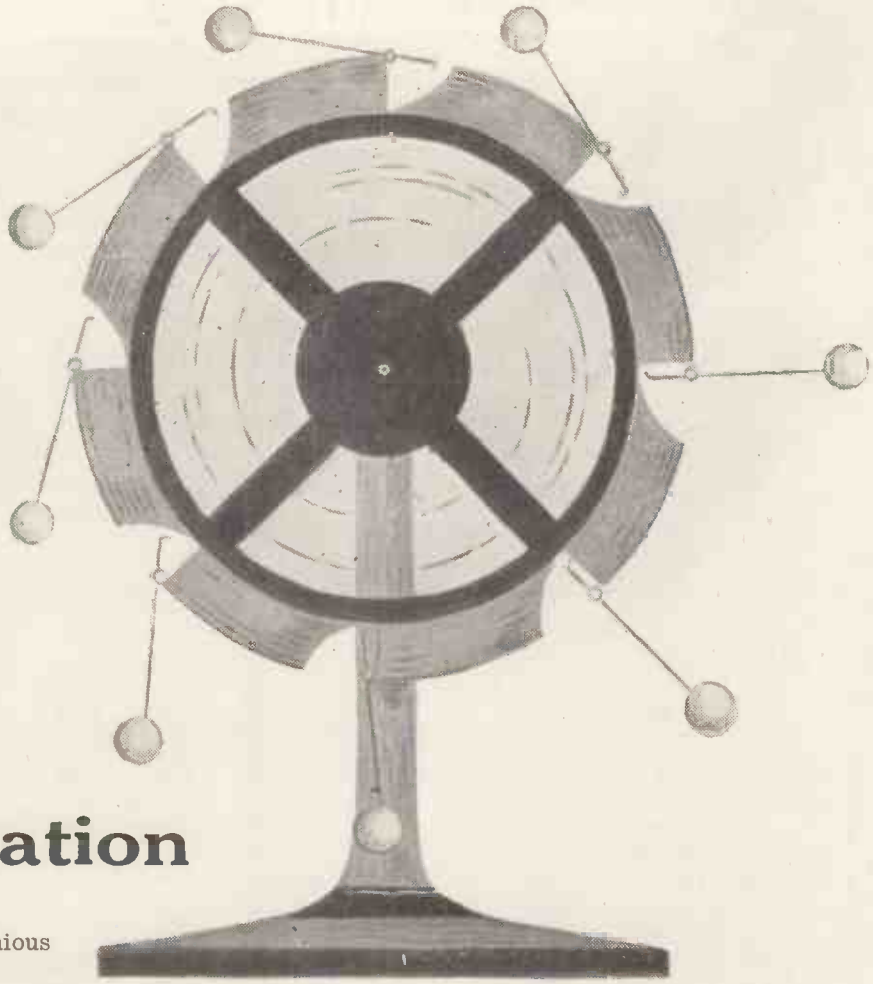
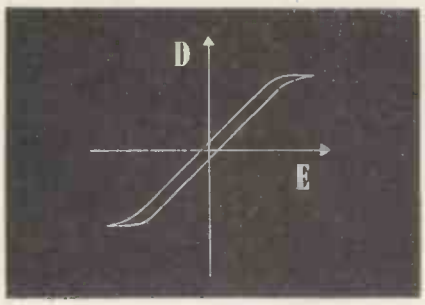


Conservation

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.



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- **Low dielectric loss**
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A quality component which may be economically used in commercial equipment

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- ★ **Frequency Response**
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  50 - 7,000 c.p.s. ± 3db. at 3¾ i.p.s.
- ★ **Ten-inch Loudspeaker**
- ★ **Autostop**
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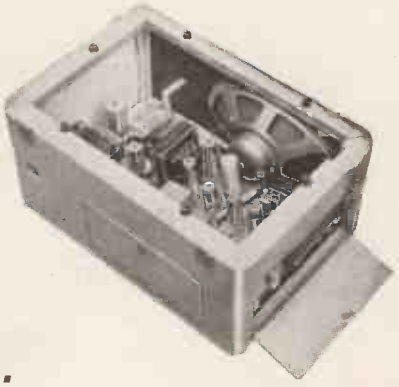
- ★ **'Fingertip' Control**
- ★ **Three Motor Drive**
- ★ **10 watts p.p. output**
- ★ **Independent Bass & Treble**
- ★ **Twin-track recording**
- ★ **High Fidelity Amplifier**
  can be used independently of the recorder for P.A., Radio or Record Reproduction.

85 gns.
H.P. FACILITIES WITH PLEASURE

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 new SP/2 is designed and built by the engineers responsible for the supply of airport and general communications monitoring equipment to H.M. Government, Crown Agents, London Fire Brigade, etc.

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.

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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.

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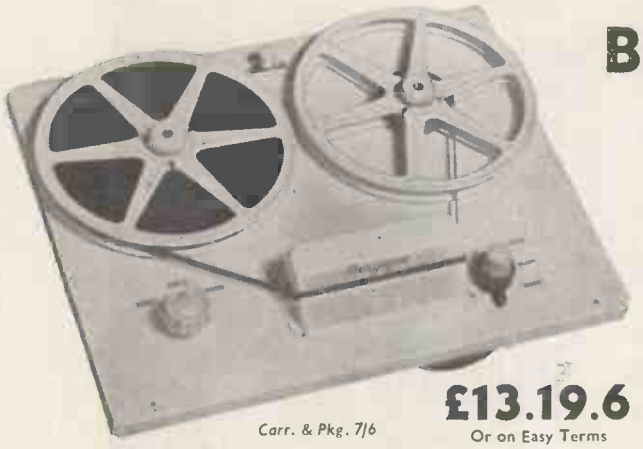

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Here is the heart of your Tape Recorder. If you are building or modernising your own equipment, you MUST have the BURGOYNE Tape Deck giving 2 speeds, designed for building into complete recorders, and IDEAL for PRE-RECORDED TAPES.

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Easy to carry—easy to look at, the "Editor" is the smallest mains-operated fully automatic two-speed recorder with 7in. spools. Twin track heads; INDEPENDENT BASS AND TREBLE controls for recording and playback; two hours' playing time at 3¾in. 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.

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Complete with micro phone and tape
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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.

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•*Manufacturer-to-Consumer policy saves you at least one-third cost!*

We are now specialising in the supply of units for making up high-fidelity Radio and Record-reproducing Equipments for use in the Home, small Halls, Schools and Gramophone Societies and single items for replacing in existing equipments and radiograms.
Our Chief Engineer, who is operating a Technical Guidance Service, is available daily, including Saturdays, from 10 a.m. to 6 p.m., or will deal with enquiries by return of post. Our new illustrated Catalogue and Supplement will be a great boon to those desiring high quality equipment for modest expenditure. Send two 2½d. stamps for your copy now. It may well save you pounds.

No. 1 "SYMPHONY" AMPLIFIER is a 3-channel 5-watt Gram/Radio Amplifier with astonishingly flexible tone control. You can lift the treble, the bass, or—and here is the unique feature—the middle frequencies to suit your own ear characteristics and the record or radio programme being heard. It is thus possible to arrange the frequency-response of the amplifier to a curve equal and opposite to the resultant curve of the other items in the chain so that what finally registers in the brain is as per original. This flexibility of control is far more important than mere nominal linear response of the amplifier, as the pickup, speaker, etc., are not linear. Independent Scratch-Cut is also fitted and special negative-feedback circuit employed. The Amplifier can accommodate a wide variety of records from old 78s to new L.P.s. Input is for all types of pickup of 0.1 v. output or more and there is full provision (and power) for Radio Tuner. It is available to match 2/3 or 15 ohms speakers. Price: 11 gns. (carriage 5/-). Fitted in portable Steel Cabinet, 35/- extra.

No. 2 "SYMPHONY" AMPLIFIER as No. 1 but with 10-watt Push-pull triode output and triodes throughout. Woden mains and output transformers and choke. Full provision and power for Tuner. Output tapped 3, 7.5 and 15 ohms. Competes with the most expensive amplifiers on the market yet costs only 16 gns. (carriage 5/-). Fitted in portable Steel Cabinet 2 gns. extra.

"SYMPHONY" AMPLIFIERS with REMOTE CONTROL. Both the above model Amplifiers are available with all controls on a separate Control Panel with up to 4ft. flexible cable which simply plugs into the amplifier. Enables the Amplifier proper to be sat in the bottom of a cabinet whilst the controls are mounted conveniently higher up. Extra cost 2 gns.

STUDIO "SYMPHONY" AND DECCA AMPLIFIERS, Models 1 and 2. These amplifiers possess all the facilities of the above standard models together with valve amplification stage and precise tone correction circuits (separate for Std. and L.P.) to match the Studio Type "P" or Transcription and the Decca XMS Magnetic Heads respectively. Prices: No. 1, 13 gns. No. 2, 18 gns. Carr. 5/-.

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.2, £10/16/-, or with Acos HGP 33 or 37 heads, £10/14/-, or with two separate high fidelity Acos HGP35 heads, £12/17/-. Unit less heads, £8/11/-, post 2/6. Heads, 42/3 each, post 1/-.
MODEL TB as above, but with long pickup arm. Less heads, £8/11/-, post 2/6.
Heads to fit this unit: Decca XMS, 54/6, Decca Crystal, 30/-, Garrard Standard Magnetic, 28/-, miniature magnetic low impedance, 28/-, miniature magnetic high impedance, 38/-. Post on heads 1/-.

MODEL RC80M AUTOCHANGER. We recommend this as being the most mechanically perfect Autochanger on the market, and with absolute minimum motor noise—approaching Transcription quality. Price LESS HEADS £15/5/-. Price with short pickup arm and Garrard GC2 or Acos HGP37 turnover pickup Head £17/7/6 or with full-length Decca arm and complete with two Decca XMS Heads £20/15/- or with two Decca crystal Heads £18/10/- or two Acos Hi-g Heads £20/5/-. Stylus pressure accurately adjusted before despatch.

COLLARO PICKUPS AND HEADS. Studio Pickup Arm, 13/10. Studio Pickup head type "O" or "P," £3/0/9. Pickup complete £3/14/7. Studio Transcription Pickup Arm with Studio "P" head, £4/15/9. Ditto with Transcription head, £5/2/5.

COLLARO 3-SPEED SINGLE RECORD UNIT AC3/554 and COLLARO 3-SPEED MIXED-RECORD AUTOCHANGER RC54. Both above fitted with either Studio Type "O" or Studio Type "P" pickup heads with permanent sapphire styli. Price £8/18/4 and £13/4/2 respectively. Transcription cartridge 6/9 extra.

COLLARO TRANSCRIPTION UNITS. Model 2000, Mk. II, £13/9/6. Model 2010, including Transcription pickup and PX cartridge, £18/12/. Carriage 5/- in either case. Immediate delivery at present.

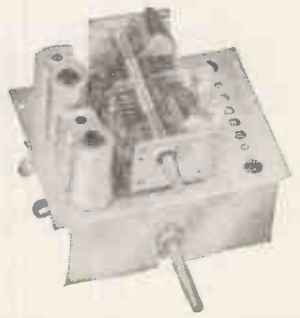
NEW CONNOISSEUR MOTOR variable speed on all 3 speeds £25/15/5.

GARRARD Model 301, £25/3/6.

Cabinets available to house any of the above three motors together with pickup, price £3/7/6. Carriage 5/-.

BSR MONARCH 3-SPEED MIXER CHANGER. New version with Acos HGP37 turnover pickup head with two separate sapphire styli £13/10/-.

Leaflets on any of the above gramophone units free on request.



WONDERFUL THINGS TO COME!
(NOW JUST ROUND THE CORNER).

Highly efficient **AM/FM TUNING AND COIL ASSEMBLY** with I.F. Transformers and Discriminator Coils to match. Suitable for building AM/FM Radio Receiver or Tuner. (Complete circuits supplied.)
ALSO
N.R.S. AM/FM TUNER incorporating above.
ALSO
N.R.S. RADIO/GRAM CHASSIS incorporating above.
ALSO
N.R.S. FM only Radio Feeder Unit and complete receiver.
ALSO
The new **N.R.S. SYMPHONY TAPE RECORDER** embodying 3 speeds, instantaneous braking and a higher standard of precision engineering in the mechanical part and a higher fidelity reproduction on the electronic side.
By the time this advertisement appears we should be in a position to give full details, please drop us a card.

"SYMPHONY" BASS REFLEX CABINET KITS. 30in. high, consist of fully-cut ¾in. thick, heavy, inert, non-resonant patent acoustic board, deflector plate, felt, all screws, etc., and full instructions, 8in. speaker model, 85/-; 10in. speaker model, 97/6; 12in. speaker model, £5/7/6. The design is the final result of extensive research in our own laboratory and is your safeguard of optimum acoustic results. Carriage 7/6. Ready built, 10/6 extra.
"SYMPHONY" BASS REFLEX CABINETS. Fully finished in figured walnut, oak or mahogany to our own design and to match our Console Amplifier Cabinet, enabling the housing of a whole equipment in a two-piece suite; cost: 12in. speaker model, £11/10/-; 10in., £11; 8in., £10/10/-. Carriage according to area. The 10in. model is ideal for the WB HF 1012 (see "The Gramophone" review March).
TREBLE BAFFLE veneered to match, optional extra 50/-.

CONSOLE AMPLIFIER CABINETS. 33in. high, lift-up lid with piano hinge, take Tape Deck, Gram Unit or Auto-changer, Amplifier, Pre-Amplifier and Radio Feeder Unit finished medium walnut veneer. De Luxe version, price 11 gns. Oak or mahogany veneers 10/- extra. Special finishes to order. Carriage according to area, we will quote.

HIRE PURCHASE FACILITIES
NOW AVAILABLE on orders of £15 or over.
Send one-third deposit with order, balance over 6 or 12 monthly instalments. *State which required.*

NORTHERN RADIO SERVICES

11, KINGS COLLEGE RD., ADELAIDE RD., LONDON, N.W.3. *Phone: PRImrose 8314*
Tubes: Swiss Cottage and Chalk Farm.
Buses: 2, 13, 31, 113, 187.

"SYMPHONY" RADIO FEEDER UNITS

No. 1 "SYMPHONY" TUNER A T.R.F. model designed for the quality reception of local stations. Quality is adequate for amplifiers of the highest fidelity class. Infinite impedance detection. Controls: gain, wave-change and radio/gram switch. Illuminated engraved glass dial. Latest miniature valves. Overall dimensions: 9in. wide x 6in. deep x 6in. high. Power required: 6.3 v. at 1 amp. and 250/300 v. at 15 m/a. Price £7/7/-. Carr. and pkg. 5/-.

No. 2 "SYMPHONY" SUPERHET TUNER. Three wavebands, advanced circuit, very newest valve types, floodlit glass dial with bronze escutcheon provided. Suitable for use with the best amplifiers. Overall dimensions: 12in. wide x 8¼in. high x 7in. deep. Controls: on/off/gain, radio/gram, wave-change and tuning. Dial cut-out: 8in. x 4¼in. reading horizontally or vertically (state which required). Tuner can be readily mounted at any angle. Requires 6.3 v. at 1.5 amp. and 250/300 v. at 20 m/a. Price £11/11/-. Carr. and pkg. 5/-.

No. 2/VS "SYMPHONY" SUPERHET TUNER. As No. 2 but incorporating on the wave-change switch an extra position for radio, giving T.R.F. bandwidth. Price 13 gns. Carr. and pkg. 5/-.

TAPE DECKS & AMPLIFIERS

TRUVOX Tape Deck Mark III. T.R.2/U. Latest version to take pre-recorded tapes. Price 22 gns. Illustrated leaflet 2½d.

TAPE AMPLIFIER TYPE C, expressly designed by Truvox to work perfectly with their Deck, 3 valves plus rectifier and Magic Eye level indicator. Price 16gns.

PORTABLE TAPE RECORDER CABINET to house Truvox Tape Deck and Amplifier together with speaker. Very strongly made and attractively finished in Rexine. Price £4/15/-, carriage paid.

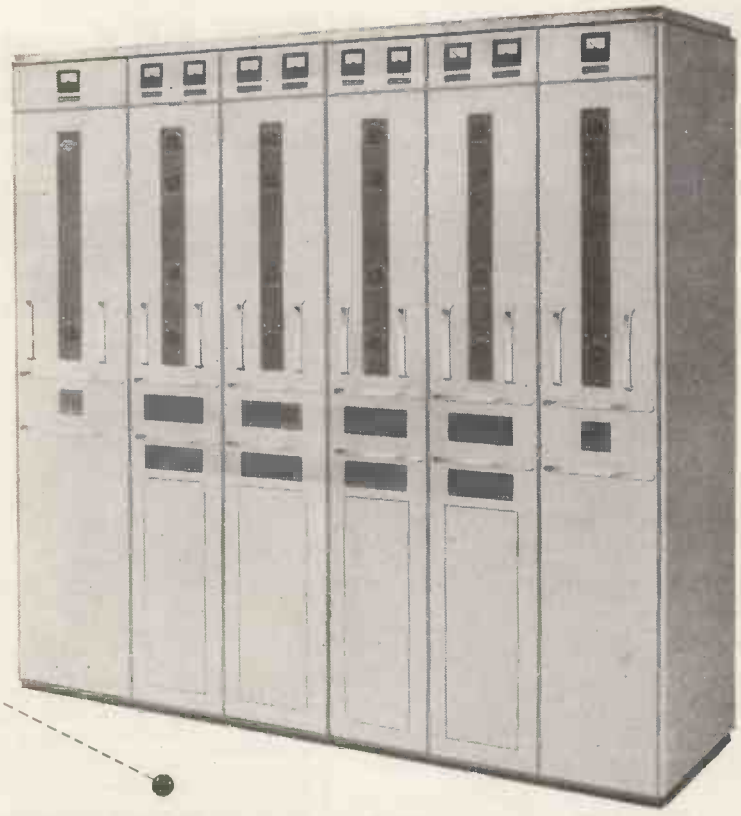
NEW MODEL PORTABLE RECORD PLAYERS

We are pleased to announce the entry on to the market of two "Symphony" Record Players designed to represent the greatest value in this line ever offered. Model No. 1 contains the Collaro 3-speed single record playing unit AC3/554 and model No. 2 contains the Collaro Autochanger RC54. They are available with either Type "O" Insert, "P" insert or transcription insert. Prices (in attractive rexine case), No. 1 £10/19/6, No. 2 £14/19/6, Carr. 7/6. Transcription insert 6/9 extra.

FREQUENCY MODULATION TUNER UNITS

CHAPMAN MODEL FM81. Tunable model with attractive facia panel and dial: will provide amazing degree of realism with complete absence of background noise when working with one of our Symphony Amplifiers or other high-grade amplifier. Price £21. Suitable power pack to operate this model £4. **MODEL FM82** with switched tuning and being self-powered: price £24. Leaflet 2½d. Demonstrations daily.

GOODMANS CORNER CABINETS for the AXIOM 150 Mark 2 manufactured by us to Messrs. Goodmans' specification and approved by Messrs. Goodmans. Height 44in. Price: complete kit in plain board with 1in. thick felt, 8 gns. Price: ready built, 10 gns. Finished in figured walnut. 16 gns. Other veneers to order. Carriage extra according to area. Quotation by return.



2-3 kW Channelised Transmitter

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 A,1, A2, A3, F1 *Output Impedance* 600 ohms balanced twin feeder *Power Supply* 400V, 50-60 c/s, 3-phase.

Mullard

SPECIALISED ELECTRONIC EQUIPMENT

MULLARD LIMITED · EQUIPMENT DIVISION · CENTURY HOUSE · SHAFTESBURY AVENUE · LONDON · WC2
(M1469)

G.E.C.

ELECTRONIC DEVICES

OF INTEREST to all engineers, this new publication forms an invaluable reference to current G.E.C. electronic products suitable for such industrial applications as control instruments, scientific measurement, counting, radio-active indication, photoelectric alarms and indicating devices and electronic relays and voltage stabilisation. The technical information which includes ratings, dimensions, base connection diagrams and screen characteristics, enables the potential user to choose the device most suitable for a particular application.

The contents include:

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

Write to
OSRAM VALVE AND ELECTRONICS DEPT. FOR **OV 2507**

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

50 Watt V.H.F. FIXED STATION

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.

Telecommunications
CAMBRIDGE ENGLAND

Pye (New Zealand) Ltd. Auckland C.I., New Zealand	Pye Canada Ltd Ajax, Canada	Pye-Electronic Pty., Ltd. Melbourne, Australia	Pye (Ireland), Ltd Dublin, Eire
Pye Radio & Television (Pty.) Ltd. Johannesburg South Africa	Pye Limited Mexico City	Pye Limited Tucuman 829 Buenos Aires	Pye Corporation of America 270 Park Avenue New York

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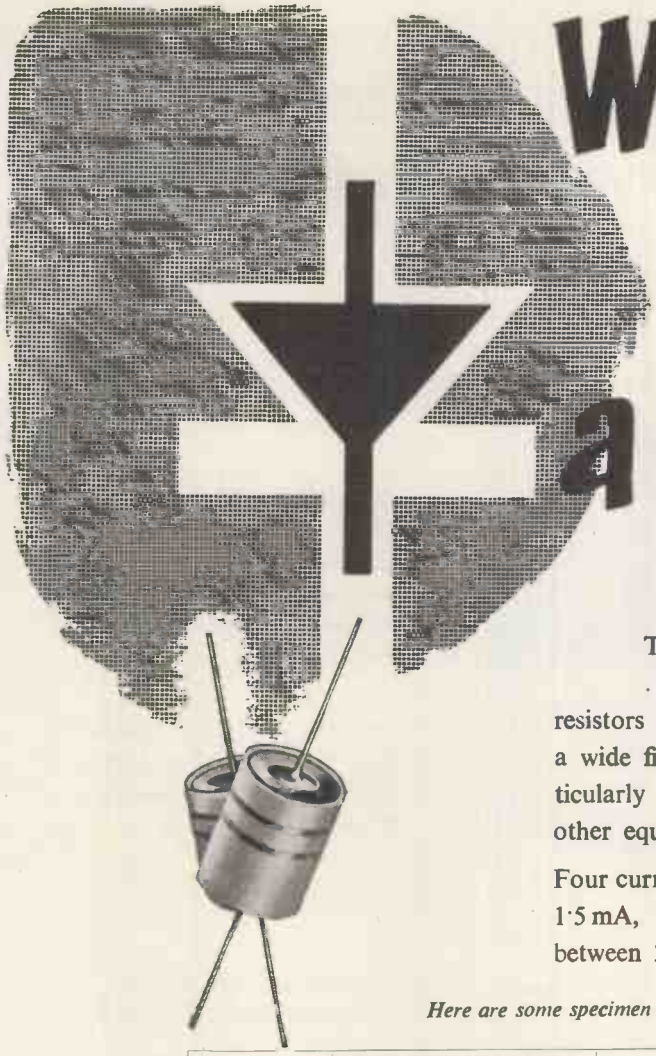


When is this *Not* a rectifier?

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 computors 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.

Unistor Code	D.C. Current Rating in Max. Ambient Temp. 55°C.	D.C. Current Rating in Max. Ambient Temp. 71°C.	Maximum Continuous Inverse D.C. Voltage	Maximum Instantaneous Inverse D.C. Voltage	Capacitance at Approx. Zero Volts
	mA	mA	Volts	Volts	pF
Q1/1	0·25	0·25	20	56	20
Q3/1	1·5	1·5	20	56	65
Q6/1	7	3	20	56	500
Q8/1	10	4	20	56	1,000

SenTerCel UNISTORS

(asymmetric resistors)

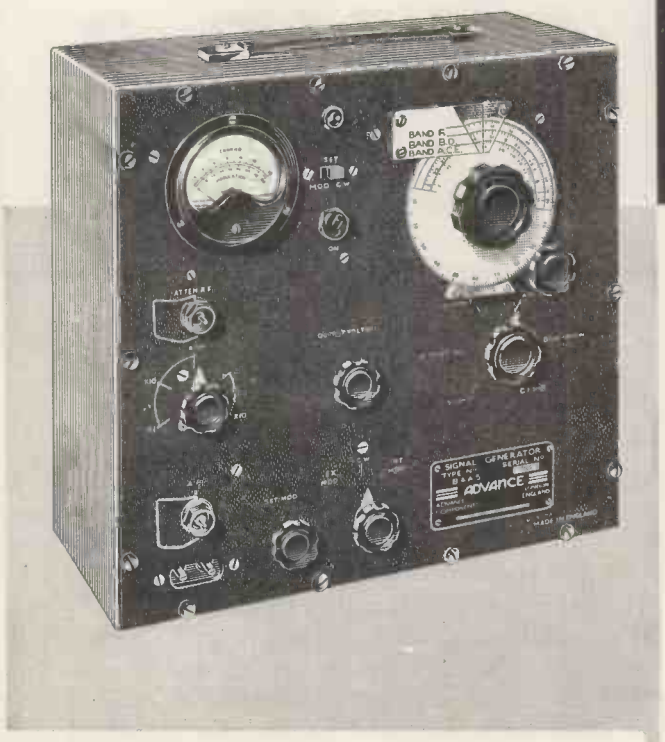
Standard Telephones and Cables Limited

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

RECTIFIER DIVISION: Edinburgh Way · Harlow · Essex

Telephone : Harlow 26811 Telegrams : Sentercel, Harlow

ADVANCE COMPONENTS LTD., MARLOWE ROAD, WALTHAMSTOW, LONDON, E.17. *Telephone : LARkswood 4366/7/8*



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

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.

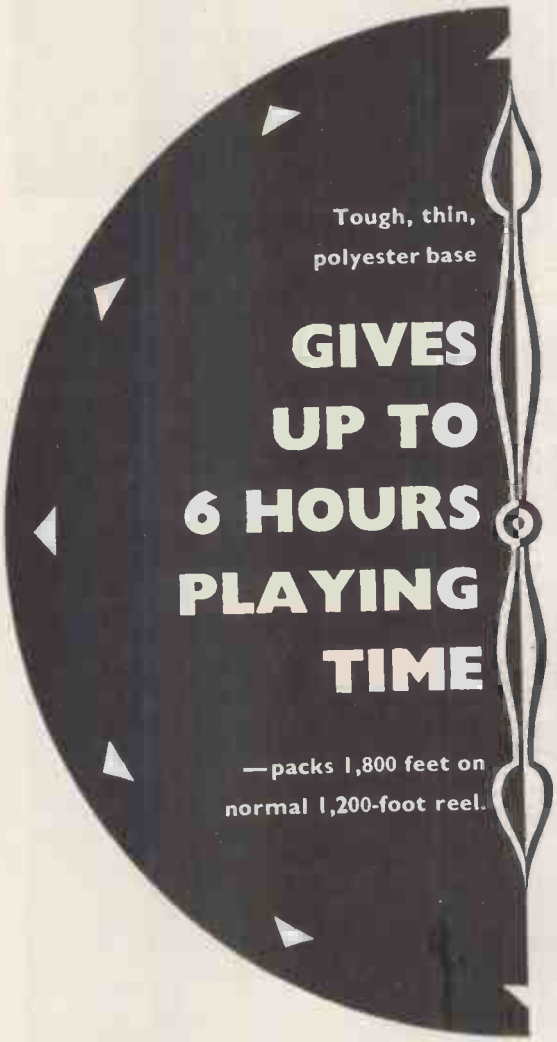
Full technical details in Folder W11

Advance
signal generator

ADVANCE COMPONENTS LTD., MARLOWE ROAD, WALTHAMSTOW, LONDON, E.17. *Telephone : LARkswood 4366/7/8*

new world-beating 'SCOTCH BOY' extra-play magnetic recording tape 190m

Regd. Trade Mark



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.

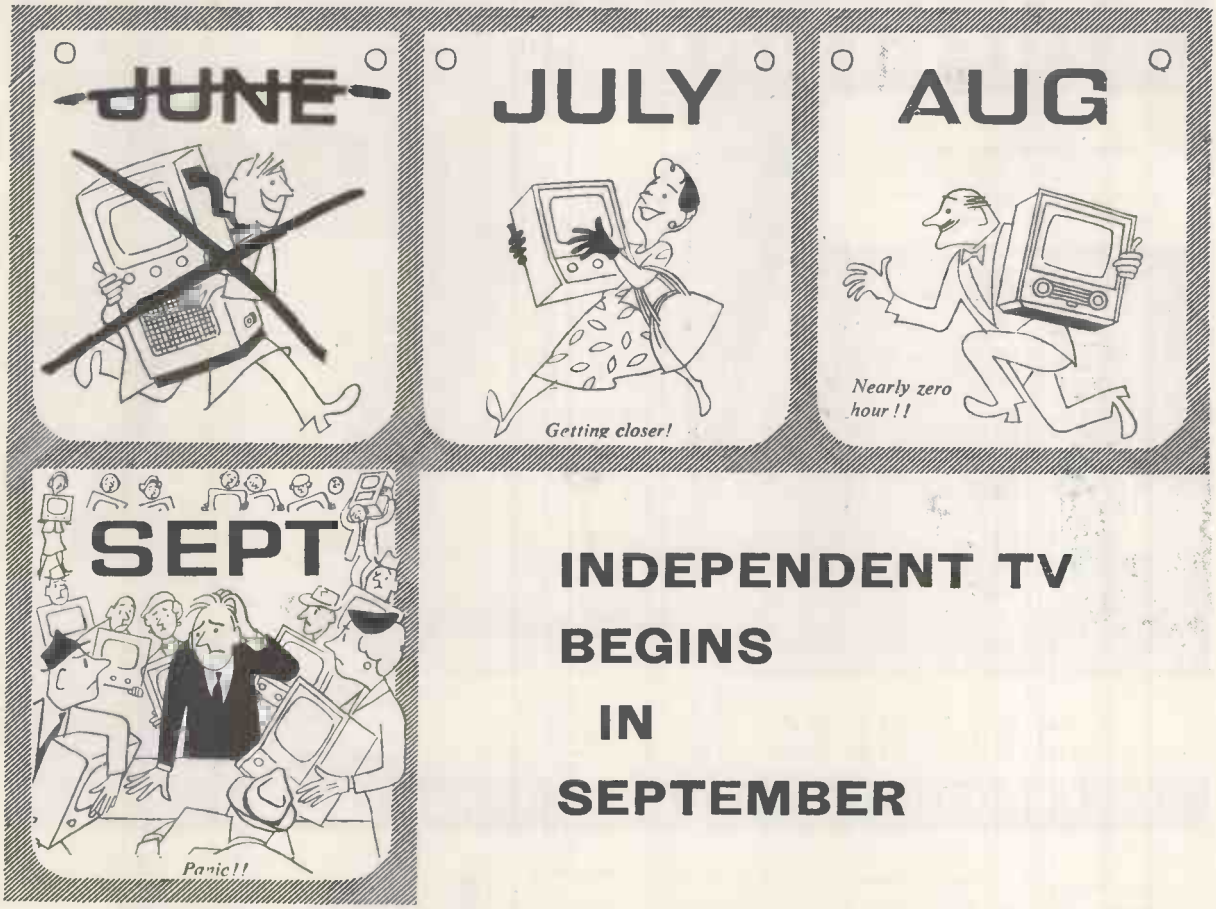
'SCOTCH BOY' 190m

MAGNETIC RECORDING TAPE

with polyester base

ANOTHER 3M COMPANY PRODUCT

MINNESOTA MINING & MANUFACTURING CO. LTD.
LONDON, BIRMINGHAM, MANCHESTER AND GLASGOW.



INDEPENDENT TV BEGINS IN SEPTEMBER

SAVE YOURSELF A RUSH

Urge your TV customers to convert now!

NO-ONE WANTS to turn down business, but you may find yourself in that situation when independent TV begins—unless you urge your customers to convert *now!*

We are doing our bit with a big advertising campaign which is now running. Big spaces in London evening and suburban newspapers, posters in the Underground, leaflets for your counter, and windowbills—all these are telling your customers about the forthcoming programmes: most of the biggest names in the entertainment world will be appearing regularly on the new station. We are telling viewers, too, to come to *you* with their enquiries.

But *you* know what people are like for putting things off! So warn your customers that they may miss the first months of the new programmes *unless they take steps now!*

The new station will bring you plenty of new business—make sure *now* that you can cope with it!

ASSOCIATED BROADCASTING COMPANY LTD · ASSOCIATED-REDIFFUSION LTD
THE LONDON PROGRAMME COMPANIES

Can you accept orders for conversion work *now?*

There will shortly be a heavy demand on your skilled labour for conversion work. May we suggest you look into whether you are ready for it—with the necessary labour know-how and equipment supplies?

The SWISS have a word for it...

KATHODENGEGENKOPPLUNGSWICKLUNGEN

a singularly factual one describing the design of the output circuit of the QUAD II Amplifier.

In other words the output transformer includes cathode as well as anode and output windings. Thus, the screen characteristics of the valves are used as well as those of the anode, while the voltage appearing across the cathode winding is also applied in the grid circuit as overall negative feedback without either sacrificing gain wastefully or increasing the load on the previous state.

The resulting decrease in distortion and increase in efficiency have contributed considerably to the success of Acoustical Amplifiers over the last ten years, and are reflected in the rather unusual performance-for-size of the QUAD II.

For a full description of this circuit from its basic principles see "Amplifiers and Superlatives" Wireless World, Sept. 1952.

The Quad II Amplifier

The Quad II Control Unit

ACOUSTICAL

QUAD II

AMPLIFIER

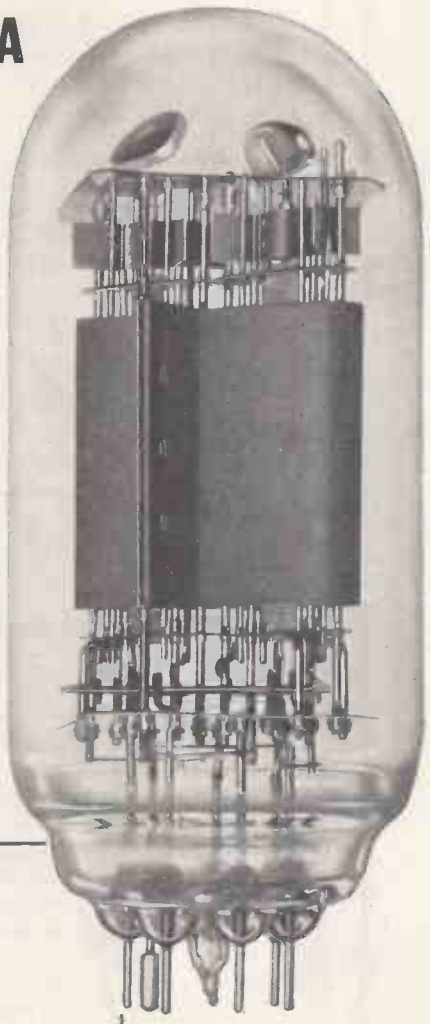
For the closest approach to the original sound

✳ Send for the QUAD II booklet giving full details of today's most advanced amplifier— Acoustical Mfg., Co., Ltd., Huntingdon, Hunts.

A new beam tetrode D.C. control valve of exceptional performance

gm = 35mA/V

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.

RATING			BASE CONNECTIONS—B.7A.	
Vh	26.0 v	13 v.	Pin 1	h
Ih	1.3 A	2.6 A	Pin 2	h tap
Va max	800 V		Pin 3	g1
Vg2 max	300 V		Pin 4	k
Vg1 max	−100 V		Pin 5	g2
Wa max	90 W		Pin 6	a
Wg2 max	10 W		Pin 7	h
Ik Max	800 mA			

Vh/k max. (cathode+VE) 300 V

EDISWAN

MAZDA

VALVES AND CATHODE RAY TUBES

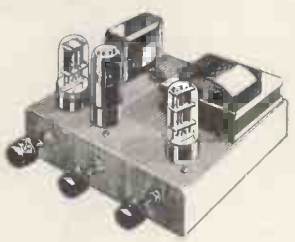
THE EDISON SWAN ELECTRIC CO. LTD.

Member of the A.E.I. Group of Companies

155 Charing Cross Road, London, W.C.2. Telephone: Gerrard 8660. Telegrams: Ediswan, Westcent, London

PREMIER RADIO COMPANY

4-WATT AMPLIFIER



MAY BE BUILT FOR **£4.10.0** Plus 2/6 Pkg. & Carr.

Valve line-up 6SL7, 6V6 and 6X5, FOR A.C. MAINS 200/250 VOLTS. The twin triode 6SL7 is used for preamplification and also for a comprehensive tone control circuit, which includes two very wide range and continuously variable tone controls for bass and treble. The output Valve is of the beam type and feeds 4 watts into a specially designed output Transformer which is suitable for either 3 ohms or 15 ohm Speakers. Negative feed-back is applied from the secondary of the output Transformer over the whole Amplifier to the input stage giving an excellent frequency response. Due to the high gain and wide range tone controls any type of pick-up may be used. Overall size 9 × 7 × 5in. Price of Amplifier complete, tested and ready for use, £5/5/-, plus 3/6 pkg. and carr.

INSTRUCTION BOOK, 1/- (Post Free) which includes Assembly and wiring diagram, also a detailed Stock List of priced components.

QUALITY ENTHUSIASTS

Electrostatic H.F. Speaker type LSH75 gain of 20 db over the range of 7-18 kcs., inherent capacity 800pf, maximum polarising voltage 300 D.C., operative A.C. voltage 60, suitable for outputs of up to 5 watts, size 2½in. x 2½in. x ½in., price 12/6.

Type LS100, details as above, inherent capacity 1100pf., suitable for outputs of up to 20 watts, size 5in. x 3in. x ½in., price 21/-.

Will add sparkle to the top response of any equipment.

RECTIFIERS

E.H.T. Pencil Type S.T.C.

Type K3/25	650 v.	1 mA.	4/7
,, K3/40	3.2 kV.	1 mA.	6/-
,, K3/45	3.6 kV.	1 mA.	8/2
,, K3/50	4 kV.	1 mA.	8/8
,, K8/100	8 kV.	3 mA.	14/8
,, N3/160	12 kV.	1 mA.	21/6
,, K3/180	14.4 kV.	1 mA.	24/6

H.T. Type S.T.C.

Type RM1	125 v.	60 mA.	4/-
,, RM2	125 v.	120 mA.	4/6
,, RM3	125 v.	125 mA.	5/6
,, RM4	250 v.	250 mA.	18/-

L.T. Type Full Wave

12 v. 1 amp.	8/-
12 v. 2 amp.	10/9
12 v. 4 amp.	19/6

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

Teletron Ferrite Rod Aerials. Medium Wave 8/9. Medium/Long Wave 12/9.

Corner Reflex Cabinet for Goodmans Axiom 150 to specification £12/10/-, pkg. and carr. 15/-.

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Aluminium with four sides:

7 × 5½ × 2in.	4/-	10 × 9 × 3in.	7/-
7 × 3½ × 2in.	3/9	12 × 10 × 3in.	7/9
9½ × 4½ × 2in.	4/3	14 × 10 × 3in.	7/11
10 × 8 × 2½in.	5/6	16 × 10 × 3in.	8/3
12 × 9 × 2½in.	7/-	16 × 8 × 2½in.	8/-
14 × 9 × 2½in.	7/6		

ALUMINIUM PANELS 18 s.w.g.

7 × 6in.	1/3	7 × 4in.	1/-
9½ × 6in.	1/8	9½ × 4in.	1/5
10 × 9in.	2/2	10 × 7in.	1/11
12 × 9in.	2/8	12 × 7in.	2/5
14 × 9in.	3/2	14 × 7in.	2/11
16 × 9in.	3/8	16 × 7in.	3/5
20 × 9in.	4/8	20 × 7in.	4/5
22 × 9in.	5/2	22 × 7in.	4/11

CABINETS—PORTABLE

Model PC/1
Brown Rexine covered **15/11**
Overall dimensions 15in. × 13½in. × 5in.
Clearance under lid when closed 2½in.

Model P2/C
Grey Lizard Rexine covered **45/-**
Overall dimensions 15in. × 13in. × 6in.
Clearance under lid when closed 3in.

Model PC/3
Rexine type covering in various cols., **69/6**
Overall dimensions 16½in. × 14¼in. × 10¼in.
Clearance under lid when closed 6¼in.

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 UT340 permeability tuned, coverage 86-103 mcs. stage gain Aerial to output of 1st I.F. (contained in Unit) approximately 350. Maximum frequency drift 0-70 degrees centigrade 30 kcs. Radiation less than 26 microvolts per metre, price 59/5 (including tax). Valve UCC85.

I.F. type U.F.376 inter-stage, 10.7 mcs., Q-110. Coupling factor unity price, 7/-.

Ratio Filter type URF377 Q1-75. Q2-105, price 10/6.

Overall bandwidth of the above Units 200 kcs.

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

★QUALITY CRYSTAL PICK-UP ROTHERMEL TYPE U48 26/-. Plus 1/6 Pkg. and Carr.

The New

"PREMIER PORTABLE"

TAPE RECORDER

USING THE NEW LANE 2-SPEED TAPE UNIT MARK 6

COMPLETE 39 GNS CASH

Packing & Carriage 1 gn.

(Including Reel of Scotch Boy Tape and Microphone)

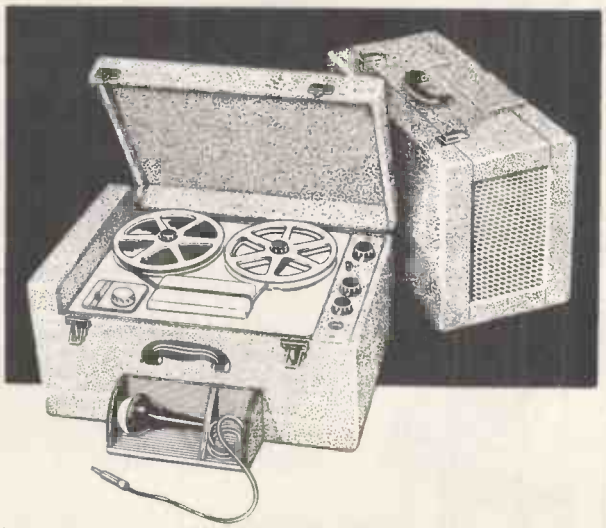
H.P. Terms: Deposit £10.4.9 and 12 monthly payments of £2.16.11,

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 3¾in. PER SECOND.
- ★ THREE SPECIALLY DESIGNED RECORDING MOTORS.
- ★ 1,200FT. TAPE REELS PROVIDING PLAYING TIMES OF 1 HR. AND 2 HRS.
- ★ DROP-IN TAPE LOADING.
- ★ EASY FORWARD OR REWIND WITHOUT REMOVING TAPE.
- ★ ONE KNOB DECK OPERATION.
- ★ 7-VALVE HIGH QUALITY AMPLIFIER.
- ★ INDEPENDENT TREBLE AND BASS CONTROLS.
- ★ MAGIC EYE RECORD LEVEL INDICATOR.
- ★ AMPLIFIER MAY BE USED FOR RECORD REPRODUCTION OF HIGH QUALITY.
- ★ COMPARTMENT FOR HOUSING MICROPHONE.
- ★ SPECIALLY DESIGNED MICROPHONE BY A LEADING MANUFACTURER.



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 £1/0/6.
Amplifier Kit (including Speaker). £11/-/- plus packing and carriage 5/-.
Hire Purchase terms, Deposit £2/15/- and 9 monthly payments of £1/0/7.
New Lane 2-speed Tape Unit Mark 6. £18/10/- plus packing and carriage 7/6.
Hire Purchase terms, Deposit £4/12/6 and 12 monthly payments of £1/5/9.
Portable Cabinet (rexine covered). £4/19/6, plus postage and carriage 5/-.
Microphone, £2/15/-, plus postage and carriage 1/-.
Reel Scotch Boy Tape MC2-111 (1,200ft.), £1/15/-, plus packing and carriage 1/-.
Instruction Booklet. 2/6. Post free.

Wireless World

RADIO, ELECTRONICS, TELEVISION

Managing Editor:
HUGH S. POCOCK, M.I.E.E.

Editor:
H. F. SMITH

JULY 1955

In This Issue

VOLUME 61 NO. 7
PRICE: TWO SHILLINGS

FORTY-FIFTH YEAR
OF PUBLICATION

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VALVES, TUBES & CIRCUITS

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.

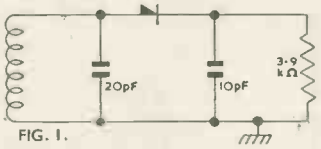


FIG. 1.

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.

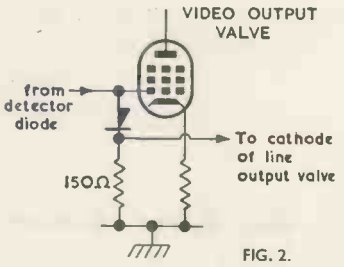


FIG. 2.

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 100k)Ω and the OA71 (1MΩ), depending on the peak inverse voltage which will be encountered and on the value of the load resistor.

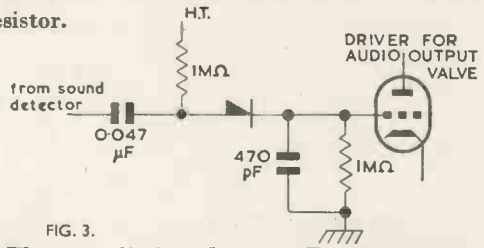


FIG. 3.

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.

"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.

Sound carrier frequency:
191.27 Mc/s.

Vision peak white E.R.P.:
1 kW. (approximately)

Sound carrier E.R.P.:
50 W. (approximately)

Constancy of vision power output:
± 2dB

Type of vision aerial:
Four bays of folded dipoles, each bay consisting of four folded dipoles arranged in turnstile

Type of sound 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
Saturdays: 10.00—13.00

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

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 post-card 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 —ask 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 have 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.

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.

COSSOR 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.

BRITISH INSTRUMENT INDUSTRIES EXHIBITION
EARLS COURT LONDON
June 28 - July 9 1955

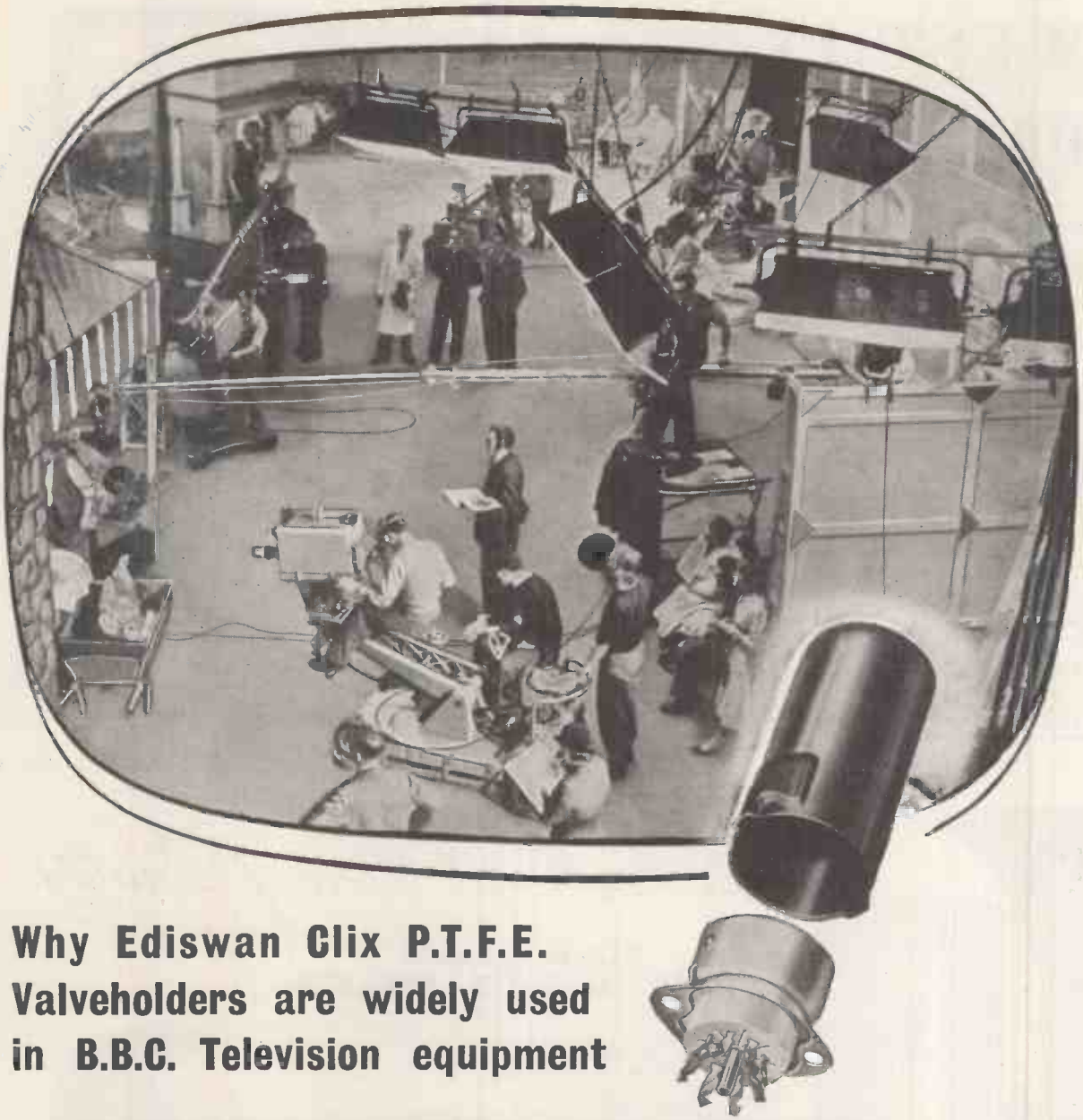
COSSOR INSTRUMENTS LIMITED

Write for illustrated leaflets about both these instruments:

C1.60

COSSOR INSTRUMENTS LIMITED (Dept. 1) HIGHBURY GROVE, LONDON, N.5.

Telephone: CANonbury 1234 (33 lines) *Telegrams: Cossor, Norphone, London* *Cables: Cossor, London.*



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—Berylium 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.

EDISWAN

CLIX

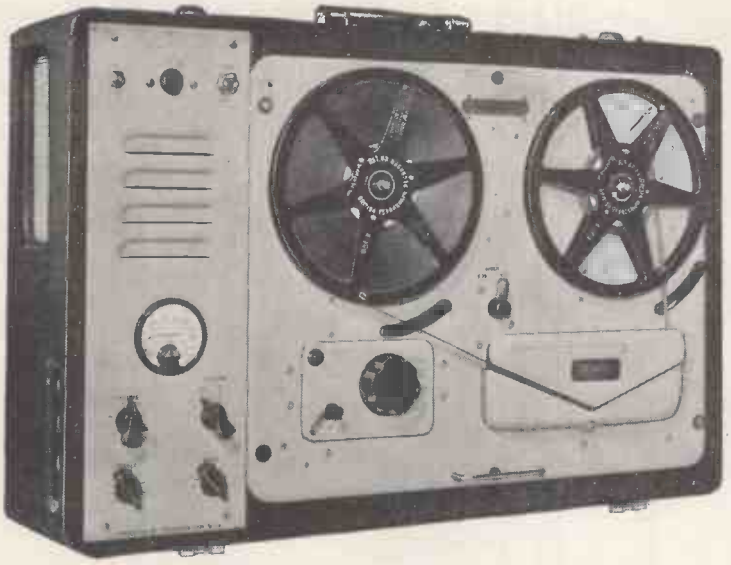
RADIO, TELEVISION & ELECTRONIC COMPONENTS

THE EDISON SWAN ELECTRIC COMPANY LIMITED, *Member of the A.E.I. Group of Companies*

155 Charing Cross Road, London, W.C.2 and Branches. *Telephone: Gerrard 8660. Telegrams: Ediswan, Westcent, London*

CA3

VORTEXION TAPE RECORDER



★ The total hum and noise at 7½ 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 20ft. 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.

The amplifier, speaker and case, with detachable lid, measures 8¼in. x 22½in. x 15¾in. and weighs 30 lb.

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ 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.

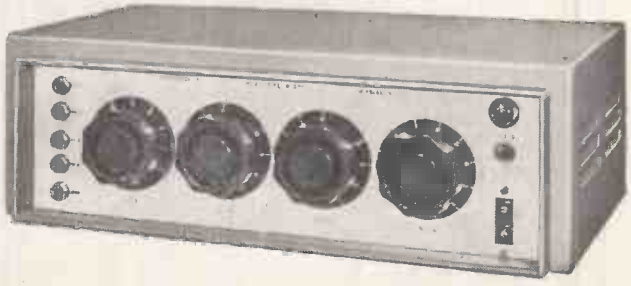
★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.
★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

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

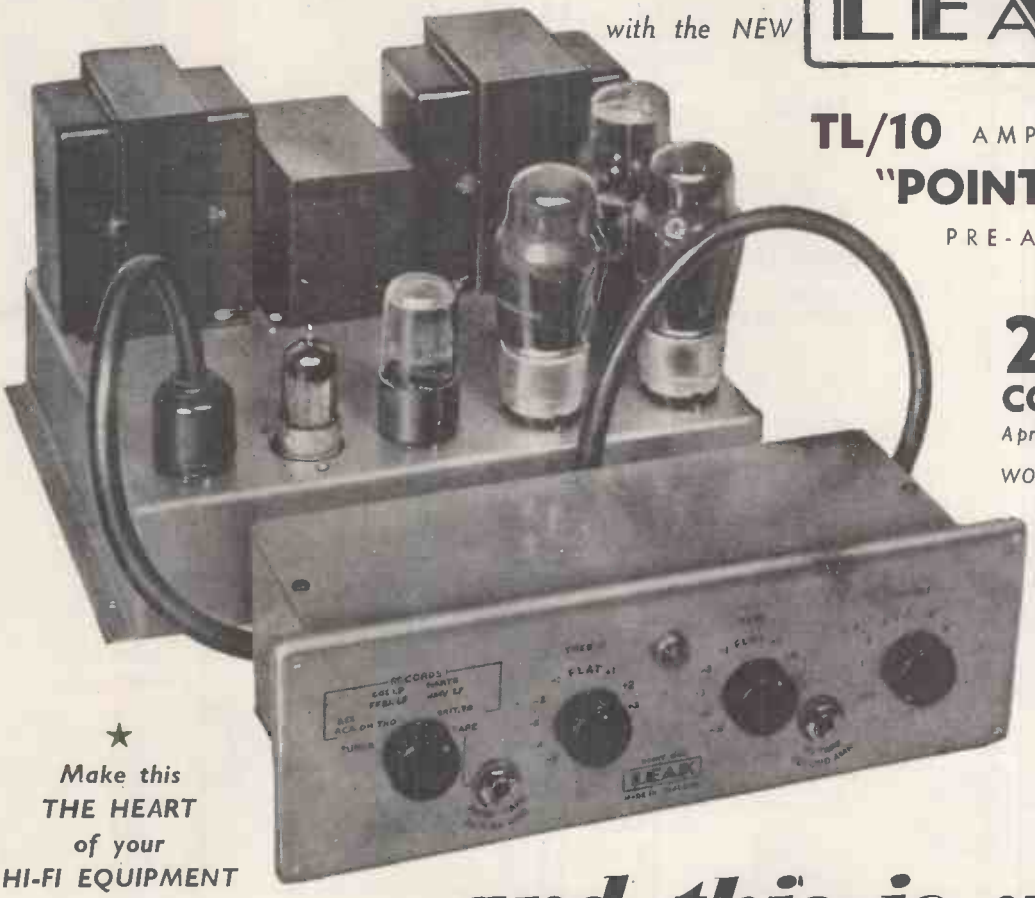
VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3 Telegrams: "Vortexion, Wimble, London."

Sales up 300%!

with the NEW **LEAK**

TL/10 AMPLIFIER & "POINT-ONE" PRE-AMPLIFIER



27 GNS COMPLETE

A price made possible only by WORLD-WIDE SALES

★

Make this THE HEART of your HI-FI EQUIPMENT

and this is why

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.

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.

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.

"POINT ONE" PRE-AMPLIFIER

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.

★ **Input selector**
Radio, tape, records; any and all records can be accurately equalised.

★ **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.

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.

★ *Write for leaflet W* ★

H. J. LEAK & CO. LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3

'Phone : SHEpherds Bush 1173/4/5 *Telegrams : Sinusoidal, Ealux, London* *Cables : Sinusoidal, London*

CHASSIS ASSEMBLY

3-colour, 3 waveband scale covering standard, Long, Medium, and Short wavebands, scale pan, chassis, punched for standard 5-valve superhet, pulley driving head, springs, etc., to suit. Scale size 14¼in. × 3¼in. Chassis size 15in. × 5in. × 2in. deep. Price 15/- plus 1/6 post. Note.—This is the one that fits our 37/6 cable cabinet.

SOMWEAVE

This really lovely loudspeaker fabric we offer at approximately a third of to-day's cost. It is 42in. wide and our price is 12/- per yard, or panels 12in. × 12in., 1/9 each. This is also very suitable for covering plain wooden case, for portable radio amplifiers, etc.

THIN PAXOLIN PANELS

Size 8in. × 5in. Price 3/- doz. Post 6d. Ref. 3J2.

CONNECTING WIRE SNIP

P.V.C. insulated 23 s.w.g. copper wire in 100ft. coils, 2/9 each. Various colours available; 4 coils assorted colours for 10-.

H.T. RECTIFIERS FAMOUS SELENIUM "SENTERCEL"

All are this year's stock—for higher voltages joint two or more in series.

R.M.1	125 v.	60 mA.	3/9
R.M.2	125 v.	100 mA.	4/2
R.M.3	125 v.	120 mA.	5/9
R.M.4	250 v.	250 mA.	16/-

SERVICE DATA

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makes are included: Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster-Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price £1 for the complete folder. Our Folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry" etc., which have been imported into this country. Names include Sparton, Emmerson Admiral, Crossley, R.C.A., Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is £1. Post free.

BAND III

AERIALS

BAND III Aerials—These aerials have quick fitting elements, all alloy tube construction and polythene low-loss insulators.

Arrays only 1in. Mast Fixing
Model 700 × 0 3-element ..... 45/- each
Model 702 × 0 5-element ..... 60/- each

Aerials Cranked Arm Wall Mounting
Model 700CW 3-element ..... 67/6 each
Model 702CW 5-element ..... 82/6 each

Aerials 6ft. Chimney Lashing
Model 700S 3-element ..... 77/6 each
Model 702S 5-element ..... 93/- each

DOWNLEADS

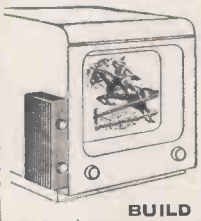
BAND III DOWNLEAD.
Patented five cell construction ensures maximum air to polythene ratio around the conductor high performance 9d. per yard.

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, Coils, etc.
3. Can be made to give a pattern on 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 2/6.



BE READY FOR THE NEW COMMERCIAL T.V.

Daily Test Transmissions are already taking place

Our adapter which fixes to the side or back of your T.V. will give you the new station or the old by the flick of a switch. You do nothing to your existing set; just plug in mains and aerial leads. Suitable for any T.V. Price £8/10/-, or 30/- deposit and six payments of £1.

BUILD YOUR OWN CONVERTOR

The Elpreq Band III Convertor has given very satisfactory results from the experimental Beulah Hill station. It uses 9 valves, is not at all difficult to make and can be lined up with the simple 25/- instrument described above. Price for all the components including constructional data is £3/10/—data available separately price 2/6.

10 VALVE 1½ METRE SUPERHET

Designed to receive 200 mc/s transmission, the receivers should be ideal for conversion to the Commerical T.V. Band. These contain 6 valves type SP61, and one each RL7, RL16, and EA50. Six IF transformers 12 Mc/s. band, and hundreds of other useful components. Price 59/6, plus carriage and packing 7/6. These receivers are unused.

THE ELPREQ F.M. UNIT

In the ELPREQ F.M. Tuner four valves and two crystals are used. The last valve acts as a limiter so reducing the necessity of exact tuning and at the same time improving interference rejection. Crystals are used in the ratio detector to avoid heater-cathode hum so often encountered with valve ratio detectors. Stability is extremely good and tuning most simple. The tuner draws its power supplied from the set or amplifier, its valve heaters are not connected to earth.
With only a simple indoor aerial made by parting 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 £6/12/6, data is included free with the parts or is available separately price 2/-.

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 × 31in. (deep to corner) × 50in. high. Made to house 15in. Televisor, 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 in future should be addressed to: E.P.E. Ltd., Dept. 2, Bourne House, Grove Road, Eastbourne.

CABINETS 19/6

You can make an excellent bass reflex cabinet with this well made veneered and polished walnut cabinet. Limited quantity offered at 19/6. Carriage, etc., 3/6.

COMPLETE TOOL KITS THE ELECTRICIAN'S

This is as illustrated and contains 55 fine tools arranged on 5 trays in an automatic steel tool-box. The box opens under slight pressure of the hand and closes automatically when lifted. The tools are all that a practical electrician needs, including tenon saw, ratchet brace, hack-saw, chisels for wood, brick and steel, pliers, side cutters, hammers, spanners, socket wrenches, pad-saw, etc. Price £13/10/-, or 37/3 deposit and 12 payments of 20/5.

RADIO ENGINEER'S

This again is fitted into an automatic tool-box and contains 50 tools including pliers, side counters, screwdrivers, side and straight snips, hammers, spanners, and socket wrenches, hand-drill, B.A. taps, drills, etc. Price £9/10/-, or 28/6 deposit and 12 payments of 15/6.

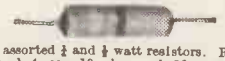
1in. MICROMETER

Exceptional purchase enables us to offer a 1in. precision micrometer at the very low price of 10/-. A micrometer is an essential part of an engineer's equipment. You will have found the need for one on many occasions in the past for measuring wire gauge, etc. Price 10/-, post free.

TRANSFORMER 100 WATTS

These are transformers with a wound primary tapped 200, 220, 240, but no secondary. There is ample window space, however, for the hand winding of secondary to suit your own requirements. Approximately two turns per volt are required. The amps. taken out will depend upon volts, e.g., 10 amps. at 10 volts, 50 amps. at 2 volts, etc., etc. Price 10/-, post and packing 2/-.

RESISTORS



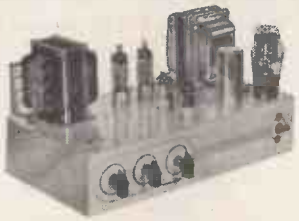
50 assorted ½ and ¼ watt resistors. Ranging between 10 ohm and 10 megohm. (Our selection.) Price 5/- pkt. 50 at 1 watt, 7/6.

PUSH BUTTON UNIT

9 way. Price 2/-. Post 6d. Ref. 2J146.

CONDENSERS

High voltage .05 MFD. × 5 KV. 5¾in. × 1½in. dia.
Price 4/6. Post 6d.
Ref. 2B60.



MULLARD AMPLIFIER "510"

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 20,000 C.P.S.—three controls are provided and the whole unit is very suitable or use with the Collaro Studio and most 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, 4BA, 6BA. Price 6/- doz. sets. Post 9d. Ref. 2F75.

CONDENSERS

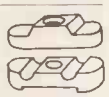
High voltage. .05 mfd. plus .05 mfd. × 2.5 kV. 4½in. × 1½in. dia. Price 3/6. Post 6d. Ref. 2B61.

CONDENSERS

High Voltage .001 × 4kV. 2½in. × 1in. dia. Price 2/6. Post 6d. Ref. 2B63.

1/9 Doz.

Post 6d.

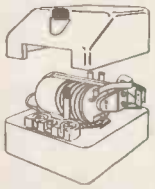


WIRING CLEATS

Vitreous porcelain; two groove 1/9 per doz.; three groove 2/9 per doz.

9/6

Post 6d.



CHARGING CUT-OUT

Bakelite case, suitable 6, 12 or 24 volts.

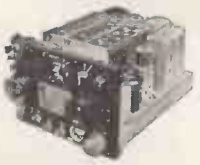
TRIMMER 1/3 Post 3d.

Long spindled 35 p.f.—also 2-gang 75 p.f., 5/3.

BENDIX RA-1B 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 if you act promptly. Designed to receive C.W. or R.T. it uses probably the finest Vernier tuning and band spreading arrangement possible, it covers the following bands:—

Band 1	.15	to	.315	mc.	i.e. 20 to 200 metres.
Band 2	.315	to	.680	mc.	
Band 3	.680	to	1.5	mc.	
Band 4	.18	to	3.7	mc.	
Band 5	3.7	to	7.5	mc.	
Band 6	7.5	to	15.0	mc.	



The sensitivity is 4 micro volts for full output. It uses 8 valves and operates from batteries (12 or 24 volt) or from the mains through a power pack. It has built-in output stage with a jack socket for phones. Controls, 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.

Very compactly built in crackle finished case, these sets are brand new having never been used and in perfect working order—special price this month is £14/10/- each or 45/- deposit, balance over 12 months—carriage and insurance 10/-. Order now to avoid disappointment. Circuit diagram and component data given free with sets, or available separately price 2/6, post free.

Mains Power Pack for Bendix RA-1B, £3/10/-.

RECORD PLAYER BARGAIN

3-speed record player with pick-up using the famous Acos "Hi G" turnover crystal—motor also by very 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 15/- deposit.

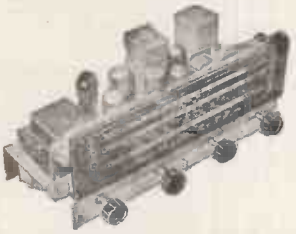


TABLE RADIO CABINET

Due to a special purchase, we are able to offer this very fine cabinet, size approx. 15½ × 14 × 6½in. Walnut veneered and satin finished, 37/6, carriage and packing 3/6. Note—This cabinet is the correct one for the Windsor chassis above with 6½in. speaker.

THE "WINDSOR 5"

This is a 5-valve A.C. superhet covering the usual long, medium and short wavebands. It has a particularly fine clear dial with an extra long pointer travel. The latest type loctal valves are used and the chassis is complete and ready to operate. Chassis size 15in. × 6in. × 6in. Price £9/19/6 complete with 8in. speaker. Carriage and insurance 10/-. H.P. terms if required.

THIS MONTH'S SNIP

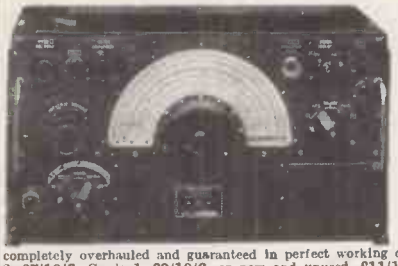
3-SPEED AUTO-CHANGER by most famous Maker.

- Plays all records 7in., 10in. and 12in.
- Records may be mixed. 7in., 10in. and 12in.
- Uses famous Acos Hi-G turnover Sapphire c'dge.
- Brand new, in maker's carton.
- Free 12 months' guarantee.

Normal price £16/10/-. Huge purchase enables us to offer these at £9/17/6 or £3 deposit and five monthly payments of £1/10/- each. Non-callers please add 7/6 for carriage and insurance.

YOURS FOR 30/- ONLY

COMMUNICATIONS RECEIVER R1155



This set, as most will know, is considered to be one of the finest communications receivers available to-day. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F., so obviously a robust receiver which will give years of service. Slightly used but completely overhauled and guaranteed in perfect working order. PRICES Grade 2 £7/19/6. Grade 1 £8/19/6, or new and unused £11/19/6. Or will be sent against deposit of 30/-. If you cannot call to collect please include an additional 10/- to cover cost of transit case and carriage. This partly returnable to you if and when you return the transit case.

MAINS POWER PACK FOR R1155

With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price £5/10/- complete with speaker ready to work, carriage 3/6. If bought with receiver, deposit is 11/-.

IMPORTANT NOTE

Owing to the bulkiness of many of the items listed on the next two pages it may not be possible to keep stocks at all branches, therefore please telephone confirmation that the item is actually at the branch before journeying specially to see it.

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 and finely polished. The control board is revealed when the front is dropped. Both radio board and motor board are left uncut to suit your own equipment. Price is 16 guineas, carriage 12/6. We have many other types in stock. Pay us a visit, or send for Cabinet List.

THE CLEVELAND ORGANTONE

5 valve 3 waveband superhet covering Long, Medium and Short waves—built to attain highest performance of sensitivity, fidelity and output—Osram miniature valves—low loss iron coils—permeability tuned I.F.S.—full A.V.C.—variable negative feedback—gram. position on wave change switch—4 watts output—particularly fine tone especially on gram. Chassis size 7 × 7 × 7 approx. scale size 4½ × 4½ approx. Tested in difficult areas where exceptional results have been obtained. Price £11/10/-, or £3/16/- deposit. Carr. etc., 7/6.

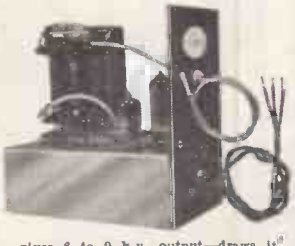
THE CLEVELAND 'TREMENDO'

The Cleveland Organtone was good, but this one is really superb. It has a 7-valve circuit with 6-watt output, fitted with independent bass and treble controls. It is really an efficient R.F. circuit coupled to a high fidelity amplifier. The chassis size is the same as the Organtone, namely 12 × 7 × 7 with the 10½ × 4½ multicoloured scale, and it is built to the same exacting specification as the Organtone. Price £15/10/- carriage and packing 7/6. Terms £2/5/- deposit.

T.V. E.H.T. GENERATOR

69/6

Post 2/-



—gives 6 to 9 k.v. output—draws its power supplies (6.3 volt .8 amp. 250 volts 59 mA.) from the set.

1/9

Post 3d.

SAPPHIRE TIPPED GRAMOPHONE NEEDLE

Straight or trailer type.

PAGE OF SPECIAL EQUIPMENT

POTTED MAINS TRANSFORMERS

These are of really superior construction fitted in cast metal cases and compound filled. Terminals come to ebonite baseboard. All are upright mounting and have 220/230 normal 50 cycle mains input and fully screened primary.

Type 5F1. 265-0-265 at 300 mA.: 6.3 v. at 7 amp.: 4.4 v. at 2.5 amp.: Price 35/- plus 3/6 carriage.

Type 5F2. 365-0-365 at 150 mA.: 4 v. at 2.5 a.: 6.9 v. at 4.2 a. Price 32/6, carriage and packing 3/6.

Type 5F3. 1540 v. 2 v. at 2 a.: 4 v. at 1 a.: This is an ideal transformer for televisors and scopes using V.C.R. 97, etc. Price 25/-, carriage 2/6.

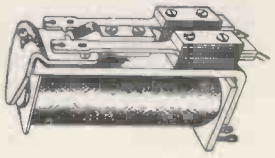
POTTED CHOKES

These chokes are in similar type cases and therefore match the above transformers.

Type 5F4. 5 H. at 300 mA. Price 10/-, carriage and packing 2/6.

Type 5F5. 10 H. at 150 mA. Price 12/6, post and packing 2/6.

RELAYS P.O. 3000 TYPE



Ref. 5A1. 2,000 ohm, slow close coil plat. contacts, one break, two make. Price 12/6 each.

Ref. 5A2. 2,000 ohm. standard coil, plat. contacts, change over make before break, two make, 1 break. Price 15/-.

Ref. 5A3. 200 ohms. standard coil, plat. contacts, two make. Price 7/6 each.

Ref. 5A4. 10 ohm. standard coil, one pair plat. contacts, also mounted but not operated by the relay, are thermal change-over contacts, make before break. Price 8/6 each.

WELD TYPE WIRE JOINTER

This jointer melts the wires and causes the metal of each to run together, thus making a strong and permanent weld. It obviously is not intended to replace the soldering iron but nevertheless is ideal for making joints that have, for instance, to withstand heat, vibration, chemical action, etc.

In many cases also this method is faster than soldering and there can be a considerable saving of current. Price 9/6. Or complete with enclosed mains transformer 29/6.

AUTO TRANSFORMERS

For working American equipment off our mains etc., etc. Input tapped 200-240 v. Output 115 v. In addition to those listed below we have special this month 150/200 watt totally enclosed in metal box with input and output leads. Price 47/6, plus 2/- post and packing.

Totally enclosed and screened.

	Price	Carr.
50 watt	£1/2/6	1/6
100 watt	£1/16/-	1/6
150 watt	£3/-/-	2/-
250 watt	£4/10/-	2/6
500 watt	£5/10/-	2/6

Unscreened.

1 KVA (1,000 w.)	£6/10/-	5/-
1.5 KVA (1,500 w.)	£7/17/6	5/-
2 KVA (2,000 w.)	£10/17/6	7/6
3 KVA (3,000 w.)	£12/7/6	10/-
5 KVA (5,000 w.)	£19/5/-	12/6

VARIABLE RESISTORS

Heavy Duty Type.

11 ohms 4.5 amp., 22/-; 1.2 ohms 15 amp., 15/-; 3 ohms 10 amp., 15/-; .5 ohms 250 amp., 35/-; 1 ohm 250 amp., 35/-; 50 ohm 1.5 amp., 45/-; 100 ohm 1 amp., 45/-.

UNITS FOR ROTATING HEAVY AERIALS

We have brand new, still in original unopened packing cases as shipped from America. Two items of equipment which form part of the radar system RC84. These two units work together to form a Tower rotating device, with remote control.

Item 1, known as Tower 24A, is in fact the geared driving motor which rotates the mast. This is quite a heavy construction and would rotate a heavy scanner, reflector, Beam array, etc., etc.

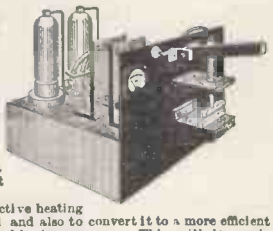
Item 2, known as Indicator 1-221-A is the remote controller which enables the azimuth position of Tower 24A to be controlled from a remote point. Conversely it enables the azimuth position of the tower to be known at any time. Both the Tower and the Indicator contain selsyn transmitter/receivers and it is these that provide the impulses which cause the aerial to rotate backwards or forwards. The equipment intended for 117 volt A.C. mains but will operate from our mains if connected through step down transformer of 1 K.W. rating.

Prices; 1-221-A £25 plus carriage. TR24A £35 plus carriage.

Special discount of £5 for cash with order or C.O.D. if both units purchased together.

R.F. HEATERS CONSTRUCTOR'S KIT

THE ELPREQ R.F. HEATER



The Elpreq R.F. Heater has been planned to fill the need in industry for a reasonably priced unit to be used in the works or for development.

The heater is supplied in kit form, mainly to keep the cost low but also as it is thought that many users will wish to assemble the units within special casings to be close to the production line.

As it is not possible to have one frequency which is equally efficient for both dielectric and inductive heating a frequency efficient for dielectric work has been chosen. It being felt that this fills the greater need.

However, simple practical examples of inductive heating can be given with the apparatus as supplied and also to convert it to a more efficient frequency only a different tank coil assembly is necessary. This will be made available at a later date if the demand is sufficient.

THE POWER PACK

The Power Pack used is the "Elpreq Variable 500" which is fully described in another section. this gives ten variations of power to a maximum of 500 mA. at 1,000 V.— continuous rating.

THE R.F. UNIT

Two carbon anode, high power triodes working into a push-pull circuit act as R.F. generators. The oscillator coil comprises a centre conductor carrying the H.T. surrounded by an outer conductor, but insulated from it by a layer of polythene. The R.F. output to the "work" is taken from this outer conductor, which is the tank coil proper. Clips can be fitted anywhere along the length of the tank coil and permit a wide variation of R.F. voltages, also any point along the coil can be connected to earth. Alternatively, the centre point can be earthed, and the output balanced about earth.

Two meters are provided. The one in the main H.T. line shows the total milliamps being drawn by the R.F. unit. The other in the R.F. output stage indicates the R.F. current into that circuit.

The type of valves employed are not easily damaged but a resistor which will provide bias should oscillations cease is included in the circuit. The output frequency is approximately 15 megacycles but this will vary with the work and can be deliberately changed by tuning or by altering the size of the tank coil.

The tank condenser (not provided) will usually take the form of metal plates between which the dielectric is heated. Connection to the work is through two substantial pillar terminals brought out to the front panel.

Size is approximately 16½in. x 13in. x 14in. and weight is approximately 25 lbs.

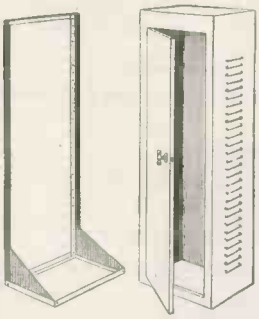
Price of all components including metal chassis to make power pack and R.F. unit is £40.

Or wired up ready to work £55.

All prices are ex our Eastbourne works and terms are cash with order.

RACKS AND RACKING EQUIPMENT

ALL EX MINISTRY EQUIPMENT



STANDARD RACK

6ft. high and 19in. wide, heavy steel construction. Holes drilled and tapped at the standardized spacings. Price £4/15/- plus carriage.

ENCLOSED RACK

As above but rectangular and with sheet metal enclosed sides (vented), fitted handle and closing bars. Price £7/15/- plus carriage.

MOUNTING PLATES

to fit above racks. Heavy ¼in. steel plates (drilled at standard intervals and 19in. centres) with chassis mounting brackets.

Ref. 5A5—19×14 front plate with chassis brackets, 17/6.

Ref. 5A6—19×12 front plate with chassis brackets, 16/6.

Ref. 5A7—19×10½ front plate with chassis brackets but drilled for meters and other items 8/6.

SAFETY SWITCH

When fitted this switch will cut off the mains as rack door is opened. 5/6.

CHARGING SWITCHBOARD

Feed this Switchboard through a Mains Transformer and Rectifier giving 24 volt D.C. up to 50 amps. and you have an excellent multi-circuit charger for simultaneously charging several batteries at different currents. This is an ex-Government switchboard rated at 550 watts 18 volts fitted into steel cases with doors. It contains three reverse current relays, one voltmeter, one main ammeter, two secondary ammeters and three variable resistors for controlling circuits. These are brand new, in original cases. Price £4/10/-, carriage 10/-.

We can supply a 12 volt, 50 amp. Mains Transformer at £4/5/-, plus 5/- carriage.

IMPORTANT NOTICE

The equipment described on this page is not available at our normal retail shops—it can be seen at our special sales department address as below. Order and enquiries should also be addressed as below:—

E.P.E. LTD., SPECIAL SALES DEPT., BOURNE HOUSE, GROVE ROAD, EASTBOURNE, SUSSEX.

HIGH POWER TRANSFORMERS

For R.F. Heaters, transmitters, etc., etc These are open wound type for maximum cooling and have the normal 200-250 primary fully screened.

Type 5F6. 1,000 v. at ½ amp., e.g., .5 K.V.A. Price £8/10/-, carriage and packing 5/-.

Type 5F7A. 2,200 v. at 1 amp., e.g., 2 K.V.A. Price £15, carriage and packing 7/6.

Type 5M1. 1000-0-1000 v. at 1.5 amps., e.g., 1½ K.V.A. Price £12/10/-, carriage and packing 7/6.

Type 5M2. 1000-0-1000 v. at 500 mA. and 4 v. at 4 a. Price £7/10/-, carriage and packing 4/6.

Type 5M3. 375-0-375 v. at 250 mA. and 4 v. at 4 a. Price 37/6, carriage and packing 3/6.

Type 5J1. 500-0-500 v. at 500 mA., 6.3 v. at 6 a., 45/-, carriage and packing 3/6.

POWER FILAMENT TRANSFORMERS

Type 5M4. 4 v. at 4 a. 2-0-2 v. at 10 a. Price 18/6, carriage and packing 3/6.

Type 5M5. 3.15-0-3.15 at 10 a. 4-0-4 at 10 a. 4-0-4 at 2 a. 4 at 4 a. 2.5-0-2.5 at 3 a. Price 27/6, plus carriage and packing 3/6.

Type 5M6. 34 v. at 2 a. tapped 32 v., 30 v. and 28 v., for relays, etc., 22/6, plus 3/6 carriage and packing.

Type 5J2. 4 v. 10 a. centre tapped secondary 35/-. Plus 3/6 packing and post.

POWER CHOKES. Open wound type and feet with clamps.

Type 5M7 30 Henry at 500 mA., 35/-

Type 5M8 20 Henry at 500 mA., 32/6

Type 5M9 15 Henry at 500 mA., 27/6

Type 5M10 10 Henry at 500 mA., 22/6

Type 5M11 25 Henry at 250 mA., 18/6

Type 5M12 3 Henry at 10 amps., 18/6

Type 5M13 200 Henry at 5 mA., 15/-

POWER FOR TR1154

We can offer brand-new and unused the two rectifier units for mains operating the transmitter TR1154. Both rectifier units are completely enclosed in metal cases and operate directly from normal 50 cycle A.C. mains. Price £17/10/- the pair, carriage and packing £2 extra.

TRANSMITTER 1131

This is a high powered transmitter for operating over the same frequency range as the Receiver 1132, i.e., 70-130 megacycles. It is a very bulky transmitter and probably contains around £300 worth of equipment. As far as we know these have never been used but of course have been in store for a long time and therefore they will need attention before being put into operation. We offer these, less valves, £37/10/- plus carriage.

R1132

We have a small quantity of these receivers still available less valves. Their condition unfortunately is not good but they appear to be repairable, and, of course, contain a multitude of spare parts. At 30/- each they represent a real bargain. If not collecting, please include 5/- for packing and carriage.

AUTOMATIC MOTOR STARTER

For remote control of D.C. motor between 1 and 3 kw., adjustment for 100 v. or 230 v. Unused and in first-class condition, complete with metal and wired glass cover. Price £10, carriage 5/-.

MORE SPECIAL EQUIPMENT

EX-ROYAL NAVY SOUND POWERED TELEPHONE

These require no batteries, and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note, easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or where several headphones are used together will indicate which one is being called. Size 7¾in. × 9in. × 7¾in., wall mounting, designed for ships' use but equally suitable for home, office, warehouse, factory, garage, etc. Price 57/6 each, plus 4/6 carriage.

BLOCK CONDENSERS

New and unused. .5 mfd. at 2,500 v., 3/6; 4 mfd. at 750 v., 3/6; 8 mfd. at 500/600 v. 5/-. 4 mfd. at 500 v. 2/6; 4 mfd. at 1500 v. 6/6.

SENSITIVE ALTIMETER

These contain aneroid barometer movement and useful gears. Price 7/6 each. Post 1/-.

Note.—Also a few unused and in good working order, available at 22/6.

SCRAMBLER—TELEPHONE EQUIPMENT

As used by Ministries and Forces for holding secret conversations. Works in conjunction with normal telephone equipment.

Items available, all new and unused, are:—Frequency Changer, Type 6AC, Ref. No. YBO2700, price £5. Standard G.P.O. desk type instrument with scrambler switch, complete with lead and junction box, price £2/10/-. Hand-ringing generator in wooden box, 15/-. Junction box with three multiple relays and cable stripa, 35/-. Bank of three drop indicators in box, 15/-. Instruction book £1 refunded if returned within 14 days.

GREATLY REDUCED CATHODE RAY TUBES

VCR97. Brand new and unused. "cut-off type," ideal for 'scope, etc. Price 12/6. Carriage and insurance 5/- extra.

VCR517. 6½in. guaranteed full picture, 29/6, plus 5/- carriage and insurance.

VCR139A. 2½in., 32/6, plus 2/6 carriage, etc.

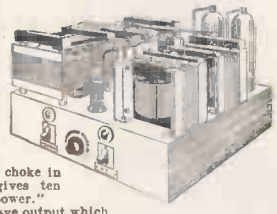
VCR138. 3½in. electrostatic short persistence, suitable for T.V. and ideal for 'scope work, 37/6 plus 3/6 carriage, etc.

VCR112. 5in. electrostatic, persistence not known, 15/- each, plus 5/- carriage, etc.

CV996. 6in. electrostatic persistence not known, 15/- each, plus 5/- carriage, etc.

CV1140, CV1500, CV1546. All 12in. magnetic long persistence, £4/10/-, plus 10/- carriage.

HEAVY DUTY POWER PACKS



THE VARIABLE 500/1,000 v.

The conventional circuitry is employed throughout and all components are amply proportioned to permit substantial overloading. A master switch controls the whole unit and whenever this is on current is supplied to the rectifier filaments, thus keeping them always in the emissive state. The H.T. transformer is supplied from the primary of the filament transformer, connection being via an on/off switch and a tapped choke. The on/off switch controls the H.T. and the tapped choke in conjunction with its selector switch gives ten variations from "low power" to "high power." Two directly heated rectifiers give a full 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 which otherwise would be a source of danger to users.

The continuous rating of the power pack is 1,000 volts at 500 milliamp (500 watts). But the proportions of the various components are such that 100 per cent. over-loading can be allowed for pulse work or other intermittent operations. The size of the power pack is approximately 16½in. × 13in. × 13in. and its weight is approximately 87 lb. Price; Kit of parts £27/10/-, or made up ready £37/10/-.

THE VARIABLE 250/2,000 v.

The maximum continuous rating of this is 250 milliamps at 2,000 volts. Rectification is half wave. Specification otherwise as for the variable 500/1,000 v.

THE VARIABLE 500/2,000 v.

The continuous power rating of this is 500 milliamps at 2,000 volts. But the tapped choke and selector switch enables this to be reduced in ten steps. Weight approximately 120 lb., size 16½in. × 13in. × 13in. Price £37/10/- in kit form, or made up ready to use £47/10/-.

THE VARIABLE 1,000/1,000 v.

The maximum continuous rating of this is 1 amp. at 1,000 volts. Rectification is full wave, output is variable. Weight approximately 120 lb., size 16½in. × 13in. × 13in. Price £37/10/- in kit form, or £47/10/- made up ready to work.

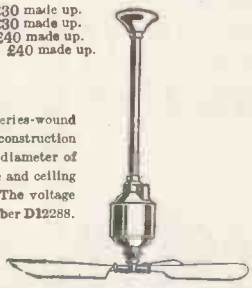
FIXED MODELS

Any of the models mentioned above can be supplied without the tapped choke and selector switch. The prices are as follows;—

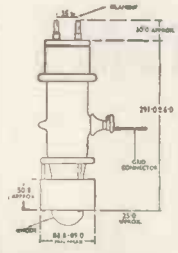
Fixed 500/1,000 v. £22/10/- in kit form, or £30 made up.
Fixed 250/2,000 v. £22/10/- in kit form, or £30 made up.
Fixed 500/2,000 v. £32/10/- in kit form, or £40 made up.
Fixed 1,000/1,000 v. £32/10/- in kit form, or £40 made up.

All prices quoted are ex Works.

CEILING FAN



This model, made by Revo, incorporates a series-wound totally enclosed ball-bearing motor of robust construction and noiseless operation. The fan has a blade diameter of 36in. and is supplied with 20in. suspension tube and ceiling canopy. All finished white cellulose enamel. The voltage working is 230-250 v. D.C. Revo catalogue number D12288. Price £10/10/-.



SPECIAL PURPOSE VALVES

Triode Type CV1098—this is a high-power air-cooled triode. Specification of which is as follows; Filament voltage 8.2 v., filament current 35 amps., anode dissipation 750 watts. Maximum anode voltage 23 kV.

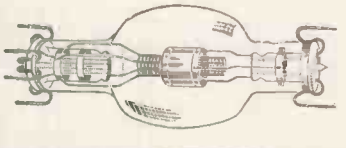
This valve is very suitable for R.F. heating at high frequencies and two of these in push-pull under Class C conditions would have an output of approximately 2 kilowatts.

Brand new, still in original shockproof packing, price £15 each.

TETRODE TYPE VT31

This is a high-powered air-cooled tetrode. Specification of which is as follows:—Heater volts 11.25, heater current 8 amp., maximum anode voltage 5 kV., anode dissipation 250 watts, size approximately 14½in. long and 6½in. across the bulb.

Limited quantity only at £4 each, still in original packing.

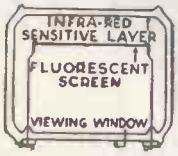


WATCH THESE COLUMNS FOR DETAILS OF VARIOUS OTHER INDUSTRIAL TYPE VALVES. ANTERNATIVELY SEND US YOUR ENQUIRIES

HIGH CYCLE MOTOR ALTERNATOR

TYPE 1. Has a motor 230 v., 50 cycle single phase 2,800 r.p.m., coupled to a generator output 250 v., 1,728 cycles at .24 amps. Good condition, with wiring diagram, £3/10/-, plus 7/6 carriage.

TYPE 2. Has a motor 230 v. 50 cycle single phase, coupled to an alternator output 950 v. 625 cycles .24 amps. Price £3/10/-, plus 7/6 carriage.



"SNIPER-SCOPE"

Famous wartime "cats eye" used for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. It follows that as light from an ordinary lamp is rich in infra-red these cells will work: burglar alarms, counting circuits, smoke detectors and the hundred and one other devices as will the simpler type of photo cell. Here then is a golden opportunity for some interesting experiments, price 5/- each. Data will be supplied with cells if requested.

METERS

2½in. Flush mounting

0-30 mA. moving coil	10/6
0-300 mA. moving coil	10/6
0-500 mA. moving coil	10/6
5-0-5 mA. moving coil	17/6
0-1 amp. moving coil	17/6

2in. Flush mounting

0-2 amp. R.F. thermo	7/6
0-3 amp. R.F. thermo	7/6
0-5 amp. R.F. thermo	7/6
0-5 mA. moving coil	8/6
0-3 mA. moving coil	8/6

Hot Wire Amp. Meters

0-9 amp. 2½in. flush	12/6
0-10 amp. 5in. surface	25/-

PYREX AERIAL INSULATORS

Ideal for aerial connections through cabin walls or through panels. Consists of glass dome with threaded rod and terminal ends and metal fixing flange. Price 2/- each.

PLUG AND SOCKET

This brass cased plug and socket is extremely robust and ideal for P.A. or outside work. Ideal also for taking power to units as it insulates the ends of the wires. Contacts are quite suitable for carrying up to 10 amps. so this can be used for lighting or power. Price 2/6 per pair.

JUMBO VALVE BASES

Ceramic 4-pin for transmitting valves. Price 3/6 each.

FLEXIBLE COUPLINGS

These are sometimes known as bellows couplings because they will extend as well as bend. They are ideal for joining shafts which are out of alignment and for slug tuning controls where the core has to come in and out. Price 1/9 each.

ELECTRONIC PRECISION EQUIPMENT LTD.

249, Kilburn High Road, Kilburn. (Now Open)

42-46, Windmill Hill, Ruislip, Middlesex. Phone: RUISLIP 5780 Half-day Wednesday.

152-153, Fleet Street, E.C.4. Phone: CENTRAL 2833 Half-day Saturday.

29. Stroud Green Road, Finsbury Park, N.4. Phone: ARCHWAY 1049 Half-day Thursday.

Post orders should be marked "Dept. 2" and addressed to E.P.E. LTD., 123, TERMINUS ROAD, EASTBOURNE.

CLYNE RADIO LTD.

18, TOTTENHAM COURT ROAD, LONDON, W.1.

MUSeum 5929/0095.

(50 yards only from Tottenham Court Road Tube !)

All post orders please to:— 24-26, HAMPSTEAD ROAD, LONDON, N.W.1.

EUSton 5533/4/5

HIRE PURCHASE

We are pleased to announce advantageous hire purchase facilities on any single item over £5. Ask for details, mentioning what you are interested in. We regret we cannot extend this facility to kits.

R1155A RECEIVERS guaranteed serviceable in original packing cases. £7/19/6. Fully assembled Power Pack and output stage, to plug straight into R1155 for A.C. 200/250 volts at 79/6. We have a few brand new R1155A at £11/19/6, also in original packing cases—Deduct 10/- if purchasing either receiver together with power pack. Plus 10/- packing and carriage.

R1124 RECEIVER UNIT. Coverage 30-40 Mc/s. Including 6 valves—3 type 9D2, 1 each, 8D2, 15D2 and 4D1—six valve screening cans, 24 ceramic trimmers, 3 ceramic valve holders, resistors, condensers I.F.T.'s coils, etc. In very good condition, a bargain at 16/6 each only, plus 3/6 packing and postage.

RECEIVER TYPE 25/73. (The receiver section of TR1196). Supplied complete with full data for conversion to 3-wave superhet receiver. Unit is complete with 6 valves 2-EF39, 2-EF36, FK32 and EBC33, also standard I.F.T.'s 465 Kc/s. Price 27/6 plus 2/6 P. & P.

TR1196 TRANSMITTER PORTION. We can also supply the transmitter portion of the above receiver incorporating valves, EL32, EF50, CV501. Type 600 relay transformer, coils, switches, etc. Limited quantity at 12/6 only, plus 2/6 P. & P.

No. 17 Mk. II TRANSMITTER/RECEIVER. Built into a strong wooden cabinet 15in. × 14in. × 9in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. 44-61 m/cs. (5-7 metres). Uses standard 120 v. H.T. and 2 v. L.T. batteries. Illustrated instruction book supplied with each unit. 50/- each plus 7/6 post and packing.

INDICATOR UNIT TYPE 302—A bargain! Incorporates, VCR97, Mu-metal shield, 4 valves, EF50, 3 type 8P61, 3 Type EB34, EA50, .1 mfd. 2.5 Kv., 10 pots, etc., etc. 50/- only, plus 7/6 P. & P

U.S.A. PACKARD-BELL PRE-AMPLIFIER. Incorporating valves, 6SL7GT, 2SD7GT, relay-plugs, sockets, condensers, etc. Brand new, with instruction booklet. 12/6 only.

MAINS TRANSFORMER BARGAINS! Limited quantities only. Manufacturers Surplus. 350-0-350, 80 mA., 6.3 v. 3 a., 5 v. 2 A. Half shrouded, drop-through, 14/6 only. plus 1/6 P. & P. 110/210/240 v. Input. 350-0-350, 120 mA., 6.3 v. 6 A., 6.3 v. 1.5 A., 5 v. 3 A., tropicalised drop-through type, 21/- only, plus 2/6 P. & P. 110/210/240 v. Input, 250-0-250 120 mA. 6.3 v. 4 A., 5 v. 2 A. Upright mounting, 21/- plus 2/- P. & P. 230 v. Input, 300-0-300 80 mA., 6.3 v. 3 A., 4 v. 2 A. Tropicalised drop-through type, 16/6 only, plus 1/6 P. & P. Input 110/230 v. Auto load 230 v. 750 mA. 350-0-350 130 mA. Topped filament winding 6 v. 3 A., 15 v. .3 A., 21.5 v. .6 A., also 5 v. 2 A. Tropicalised drop-through type. 21/- plus 2/6 P. & P.

L.T. TRANSFORMER — ADMIRALTY Heavy duty type, 180/230 v. input, 4.2 v. plus 4.2 v. at 10 amp. 25/- only plus 1/6 P. & P.

TELESCOPIC AERIAL MAST. Ex-R.AF. dinghy transmitter mast. Total length when extended, 17ft. Collapses into two sections each approx. 24in. Complete with dies and lashings, lightweight duralumin construction, diameter at thickest point, 1½in. approx, tapering to ¾in. New condition. 32/6 Plus 2/- post and packing.

EX-W.D. CATHODE RAY TUBES. Guaranteed full picture. VCR97 at 40/-. VCR517C at 35/-. Also VCR139A—Ideal for oscilloscope 2½in. screen at 35/-. We also have VCR97 with slight cut-off, very suitable for oscilloscope, testing purposes, etc., at 15/- only. All these tubes are brand new, in original packing, and tested before despatch. Please add 2/6 packing and carriage for any of the above tubes.

TRANSISTORS. Mullard Type OC71 available from stock. 40/- post free.

MINE DETECTOR UNITS. Complete with 3-VP23 Valves, 1 pair CHR, High resistance headphones, condensers, resistors etc. in web haversack. 19/6 only, plus 3/6 packing and carriage. New Condition.

F.M.!! (Frequency Modulation)

We are pleased to announce our complete Kit for the " Denco " F.M. Feeder Unit.
This unit provides an A.F. output suitable for feeding into the audio section of a standard broadcast receiver where triode/pentode output are available. Within an average of 30 miles from a V.H.F. transmitter one I.F. stage should be adequate, but our complete Kit supplied includes all components and valves for an extra I.F. stage if necessary, or if the unit is used at greater distances. Full Constructional details, theoretical circuit and point-to-point wiring diagram can be supplied for 1/6 post free, or the complete Kit right down to the last nut and bolt, at only £6/7/6, plus 2/6 packing and postage. This unit can be supplied if desired, ready assembled, aligned and tested, at £8/10/-. plus 2/6 packing and postage.
If required we shall be pleased to align this unit for constructors not possessing the necessary equipment, for a charge of 7/6. N.B.—Valve line-up is 6AM6, 12AH8, 2-6BA6 and 6AL5. Chassis measures only 6½ × 5½ × 1½in.
Demonstrations at 18, Tottenham Court Road !!

The Jason F.M. Tuner Kit!

This kit has been based on the booklet by Data Publications, price 2/- post free. With each booklet is enclosed our individually priced parts list. The construction and alignment of this tuner are no more difficult than a normal medium wave tuner. It is highly sensitive and free from drift. Incorporates 4 valves type 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in megacycles, and attractive bronze stove enamelled front plate already mounted (as illustrated) front plate size 8in. × 5in., chassis size 7in. × 4½in. × 1½in. N.B. The standard model is at present operating satisfactorily up to 80 miles from Wrotham! Our price for the complete standard kit is £8/15/- only! Plus 2/6 p. & p. Fringe area. model including extra valve, coil etc. (results could be expected up to 150 miles from Wrotham!) is £7/15/-, plus 2/6 p. & p.
The Standard Model Tuner can be supplied ready built, aligned, tested and manufactured by the Jason Motor and Electronic Company at a price of £15/17/-. purchase tax paid.
N.B. THESE TUNERS ARE BEING DEMONSTRATED AT 18 TOTTENHAM CT.RD.
A ready built power pack, also by the Jason Company, is available at £3/10/-. This unit is suitable for the above Tuners, or any similar type F.M. Tuner unit. A power pack kit is in process of preparation, and should also be available by the time this advertisement appears.

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 2in.	M.C.	R.F.	50/-
50 microamp	D.C. 2½in.	M.C.	R.F.	60/-
500 microamp	D.C. 2in.	M.C.	R.F.	13/6
500 microamp	D.C. 2in.	M.C.	F.B.	18/6
1 mA.	D.C. 2in.	M.C.	F.B.	17/6
1 mA.	D.C. 2½in.	M.C.	F.B.	22/6
1 mA.	D.C. 2½in.	M.C.	Desk Type	27/6
5 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
10 mA.	D.C. 2½in.	M.C.	R.F.	8/-
10 mA.	D.C. 2½in.	M.C.	F.B.	10/-
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
200 mA.	D.C. 2½in.	M.C.	R.F.	10/-
1 amp.	R.F. 2½in.	Thermo	R.F.	10/-
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
6 amp.	R.F. 2½in.	M.C.	Thermo F.B.	7/6
20 amp.	D.C. 2in.	—	R.F. (with shunt)	10/6
25 amp.	D.C. 2½in.	M.I.	F.B.	6/6
30 amp.	D.C. 2½in.	M.I.	F.B.	12/6
15 volt	A.C. 2½in.	M.I.	F.B.	10/-
20 volt	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2½in.	M.C.	F.B.	17/6
150 volt	D.C. 2in.	M.C.	F.B.	15/-
300 volt	A.C. 2½in.	M.C.	F.B.	35/-

R.F. = Round projection. M.C. = Moving Coil. Thermo = Thermo-couple.
F. Sq. = Flush Square. F.B. = Flush Round. M.I. = Moving Iron.

METER RECTIFIERS. 1 mA. by G.E.C., at 8/6, also 5 mA. by Westinghouse at 8/6.

CO-AXIAL CABLE. Standard 80 ohms. brown, stranded centre, conductor, 8d. per yard only! Not Govt. Surplus. Min. 12 yds.

22 SET POWER UNITS No. 4MK1 ZA10478—Complete with 4 metal rectifiers each 250 v. 60 mA. 2-12 v. 4 pin Mallory Vibrators, transformers, condensers, resistors, signal 1 amp. indicator, etc., etc., in good condition. Complete in metal box size 10½in. × 6in. × 8in. Weight 19lb., 27/6, plus 5/- P. & P.

L.T. RECTIFIERS TYPE R.K. A newly manufactured range guaranteed 12 months.

6 or 12 v. 1 a. F.W. bridge type	7/6
6 or 12 v. 1.5 a. F.W. bridge type	9/6
6 or 12 v. 2 a. F.W. bridge type	11/3
6 or 12 v. 2.5 a.	12/6
6 or 12 v. 4 a. F.W. bridge type	15/-

CHARGER TRANSFORMERS. Input 230 v.

6/12 v. 1 a.	9/9
2/6/12 v. 2 a.	14/6
2/6/12 v. 4 a.	17/6

ACOS TYPE 7 Crystal Microphone Inserts. Brand new, 7/6 each, plus 9d. P. & P. We also have a limited number of Ronetts Type ZA crystal microphone inserts at 23/6.

METER SPECIAL! We have a limited quantity of aircraft electrical thermometers Brand new, by Weston. 2in. moving coil meter, flush square fitting. These meters have a luminous scale graduated 40-140 degrees centigrade, but the full scale deflection is approximately 150 microamps! Price 12/6 each only, plus 1/- P. & P.

VIBRATOR PACK. Brand new, by Mallory, 12 volt input, 150 v. 40 mA. output. Complete with synchronous vibrator. 27/6.

DECCA LIGHTWEIGHT PICKUPS. Complete with either standard or L.P. Crystal Cartridge insets. Complete with Rest and Tracking instructions. 32/6 plus 1/6 P. & P. Also their very latest type, as above, but with turn-over head .47/6 only! Plus 1/6 P. & P.

6-VOLT VIBRATOR PACK. Ex-W.D. 6-volt input, output 140 v. 30 mA. Fully smoothed and rectified, incorporating Wearite 6 volt 4 pin vibrator type NSB6. Unit size only 6½in. × 5in. × 2½in. Price 15/- plus 1/6 P. & P. New condition.

SPECIAL OFFER — TRANSMITTING VALVES. These are brand new originally boxed, and guaranteed O.K. Type 813, 80/- ea. Type 866A, 17/- per pair, both post free. Also type 29C1 at 20/-. 12E1 at 25/- ea.

VALVES. We have a very comprehensive stock of surplus valves at competitive prices. A stamp will bring Valve Price List.

R.F. UNITS. All new condition and complete. Case size 9½in. × 7½in. × 5in.
Type 24.—20-30 Mc/s. 15/-. Switched Tuning. Type 25.—40-50 Mc/s. 19/6. Switched Tuning. Type 27.—65-86 Mc/s. 45/-. Variable Tuning. Type 26.—50-65 Mc/s. Variable Tuning 35/-. We have a limited supply of BF27 new condition and complete, but tuning dial damaged. Price only 30/- each. ALL these units Post Free!

LOUDSPEAKER SPECIAL !! 12in. 3 ohm Plessy P.M. 37/6 plus 2/6 P. & P.

I.F. TRANSFORMERS SPECIAL OFFER. All iron-cored 465 Kc/s. Plessey—Iron-cored 2½in. × 1½in. × 1in., 7/6 pr. Philips size 2½in. × 1½in. diameter (cylindrical), 7/6 pair. By Invicta—Cylindrical 2½in. × 1½in. diameter, 8/6 pr. Also our own special ultra midget size 1½in. × 13/16in. × 13/16in. Only 9/9 per pair. By Wearite, Type 501 and 502 12/6 per pair. M800 12/6 pair.

AMERICAN CONTROL UNIT C58/APT1. Box measures only 5in. × 3½in. × 2in. Incorporating 2in. round 0-1 mA. meter 200 ohm. pot, 2 toggle switches, indicator lamp, etc. Price 22/6, post free.

HEADPHONES. Brand new, ex-Govt., by S. G. Brown. Type CLR. Low resistance, 7/6 per pair. Type CHR high resistance, 12/6 per pair.

" VOLTALYTE " 2 volt 60 amp. ACCUMULATORS MULTI-PLATE Type in Celluloid containers. Size 3in. × 3in. × 4½in. high at 9/6 each plus 2/- P. & P. Or 3 for 28/6, post free.

No. 38 TRANSMITTER/RECEIVER WALKIE-TALKIE. Range approx. 5 miles. Coverage 7.4-9 Mc/s. The set only, complete with valves at 30/-, in very good condition.

AMERICAN INDICATOR UNIT TYPE BC929A. Brand new Incorporating 3in. tube 3BP1, with mu-metal shield, 2-6SN7GT 2-6H6GT, 6X5G, 2X2, 6G6G, 9 potentiometers, 24 v. aerial switch motor, transformer, and a host of small components. The whole unit which measures only 8½in. × 8½in. × 13½in. is brand new, enclosed in black crackle box, and can be supplied at 65/-, plus 5/- p. & p.

Please add postage under £1, C.O.D. or Cash with order. C.O.D. charge extra—open 9 a.m.-6 p.m. Monday to Friday. Sorry, but we close at 1.0 p.m. on Saturday.

THE R.C. 3/4 WATT AMPLIFIER KIT.— Just released! Compare the advantages! Treble, bass, AND middle tone controls! For crystal or magnetic pick-up! A.C. Mains. 200/250 v Valve line-up, 6V6GT, 6SG7, metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. x 4in. x 1¾in. Four engraved cream knobs are included in the price of the complete Kit with all necessary practical and theoretical diagrams, at £4/5/- only, plus 2/6 packing and post, or Instruction Book, fully illustrated, for 1/-, post free! This amplifier can be supplied assembled, tested, and ready for use at £5/5/-, plus p. & p. Hearing is believing!

THE R.E.P. ONE-VALVE BATTERY RECEIVER KIT. Simple one-valve all dry battery receiver for headphones, easily built in one evening. All required components including headphones, can be supplied at inclusive cost of 42/- plus 2/- p. & p. Operated by Ever Ready B114 type battery available at 7/9. Full assembly details available separately at 9d. plus 3d. post.

THE NEW R.C. HIGH-FIDELITY AMPLIFIER. P.P. 6V6 output. Freq. 25—18,000 cps—60 db at 6½ watts. Treble boost and cut—Bass boost—L.P. correction. Provision for Feeder Unit Max. UNDISTORTED OUTPUT 3½ watts. Price 14 gns. plus 7/6. NOW AVAILABLE—Kit of Parts, complete with fully illustrated instructions, £11/19/6. plus 5/- carriage. Illustrated booklet available separately at 1/6. Attractive metal cover, now available, with built in carrying handle 19/6.

ANOTHER GRAM UNIT BARGAIN! Collaro RC/531 — 8 record auto-changer for 78 r.p.m. Brand new complete with separate plug-in magnetic head. Our price £6/19/6 only, plus 5/- p. & p.

We also have in stock—Connoisseur 3 speed motors, pick ups. Pick ups and heads by Garrard, Decca, Collaro, Acos, Chancery, etc., etc., at current prices.

COLLARO RC/54 PLAYER! Just released. Fawn leatherette covered portable case, incorporating very latest Collaro 3 speed mixer-changer. Cream finish. Lightweight turn-over crystal pick up head. Only £13/5/- cash, plus 5/- p. & p. Complete, or, 65/- deposit plus P. & P. and 12 monthly payments of 18/7.

LATEST 3-SPEED AUTO-CHANGER, long arm model complete with C. and D. high fidelity heads. Limited quantity at £16/10/- plus 5/- P. & P. H.P. terms available.

Carrying cases in black leatherette finish An extremely well-made case with chrome locks and corner-pieces for extra strength. This cabinet will house any 12in. Hi-Fi speaker, but can be put to a number of uses. Front panel and lid are removable. Size: 18½in. x 10½in. x 16½in. high. 47/6, plus 5/- post and packing. N.B. To the many previous purchasers of this cabinet at 55/- we are now no longer able to supply the baffle with cabinet. Thus the reduction!

LATEST IMPORTED F.M. COMPONENTS

UT.340. A self-contained V.H.F. front end Unit incorporating a grounded grid amplifier, mixer oscillator (ECC85) and first I.F. amplifier. Completely wired and tested, 59/9.

UT.341. As above but with baseplate and 2-gang condenser incorporating 1.3 reduction drive. Supplied pre-aligned 95/5.

TA.350. 6-button Coil Pack for long, med. and short waves, gram and off, together with a F.M. position which incorporates switching for change over from A.M. to F.M. Designed for use with UT.340 or UT.341, 85/-.

Ratio Discriminator Coils, **URF**, 10/- each.

10.7 mc/s. I.F. Trans., UF376, 7/- each.

AM/FM. We are now demonstrating the Chapman all wave FM/AM Tuner at £32/10/- tax paid. For those unable to call, illustrated literature is available. H.P. terms £8/10/- deposit, 12 monthly payments of 44/-. Also FM Tuner model FM81 by Chapman at £21. Model FM56 by Armstrong, also £21. H.P. Terms available.

VERY LATEST 3-SPEED AUTO-CHANGER BY FAMOUS MANUFACTURER

Further limited quantity-mixer, turn-over crystal head. Cream finish. Our Price

£9.19.6

or 50/- deposit plus P. & P., and 10 monthly payments of 16/6.

RECORD PLAYER CABINETS. Specially made to house any type of single record unit. Finished in dove-grey leatherette. Baseboard measures 14½in. x 12½in. Clearance above and below board 3in. 45/- plus 3/- P. & P.

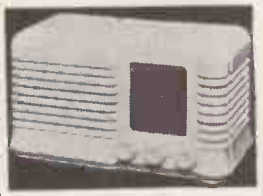
We can also supply equally attractive dove grey cabinet to house any standard auto-changer at 69/6 plus 3/- P. & P. We carry a large selection of cabinets for all purposes. A stamp will bring illustrated cabinet leaflet.

THE "SUPERIOR" FOUR KIT. Our new four-valve receiver. A.C. mains. 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6BG7, 6X5GT and 6V6GT. Chassis ready drilled. Cabinet size, 10½in. x 10in. wide. Maximum depth at base 5in. tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided Booklet. available at 1/6, post free. Our price for complete kit, £6/9/6!!! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wavechange switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at 45/-, plus 2/6 packing and carriage.

N.B.—Our kits are even supplied with sufficient solder for the job.

N.B. All our T.R.F. Kit circuits now include specially wound Denco "Maxi-Q" coils on polystyrene formers, improved performance! Price remains the same.

THE "ECONOMY FOUR" T.R.F. KIT



A three valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up, 6K7 6J7, and 6V6, Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown bakelite, or wooden, walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/6 post free. This is allowed if kit is purchased later. Please, 2/6 packing and carriage for complete kit.

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. Valve line-up: 6K8 Frequency changer, 6K7, I.F. Amplifier, 6Q7 1st Audio, Detector and A.V.C. 6V6 Output, 6X5 Full-wave rectifier. For A.C. mains 200/250 volts. 4 watts output. Excellent quality. High sensitivity. Provision for gram. Attractive illuminated black, red, green and gold dial for horizontal tuning. Four controls are: Tuning, L/M/S/Gram. Vol./on/off, Tone (variable), Chassis size: 13½in. x 5½in. x 2½in. Dial size: 10in. x 4½in. Assembly is simplified by the use of a 3-waveband coil pack, and pre-aligned 465 Kc/s. I.F. transformers—high-grade drop-through half-shrouded Mains Transformer, with voltage adjuster panel. This chassis can easily be assembled in one evening. Illustrated pamphlet with full assembly instructions, practical and theoretical wiring diagrams and itemised price list, 1/6, post free. The main items for this receiver can be supplied separately, as under. Drilled chassis, complete with valve-holders, A/E panel, P/U panel, tuning condenser and ready-assembled dial and drive at 39/6. 3 waveband coil pack with gram position, 39/6, tax paid. Pair of 465 Kc/s. I.F. Transformers, 9/6 pair. Half shrouded drop through Mains Transformer, 22/6. The total cost of ALL items purchased separately is nearly £10, but we shall be pleased to supply all the required components right down to the last nut and bolt, at a special inclusive price of £8/8/-, plus 2/6 packing and postage. A set of four small brown and cream engraved knobs to suit is available at 1/2 each knob. This chassis is a professional job in every respect and can be seen and heard at our premises. This chassis can also be supplied, ready assembled, in very limited quantities at £9/19/6, plus 5/- carriage and packing.

ARMSTRONG F.C.48. Their very latest high quality replacement chassis having provision for F.M. feeder unit, 8 valves, four wavebands. Independent bass and treble with unique thermometer visual indicator. Ready for use £23/18/- plus 5/- p. & p. or £5/18/- deposit and 12 monthly payments at 33/9. Illustrated leaflet available.

DULCI RADIO/RADIOGRAM CHASSIS. All latest models including F.3 and F.3 push-pull are in stock. Cash or H.P. Ask for illustrated leaflet.

COLLARO 2010. Transcription motor with Studio Pick-up. This very popular unit can now be supplied from stock. £18/5/3. cash or 95/3 deposit, and 12 payments of 25/8.

London's largest selection of Amplifiers, Recording equipment, etc., etc.

THE R.C. RAMBLER ALL-DRY PORTABLE KIT

Full assembly details with practical and theoretical diagrams can be supplied at 1/6 post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, adds to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attache-case type cabinet; measuring only 9in. x 7in. x 5½in. Weight less batteries, 4½lb. with batteries 6½lb. This set really has everything! Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up: 3V4, 1R5, 1S5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of £7/7/- plus 2/6 p. & p. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at 9/3. Also L.T. 1.5 v. A.D.35 at 1/4.

RAMBLER MAINS UNIT!—At last we are able to offer our special mains units kit for using our popular all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits snugly into battery compartment, can be supplied at 47/6, plus 1/6 packing and postage. Price includes all required components, and full assembly instructions. N.B.—This unit is completely self contained in a metal box measuring 7in. x 2½in. x 1½in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 v. L.T.

SUPER-QUALITY 6-VALVE RADIOGRAM CHASSIS

Very limited quantity by Britain's leading quality manufacturers, 3 waveband, superhet, valve line-up, 6V6G, EZ40, ECH42, L63, EF41 and EBC41. Combined pick-up amplifier and A.F. amplifier on Radio and Gram. Employs a special circuit for gramophone pre-amplification. Large glass dial horizontal tuning measuring 11in. x 3½in. Chassis measurement: 14½ x 9 x 8in. This is a superior chassis designed to sell originally in a Radiogram costing £79. Our price is £12/19/6 only, tax paid, plus 5/- packing and carriage. We will gladly demonstrate this chassis or any other working item from our stocks, to personal callers!

REGAL. A well-made cabinet in medium coloured walnut veneer. Size 29½ x 14½ x 29½in. Uncut motor-board measures 25½ x 13½in. Record or tape storage aperture alongside motor board measures 9½in. wide x 12in. deep. Price £9/19/6 plus 10/- P. & P. H.P. terms available.

CLYNE RADIO LTD.

18, Tottenham Court Road, London, W.1.

SELENIUM RECTIFIERS

L.T. Types

2/6 v. ½ a.h.w.... 1/9
6/12 v. ½ a.h.w. 2/9

F.W. Bridge Types

6/12 v. 1 a..... 4/11
6/12 v. 2 a..... 8/9

H.T. Type H.W.

120 v. 40 mA.... 3/11
250 v. 50 mA.... 5/9
250 v. 80 mA.... 7/9
250 v. 150 mA. RM4 250 v. 250 mA. 9/9 11/9
300 v. 275 mA. 12/11

CO-AXIAL CABLE. 75 ohms ½in., 7d. yard. Twin screened feeder, 10d. yard.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000 pfd. (.001μF), .002 mfd. (2,000 pfd.). All at 5d. each, 3/9 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.

Tubular Types		Can Types	
8μF 450 v.....	1/9		
8 mfd. 500 v....	2/6	16 mfd. 350 v....	1/11
16μF 350 v.....	2/3	16μF 450 v.....	2/9
16μF 450 v.....	2/9	24μF 350 v.....	2/11
16μF 500 v.....	3/9	32μF 350 v.....	2/11
32μF 350 v.....	3/9	32 mfd. 450 v....	4/9
32 mfd. 500 v....	5/9	64 mfd. 450 v....	4/9
8-16μF 500 v....	4/11	100 mfd. 450 v.	4/9
25μF 25 v.....	1/3	8-8μF 450 v....	3/6
50μF 12 v.....	1/3	8-8 mfd. 500 v.	4/9
50μF 50 v.....	2/3	8-16μF 450 v....	2/11
100 mfd. 12 v....	1/9	16-16μF 450 v.	4/11
100 mfd. 25 v....	2/3	16-32μF 350 v.	4/9
Can Types		32-32μF 350 v.	4/9
8 mfd. 350 v....	1/3	32-32μF 450 v.	5/11
8 mfd. 450 v....	2/3		
16 mfd. 500 v....	3/9		

R.S.C. TRANSFORMERS

FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a., Midget type, 2½-3-3in..... 17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5v. 2a. ... 19/9
250-0-250 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a..... 26/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.... 23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion..... 31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.... 23/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a..... 26/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.... 23/9
350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a..... 26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.... 33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a..... 33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a., suitable Williamson Amplifier, etc..... 49/9
450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a..... 69/6

TOP SHROUDED DROP THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2.5 a..... 13/9
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a..... 16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.... 18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.... 22/9
300-0-300 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a..... 23/9
350-0-350 v. 100 mA., 6.3 v. 4 a., c.t., 5 v. 3 a. 22/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a..... 23/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a..... 29/11
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.... 29/9
E.H.T. TRANSFORMERS, 2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 ..... 37/6

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a..... 5/9
6.3 v. 3 a..... 8/11
12 v. 1 a..... 7/9
0-2-4-5-6.3 v. 4 a. 16/9
6.3 v. 2 a..... 7/6
0-4-6.3 v. 2 a.... 7/9
6.3 v. 6 a..... 17/6
12 v. 3 a. or 24 v. 1.5 a..... 17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 16/9; 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s. 120 v. 40 mA. 7/11
130 v. 50 m.A. 6-3 v. 3 a. 14/9
120 v. 40 mA., 5-0-5 v. 1 a..... 14/9
90 v. 15 mA. 6-0-6 v. 250 mA. 9/11

OUTPUT TRANSFORMERS
Midget Battery Pentode 66:1 for 3S4, etc.... 3/6
Small Pentode, 5,000Ω to 3Ω..... 3/9
Standard Pentode, 5,000Ω to 3Ω..... 4/9
Standard Pentode, 8,000 to 3Ω 4/9
Battery Pentode, 10,000 ohms to 3 ohms... 4/9
Multi-ratio 40 mA. 30:1, 45:1, 60:1, 90:1, Class B Push-Pull..... 5/6
Push-Pull 8 Watts 6V6 to 3 ohms..... 8/9
Push-Pull 10-12 Watts 6V6 to 3Ω to 15Ω... 15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω..... 16/9
Push-Pull 20 Watts high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω..... 47/9

SMOOTHING CHOKES
250 mA., 3 H., 50 ohms..... 11/9
150 mA., 7-10 H. 250 ohms..... 11/9
100 mA., 10 H., 150 ohms potted..... 9/9
100 mA., 10 H. 200 ohms..... 8/9
80 mA., 10 H. 350 ohms..... 5/6
60 mA., 10 H. 400 ohms..... 4/11

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

WIRE WOUND POTS: 20 ohms, 500 ohms, 5K, 20K, 100K (medium length spindles), 2/9. 220 ohms, 2K, 10K, 20K, Preset type, 1/9 each.

EX GOVT. AMMETERS. Moving coil G.E.C. 0-5 amps., 2in. scale, 11/9.

EX GOVT. E.H.T. SMOOTHING CONDENSERS
.25 mfd., 4,000 v. Blocks..... 4/9
.5 mfd., 2,500 v. Blocks..... 3/9
.5 mfd., 3,500 v. Cans..... 3/3
.1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated)..... 9/6
1.5 mfd., 4,000 v. Blocks..... 5/9

EX GOVT. METAL BLOCK PAPER CONDENSERS
2 mfd. 800 v.... 1/9
4 mfd. 500 v.... 2/9
4 mfd. 1,000 v. 4/3
4 mfd. 1,500 v. 4/9
4 mfd. 400 v. plus 2 mfd. 250 v..... 1/11
6-6 mfd. 450 v. 5/9
8 mfd. 500 v.... 5/9
8-8 mfd. 500 v. 5/11
15 mfd. 500 v.... 7/9

M.E. SPEAKERS. All 2-3 ohms, 8in. R.A. field, 600 ohms, 11/9. 10in. R.A. field, 1,500 ohms, 23/9. 10in. R.A. field, 1,000 ohms, 23/9.

MANUFACTURERS SURPLUS TRANSFORMERS
Fully shrouded upright. Primary 200-230-250 v. Secs. 425-0-425 v. 150 m.a. 6.3 v. 3 a. 5 v. 3 a. 37/9.

GOODMANS 3½in. P.M. SPEAKER (ex equip.), with battery pentode trans., 12/9.

HEAVY DUTY BATTERY CHARGER
For normal 200/250 v. A.C. mains input. To charge 12 v. battery. Variable charge rate of up to 16 amps. Fitted Meter and Fuses. Guaranteed 12 months. Carr. 10/-. £6/19/6.

OIL FILLED BLOCK CONDENSERS
Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT with louvred crackle finished case. Mains input 200-250 v. Output 120 v. 40 mA., and 2 v. ½ a. Price with circuit, 29/6. Or in working order, 37/6.

THE SKY FOUR T.R.F. 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. It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-point wiring diagrams, instructions, and parts list, 2/3. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

P.M. SPEAKERS. All 2-3 ohms. 6½in. Plessey, 16/9. 8in. Plessey, 16/9. 10in. R.A., 26/9. 10in. Rola with Trans., 29/6.

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. battery at 2 a., 31/6. To charge 6 v. or 12 v. battery at 4 a., 49/9. ABOVE KITS CONSIST OF GREEN CRACKLE LOUVRED STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSES, FUSE-HOLDERS AND CIRCUIT. Any type assembled and tested for 6/9 extra.

R.S.C. 6 v. or 12 v. BATTERY CHARGER
For normal A.C. mains input 200-230-250 v., 50 c/s. Selector panel for 6 v. or 12 v. charging. Variable charge rate of up to 4 AMPS. Fused, and with 5 amp. meter. Well ventilated metal case with attractive crackle finish. Guaranteed for 12 months, 69/6. Carr. 2/6

EX GOVT. MAINS TRANSFORMERS
All 230 v. 50 c/s. input.

8.8 v. 4 a..... 9/9
48 v. 1 a..... 9/9
300-0-300 v. 80mA. 5 v. 3 a..... 8/11
278-0-278 v. 100 mA..... 8/9
0-11-22 v. 30 a..... 72/6
16-18-20 v. 35 a..... 79/6
Carriage on following types 5/- extra.
7.7 v. C.T. 7 amps., 4 times..... 25/9
460 v. 200 mA., 6.3 v. 5 a..... 27/9
300-0-300 v. 150 mA., 610-0-610 v. 150 mA., 1,200 v. 350 mA..... 29/6
400 v. C.T. 150 mA. 4 v. 5 a., 6.3 v. 6 a., 6.3 v. 0-6 a., 4 v. 6 a., 4 v. 6 a., 4 v. 3 a., 4 v. 3 a., 5 v. 2 a..... 22/9
325-0-325 v. 150 m.a., 6.3 v. 4-6 a. 5 v. 2-3 a. 29/9

EX GOVT. AUTO TRANSFORMERS
15-10-5-0-195-215-235 v. 500 watts..... 27/9
Double wound 10-0-200-240 v. to 10-0-275-295-315 v. 1,000 watts..... 69/6
Double wound 0-110-240 v. to 0-130-140-150-160-170 v. 1,500 watts..... 69/6
Carriage on any of above 5/- extra.

EX GOVT. SMOOTHING CHOKES
250 mA., 10 H. 50 ohms..... 14/9
250 mA., 10 H. 100 ohms..... 14/9
250 mA., 3 H. 50 ohms..... 8/9
150 mA., 10 H. 50 ohms..... 10/11
100 mA., 10 H. 100 ohms, Tropicalised..... 6/9
100 mA., 5 H. 100 ohms, Tropicalised..... 3/11
50 mA., 50 H. 1,000 ohms, Potted..... 8/11
90/100 mA., 10 H. 100 ohms, Potted..... 8/9
50 mA., 5-10 H..... 2/9
L.T. type 1 amp..... 2/9

CHASSIS

18 s.wg. undrilled aluminium amplifier type (4-sided).
14in. × 10in. × 3in. 7/11
16in. × 10in. × 3in. 8/3
18 s.wg. aluminium receiver type.
6in. × 3½in. × 1½in. 1/11
7½in. × 4½in. × 2in. 2/9
10in. × 5½in. × 2in. 3/3
11in. × 6in. × 2½in. 3/11
16 s.w.g. aluminium receiver type.
12in. × 8in. × 2½in. 5/3
16in. × 8in. × 2½in. 7/6
20in. × 8in. × 2½in. 8/11
16 s.w.g. aluminium amplifier type, 4-sided.
12in. × 8in. × 2½in. 7/11
16in. × 8in. × 2½in. 10/11
20in. × 8in. × 2½in. 13/6
14in. × 10in. × 3in. 13/6

R.S.C. HIGH FIDELITY 25 watt AMPLIFIER A4

A NEW DESIGN FOR 1955

HIGH GAIN "PUSH PULL OUTPUT." BUILT-IN PRE-AMP. 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 negative feedback loops giving total of 24 D.B. Frequency response ± 3 D.B. 30-20,000 c/s. Hum level 66 D.B. down. Certified total harmonic distortion of only 0.35% measured at 10 watts. Comparable with the very best designs. SUITABLE FOR SMALL HOMES OR LARGE HALLS, CLUBS, GARDEN PARTIES, DANCE HALLS, etc., etc. For ELECTRONIC ORGAN OR GUITAR. For STANDARD OR LONG PLAYING RECORDS. Size 12 × 10 × 9in. 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 are supplied. EXTRA HIGH SENSITIVITY, HIGHEST QUALITY for Or assembled ready for use 50/- extra. **9 Gns.**

H.P. Terms on assembled units. Deposit 26/- and 12 monthly payments of £1. Plus carr. 10/-.
Terms to include cover, mike, speakers, etc., on request. Cover as illustrated if required, price 17/6 extra.

A PUSH PULL 3-4 WATT HIGH GAIN ASSEMBLED AMPLIFIER FOR £3/19/6.
For mains input 200-250 v. 50 c/s. 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 with 400-0-400 v. Trans. Output is for 2-3 ohm speaker. (We can supply a very suitable 10in. unit by Rola at 27/9.) Supplied ready for use. £3/19/6. Full descriptive leaflet 6d.

MICROPHONES. Crystal, hand or Desk type, high fidelity Acos, 50/-. Stand type with base and adjustable stem, £6/19/6. Both suitable for use with our amplifiers.

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). Speed 33⅓ r.p.m. BRAND NEW, CARTONED. Only £3/19/6 (approx. half price). Carr. 5/- (for 200-250 v. A.C. Mains).

GOLDRING MAGNETIC PICK-UPS. Due to a fortunate purchase we can offer these popular high-impedance pick-ups, Brand new, boxed, at only 23/9.

R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

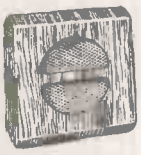
A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads, in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 25 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate), with green crackle finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carr.

SPECIAL SUMMER OFFER FOR ONE MONTH ONLY. BRAND NEW B.S.R. MONARCH 3-SPEED MIXER AUTO-CHANGERS.
With crystal pick-up and separate sapphire point stylt for standard or long playing records. Plays ten 7in., 10in. or 12in. intermixed. Supplied in sealed cartons with template and operating instructions. DO NOT MISS THIS OPPORTUNITY. ACT NOW. £8/19/6. Carr. 7/6.

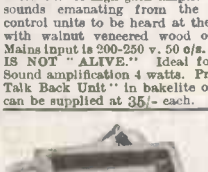
COLLARO HIGH FIDELITY MAGNETIC PICK-UPS
High impedance type. Limited number, brand new, boxed and perfect at fraction of normal price. Only 35/-.

DEFIANT RECORD PLAYING TURNTABLE COMPLETE WITH MAGNETIC PICK-UP.
Pick-up is high impedance type unit is housed in a beautiful walnut veneered cabinet of attractive design. For all standard records (78 r.p.m.). Limited number. Brand new, cartoned. £5/19/6. Carr. 7/6.

ACOS HIGH FIDELITY CRYSTAL MICROPHONES. Type 22-2. Complete with table stand. Normal price 4 gns. Limited stocks, brand new, boxed, £2/19/6.



R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen-Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. Supplied with walnut veneered wood or brown bakelite cabinet. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHASSIS IS NOT "ALIVE." Ideal for use as "Baby Alarm." Sound amplification 4 watts. Price only £7/15/-. "Listen Talk Back Unit" in bakelite or walnut veneered cabinet, can be supplied at 35/- each.



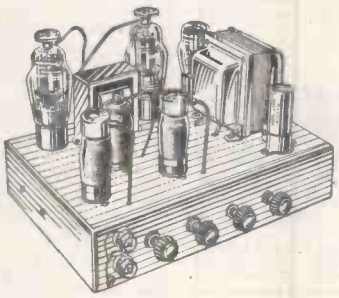
ALL DRY RECEIVER BATTERY SUPERSEDER KIT

All parts for an "All Dry" Battery. Eliminator Complete with case. Completely replaces 1.4 v. and 90 v. batteries where normal mains supply of 200-250 v. 50 c/s. is available.
Price with circuit, 38/9.
Or ready for use, 45/6.
Size of unit 5½ × 4½ × 2½in.

BATTERY SET CONVERTER KIT. All parts for converting any type of battery receiver to all mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed H.T. of 120 v. 90 v. or 60 v. at up to 40 mA., and fully smoothed L.T. of 2 v. at 0.4 a. to 1 a. Price complete with circuit and instructions only 48/9. Supplied ready for use for 8/9 extra.

R.S.C. A3 10 WATT "PUSH-PULL" HIGH FIDELITY AMPLIFIER.

With Self Contained Pre-amplifier and Tone Control.



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 sudden loud sounds.
Large safety factors in every component A.C. and H.T. fuses, punched chassis with baseplate, screened input plugs, valves, and with easy-to-follow point-to-point wiring diagrams. Everything is supplied down to the last nut and bolt.
Two independent inputs are provided with two associated independent volume controls so that programmes can be mixed together if desired, such as microphone announcements superimposed on a musical programme, or two independently controlled microphones, or even just gramophone/radio, fading over from one to the other. Variable base lift and cut with variable treble lift and cut tone controls are fitted, giving full long playing record equalisation for uncorrected pick-ups. They are also provided so that the user can alter the tonal value to suit his personal taste and surroundings. Terminals are provided for 3 ohm and 15 ohm loudspeakers.
H.T. and L.T. available for the supply of a Radio Feeder Unit.
Six Negative Feedback Loops.
130 millivolts input only required for full output.
Frequency response + 3 DB 50-20,000 cycles.
Negligible hum and distortion.
For A.C. mains input 200/230/250 v. 50 c/s.

COMPLETE Kit of Parts **7 GNS.** (carriage 5/-).
Supplied assembled and tested for 45/- extra.
H.P. TERMS AVAILABLE ON ASSEMBLED UNITS.

FOUR STAGE RADIO FEEDER UNIT.
Design of a HIGH FIDELITY L. and M. wave T.R.F. Unit with self-contained heater supply and thorough H.T. decoupling. Only 250-400 v. 15-20 mA. H.T. required from main amplifier. Three valves and Low Distortion Germanium Diode Detector. Flat topped response characteristic. Loaded H.F. coils. Two variable Mu controlled H.F. stages, 3 gang condenser tuning. Cathode follower output stage. Switch position for Gram. and Gram. input and output sockets. Performance comparable with the best in Feeder Units. For A.C. mains 200-230-250 v. operation. Size 11·6·7½in. Illustration, full set of easy-to-follow wiring diagrams and instructions and individually priced parts list 2/6. This unit can be built for only £3/15/- including Dial and Drive Knobs and every item required.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKER. HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required we highly recommend this unit with an amazing performance. £3/17/6.

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS, 2.

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/- extra under 10/-. 1/6 extra under £2, 2/6 extra under £3. Full Price List 6d. Trade List 5d.
Open to Callers : 9 a.m. to 5.30 p.m. Saturdays until 1 p.m.

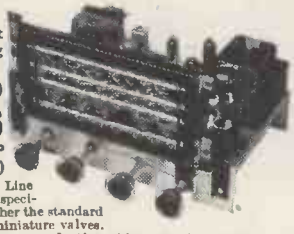
RECEIVER CHASSIS — *Modernise your old Radiogram* — RECORD PLAYERS

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.



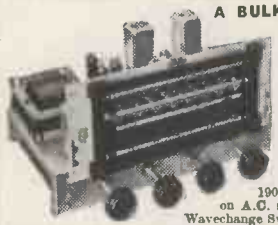
YOU CAN BUILD IT FOR £10/7/6

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 playings, and excellent clarity of speech and music is obtained.
A few brief details,

- Covers 3 wavebands 18-50 metres, 190-550 and 800-2,000 metres.
- Employs 6 valves having PUSH-PULL for 5-6 watts output.
- Incorporates delayed A.V.C. on all wavebands and pre-selective feedback.
- A 4 position Tone Control operation on both Radio and Gram.
- Has independent mains supply socket for a Record Player.
- Size of Assembled Chassis 12in. × 8in. × 8in. Dial aperture 8½in. × 4½in.
- For operation on A.C. mains 200-250 volts 50 cycles.

THE INSTRUCTION and ASSEMBLY MANUAL is available for 1/6 It contains very detailed practical drawings and circuit diagrams and a complete Component Price List.



A BULK PURCHASE ENABLES US TO OFFER THIS "PUSH-PULL" 7-VALVE SUPERHET RECEIVER For only £12'19'6

(Carr. & ins. 7/6 extra)
H.P.—£3/4/6 Dep. 12 mths. at 18/4.

These receivers Models AW3-7 are made by a well-known set of manufacturers and incorporate the latest Osram Valve Line-up of X79—W77—DH77—H77—U78 and two N78s in Push-Pull for approx. 7 watts output. They cover 3 wavebands 18-50 metres. 190-550 and 800-2,000 metres, and are for operation on A.C. mains 200-250 volts. A Gram. position is on the Wavechange Switch.
They make an excellent replacement Radiogram Chassis having a P.U. connection on the Chassis. Extension speaker connection is also provided. Overall size of chassis: 12in. long × 7½in. × 6½in. high, dial aperture 8½in. × 4½in. (Dial Escutcheon available for 4/9.)

!!! THE LATEST !!!

RADIO-RADIOGRAM CHASSIS

Model F3PP. A 7-valve 3-waveband Superhet Chassis with a Push-Pull Stage. This Chassis has been designed with particular regard to the quality of reproduction. It incorporates SEPARATE BASS and TREBLE CONTROLS thereby ensuring the utmost flexibility of Tone on both Radio and Gram.

Briefly:

- Waveband coverage 16-50, 190-550 and 900-2,000 metres.
- Valve line-up X79, 6BA6, 6AT6, ECC83, GZ30 and two 6AQ5s in push-pull for approx. 6 watts output.
- Negative feedback and delayed A.V.C.
- Has independent mains supply socket for gram. connection.
- Overall size of Chassis 12in. × 8in. high × 7in. with dial size 11½in. long × 4½in.

For use on A.C. Mains 100/110 volts and 200/250 volts.
Cash Price, tested and ready for use **£17'17'0**
H.P. Terms: Deposit, £4/7/-, and 12 monthly payments of £1/5/4. (Plus 7/6 carr. and ins.)

WE RECOMMEND THE W.B. "STENTORIAN" P.M. SPEAKERS
They have the NEW CAMBRIC CONE and a matching device for 3 ohm-7.5 and 15 ohm outputs.

(a)	5in. Model	HF510	£1 19 6	(d)	9in. Model	HF912	£3 9 6
(b)	6in. „	HF610	£2 12 6	(e)	10in. „	HF1012	£3 17 6
(c)	8in. „	HF810	£3 5 6	(f)	12in. „	HF1214	£9 15 6

OTHER TYPES IN STOCK

3½in. P.M.	3 ohm V/Coil	15 9	8in. P.M.	3 ohm V/Coil	18/9, 19/6 & 25/-
5in. „	3 „ „	16 6	10in. „	3 „ „	25/- & 37/6
6½in. „	3 „ „	16 9	12in. „	15 „ „	£5 5 0

All are NEW and FULLY GUARANTEED

This 3-SPEED AUTOCHANGER is by a Famous Manufacturer and is offered for **£9'19'6** (Plus 7/6 carr. & ins.) Normal Price £13/10/-.

Hire Purchase Terms £2/9/6 Dep. and 9 months at 19/-.

- These units will autochange on all three speeds, 7in., 10in. and 12in.
- They play MIXED 7in., 10in. and 12in. records.
- They have separate sapphire for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- Minimum baseboard size required 14in. × 12½in., with height above 5½in. and height below baseboard 2½in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

WE CAN ALSO SUPPLY

(a) THE GARRARD 3-SPEED CHANGER MODEL R.C.80M.
(b) THE GARRARD 3-SPEED NON-AUTO MODEL "T."
(c) THE COLLARO 3-SPEED CHANGER MODEL R.C.54.
(d) THE COLLARO 3-SPEED NON-AUTO MODEL 3/554.
(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.

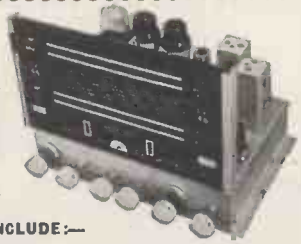
WE CAN SUPPLY FROM STOCK

The COLLARO 3-SPEED "TRANSCRIPTION" PLAYERS

MODEL 2010 with the NEW LIGHTWEIGHT "STUDIO P" CRYSTAL PICKUP.

PRICE **£18 / 5 / 3** (plus 7/6 carriage and insurance).
H.P. TERMS: Deposit £4/11/3. 12 monthly payments of £1/5/5.
MODEL 2000 (few only) 3-speed unit only (excluding pick-up).
PRICE £13/9/6 (plus 7/6 carriage and insurance).
H.P. TERMS: Deposit £3/7/6 and 12 months payments of 18/10

THE NEW ARMSTRONG F.C. 48



A high quality replacement Radio or Radiogram Chassis having provision for an F.M. Feeder Unit.
PRICE ASSEMBLED AND READY FOR USE **£23'18'0**
(Plus 7/6 Carr. and Ins.)
H.P. Terms: £5/18/- Deposit and 12 months at £1/13/9.

OUTSTANDING FEATURES INCLUDE:—

- 8 Valves including 2 double Triodes.
- 8 Watts output from push-pull tetrodes. Heavy negative feedback is used, resulting in negligible distortion and high damping factor.
- Provision for using FM adaptor 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 give BASS and TREBLE lift and cut with unique Thermometer visual indicator.
- Gram. position on a wavechange switch.
- 4 Wavebands Coverage 16-51, 50-120, 190-550, 1,000-2,000 metres.
- Large four-colour illuminated dial.

WE HAVE THE NEW... ARMSTRONG F.M. FEEDER UNIT Model F.M. 56

One of the best F.M. units in production. Consisting of a 5-VALVE SUPERHET DESIGN with frequency coverage 85-95 mc/s. Power supplies required 250 volts at 30 m/a and 6.3 volts at 2 amps. Price £21 (plus 7/6 carr. and insur.). H.P. TERMS: Deposit £5/5/- and 12 months of £1/8/4.
Send S.A.E. for descriptive leaflet.

SPECIAL REDUCTIONS FOR COMPLETE EQUIPMENT

SUMMARY—Select a RECEIVER CHASSIS and we will supply it TOGETHER WITH A 3-SPEED CHANGER AND AN 8in. or 10in. P.M. SPEAKER as follows:—

THE B.S.R. MONARCH, P.M. SPEAKER and:—

	Cash Price	Deposit	Monthly
(a) With Model B3PP Chassis	£22 19 0	£5 15 0	£1 11 11
(b) With Model AW3-7 Chassis	£23 19 0	£6 0 0	£1 13 4
(c) With Model F3PP Chassis	£28 16 6	£7 4 6	£2 0 1
(d) With Model FC48 Chassis (includes Goodmans 10in. P.M.)	£35 7 6	£8 17 6	£2 9 2

THE COLLARO MODEL R.C.54, P.M. SPEAKER and:—

(a) With Model B3PP Chassis	£24 9 0	£6 2 0	£1 14 0
(b) With Model AW3-7 Chassis	£25 9 0	£6 7 0	£1 15 5
(c) With Model F3PP Chassis } Includes latest Goodmans	£30 17 0	£7 14 0	£2 3 1
(d) With Model FC48 Chassis } 10-in. P.M. speaker	£36 18 0	£9 4 0	£2 11 4

GREATLY REDUCED—WE OFFER THE ACOS "MIC 22-2" CRYSTAL MICROPHONE

This is a High Fidelity Mike incorporating the "Filtercel" insert and normally retails at £4/4/-. It is complete with Table Stand. for **39/6** (plus 2/- carr. & insur.)

When submitting orders, please include postage and packing.

STERN RADIO LTD.

MAKE YOUR OWN PORTABLE RECORD PLAYER ! ! !

WE OFFER THE PORTABLE CASE ILLUSTRATED

CONTAINING A 3-VALVE AMPLIFIER AND A P.M. SPEAKER FOR ONLY £7/17/6

(plus 10/- carriage and insurance—7/6 refunded on return of Packing Case).
The Portable Case was originally used by Collaro Ltd. for their Microgram Record Player. It is robustly constructed and finished in good quality grey rexine. It will accommodate the COLLARO R.C.54 3-SPEED AUTOCHANGER and any make of 3-speed Single Record Player, all of which we can supply.
The Amplifier will operate with any high impedance Pick up and comprises a 3 VALVE A.C. MAINS design employing a 6K6 Output Valve for approx. 3 watts output. Tone and Volume Controls, combined with On-Off Switch are provided together with a coloured indicator.
Case and Amplifier are available separately.

(a) Portable case (plus 10/- carriage and insurance, 7/6 refunded) £3 7 6
(b) 3-VALVE AMPLIFIER, with P.M. SPEAKER £4 10 0
(Plus 3/- carriage and insurance.)

THE "MINI TWO-THREE"

An "Alldry" Battery Portable of midget size, 6¾in. × 4¾in. × 3¾in. designed to cover medium waveband 190-559 metres, with use of short trailer aerial.
The simple design of this Receiver is so arranged that either a 3-valve set or a 2-valve (afterwards easily converted to the 3-valve) can be made.
Consists of a T.R.F. circuit using a regenerative detector with H.F. stage and a high gain output pentode. Valve line up IT4—1T4—DL94.
The 2-valve set can be completely built for £2/3/6 (less case) and the 3- valve for £2/3/- (less case). Each price includes valves, speaker and drilled chassis.

Send 2/- 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 £15/15/- each.

WE CAN NOW OFFER THEM FOR £11'19'6

(plus 7/6 carriage and insurance).
H.P. Terms, DEPOSIT £3 and 12 Monthly payments of 17/5.

These Receivers Chassis have undoubtedly proved to be about 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" TC.

ALL CHASSIS ARE BRAND NEW and GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS).

GENERAL DETAILS

- For use on A.C. Mains 100/110 Volts and 200/250 volts.
- Employs the latest Valves 6BE6, 6BA6, 6AT6, two 6BWG's in push-pull and 6X4 (or similar) Rectifier.
- It has a Mains socket on the chassis for connection to Gram unit.
- Incorporates extension speaker and Pick up sockets.
- Overall size of Chassis is 11in. × 7¾in. 8¼in. high.
  Dial size 8¼in. × 4¼in.
  (A Bronze coloured Dial Escutcheon is available for 4/6.)
- Waveband coverage is 8shortwave 16 to 50 metres, Medium 187 to 550 and Long-wave 900 to 2000 metres.
- Has four controls: (1) Volume Control with on-off switch. (2) Tone Control (operative on Gram and Radio). (3) Wavechange Switch with Gram position. (4) Tuning Control (Flywheel type drive).
- Negative Feedback is employed over the entire audio stages.
- Excellent reproduction up to approximately 6 Watts output.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build a Midget "Alldry" Battery Eliminator, giving approx. 69 volts at 10 mA and 1.4 volts at 250 mA.
This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver, requiring H.T. and L.T. voltage as above, or approx. to 69 volts. The Kit is quite easily and quickly assembled and is housed in a light-aluminium case size 4¼in. × 1¾in. × 3¼in. Price of complete Kit with easy-to-follow assembly instructions, 42/6.
In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts at 10 mA. and 1.4 volts at 250 mA. Size of assembled unit 7in. × 2¼in. × 1¾in. Price 47/6.

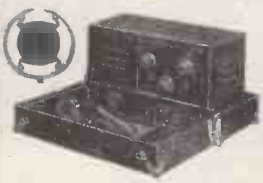
A BULK PURCHASE ENABLES THIS

SPECIAL PRICE REDUCTION

OF THE FAMOUS

SHAFTESBURY PORTABLE AMPLIFIER

Suitable for home use and small Halls Has matched inputs for both Record Players and Microphone. Also provides for the "mixing" and "fading" of both Gram. and speech as request.



COMPRISING

(a) A 4-Valve High Gain Amplifier for use on A.C. or D.C. mains, 200-250 volts with 5 watts output. Incorporating Independent Volume Controls for Mike and Gram., either of which can be faded at will, a variable Tone Control and independent input sockets for Mike and Gram.
(b) A Transverse Carbon microphone which obtains its polarizing current from the amplifier—no batteries are necessary.
(c) A 8in. Goodmans P.M. Speaker with the "Ticonal" magnet for first-class reproduction.

THE COMPLETE EQUIPMENT is all contained in the

PORTABLE CARRYING CASE £18'0'0

Having been reduced from £30/9/-. HIRE PURCHASE TERMS DEPOSIT £4/10/- and 12 monthly payments of £1/5/4 ● Light in weight ● Easy to CARRY ● GENUINELY PORTABLE. An illustrated leaflet containing free data is available on receipt of S.A.E.

A DUAL-CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

Attractively finished in "Old Gold" and providing full control of BASS and TREBLE 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 affording ample compensation for all types of pick-ups and all natures of recordings, i.e., English, American and long-playing without recourse to pick-up correction.
The extreme flexibility of the bass and treble control is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the ampilifier. Response characteristics are given in 12-watt amplifier advt. The unit measures only 9in. × 4in. × 2¼in., including self-contained power supply and can be accommodated either on or away from the main ampplifier, i.e. on the front panel of a cabinet or any other position. Price including drilled chassis, valves (6SN7 and 6J5), £3/16/9. Complete assembly data are available separately for 1/-. Completely assembled and ready for use, £5/5/-.

! ! THE IDEAL SET FOR USE IN CARAVANS, ETC. ! !

A 5-VALVE 2-WAVEBAND SUPERHET RECEIVER OPERATED FROM A 6-VOLT BATTERY FOR ONLY £6'17'6

(plus 5/- Carriage and Insurance).

These Receivers, which we have recently acquired by bulk purchase, are ex-British Ministry of Supply, and are new and unused. They are a two-waveband Superhet with R.F. Stage, covering Short Wave 18 to 50 metres and Medium Wave 200 to 550 metres, fully calibrated on a clockface dial. A 5in. loudspeaker is built in and the whole Chassis is contained in a metal cabinet with lid and carrying handle which measures 12¼in. × 7¼in. × 7¼in. overall. Valve line up is 7A7, 7Q7, 7A7, 7B6 and 7C5. They possess excellent sensitivity and will give very good results on a very short aerial. They are made for 6 Volt D.C. supply (current consumption is 4/6 amps.) but we can supply a dropping resistor at 7/6d. to also enable their use from a 12 volt battery.

WILLIAMSON AMPLIFIERS BY GOODSELL

These Amplifiers hardly need enlarging upon, being sufficient to say that they have now become the accepted standard for quality 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 but otherwise is built completely to specification.
Price **£27/10/-** (Plus 7/6 Carriage and Insurance.) H.P. Terms Deposit £6/17/6 and 12 months at £1/18/8.

THE MODEL P.F.A. TONE CONTROL UNIT

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/-/-** (Plus 7/6 Carriage and Insurance.) H.P. Terms. Deposit £5 and 12 months at £1/8/2.

SEND S.A.E. FOR ILLUSTRATED LEAFLETS

109 and 115 FLEET ST.

LONDON, E.C.4. *Phone :* CENTRAL 5812-3-4

RADIO TRADERS LTD.

23 WARDOUR ST., LONDON, W.1. (Coventry Street end)

Phone No. GERrard 3977/8 *Grams: "Radiotrade"*

BARGAIN OFFER OF BATTERIES

4½ v. Heavy Duty Bell Battery. Size 6½ x 4½ x 2½in..... 4/6
72 v. H.T. 1.5 v. L.T. Size 6 x 5 x 1¾in. 5/6
150 v. H.T. Size 2¾ x 5½ x 1¾in. 5/6
67½ v. Size 2¾ x 1⅞ x 3¾in. 6/6
All batteries sealed and unused. All plus 1/6 post and pkg. Special reduction for quantities.

	Per doz.
ELECTROLYTIC CONDENSERS	
16 mfd. 375 v., 2/- each	21/-
16 x 24 mfd. 350 v. 2/6 each	27/-
20 x 20 mfd. 275 v. 2/3 each	24/-
24 mfd. 350 v. 1/6 each	15/-
24 mfd. 450 v. 2/3 each	24/-
Condenser Clips for above	3/6
BIAS CONDENSERS	
50 mfd. 12 v. Single Hole Fixing 1/- each	10/6
100 mfd. 6 v. Tag End 10d. each	9/-
100 mfd. 25 v. Tag End 1/3 each	12/-
BLOCK PAPER CONDENSERS	
4 mfd. 400 v. D.C. 3/6 each. Many other types in stock. Your enquiries invited.	
LARGE ASSORTMENT OF TUBULAR CONDENSERS	4/-
MIDGET MICA CONDENSERS. .0001, .0002, .0003, .0004, .0005	5/-
200 Assorted Moulded Micas. Popular Values	£2 10 0
200 Assorted Silver Micas. Popular Values	£2 10 0
200 Assorted Carbon Resistors: ¼, ½ and 1 watt. Good selection	£1 10 0

SPECIAL OFFER

0.1 mfd. 12,000 volts test Mansbridge Condensers. Height 6¼in. Width 3¼in. Depth 2½in. Fixing Centres 4in. Plus 1/- post..... 5/6

PAXOLIN SHEET
18 x 4½ x 1/16in., 1/- each; 10 x 10 x 1/16in., 1/6 each; 20 x 10 x 1/32in., 1/6 each; 20 x 10 x 1/16in., 3/- each.

RESISTORS
Carbon ½ watt 2/6; ½ watt 3/-; 1 watt 4/-; 2 watt 6/- per doz.
WIRE WOUND AND VITREOUS. 5 watt 1/6; 10 watt 2/6; 15 watt 3/-; 20 watt 3/6 each.
HIGH STABILITY. ½ watt 5% 6d.; ½ watt 5% 9d.; 1 watt 5% 1/3 each. A few values in 1% and 2% still available.
ALL ORDERS FOR RESISTORS C.O.D. PLEASE AS WE CANNOT GUARANTEE TO STOCK ALL VALUES.
W.W. V/CONTROLS. ALL WELL-KNOWN MAKES. Pre-set 2/6 each. Spindle types 3/- each. Values from 5 ohms to 50k.
V/CONTROLS WITH SWITCH 5k, 50k, ½ meg., 1 meg.... 3/6 each
V/Controls Less Switch. Most values spindle and preset ..... 2/- each

METERS

0-300 mA. 2½in. Flush Mounting. Brand new. Guaranteed 8/6 each
0-500 mA. 2½in. Flush Mounting. Brand new. Guaranteed 10/6 each

TWIN GANG .0005 Less Trimmers	6/6 each
4-Way push button units 2/6 each	27/- doz.
Push Button Knobs	3/- doz.
TAG STRIPS. 3-way 2/-; 4-way 2/6; 5-way 3/-; 7-way 4/-; 28-way	12/- doz.
SLEEVING. 2 mm. 2/6; 3 mm. 3/6; 4 mm. 4/6; 5 mm.....	5/6 per doz. yd.
POINTER KNOBS. Small black with white line, standard ¼in. spindle	7/6 doz.
WANDER PLUGS. Red and Black	2/- doz.
PHILIPS TRIMMER TOOLS. 1/- each	10/6 doz.
BELLING LEE FUSE HOLDERS Type L.356 (Pnl. Mtg.)...	2/6 each
WEARITE COILS. PA4, PO4, PA5, PO5, 1/3 each	12/- doz.
VALVE HOLDERS. Moulded B9A 7/6; B7G 6/-; Int. Oct. 9/-; Eng. Oct.	4/6 doz.
VALVE HOLDER FITTED WITH LOWER CAN 1/6 per doz. extra.	
Screening Cans for B7G and B9A	6/- doz.
Paxolin V/H Int. Oct. B9A, B7G 5/- per doz.; Eng. Oct., 5-pin, 7-pin	3/- doz.
STANDARD SCREENING CANS 3-piece 1/- each; Spring Loaded	1/- each
BELLING LEE PLUGS AND SOCKETS, 5-pin 1/9; 7-pin 2/-; 10-pin	2/6 each
AIR SPACED TRIMMERS 5, 10, 15, 20, 25, 50 and 75 pf pre-set and spindle types 1/6 each	15/- doz.
PYE PLUGS AND SOCKETS 1/6 per pair, "Tee" pieced	1/9 each
GROMMETS 1 grs. assorted grommets ¼in. to 1in.	8/6 gross
POST OFFICE LAMP JACKS No. 10 1/- each	9/- doz.
Lamp covers for same	3/- doz.

WESTINGHOUSE KHI Half-wave Rectifier, rating 6 v. at 10 mA., 2/6 each ..... 27/6 doz.

OUTPUT TRANSFORMERS. Multi-ratio, 5/- each; Pentode or power	4/- each
DRUM DRIVES, 3¾in.	1/- each
WESTECTORS, WX6, WX12, W1, W12, W4, 1/- each	9/- doz.
ARCOLECTRIC (Whitney Lamp), Red, Green, Clear, 1/6 each	15/- doz.
SIGNAL LAMP HOLDERS. Panel mounting, complete with adjusting lampholder, 1/9 each	18/- doz.
NUTS 9 BA 3/-; 6BA 2/6; 4BA 3/-; 2BA	4/- per gross
SOLDER TAGS 2/6 per gross; Shakeproof Washers	2/- per gross
JONES PLUGS AND SOCKETS. 4-pin, 2/6; 6-pin, 3/-; 8-pin, 3/6; 10-pin, 4/-; 12-pin	6/- pair

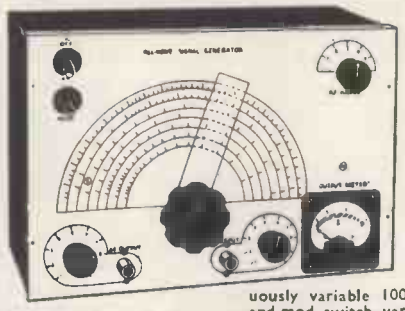
CASH WITH ORDER OR C.O.D. **ALL ORDERS DEPT. W.1**
ALL ORDERS FOR LESS THAN £2 ADD POSTAGE

We Invite your enquiries for items not listed

Trade Counter open 9 to 6 Monday to Friday
Callers Welcomed

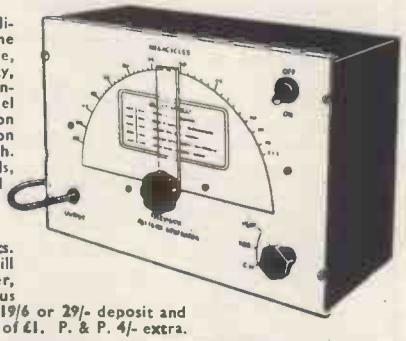
WHOLESALE, MANUFACTURERS' AND EXPORT ENQUIRIES INVITED

COMPLETELY BUILT SIGNAL GENERATOR



Coverage 120 Kc/s-320 Kc/s., 300 Kc/s-900 Kc/s., 900 Kc/s-2.75 Mc/s., 2.75 Mc/s. 8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s.-84 Mc/s. Metal case 10 x 6¾ x 4¼in. Size of scale 6½ x 3¼in 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. ouput continuously variable 100 milli volts. C.W. and mod. switch, variable A.F. output and moving coil output meter. Black crackle finished case and white panel. Accuracy plus or minus 2%. £4/19/6 or 34/- deposit and 3 monthly payments 25/-. P. & P. 4/- extra.

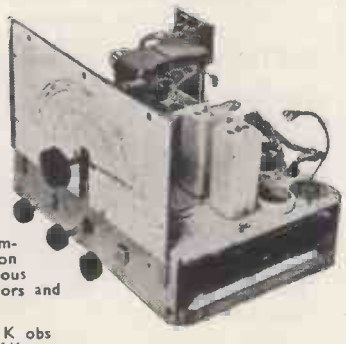
PATTERN GENERATOR



40-70 Mc/s. direct calibration, checks frame and line time base, frequency and linearity, vision channel alignment, sound channel and sound rejection circuits and vision channel band width. Silver plated coils, black crackle finished case 10 x 6¾ x 4¼in. and white front panel. A.C. mains 200/250 volts. This instrument will align any T.V. receiver, accuracy plus or minus 1%. Cash price £3/19/6 or 29/- deposit and 3 monthly payments of £1. P. & P. 4/- extra.

★ **Both generators guaranteed for 12 months** ★

USED A.C. MAINS 5 VALVE, 3 WAVE-BAND SUPERHET CHASSIS



Size 11½ x 8½ x 3in., complete with 3 wave-band scale, size 10¾ x 5¾in., pair of 465 Kc/s IFs, tuning condenser, mains transformer, volume control with switch, tone control. 3 wave-band coil pack (this is a completely detachable coil pack on separate small chassis), various small condensers and resistors and biasing condensers.

19'6 Post & Packing 3/6. K obs 1/6 extra.

As above, two wave-band. **15'-** Post & Packing 3/6. Knobs 1/6 extra.

FLUORESCENT BALLAST UNIT

Frustrated export order, by very famous manufacturer, at an original cost of approximately £3. VERY LIMITED QUANTITY. Twin 40 watt, both of which are in parallel, can be used as one single 40 watt. The unit comprises 2 chokes and power-factor condenser in metal case, size 13in. x 3½in. x 2in. Completely sealed and fully impregnated. Four lug fixing. A.C. mains 230/250 volts. Fuly guaranteed. Post and packing 2/6 each, 15/-.

20 watt A.C. or D.C. 200/250v. **FLUORESCENT KIT** comprising trough in white stoved enamel finish, two tube holders, starter and holder and barreter. Post and packing 1/6, 12/6.

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 up to 10/-, 2/- up to £1, and 2/6 up to £2. All enquiries, S.A.E., lists 5d. each.

MAINS TRANSFORMERS

Primary, 200-250 v. P. & P. 2/-.

300-0-300, 100 mA., 6 v. 3 amp., 5 v. 2 amp., **22/6.**

Semi-Shrouded, drop-through 380-0-380 v., 120 mA., 6.3 v. 4 amp., 5 v., 2.5 amp., **22/6.**

Drop thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., **14/6.**

Chassis mounted and fully shrouded. 80 mA., 6 v. 3 amp., 5 v. 2 amp., **14/6.**

250-0-250 80 mA., 6 v. 4 amp., **14/-.**

Drop thro' 270-0-270, 80 mA., 6 v. 3 amp., 4 v. 1.5 amp., **13/6.**

Drop thro' 270-0-270 60 mA., 6 v. 3 amp., **11/6.**

250 v. 350 mA., 6.3 v. 4 a., twice 2 v. 2 a., **19/6.**

Auto-trans. Output 200/250 H.T. 500 v. 250 mA., 6 v. 4 a., twice, 2 v. 2 a., **19/6.** 250-0-250, 60 mA., 6.3 v. 1.5 a., 0-5-6.3 v. 1.5 a., **10/6.**

Auto Trans. Input 200/250. H.T. 350 v. 350 mA. Separate L.T. 6.3 v. 7 a., 6.3 v. 1½ amp., 5 v. 3 amp., **25/-.** P. & P. 3/-.

Primary, 230 v., fully shrouded, screened primary, **13** v. 1 amp., **7/6.**

Pri. 200 v. Sec. 500-0-500 and 500-0-500 250 mA. both windings. 4 v. 3 amp., 4 v. 3 amp., **39/6.** P. & P. 5/-.

Mains Transformer, fully impregnated. Input 210, 220, 230, 240. Sec. 350-0-350 100 mA., with separate heater transformer. Pri. 210, 220, 230, 240. Sec. 6.3 v. 2 amp., 6.3 v. 3 amp., 4 v. 6 amp. and 5 v. 2 amp., **30/-.** P. & P. 5/-.

MAINS TRANSFORMERS, chassis mounting, feet and voltage panel. Primaries 200/250.

350-0-350 75 mA. 6.3 v. 3 a. tap 4 v. 6.3 v. 1 a., **13/6.**

500-0-500 125 mA. 4 v. C.T. 4 a., 4 v. C.T. 4 a., 4 v. C.T. 2.5 a., **27/6.**

500-0-500 250 mA. 4 v. C.T. 4 a., 4 v. C.T. 5 a., 4 v. C.T. 4 a., **38/6.**

5½in. M.E. Speaker, 1,000 ohm field, **15/-.**

R. & A. T.V. energised 6½in. speaker with O.P. trans, field coil, 175 ohms **9/6.** P. & P. 2/6.

R. & A. 6½in. M.E. speaker, with O.P. trans, field 440 ohms, **10/6.** P. & P. 2/6.

Volume Controls. Long spindles less switch, 50K, 500K, 1 meg., **2/6** each. P. & P. 3d. each.

Volume Controls. Long spindle and switch, ½, ¼, 1 and 2 meg., **4/-** each. 10K and 50K, **3/6** each. ¼ and 1 meg., long spindle double pole switch, miniature, **5/-.** P. & P. 3d. each.

Trimmers, 5-40 pf., 5d. 10-110, 10-250, 10-450 pf., **10d.**

Twin-Gang .0005 Tuning Condenser, **5/-.** With trimmers, **7/6.**

Twin Gang, .0005, with feet, size 3½×3×1½in., **6/6.**

3-gang .0005, with feet, size 4½×3×1½in., **7/6.**

T.V. Coils, moulded former, iron-cored wound for re-winding purposes only. Ali-can 1½×1in., **1/-** each, 2 iron-core Ali-can 2½×½in., **1/6** each.

Used Metal Rectifier, 250 v. 150 mA., **6/6.** Metal Rectifier, 230 v. 45 mA., **6/-.**

Metal Rectifier, RM2, 125 v. 100 mA., **3/6.**

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., **4/6**; 42-1 with extra feed-back windings, **4/3.** Miniature 42-1, **3/3.** Multi-ratio 3,500, 7,000 and 14,000, **5/6.** 10-watt push-pull, 6V6 matching, **7/-.** 90-1 3 ohm speech coil, **6/6.**

PUSH-BACK CONNECTING WIRE. Doz. yds., **1/6.** Post paid.

STANDARD WAVE-CHANGE SWITCHES 4-pole 3-way, **1/9**; 5-pole, 3-way, **1/9**; 3-pole, 3-way **1/9**; 9-pole 3-way, **3/6**: Miniature type, long spindle 3-pole 4-way, 4-pole 3-way and 4-pole 2-way, **2/6** each. 2-pole 11-way, twin wafer **5/-**; 1-pole 12-way single wafer **5/-.** P. & P. 3d.

PERMEABILITY TUNED T.V. UNIT Input 300 ohm balanced line, coverage 54 Mc/s—89 Mc/s and 174 Mc/s—217 Mc/s. Vision I.F.:—45 Mc/s., sound 40.5 Mc/s. Uses 6AK5 RF valve, 6AK5 as mixer, and 6C4 Oscillator. Provision for auto-gain control. Dimensions 9in. wide. 6½in. deep, 4in. high. 9in. blank-scale. Width including scale-overlap 14in. Four stages permeability tuned. Complete with 3 valves. Post and Pkg. 3/-. **£2/19/6.**

T.V. CONVERTER for the new commercial stations complete with 2 valves. Frequency:—can be set to any channel within the 186-196 Mc/s. band. I.F.:—will work into any existing T.V. receiver designed to work between 42-68 Mc/s. Sensitivity:—10 Mu/v. with any normal T.V. set. Input:—arranged for 80 ohm feeder. Circuit EF80 as local oscillator. ECC81 as R.F. amplifier and mixer. The gain of the first stage, R.F. AMPLIFIER 10 db. Required power supply of 200 v. D.C. at 25 mA. 6.3 v. A.C. at 0.6 amp. Input filter ensuring complete freedom from unwanted signals. 2 simple adjustments only. **£2/19/6.** P. & P. 2/6.

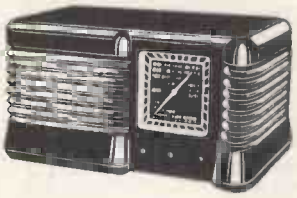
R.F. E.H.T. OSCILLATOR COIL

6-9 KV with EY51 rectifier winding, and circuit diagram, 15/-.

As above but complete with 6V6, EY51 and associated resistors and condensers. Circuit diagram, 37/6.

As above but complete with line O.P. transformer, scan coils and frame O.P. transformer, £2/19/6. P. & P. 3/-.

PLASTIC CABINET, as illustrated, 11½in. × 6½in. × 5½in., in Walnut and Cream, also in polished Walnut complete with T.R.F. chassis, 2 waveband scale, station names, new wave-band, back-plate, drum, pointer, spring, drive spindle, 3 knobs and back. **22/6.** P. & P. 3/6. **AS ABOVE**, with superhet chassis, **23/6.** P. & P. 3/6. Either of the above complete with 5" speaker and O.P. transformer. **17/6** extra.



Used metal rectifier, 230 v. 50 mA., **3/6**; gang with trimmers, **6/6**; M. and L.T.R.F. coils, **5/-**; 3 obsolete ex-Govt. valves 3 v/h and circuit, **4/6**; heater, trans., **6/-**; volume control with switch, **3/6**; wave-change switch, **2/-**; 32×32 mfd., **4/-**; bias condenser, **1/-**; resistor kit, **2/-**; condenser kit, **4/-**.

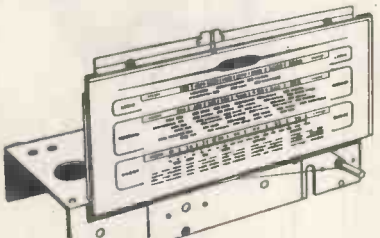
Used AC mains 200/250 volts, 4 valve plus metal rectifier, medium wave superhet in polished walnut cabinet, size 14×9½×7½", complete with valves 6K8, 6K7, 6Q7 and 6F6. 6½ P.M. speaker. Fully guaranteed. P. & P. 7/6. **£3/15/-.**

P.M. SPEAKERS. 6½" closed field **18/6.** 8" closed field **20/6.** 10" closed field **25/-.** 3½ **16/6.** P. & P. on each 2/-.

CONSTRUCTOR'S 3-VALVE PLUS METAL RECTIFIER T.R.F. PARCEL. Complete with gang, valves, v/holders, metal rec., heater-trans., wave-change, volume-control, electrolytics, resistors and condensers. Medium and long wave Litz wound coils. Post and pkg. 2/-. **27/6.** Circuit and point to point **1/-.**

Radiogram Chassis, 5 valve A.C./D.C. 3 wave-band superhet 195/255 v., 19-49, 200-550 and 1,000-2,000 metres, I.F. 470 Kc. size of chassis 13×6½×2½in., size of scale 7½×3½in. Valve line-up 10C1, 10F9, 10LD41, U404 and 10P14. Twin mains filter input, 2 dial lights and 8in. P.M.. **£8/17/6.** P. & P. 5/-.

CONSTRUCTOR'S PARCEL, medium and long wave A.C. mains 230/250 2-valve plus metal rectifier, comprising chassis 10½×4½×1½in., 2 wave-band scale, tuning condenser, wave-change switch, volume control, heater trans., metal rectifier, 2 valves and v/holders, smoothing and bias condensers, resistors and small condensers, and medium and long wave coil, litz wound, **22/6.** P. & P. 2/6 extra. Circuit and point-to-point, **1/3.**



CONSTRUCTOR'S PARCEL, comprising chassis 12½×8×2½in., cad. plated, 18 gauge, v/h., I.F. and trans. cut-outs, back-plate, 2 supporting brackets, 3 wave-band scale, new wavelength stations names. Size of scale 11½ × 4½in., drive, sp., drum, 2 pulleys, pointer, 2 bulb holders, 5 pax. L.O. v/h., 4 knobs and pair of 465 I.F.s, twin gang, 16×16 mfd. 350 wkg., mains trans. 250-0-250 60 mA. 6.3 v., 2 amp., 5 v. 2 amp. and 6½in. M.E. speaker with O.P. trans. **39/6.** P. & P. 3/6.

CR100 Coil packs in first-class condition less oscillator section, complete with 4-gang tuning condenser, 19/6. P. & P. 3/6.

CR100 465 Kc. I.F.s, types 3, 4 and 5 and F.B.O., new condition, 7/6 each. 465 Kc. Xtal for CR100, 12/6.

4-gang tuning condenser for CR100, 9/6.

POLISHING ATTACHMENT for electric drills. Quarter inch spindle, chromium plated 5in. brush, 3 polishing cloths and one sheep-skin mop mounted on a 3in. rubber cup. Post & pkg. 1/6. **12/6.** Spare sheepskin mops. **2/6** each.

POTATO AND VEGETABLE PEELER

By famous manufacturer. To suit models A200 and A700. Capacity 4½lbs., complete with water pump. All aluminium construction, white stove-enamelled finish. Originally intended for adaption on an electric food-mixer, can be easily converted for hand operation. **39/6** P. & P. 3/-.

Mains Droppers. 0.3 amps., 460 ohms, tapped 280 and 410, **1/6**; 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, **1/6**; 0.3 amps. 950 ohms, tapped 700 and 825, **2/6**; 0.2 amp., 1,000 ohms, vitreous, tapped **2/6**; vitreous, 0.3 amp., 700 tapped 580, 640, 600, **3/6.** P. & P. on each 3d.

T.V. Width Controls, **3/6.**

PERSONAL SHOPPERS ONLY. 9in. Enlarger, **17/6**; 12in. **27/6.**

Germanium Crystal Diode, **1/6**, post paid Used 9in. Tube with Ion burn, **17/6**, post paid.

Line O.P. Transformer in aluminium can mounted in rubber, **12/6.**

Speaker Matching Unit on aluminium chassis, 3-15 ohms reversible, **12/6.** Line and E.H.T. Transformer, 14 Kv., using ferrocart core, complete with line and width control, and corona shields U37 rectifier winding, **35/-.** Line and E.H.T. Transformer, 9 Kv., using ferrocart core, complete with built-in line and width control. Mounted on small all-chassis. Overall size 4½×1½in. EY51 rec. winding, **27/6.**

Scan coils, low line low impedance frame, complete with frame transformer, to match above, **27/6.** P. & P. 2/-.

Line and E.H.T. Transformer, 9 Kv. ferrocart core, EY51, heater winding, complete with scan coils and frame output transformer, and line and width control, **£2 5/-.** P. & P. 3/-.

As above, but complete with line and frame blocking transformers, 5 Henry 250 mA. choke, 100 mfd. and 150 mfd. 250 wkg. 380 mA. A.C. ripple. **£2/19/6.** P. & P. 3/-.

Valve Holders, moulded octal Mazda and loctal, **7d.** each. Paxolin, octal Mazda and loctal, **4d.** each. Moulded B7G, B8A and B9A, **7d.** each. B7G moulded and B9A with screening can **1/6** each.

32 mfd. 350 wkg.	2/-
16×24, 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
16×8 mfd., 500 wkg.	4/6
16×16 mfd., 500 wkg.	5/9
16×16 mfd., 450 wkg.	3/9
32×32 mfd., 350 wkg.	4/-
25 mfd., 25 wkg.	11d.
250 mfd., 12 v. wkg.	1/-
16 mfd., 500 wkg., wire ends	3/3
8 mfd., 500 v. wkg., wire ends	2/6
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
100 mfd., 350 wkg.	4/-
100 mfd., 450 v. wkg., 280 mA., A.C. ripple	3/11
150 mfd., 350 v. wkg., 280 mA. A.C. ripple	4/6
200 mfd., 275 wkg.	7/6
16+16 mfd., 350 wkg.	3/3
50 mfd., 180 wkg.	1/9
65 mfd., 220 wkg.	1/6
8 mfd., 150 wkg.	1/6
60+100 mfd., 280 wkg.	7/6
50 mfd., 12 wkg.	11d.
50 mfd., 50 wkg.	1/9

Miniature wire ends moulded, 100 pf., 500 pf., and .001, each, **7d.**

Combined 12in. mask and escutcheon, in lightly tinted Perspex. New aspect edged in brown. Fits on front of cabinet, **12/6.** As above for 15in. tube, **17/6.**

Frame Oscillator Blocking Trans., **4/6.** Line Osc. Blocking Trans., **4/6.**

CHOKES:

2-20 Hen. 150 mA., **15/-.** P. & P. 3/-. 6 Hen., 275 mA., **15/-.** P. & P. 3/-. 100 Hen., 40 mA., **15/-.** P. & P. 3/-. 2 henry 150 mA., **3/6**; 250 mA. 10 henry, **10/6**; 5 henry 250 mA., 60 ohms., **8/6.**

Wide Angle P.M. Focus Units. Vernier adj. state tube, **25/-.**

Energised Focus Coil, low resistance mounting bracket, **17/6.**

Ion Traps for Mullard or English Electric tubes, **5/-**, post paid.

Standard 465 Kc. Iron-cored I.F.s 4×1½×1½in., per pr., **7/6.** Wearite standard, iron-cored, 465 Kc. I.F.s, 3½×1½×1½in., per pr., **9/6.**

Iron-Cored 465 Kc. Whistle Filter, **2/6.**

465 KC. MIDGET I.F.s. Q.120 size 1½in. long, 1in. wide, ½in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, **12/6.**

C.R.T. ISOLATION TRANSFORMERS

Designed to cover practically every demand for Transformers for Cathode Ray Tubes having Heater/Cathode short circuit or for C.R. Tubes with falling emission.
Type A. Low leakage windings. Ratio 1 : 1.25 giving a 25% boost on Secondary.

2 volt	10/6 each	With Tag
4 volt	10/6 each	Panel and
6.3 volt	10/6 each	Solder Tags
10.8 volt	10/6 each	
13.3 volt	10/6 each	

Type B. Mains Input 220/240 volts. Multi Output 0-2-4-6.3-7.3-10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for most Cathode Ray Tubes. The MOST versatile Low Capacity C.R. Transformer with Universal Output. With Tag Panel and Solder Tags. 21/- each.
Type C. A most useful low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 230/240 volts. Output 2-2½-2½-2½-3 volts at 2 amps. With Tag Panel and Solder Tags 17/6 each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.

Volume Controls

Midget type, Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg-ohms.

No Sw.	S.P.Sw.	D.P.Sw.
3/-	4/-	4/9

COAXIAL PLUGS 1/2
SOCKETS 1/-
DOUBLE SOCKETS 1/2
OUTLET BOXES 4/6

80 ohm CABLE COAXIAL

STANDARD ¼in. diam. Coaxial GRADE "A" 7d. yd.
SPECIAL Semi-air spaced Polythene insulated. ¼in. diameter. Stranded core. Losses cut 50%. 9d. yd.

BALANCED TWIN FEEDER per yd. 6d. } 80
TWIN SCREENED BALANCED FEEDER 1/- yd. } ohms
50 OHM COAXIAL CABLE, 8d. per yd. ¼in. dia.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf., 1/3; 250 pf., 1/6; 600 pf., 750 pf., 1/9.
RESISTORS.—All values: 10 ohms to 10 meg., ½ w., 4d.; ¼ w., 6d.; 1 w., 8d.; 2 w., 1/-.
HIGH STABILITY, ½ w. 1%, 2/-. Preferred values 100 ohms to 10 Meg.
WIRE-WOUND RESISTORS—Best Makes Miniature Ceramic Type—5 w., 15 ohms to 10K., 1/9; 10 w., 20 ohm to 10K., 2/3; 15 w., 30 ohms to 10 K., 2/9; 5 w. Vitreous, 12 K. to 25 K., 3/-.
WIRE-WOUND POTS. 3 WATT LAB. COLVERN, ETC.

Pre-Set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 meg., 3/-.

Standard Size Pots, 2½in. Spindle High Grade. All Values, 100 ohms to 50 K., 5/6; 100 K., 6/6.
W/W EXT. SPEAKER CONTROL 10Ω, 3/-.

O/P TRANSFORMERS.—Heavy Duty 70 mA., 4/6. Ditto tapped primary, 4/9. Multiratio, QPP, push pull 6/6. Tapped small pentode, 3/9.
L.F. CHOKES 15/10 H. 60/65 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H. 120/150 mA., 12/6. MAINS TRANS. 350-0-350, 80 mA., 6.3 v. tapped 4 v. 4 a., 5 v. tapped 4 v. 2 a., ditto 250-0-250, 21/-. AMPLIFIER TRANS. 250-0-250 v. 50 mA. 6.3 v. 2 a., 17/6. HEATER TRANS.—Tapped prim., 200/250 v. 6.3 v. 1½ amp., 7/6, tapped sec. 2, 4, 6.3 v., 1½ amp., 8/6.

CRYSTAL MIKE INSERT.—Famous make, precision engineered. Size only 1¼in. x 3/16in. Bargain Price 6/6. No transformer required.

SPEAKER FRET.—Expanded anodised metal, 12in x 12in., 4/-. EXT. L.S.—Switched Socket, on-off and parallel switching, complete with plug, 2/-.
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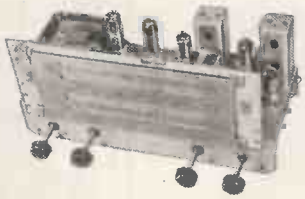

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KEEN Amateur going abroad has quantity of units and equipment for sale; moderate prices to quick buyer.—Box 4396. [6814

AVAILABLE: ET4332B, BC375 with T.U., T1131, TR1430, TR1464, W.S.38.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [4366

NEW TEST EQUIPMENT

TV signal intensity meter (S.I.M.) for aerial checks and installation, etc.; send for full details.—Radio-Aids, Ltd., 29, Market St., Watford. Tel. Watford 5988. [4737

TEST EQUIPMENT—SURPLUS AND SECONDHAND

PRECISION meter, Type 44, by Electronic Instruments, multi-range, A.C. and D.C., cost £40; accept £30 o.n.o.—Box 4195. [4741

ADVANCE signal generator, type E1 and G.E.C. select-test meter, in good condition; offers.—E. Gulliver, Chipping Norton, Oxon. [4766

ADVANCE E2 signal generator, £20; radar pattern generator, model H, channel two, £22; or both for £40; Condition as new.—Dawson, 34, Lionel Grove, Harpfields, Stoke-on-Trent, Staffordshire. [4712

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0056

NEW DYNAMOS, MOTORS, ETC.

1500 cycles altenators 2KVA, 80v.—E.W.S. Co 69. Church Rd., Moseley. Birmingham. [4601

SPECIAL televison rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb, d.c. input 12v 200va out. 24v. 32v, 50v, 110v, 230v d.o., to 230v out 250va, £28/10 del., also converters for radiogram and general use, inputs, outputs and prices as above; the above also supplied without smoothing, £25 del. immediate despatch; trade supplied.
AT a purchaser's home 60 mls. S.W. of Sutton Coldfield a 24v
TELEVISION converter was tested on Ekco television, 12in tube stated consumption 135 watts d.c. current from battery only 9½ amps, picture and sound were perfect and completely free of interference or flutter.
THE above is the latest product of British manufacture, and is guaranteed for one year. J.A.P. No. 2A 1 2hp petrol engine, air-cooled, 4-stroke, starting rope, tools; £17/10 delivered. T. W. PEARCE, 66, Great Percy St., W.C.1 (near Angel). [0013

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECOND-HAND

FOR sale, D.C. to A.C. motor generator, L.D.C., Ltd., input 220-230 volts D.C., output 230 volts A.C., single phase 6.5 amps.—Apply Burton, The Lawn, Itchen Abbas, Winchester. [4697

MOTORS Mk. X (repeater), boxed, unused, 3/6, plus 1/- p. & p.; quotations quantity 600 available; 1rpm and 3.5rpm, high torque motors, 4in diam., 7in. L, ex recording cameras, 230v 50 ~ 25/-; 12v D.C., 17/6; 1/20hp series motors, long double spindle, 4,000rpm, 19/-.—Technical Trading Co., 311-313, Fratton Rd., Portsmouth. [4760

NEW GRAMOPHONE AND SOUND EQUIPMENT

T/R amps 18gns and pre-amps £5/15 for 3-headed decks, inc. p pack and meter level ind.
GRUNDIG, Philips T/R promptly supplied; Reflectograph decks £31, for Lodestar; T/R amps. for Wearite, Truvox, etc., U/L output. TEL. Gla. 1770.
HARDING ELECTRONICS, 120a, Mora Rd., Cricklewood, London, N.W.2. [0032

TAPE recorders for sale, exchange, or hire in Greater London, good quality tape recorders wanted for cash, all types of repairs, mechanical and electronic, carried out by specialists, all accessories available, we deal exclusively in magnetic recording equipment.
THE MAGNEGRAPH RECORDING Co., Ltd., 1, Hanway Place London, W.1. Tel. Langham 2156 [3396

NEW GRAMOPHONE AND SOUND EQUIPMENT

FERROGRAPH magnetic tape recorder 76gns.
WEARITE tape decks and component parts.
DISC recording machines and blank discs.
LEAK amplifiers, 10w £17/17; preamp £10/10.
GOODSELL, 5w £13/10, preamp £10/10.
RESLO ribbon microphones and stands.
EVERYTHING for the professional recording studio and quality dealers.
SOUND DISCS (SUPPLIES), Ltd., 178, Bispham Rd., Southport, Lancs. Tel. 88153. [4731

CINE-VOX disc recording equipments, type C7J for high-quality recordings from existing microphone equipment; price from 28gns; also available as a complete channel inclusive of mic., amplifier and playback equipment, at 70gns; type C7 for highest quality professional requirements—recorder mechanism at 48gns, or complete channel at 110gns; demonstrations arranged in London.
PLEASE write for details to K.T.S., Ltd., "Coplow," Park Rd., Braunton, N. Devon. Tel. Braunton 224. Callers by appointment only. [0209

BUY British ferrograph recorders from an established studio, benefit by our many years' experience; Emitape, microphones, splicers, speakers (two only, B.S.R. ribbon mics. 600ohm, 50/- each); transfer your tapes to our wide dynamic L.P.s.—"Eroica" Recording Studios (1949), Peel St., Eccles, M/c. Eccles 1624. Director, Thurlow Smith, A.R.M.C.M. [0122

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECOND-HAND

VITAVOX Type A m/c mike, chrome, unused, cost 9gns, accept 7gns o.n.o.—Box 4299. [4776

GRUNDIG 700L, as new, original carton. phone adaptor, foot control, stethoscopic 'phones; £60; consider exchange.—Minifon, Tel. Cosham 79084. [4818

H.M.V. disk unit and amplifier, model 2300H in magnificent condition; price £135 o.n.o —Fullest details from Dearden, 11, Tubwell Row, Darlington. [4727

B.S.R. disc recorder, moving coil and ribbon mikes, 78 blanks, cost £235; also Baird tape recorder, cost 57gns; no reasonable offers refused.—362, Court Oak Rd., Harborne, B'ham. [4754

NEW COMPONENTS

FM, new W.W. design; coilsets, parts, available now; BEL, FM and transistor pioneers. —Marlborough Yard, London Archway, N.19. Arc. 5078. [0185

NEW mains transformers, fully shrouded. 210-230-250v, primaries 350-0-350 150ma, secondaries, 6.3v 4 act, 6.3v 2a, 5v 3a fly leads. 42/6; 400-0-400 200ma 6.3v 4 act, 6.3v 3act. 5v 3a. 63/-.—C. S. F. Steward, 6, Broughton Rd., Hadleigh, Essex. [4585

COMPONENTS—SURPLUS AND SECOND-HAND

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. ELECTROLYTICS, capacity, voltage, size, type of mounting, price post paid; 400, 6v, 1×2in, lug, 1/9; 250+250, 6v, 1×2in, lug, 2/-; 40, 150v, 1×2, clip, 2/6; 20+20, 275v, 1×2, lug, 3/3; 16+32, 275v, 1/2, lug, 3/3, 16+16, 275v, 1×2, clip, 3/3; 100, 275, 350v, 1⅛×3, clip, 3/6; 32+12, 350v, 1⅝×2, clip, 4/-; 16, 350v, ¾×2, lug, 1/9; 10, 450v, ¾×2, lug, 1/6; 16, 450v, ⅞×2, tag, 2/9; 15+15, 450v+20mf 25v, 1¼×3, lug, 4/6, 200, 6v ⅝×1¾, clip, 1/6; 75, 12v, ⅝×1¾, clip, 1/9; 8, 450v, 1×2, clip, 2/-; 250, 12v, ¾×1¾, wire, 2/3; 40+40, 275v, 1⅝×2, clip, 3/3; 24+24+16, 350/425v, 1⅝×2, clip, 4/9; 4, 150v, ⅝×1¾, clip, 1/1; 500, 12v, 1⅝×2¾ clip, 2/-; 8, 350v, ¾×2, clip, 1/9, 32+32, 350/425v, 1⅝×2, clip, 4/6; 2, 450/525v, ¾×1¾, tag, 1/6; 8, 450v, ¾×2, clip, 1/9; 64+120, 275v, 1¾×2½, clip, 5/6; 16+16, 350/425v, 1⅝×2, clip, 4/-; all, all cans, some with sleeves, all voltages, WKG, surge where marked, new stock guaranteed.
5mA meters, moving coil, bakelite case, 2in square, flush mounting new, boxed; 7/- post paid: 50mA, 8/6.
MAINS trans., 250-0-250v, 80ma 6.3v, 2.5A. 6.3v, 0.6A. Pri. 0-210-230-250v 12/- post paid.
TELEVISION chassis, cadmium plated, steel, size 14×13×2¼in, complete with 13 valve holders (9-B9A Pax, 1-B9A Cer, 2-B7G Cer. 1-Int. Oct. amph.), 20 various tag strips, cut away for metal rect., line trans., etc.; 9/11 each, post paid.
FRONT and rear tube mounts to fit above chassis, 3/- pair, post paid.
P.M. focus rings, wide angle, tetrode tube, fully adjustable, 12/- post paid.
RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 143. [0016

OLYMPIC radio jack, simply connect to amplifier and aerial for radio reception on medium or long wave; price £3/5.—Frank E. Jessop, 4, Oxford St., Leicester. [4759

COIL packs 3/9 (2-wave), including I.F.s, also 3-wave, with 465 k/cs I.F.s at 7/9; free drawing, money back guarantee, I.F.s only 2/- pair, P.P. 1/3.—Duke & Co., 621, Romford Rd., E.12. Gra. 6677. [4785

METAL-GLASS seals; single-way, hermetically sealed terminals for soldered connections and fixing; mostly 1kv and 2kv sizes, new (surplus), 65/- per 1,000 assorted.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0087

COMPONENTS—SURPLUS AND SECOND-HAND

SUPREME RADIO, 746b, Romford Road, Manor Park, London, E.12. Tel. Ilf. 1260 Est. 19 years.
BROWN 80ohm co-axial cable, 8d per yard or 7/6 doz yards; W/Wound 10K ohm knob-type pre-set v/controls, 2/6 ea.
EARTH Rods, copper tube type; 1/8 ea.
ELECTROLYTIC Cond., 8mfd, 450v wkg., sleeved tubular w/end: our price, 1/11 ea
METALPACK 0.1mfd 350v condensers; 8d ea., or 7/6 doz.
SPRAGUE, 0.1mfd 350v condensers, w/end; 6d ea., or 5/6 doz.
STILL a popular buy, Mains Trans, shrouded, upright mounting, with base connections. 290-0-290v 60m/a, 6.3v 1.5amp, and 4v 2amp, with screen, primary tapped on v/panel. 0-200v, 220v, 240v, size H 3¼in, W 3¼in, D 2¾in; 12/6 ea. and 1/- pack/post.
STEEL Chassis, ready punched for s/het lay-out, 14in×6in×3in; 2/6 ea.
R.M.I. Metal Recs, 3/11 ea.; R.M.2 type, 4/3 ea.; R.M.3 type, 5/11 ea.; R.M.4 type, 18/- ea.; 14A86 metal recs, 16/6 ea.; 14A100, 19/6 ea.
2-POLE 2-way w/c switches; 1/- ea.
MICRO-PACK, 25mfd, 25v, bias cond—small; 1/4 ea.
ALL parts in stock for Denco F.M. unit, manual; 1/6 ea.
MULLARD 5/10 Amplifier parts always in stock, manual; 2/6 ea.
TRY us for Radio and Television component parts at the right price; your enquiries welcomed.
TERMS: C.W.O.: no C.O.D.
SEND 9d extra for postage orders under £5. 2½d S.A.E. all enquiries and list. [0021

WANTED, EXCHANGE, ETC.

EXTRUSIONS by Marley.
BUYERS requiring rigid and flexible tubes and sections in thermoplastic materials should ask for a quotation from Marley Extrusions, Dept. 129, Lenham, Maidstone, Kent. Harrietsham 381. [4735
WANTED, receivers A.P.R.4, also T.N.16, 17, 18, 19, etc., and any radio test gear. LESLIE DIXON & Co., 214, Queenstown Rd., Battersea, S.W.8. Macaulay 2159. [0176
PROFESSIONAL precision disc cutting machine, L/P 78/45.—Box 4018. [4726
WANTED, tuning units, TN17, TN18, TN19, for R54/APR4; £50 each offered.—Box 4963. [0261
WANTED, valves, test equipment (Avo, Taylor).—Call or write Stan Willetts, 43, Spon Lane, West Bromwich, Staffs. Tel. Wes. 2392. [6815
WANTED, coils 425 Q max, RV2 V.H.F. converter, top price, good condition.—Haylock, 230, Devonshire Ave., Southsea, Hants.
WANTED, set manufacturers' or ex-Government radio equipment, large or small quantities of valves, electrolytics, speakers, meters, also components. LOWE BROS., 9a, Diana Place, Euston Rd., N.W.1. Eus. 1636/7. [4485
WANTED, HRO coils, Rxs, etc., A.R.88s, BS348s, S27s, etc.—Details to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163
WANTED, B.C.610 Hallicrafters, E.T.4336 transmitters and spare parts for same; best prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079
WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estb. 18 years.—Call, send or 'phone Ger. 4638, Miller's Radio, 38a, Newport Court, Leicester Sq., W.C.2. [6824
WANTED, signal generators types TF144G, TF517F, TF762A, frequency meters type BC221, TS174, TS175; also receivers types R1359 and R1294.—Send price and details to Hatfield Instruments, Ltd., 175, Uxbridge Rd., Hanwell, W.7. Tel. Ealing 0779/9857. [0037
ALL U.S.A. V.H.F. test and communication equipment; TS174, TS175, TS47, B.C.221 freq. meters; receivers 1294, 1359, Hallicrafters S.27, S 27CA, U.S.A.; APR4 and tuning units TN16, 17, 18 and 19. RCA AR88D-LF, Hallicrafters SX28; valves 707A-707B, 2K28, 2K39, 2K33, 2K41; highest offers given by return.—Ger. 8410 and 4447. Universal Electronics, 22, Lisle St., Leicester Sq., London, W.C.2. [0229

VALVES WANTED

ALL types of valves required for cash; state quantity and condition.—Radio Facilities, Ltd., 38, Chalcot Rd., N.W.1. Primrose 9090. [4074

CABINETS

74 walnut veneered TV cabinets.
34¾in high, 19¾in wide, 18in deep; open shelf at 8in up from bottom; TV opening 15½in×12in, speaker opening 9½in×7in, 4 spindle holes, 9½in centres, 2¼in from shelf and 1¾in centres; waterfall top and sloping front, Flexcello castors.—Offers to Box 4015. [4721
LEWIS RADIO have the best selection and finest finish.—See page 143. [0224
G.E.C. make octagonal cabinet, provision for one or two speakers, walnut finish; £13.—Box 4317. [4789
WALNUT radiogram and television cabinets, soundly constructed; stamp for details.—R. Shaw, 69, Fairlop Rd., Leytonstone, E.11. [4330

METERS WANTED

WE urgently require meters of all types, meter components, test equipment, etc.; any quantity, large or small; prompt cash. ANDERS ELECTRONICS, Ltd., 91, Hampstead Rd., London, N.W.1. Euston 1639. [4663

REPAIRS AND SERVICE

MAINS transformers rewound, new transformers to any specification. MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed. F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 47898. [0115

LOUDSPEAKERS repaired promptly.—Model Loudspeaker Service. Bullingdon Rd., Oxford. [4627

MAINS transformers, E.H.T.s, chokes, field coils, etc., promptly and efficiently rewound or manufactured to any specification. LADBROKE REWIND SERVICE, Ltd., 820a, Harrow Rd., London, N.W.10. [0222

SERVICE sheets for hire or sale, over 2,000 models, radio and television, list 1/- s.a.e. enquiries.—W. Gilbert, 24, Frithville Gardens, London, W.12. Tel. She. 3052. [4296

TRANSFORMER rewind service, mains, E.H.T. transformers and chokes, prompt delivery, range of replacement types ex-stock or manufactured to your specification. METROPOLITAN RADIO SERVICE Co., 75, Kilburn Lane, London, W.10. Ladbroke 2296. [0200

NOTICE that Melton Electronics, Ltd., 387, Ashley Rd., Parkstone, Poole, Dorset, manufacture transformers, chokes, line and frame outputs, R.F. and E.H.T. coils, and a complete range of "C" core types.

YOUR enquiries for rewinding all Commercial Types will receive immediate attention. [4669

ELECTRICAL test instruments repaired and recalibrated, all makes, ammeters, voltmeters, multi-range test meters; meters supplied or converted to any range.—Electrical Instrument Repair Service, 329, Kilburn Lane, W.9. Ladbroke 4168. [4016

D. C. BOULTON for repairs to any loudspeaker, specialists on heavy and P.A. types; cone assemblies, field coils, repair accessories, pressure units, microphones; transformers rewound and to specification; motor rewinds.—Lumby St., Manchester Rd., Bradford. Tel. 22838. [0171

ARMATURE rewinding service to the trade, vacuums, drills, grinders, hood dryers, dental motors, vacuum cleaner armatures replaced from stock; 24 hours' service; every job guaranteed we also specialize in complete overhauls and rebuilds of vacuum cleaners; all vacuum cleaner parts, hoses, bearings, fans, brushes for any make in stock.—Regam Electric, 95, Park Lane, Leeds, 1. [0028

PAINTS, CELLULOSE, ETC.

PAINT spraying handbook, 3/6 post free, cellulose and synthetic paints and all spraying requisites supplied; catalogues free.—Leonard Brooks, 53, Harold Wood, Romford. 0207

BUSINESS AND PROPERTY

LOCK-UP shop, electrical, radio, and components, main road, Croydon. Offers—urgent sale.—Box 4397. [6816

LONG-ESTABLISHED small radio, TV, electrical; £2,950 freehold; good living accommodation; modern stock at value; Portsmouth area; owner retiring.—Box 4372. [4808

RADIO and TV business in pleasant country town (W. Midlands); good position, agencies, and connection; a genuine going concern; living accom., 2 rec., kit. bath, 4 bed., garden, garage, all services; freehold. £2,750; s.a.v.—Box 4291. [4798

LARGE, modern, fully equipped, old-established and expanding engineering and electronic engineering factory, A.I.D. approved (public company), has capacity for new developments and current productions in radio and television; manufacturing, assembly, sub-assembly, wiring, etc., pressings and parts, from prototype to finished product.—Write in confidence to Box 3956. [4711

BUSINESS OPPORTUNITIES

YOUR invention or idea considered for outright purchase or production on a royalty basis by firm of electronic engineers.—Apply Box 4124. [4734

FINANCIAL & PARTNERSHIPS

WORKING partner wanted with business experience to build up small electronic subcontract business; must have sound practical knowledge of circuits and wiring layout procedure.—Box 4194. [4740

WORK WANTED

CAN we help Your development or production; assembly and wiring service at your disposal.—R.A.E. Mfg. Co., 135a, Kentish Town Rd., N.W.1. Gul. 7011. [0219

CAPACITY available for small plastic moulds and stamping tools; highest limits, clean work, reasonable prices; speciality; hearing aids and electronic components.—Toolmaker, 23b, St. Stephens Ave., London, W.12. [0084

DESIGN development and prototype construction facilities available in all fields from power supplies to Band 5 front ends, A.M./F.M., etc.; enquiries from the smaller manufacturer especially welcome.—Tel. Granby 1300. Imperial Radio and Television Co., Buxton St., Leicester. [4758

CAPACITY AVAILABLE

WAVE winding capacity available.—Avis & Baggs, Ltd., Gosbrook Rd., Caversham, Reading. [0094

MISCELLANEOUS

TO manufacturers, technical institutes, research depts., etc.
HIGH voltage oil-filled condensers, 5+ 5 mfd, 2,200 volts; normal price 56/- each; limited stock to clear at 12/6 each.—Box 3086. [4538

METALWORK, all types cabinets, chassis, racks, etc., to your own specification; capacity available for small milling and capstan work up to 1in bar.
PHILPOTT'S METAL WORKS, Ltd., (G4B1), Chapman St., Loughborough. [0208

MISCELLANEOUS

COPPER winding wires ex stock, competitive prices, 17 to 48 swgs, plain enamel, tinned, synthetic, silk, rayon, cotton covered and Litz types.—Box 4414. [4819

YOUR own tape recording transferred to disc.—Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio recordings, tape recording service. [4662

DAYLIGHT tinted, 17in×14in glass Triplex, new latest, 2/9. P.P. 1/9; 12in (14in×10in) plate with polished wood frame, 2/9. P.P. 1/9.—Duke & Co., 621, Romford Rd., E.12. Gra. 6677. [4787

LET professionals transfer your tape recordings; record your broadcasts; supply your requirements. D.s. 10in disk 15/6; 12in 18/6. Also LP-S Disk vouchers with tapes purchased from Sound News Productions, 59, Bryanston St., London, W.1. Amb. 0091. [4825

BUILD your own TV and learn about its operation, maintenance and servicing; qualified engineer-tutor available whilst you are learning and building.—Free brochure from E.M.I. Institutes, Dept. WW.58, London, W.4. (Associated with H.M.V.) [0180

CABLE and electrical fittings; best makes only supplied; P.V.C. cable, 3/.029 single 6½d yd, 1/.044 single 5d yd. 3/.029 twin 11d yd, 1/.044 twin 8½d yd; send s.a.e. for full list of switches, sockets, switch fuses, cable, flex, etc.—C. Butherway, Roch, Haverfordwest, Pembs. [4757

COPPER wires enamelled, tinned, Litz, cotton, silk covered, all gauges; B.A. screws, nuts, washers, soldering tags, eyelets, ebonite and laminated bakelite panels, tubes, coil formers; Tufnol rod, headphones, flexes, etc.; latest radio publications, full range available; list, s.a.e.; trade supplied.—Post Radio Supplies, 33, Bourne Gdns., London, E.4. [0138

BUILD your own highly efficient aerial for F.M. Commercial TV, etc., we supply an ex radar antennae display consisting of moulded bakelite insulator, stand off mounting bracket, dipole elements, and director easily adjusted to suit whatever band required; these aerials have cost several pounds to manufacture, our special price only 15/-, plus 1/6 packing and postage.—Walton's Wireless Stores, 19, Lower High St., Wolverhampton. [0145

TV cabinets, large purchase enables us to offer new table cabs. at very keen prices, 1954 model, famous manufacturer, complete mask, glass, spkr., in front, 14in, 35/- plus 6/- p. & p., 17in, 39/-, plus 6/- p. & p.; high flux elliptical speakers, 7in×4in, for above, 16/6; 3-gang condensers, standard size, boxed, new, 3/6; medium brown knobs, grub screws, 4/- doz.; midget, 465, I.F.'s, top make, 9/- pr.; spkr. cloths, brown/cream, latest weave, 10in×12½in, 1/6; chrome-vanadium screwdriver sets, 7 tools in pocket case, normally 15/-, our price 9/6; T.R.F. coils, circuits, M. & L., 5/- set; mains trans., 250-0-250 100ma 6v 4A, mains adj., top qual., 12/-; Westector WX6, 9d; metal suppressor conds., clips, .25mfd, 220v, ideal cars, etc., 4d; .1mf mica mold metal tubs, 5/- doz; valves 813, 50/-; PY31, 4/6; KTW61/63 (6K7), 4/6; etc.; telescopic dinghy masts, ideal TV aerials, rigid, 1¼in diam., 18in closed, 9ft ext., 4/6; radio cabinets, semi-midget, Rexine, back, dial, knobs, fret, new, 9/6; 4amp thermocouple meters with shorting SW, in case, ideal chargers, etc., 4/9; American jack plug adaptors, converting low imp. headphones to high, 2/9; TF336/2 Marconi, wide range, B.F.O., £12/10; mixed resistors, good qual. and assortment, 1/10-3w, 5/- for 60; ditto condensers, 36 for 5/-; small electrolytics, 32+32, 275v.w., 2/6; 10mfd 450v, 2/-; 8mfd, 150v, 6d; 24mfd, 475v.w., 3/-; 2K, 20K W.W. pots., 1/6; satisfaction or money back guarantee; 1,000's valves, components, etc.; no lists; s.a.e. enquiries.—Technical Trading, 311-313, Fratton Rd., Portsmouth. [4762

NOTICES

BRITISH SOUND RECORDING ASSOCIATION. Details of membership, open to the professional sound recording engineer and all others interested in recording high quality reproduction and other branches of audio engineering, together with details of the London lecture programme and the Manchester, Portsmouth and Cardiff Centres, may be obtained from the Hon. Membership Secretary, H. J. Houlgate, A.M.I.E.E., 12, Strongbow Rd., Eltham, S.E.9. [0031

PUBLIC ANNOUNCEMENTS

THE UNIVERSITY OF SOUTHAMPTON.

SCHOLARSHIP in electronics.

APPLICATIONS are invited for a joint post-graduate course in electronics at the University of Southampton and at Vickers Armstrongs, Ltd., Weybridge. The graduate selected will attend the diploma course in electronics at the University during the first year, and will spend the second year training in special projects in the electronics laboratory of the firm. The value of the scholarship will be that appertaining to the firm's graduate training scheme, approximately £400 per annum.—Applications should be made to the Professor of Electronics, University of Southampton. [4720

AGENCIES WANTED

WE intend sending one of our sales managers to Pakistan, India, Ceylon, Burma, Thailand, Malay, Indonesia, etc., during the latter part of this year; manufacturers of radios, parts and electrical equipment seeking new outlets and distributors, and prepared to enter into provisional agency agreements, are invited to communicate with us—B. Ashworth & Co. (Overseas), Ltd., King's House, 36/7, King St., London, E.C.2. [4629

PUBLIC APPOINTMENTS

APPLICATIONS are invited for pensionable posts as
ASSISTANT Examiners in the
PATENT Office
TO undertake the official scientific technical and legal work in connection with Patent Applications. There are a small number of similar posts in the Ministry of Supply. Applications may be accepted up to December 31, 1955, but early application is advised as an earlier closing date may be announced. Interview Boards will sit at frequent intervals. CANDIDATES must be between 21 and 28 years of age during 1955 (up to 31 for permanent members of the Experimental Officer Class) and have First or Second Class Honours degree in physics, chemistry, mechanical or electrical engineering, or mathematics. Candidates taking their degrees in 1955 may apply before the result of their degree examination is known.
STARTING emoluments in London, including Extra Duty Allowance for 45½-hour week, between £532 and £729 (men), £642 (women), according to periods of National Service and post-graduate experience, rising to £896 (men) and £799 (women). Promotion to Examiners: £934 to £1,279 (men), £820 to £1,144 (women); normally after 5 years (3 or 4 years in exceptional cases). Women's scales subject to increase under equal pay scheme. Good expectation of promotion to Senior Examiner. Candidates are recruited by selective interview.
APPLICATION forms and further information from the Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting number S 128/55. [4748

AIR Ministry: Examiner in the Aeronautical Inspection Service (Radar and Wireless Divisions). The Civil Service Commissioners invite applications for 9 pensionable posts. Age at least 25 on April 1st, 1955.
CANDIDATES must have a theoretical knowledge to the standard of the City and Guilds Intermediate Group Certificate in telecommunications engineering. They must have served an apprenticeship or had substantial inspection or development experience with manufacturers of airborne and/or ground radar equipment. Royal Air Force apprenticeship or training to the standard of fitter in radar and/or telecommunications in the Aeronautical Inspection Service, will be accepted as an alternative to experience with manufacturers.
STARTING salary £512 (women £486) at age 25 up to £575 (women £549) at age 28 or over. Maximum £665 (women £596). Women's pay being improved under equal pay scheme. Promotion prospects.
FURTHER particulars and application forms from Civil Service Commission, Scientific Branch, 30, Old Burlington St., London, W.1, quoting No. S 4469/55. Application forms to be returned by July 7th, 1955. [4767

MINISTRY of Supply requires engineer at Chertsey, Surrey, to supervise design staff on radio equipment installation in armoured fighting vehicles; co-ordinate contractors' design work and maintain necessary liaison; qualifications: British of British parents; recognized engineering apprenticeship, or equivalent in electronics, and A.M.I.C.E. or Mech.E. or E.E. or exempting qualifications; experienced installation radio equipment essential, knowledge Services radio and A.F.V.s advantageous; salary within £645 (age 25)-£995; not established, but opportunities to compete for establishment may arise.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D 236/5A. Closing date August 9, 1955. [4775

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order, 1952.

TECHNICAL writers.

A WELL-KNOWN electronic and aircraft servo manufacturer located in the West London area invites applications from experienced technical writers for positions in the engineering division of the company.
THE work would involve the compilation of technical instruction and maintenance manuals covering a wide range of equipment.
PRIMARY qualifications would include a good engineering background in the field of electronics and a marked ability to write clear and essentially readable technical information; some knowledge of the requirements for
SERVICE documentation would be an advantage; the appointments are of an interesting nature and offer permanent employment with good working conditions; a pension scheme is in operation.
WRITE, giving full details of experience and indicating salary required, to Box 3815. [4696

ELECTRICAL/electronic/radio engineers.

A NUMBER of vacancies exist in the design organisation of Vickers-Armstrongs, Ltd., Hursley Park, nr. Winchester.
THE work will include development, design and testing of latest specialised installations in aircraft; applicants with varying qualifications up to Degree standard are invited to apply; salary commensurate with experience and ability; recommendation may be made for housing after qualifying period.
APPLY: Personnel Department, Vickers-Armstrongs, Ltd., Hursley Park, nr. Winchester. [4607

SITUATIONS VACANT

SENIOR Draughtsmen.

DUE to expansion of the Electronics Division of the Plessey Company, Ltd., there are several vacancies for experienced men in the following fields:—

1. DESIGN of a wide range of electronic equipment, including work to Service requirements.
2. MECHANICAL design of precision mechanisms for quantity production.

THESE vacancies carry attractive salaries and long-term prospects in reward for hard work and offer good staff conditions, including superannuation and insurance schemes. Applications, which will be treated in confidence, should be addressed to:—
THE PLESSEY Co., Ltd., Vicarage Lane, Ilford, Essex. [4771

TELEVISION Equipment.

AN internationally known engineering company wishes to appoint a
JUNIOR Engineer.
FOR Development work in connection with Circuit work on Microwave and Television equipment.
THE successful applicant should preferably be a Graduate and, if possible, have had some experience of this type of work.
A FIRST-CLASS salary with excellent prospects is offered to the right man.—Write to Box 4290. [4768

ULTRA ELECTRIC, Ltd.,

WESTERN Avenue, Acton, London, W.3. Draughtsmen.
THE following positions offer excellent prospects to capable men:

(a) Senior Design Draughtsmen for (i) Servo Mechanisms, (ii) Electronics, (iii) Radio and T.V. These departments cover a wide range of mechanical, electro-mechanical airborne equipments, electronics, T.V. and radio development, and give opportunities for the development of new techniques.

(b) Senior Detail Draughtsmen able to produce accurate detail drawings from mechanical layouts. Opportunities of promotion to higher grades.

(c) Checker. First-class man (preferably over 30) with previous D/O checking and workshop experience in light engineering.

(d) Jig & Tool Design Draughtsmen with experience of press tools, jigs and fixtures.

Good salaries, subject to regular review, will be offered to the right men; pension scheme, ideal working conditions and equipment, social club.—Applicants are requested to write (in strict confidence) or telephone (Acorn 3434) to the Personnel Manager.
SATURDAY interviews arranged. [4784

ENGINEERS & Physicists.

FERRANTI, Ltd., in their new Laboratories are engaged in a programme of electronic development of great industrial importance. The work involves the use of digital computers to control machines and industrial processes and covers a wide and expanding field of application, offering long-term interest to those engaged in it.
DEVELOPMENT activity for these projects is taking place in the field of electronic circuitry (including pulse technique), digital computers, magnetic recording and servomechanisms; engineers and physicists having experience as well as interest in one or more of these subjects are invited to apply.
THE appointments are permanent and offer full scope for initiative in an expanding organization; a salary commensurate with the qualifications required will be paid; staff pension scheme; application form will be sent on request (quoting Ref./EP/AL) to—The Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5. [4718

AIR TRAINERS, LIMITED.

BICESTER Road,
AYLESBURY, Bucks.
SEVERAL vacancies in the folowing grades exist for interesting work at good salaries on the development of flight stimulators and other training equipment.
DESIGN Engineers.
TECHNICAL Assistants.
LABORATORY Assistants.
WITH experience in any way of the following:
PULSE Techniques.
SERVO Mechanisms.
CIRCUIT Development.
APPLICANTS for the post of design engineer should possess a degree of the H.N.C.; house available.
PLEASE reply in writing to the Personnel Officer. [4779

SENIOR Technical Engineering Staff.

A LONDON engineering company invite applications from project engineers who are capable of taking charge of microwave, electronics and mechanical engineering development in connection with guided weapon and other applications; these positions are permanent and offer ample opportunity for further advancement; the commencing salaries which will be in the region of £1,000 per annum upwards according to qualifications and experience, will be subject to review on a generous scale; engineering degree or H.N.C.—Replies, which will be treated in utmost confidence, should give full details of qualifications and experience and be addressed to Box 4313. [4778

SITUATIONS VACANT

LONDON COUNTY COUNCIL.

NORWOOD Technical College, September, 1955; assistants Grade A and Grade B for duties mainly in connection with classes for P.M.G. Cert. Exams. in Radiotelegraphy and Radiotelephony; should possess P.M.G. 1st class certificate, seagoing experience and good knowledge of technical electricity, the theory of operation and maintenance of ship's radio equipment; Ministry of Transport Radar Maintenance Certificate and/or experience of Marine Radar equipment or knowledge of television an advantage; both posts temporary in first instance; Burnham F.E. salary scale (1) Grade A, £486×£18—£773; (2) Grade B, £561×£25—£868 with additions for graduation and training if applicable; individual minimum and maximum according to age, qualifications and experience; application forms from—Secretary at College, Knight's Hill, S.E.27, returnable within 14 days. (807) [4802

RADIO & Television Engineers.

FIRST-CLASS openings for experienced television engineers and senior design draughtsmen will shortly become available with a firm of repute 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 4413. [4822

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 Circuits.
PULSE Modulators.
STROBE Systems.
VIDEO Amplifiers.
TIME Base Generators, etc.
H.F. AND V.H.F. Communication—airborne and ground receivers, transmitters and aerial systems.
APPLICANTS should have had technical training to Degree or Higher National Certificate standard, and in the case of project engineers and engineers appropriate technical design experience is necessary.
COMMENCING salaries will be dependent on qualifications and experience, and will compare favourably with scales prevailing in the radio industry. A superannuation scheme is in operation. Applicants should apply in the first instance for a technical staff application form to Personnel Manager, E. K. Cole, Ltd., Malmesbury, Wilts. [4702

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

TRANSFORMER design.
A VACANCY has arisen at the Feltham laboratories of this active Co., 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 the field; but this is not a pre-requisite for consideration; the post is pensionable, and prospects are excellent; please send your first reply to Personnel Dept., (ED/235), E.M.I. Engineering Development, Ltd., Blyth Rd., Hayes, Middx. [4677

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

MICRO-WAVE design work.
AN engineer is required at the Company's Feltham laboratories 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 pensionable post, and prospects in the Co., which is steadily expanding, are considerable; —Please reply in the first instance to Personnel Dept., (ED/245) E.M.I. Eng. Dev., Ltd., Blyth Rd., Hayes, Middx. [4681

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

A VACANCY has arisen for an electrical/radio engineer at the company's laboratory at Feltham; this post would be especially suitable for a H.N.C. man with service experience as a Radar or Communications craftsman; the salary for this pensionable post is good, and prospects are excellent.—Please reply in the first instance to Personnel Dept. (ED/242), E.M.I. Eng. Dev., Ltd., Blyth Rd., Hayes, Middx. [4685

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

EXPERIENCED valve engineer.
AN interesting vacancy has arisen at the Company's Feltham laboratories for a valve engineer with 4-6 years experience of both valves and micro-wave generators; applicants who should be qualified, will have some knowledge of testing both in quantity and for special purposes, will be able to design suitable test equipment, and have some applications experience; the salary offered for this pensionable post is attractive, and the prospects in this active Co., are excellent.—Please address your first reply to Personnel Dept., (ED/244), E.M.I. Eng. Dev., Ltd., Blyth Rd., Hayes, Middx. [4692

SITUATIONS VACANT

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

REDEVELOPMENT Authority.
A VACANCY has arisen for a senior electronics engineer who will be prepared to take over, on behalf of the Company, full responsibility for a Radar or Communications system used by the Services; his main tasks will be to formulate plans for redevelopment with special reference to increasing the reliability and extending the use of the equipment; the post carries an attractive salary and is pensionable and holds out great opportunity for the right man.—Reply in the first instance to Personnel Dept. (ED/240), E.M.I. Eng. Dev., Ltd., Blyth Rd., Hayes, Middx. [4683

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

AIRCRAFT electronic equipment.
AN extremely interesting vacancy has arisen within the Co., for an engineer to take responsibility for the solution of problems associated with the installation of all types of electronic equipment in aircraft; the successful applicant must have had wide experience in this field; he must appreciate both the aeronautic and the electronic engineer's viewpoint; the post is pensionable the salary will be commensurate with ability and experience, and the prospects are excellent; please reply in the first instance to, Personnel Dept., (ED/241), E.M.I. Engineering Dev., Ltd., Blyth Rd., Hayes, Middx. [4684

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

ASSISTANT trials planner.
AN assistant is required for trials planning at the Company's Feltham laboratories. The engineer we are looking for will have H.N.C. or similar qualifications, and 3-6 years' experience, preferably in trials activity, and should be willing to travel; a knowledge of telemetry will be a distinct advantage; the salary for this pensionable post is attractive and prospects in this active and steadily expanding company are excellent; please reply in the first instance to Personnel Dept. (ED/246), E.M.I. Engineering Development, Ltd., Blyth Rd., Hayes, Middlesex. [4682

LOUIS NEWMARK, Ltd., have vacancies in their expanding laboratories for YOUNG Engineers with Inter B.Sc., H.N.C., or Degree and some experience in electronics for work on automatic pilots and other electronic devices; good salary and prospects.—Apply, Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey. [4801

THE United Kingdom Atomic Energy Authority requires a
TECHNICIAN (Grade II) at Aldermaston, Berks., to control technical and other staff forming a team engaged upon the preparation and maintenance of complex telemetry equipment used in field trials. Duties will include supervision of work both in laboratory and in the field and involves active participation in the trials which may entail periods of detached duty at other stations. Applicants must have had approved practical training and experience in electronic or radio engineering. Previous experience of field trials and ability to work with the minimum supervision from professional staff are essential. Possession of an appropriate National Certificate or equivalent technical qualifications would be an advantage.
SALARY £710 (age 30) to £830 (male). The successful applicant will be required to join the Authority's contributory superannuation scheme. Housing accommodation will be available within a reasonable period at Aldermaston if the successful applicant is married and living outside the radius of the Establishment's transport facilities; during the waiting period a lodging allowance may be payable. The Authority may be able to assist in the purchase of a house.
REQUESTS for application forms by Post Card to Senior Recruitment Officer, A.W.R.E., Aldermaston, Berks. Quote Reference 344/WGE/45. [4804

PYE TELECOMMUNICATIONS, Ltd., Ditton Works, Cambridge, offer:—
EXCELLENT opportunities for junior and senior development engineers in the electronics and communications field.
DUTIES include development work on H.F., V.H.F., microwave and recording equipments.
APPLICATIONS from persons possessing B.Sc., Higher National or Ordinary National Certificates especially welcomed.
GOOD facilities available, however, to keen young men wishing to train and study in these fields.
PLEASANT working conditions in modern factory; single accommodation available.
WRITE, giving fullest details to Personnel Manager. [4622

FERRANTI, Ltd., Moston, Manchester, have the following urgent requirements for Technical Assistants in their Physical Laboratory in connection with the development of Cathode-ray Tubes, including tubes for colour television and for associated projects.
1. GRADUATE in Physics or General Science for work on Colorimetry and Photometry.
2. HIGHER National Certificate candidate with an interest in radio or television circuitry.
PERMANENT staff appointments with pension benefits.
APPLICATION forms from Mr. T. J. Lunt, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. Please quote reference JAD (1) or (2). [4820

SITUATIONS VACANT

THE United Kingdom Atomic Energy Authority, Aldermaston, Berks, requires TECHNICIANS Grade II and III for the following duties:—

656/WGE/45. Technician Grade II to be responsible for the specification of components to be used in complex electronic equipment and to progress the production of such equipment by outside contractors. Applicants should have had extensive experience in the specification and inspection of electronic components and be capable of deducing from circuit diagrams the tolerances and working limits of the components required.

657/WGE/45. Technicians Grade III to work in a team engaged on the development of control systems making use of relays, uniselectors and audio-tone systems. Experience of the installation, maintenance and testing of automatic telephone exchanges and carrier telephony is desirable.

658/WGE/45. Technicians Grade III to work on complex electronic instruments, both in the laboratory and on field trial sites. The work involves the development of new circuit designs, installation of equipment on trial sites and maintenance and manning of the equipment during trials. Previous experience of the construction testing and adjustment of complex electronic equipment is essential. Some experience in one or more of the following fields would be an advantage: V.H.F. transmission and reception, High Speed Pulse circuits, High Speed oscillography, Audio-frequency systems, Extra High voltage work. Successful applicants against 658/WGE/ will be required to serve periods of duty overseas.

APPLICANTS for all posts should have served a recognised engineering apprenticeship or have had equivalent training in an appropriate trade.

SALARY.

TECHNICAL Class Grade II £710 (age 30) £830 p.a. (male).

TECHNICAL Class Grade III £575 (age 26) £715 p.a. (male).

SUPERANNUATION. The successful applicants will be required to join the Authority's contributory scheme.

HOUSING. Housing accommodation will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities or alternatively the Authority may be able to assist successful applicants in the purchase of a house. During this period a lodging allowance may be payable.

REQUESTS for application forms by Post Card to Senior Recruitment Officer, A.W.R.E., Aldermaston, Berks Quoting the appropriate reference number. [4805

WIRELESS Station Superintendent required for the POST and Telecommunications Department, Gold Coast Local Civil Service, for two tours of 18 to 24 months in the first instance. Consolidated salary scale £990 rising to £1,230 a year. Gratuity at the rate of £100/£150 a year. Outfit allowance £60. Liveral leave on full salary. Free passages. Candidates should possess C. and Gds. Final Certificate in Telecommunications (Radio) or C. and Gds. Certificates Radio III and IV equivalent, and have had three years' experience in two or more of the following fields:—V.H.F. link systems; H.F. communications systems; frequency shift keying and teleprinter maintenance; V.H.F. and H.F. cathode ray direction finding system; aeronautical navigation aids (ground); manufacture of light engineering equipment.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/29100/WF. [4796

ASSISTANT lecturer (radio engineering) required for the EDUCATION Dept., Nigerian Federal Government for two or three tours totalling 36 months; appointment either (a) on temporary terms with salary scale (including expatriation pay) £807 rising to £1,453 a year plus resettlement grant at rate of £100/£150 a year or (b) with prospect of permanency with salary scale (including expatriation pay) £750 rising to £1,315 a year. Outfit allowance up to £60; free passages for officer and wife; assistance towards cost of children's passages or grant up to £150 annually for maintenance in United Kingdom; liberal leave on full salary; candidates, with H.N.C. in electrical engineering, must have had sound training in radio receiving and transmitting work and must be able to teach feeder and aerial theory; theory and practice of all types of recording apparatus and general audio and acoustic theory. They should have had wide experience in the industry and experience of teaching.—Write to the Crown Agents, 4, Millbank, London, S.W.1; state age, name in block letters, full qualifications and experience and quote M2C/40373/WF. [4783

E.M.I. ENGINEERING DEVELOPMENT, Ltd., invite applications from senior development engineers to take responsible positions on the technical staff of the Company for work in the following fields:—

(a) Circuit development, including the investigation of methods of Klystron modulation outside the micro-wave region.

(b) Engineering experimental units to withstand difficult environments.

(c) Design of laboratory test gear, particularly for use in the field.

VACANCIES also exist for engineers with more limited experience; the posts are pensionable and carry excellent salaries and prospects.—Applicants should write with full details to Personnel Dept., (ED/217) E.M.I. Eng. Dev., Ltd., Hayes, Middx. [4781

SITUATIONS VACANT

ULTRA ELECTRIC, Ltd., Western Avenue, Acton, London, W.3 ANNOUNCE the following vacancies for ENGINEERING Staff:—

(1) TELEVISION Development.

(a) SENIOR ENGINEERS required for TV receiver design; applicants should have good academic qualifications and experience of the design of radio frequency amplifiers, preferably 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.

(c) JUNIOR ENGINEERS with academic qualifications or experience in TV receiver development.

(2) RADIO DEVELOPMENT

(a) SENIOR ENGINEERS required for development of radio receivers embodying the most recent AM/FM techniques, knowledge of FM receiver design desirable.

(b) JUNIOR ENGINEERS required for receiver design; experience desirable but not essential if possessing Hr. N.C. or C. & G. (Telecoms.) Final Cert.

(3) ELECTRONICS.

(a) SENIOR ELECTRONICS ENGINEER with some experience of circuit design for work in one of the following:

(i) Pulse techniques and general waveform circuitry.
(ii) Radar display.
(iii) Feedback techniques at video frequencies.
(iv) Simple servo devices.

SUCCESSFUL applicants will have opportunities of studying recent American techniques and they should be capable of accurate recording of experimental and design data and the preparation of technical servicing information.

(b) ELECTRONIC ENGINEERS for work on one or more of the above subjects.

(4) TEST EQUIPMENT DEVELOPMENT.

(a) TEST EQUIPMENT DEVELOPMENT ENGINEER for design and development of production test equipment for TV, radio or contract work; applicants should have Hr. N.C. or equivalent and good experience.

(b) JUNIOR T.E. ENGINEER with some qualifications or preferably some experience.

(c) MEASUREMENTS SECTION LABORATORY ASSISTANT (m. or f.) with some technical knowledge and experience of calibration and certification of electronic equipment.

APPLICANTS are requested 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 arranged if desired. [4590

BURNDEPT, Ltd., have vacancies, due to expansion, for:

(1) TELECOMMUNICATIONS Development and Research Engineers. Qualified to operate as project leaders under direction of Chief Engineer on Government and proprietary designs. Experience must be within one or more of the following fields:

(a) AERONAUTICAL Telecommunications, both airborne and ground station designs, with special emphasis on U.H.F. techniques with the field.

(b) F.M. single- and multi-channel equipment development in both V.H.F. and U.H.F. bands.

(c) DEVELOPMENT of subminiaturisation techniques and special components.

(2) TELECOMMUNICATIONS Laboratory Instrument Mechanics and Wiremen.

MUST be fully conversant with modern miniature and subminiaturisation techniques, and be able to wire from circuit diagrams on own initiative. Those capable of converting experimentally wired models to final stage by own initiative will receive special consideration. Excellent working and model shop facilities.

APPLICATIONS, giving full particulars, including present salary, should be sent in confidence to Personnel Manager, Burndept, Ltd., Erith, Kent. [4698

EX-NAVAL R.E.A.s. R.E.s or R.A.F. air or ground radar fitters.

APPLICATIONS are invited for employment on development and prototype testing of radar and guided weapon equipments; there is plenty of scope for enthusiastic men with initiative and ability; the work is interesting and working conditions are good; the positions offered are permanent and are covered by a contributory pension scheme; salary according to age and experience.

APPLICATIONS should be made to the Personnel Manager, The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. Ref. RG/B. [4710

THE PLESSEY COMPANY has vacancies for development engineers familiar with one of the following subjects:—

(a) VARIABLE capacitors.
(b) SWITCHES for radio or electrical appliances
(c) V.H.F. or U.H.F. circuits and tuning mechanisms.
(d) RELAYS 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 able to undertake responsible design work after a period in the laboratory. All posts are permanent and pensionable and a modern laboratory provides efficient and agreeable working conditions. Send particulars of qualifications, experience and salary required to the Personnel Manager, The Plessey Company Limited, Ilford, Essex. [4811

SITUATIONS VACANT

ELECTRONIC component manufacturers have vacancies for the following:—
TECHNICAL assistants for sales department with ability to correspond clearly, logically, and courteously on engineering and commercial subjects—knowledge of publicity and export advantageous.
TECHNICAL sales representatives for London and South—must be car owners, but previous sales experience not necessarily essential.
ALL posts are pensionable and permanent; all applicants must have sound engineering experience in radio, T.V., and the general science of electronics; write age, experience, salary.—Box 4123. [4732

ASSISTANT engineer (telecommunications and electronics) required for their LONDON office by the Crown Agents for overseas governments and administrations; basic salary scale £650×£25 to £750×£30 to £960×£40 to £1,000 plus extra duty allowance of approximately 8 per cent and a pay supplement of from £25 to £35 a year; the £650 minimum is linked to entry at age 25 and is subject to increase at the rate of one increment for each year above that age up to 34; fully qualified officers at least 27 years old may be eligible for a special increase of £75 after two years' service; engagement on unestablished terms with prospect of appointment to the established staff after five years' service and of promotion; candidates should be between 25 and 35 years of age and have a degree in electrical engineering (Telecommunications and Electronics) or be a Graduate or Corporate member of the Institution of Electrical Engineers; they should have had works experience with an established firm specialising in telecommunication and electronic equipment and have had subsequent operating or design experience of this type of equipment; previous contract experience would be an advantage; the duties of the post will entail the purchase of all types of telecommunication, broadcasting and other electronic equipment including the preparation of detailed specifications to enable tenders to be invited, and adjudication thereon; also, the preparation of reports giving advice to administrations on problems connected with this type of equipment; write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2A/40772/W.F. [4676

THE UNITED NEWCASTLE UPON TYNE HOSPITALS.
A VACANCY exists for a technical assistant in the physics laboratory at the Royal Victoria Infirmary, Newcastle upon Tyne. Candidates must have the General Certificate of Education and a good basic knowledge of electricity. Age preferably between 18 and 25. The successful applicant will have opportunities of assisting in research with radio-isotopes as well as deputising for the technician in charge of the 4-million-volt linear accelerator at the Newcastle General Hospital. Salary will be £175 at 18 to £350 at 25 or £450 to £515 if sufficiently experienced.—Applications, together with the names and addresses of two referees, should be sent to the House Governor and Secretary, Royal Victoria Infirmary, Newcastle upon Tyne, as soon as possible. [4738

THE TELEGRAPH CONSTRUCTION & MAINTENANCE Co., Ltd., Cable manufacturers, wish to appoint:—
1. SENIOR Technical Assistant to take charge of Power Cable Test Room; comprehensive experience in electrical testing and examination of low and high tension cables for voltages up to 33 kV or higher; education to H.N.C. desirable.
2. TEST Assistant, H.N.C. or approved equivalent with experience in high frequency testing. THESE posts are pensionable; 5-day week, all welfare facilities; salaries in accordance with qualifications and experience; write details to—Personnel Manager, Telcon Works, Greenwich, S.E.10. [3717

COMPETENT TV and radio engineer, able to drive; excellent salary and prospects; S.W.3 district.—Box 3140. [4588

SENIOR TV engineers required; must drive; salary from £650 p.a.—Apply E. Coyne, 120, Ladbroke Grove, W.10. Bay. 1947.

PRODUCTION engineer required for production of miniature electronic components and test gear.—Ardente, Ltd., 62, Horn Lane, Acton, W.3. [4714

TOP grade radio service engineers required for expanding company; excellent salary and prospects.—Apply to Telefonic Radio, Ltd., 3a, Church St., Slough, Bucks. [4739

EXPERIENCED Radio Engineers required, preferably with "A" licence.—Apply, Chief Engineer, Eagle Aircraft Serviced, Ltd., Blackbushe Airport, Camberley, Surrey. [4719

TV Engineer required, Enfield (London) area, accommodation available after 6 months if required; details of experience and salary to—Box 4370. [4803

RADIO and/or television engineer required for bench and outside repairs, driver; references, age, experience, salary expected.—Field's Radio, Ltd., 52, Hall Gate, Doncaster. [3[illegible]

RADIO Engineer required for Manila by radio communications company; experience in high power fixed point to point radio communications essential.—Apply Box 4211. [4744

ELECTRICAL SERVICE (EDGWARE), Ltd., require good service engineer, bench and outside; clean licence; top salary; permanent; congenial.—93, Edgware Rd., W.2. Pad. 2342. [4797

SITUATIONS VACANT

RACAL ENGINEERING, Ltd., require additional staff for their rapidly expanding new factory at Bracknell, Berkshire. The following posts are immediately available:—
(a) SENIOR Radio Engineer for Microwave design, development and production. A University degree/A.M.I.E.E. or equivalent is essential together with considerable experience in this field.
(b) SENIOR Radio Engineer for H.F. transmitting equipment of powers up to 10kw. A knowledge of S.S.B. techniques would be advantageous. A University degree/A.M.I.E.E. is desirable but applicants with proved experience will be considered.
(c) ELECTRO-MECHANICAL Engineer for design and development work to assist in the general mechanical construction of radio and electronic equipment. 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) JUNIOR Radio Engineers for design and development work in many new applications of electronics in communications and industry. Minimum qualifications are H.N.C. or C. and G. (Telecomms.) Final Certificate.
(e) MODEL Shop Mechanics 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 wiremen.
PERSONS desirous of working in a progressive organization at a modern factory in country surroundings are invited to apply, giving full details of their previous experience and qualifications. Housing will be available to approved applicants from the Greater London Area. Racal Engineering, Ltd., Bracknell, Berkshire. [4770

DRAUGHTSMAN required for detail work on Radio Components. Apply in writing to Personnel Manager, A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garratt Lane, S.W.18. [0059

FERRANTI, Ltd., Moston, Manchester, have a number of vacancies in their Computer Department arising out of the continuing progress of this new and important part of the Ferranti organization. They are as follows:—
(1) ELECTRICAL Engineers and Physicists for design groups concerned with all aspects of electronic computing systems including circuitry, storage systems, visual displays, etc., and for basic research on new techniques.
(2) MECHANICAL Engineer 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 structures due to heating and centrifugal effects and with high-precision work involved in overcoming bearing and balancing problems. A knowledge of small motor design would be an asset.
(3) MAGNETIC Recording Engineer for investigations into special recording heads and magnetic coatings.
(4) ELECTRICAL Engineer for investigations into special 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 benefits.—Application forms from Mr. T. J. Lunt, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. Please quote reference CD (M) 1, 2, 3 or 4. [4747

DRAUGHTSMEN required, electro-mechanical work of varied nature; knowledge of circuitry an advantage.—Apply (quoting Ref. STK.196), The General Electric Co., Ltd., Union Works, East Lane, Wembley. [4774

RADIO service mechanics required by Smiths (Radiomobile), Ltd., for many parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [0342

SALESMAN required for radio and T.V. components, good prospects, permanent position, previous experience an advantage.—Lasky's Radio, 42, Tottenham Court Rd., W.1. Museum 2605. [4728

QUALIFIED electronic engineers urgently required for the research division of a prominent North London company; applicants should possess initiative and be accustomed to a high degree of responsibility.—Write Box 4315. [4782

HEARING aid manufacturers, north-west, require experienced mechanics to work on specialized production; ex-Service personnel welcome; give fullest details past employment, salary required; own staff advised.—Box 4292. [4769

ELECTRONIC technician.—An opportunity occurs for a young technician possessing some experience of fault finding, repair and inspection of electronic equipment, to join a small group engaged upon a unique and interesting production project.
THIS would suit a young and ambitious man wishing to progress to engineer or administrative status, S.W. London area.—Write, stating details of experience and technical training, to Box 3921. [4705

GOOD opportunities for engineers with knowledge of high frequency cables and/or television in the design department of a firm developing wire broadcasting systems near London.—Write giving full details of experience and salary required to Box 4314. [4780

TRAINEE television service engineer required by old-established London retail radio and electrical business; good opportunity for keen man with aptitude for this work, driving experience essential; state age and full details of career.—Box 4318. [4792

SITUATIONS VACANT

EXPERIENCED radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wirers and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238

SENIOR and junior electronic engineers required for high fidelity sound reproduction projects; applicants should give full details of qualifications and experience by letter to Chief Engineer, Pye, Ltd., St. Andrew's Rd., Cambridge. [4487

McMICHAEL RADIO, Ltd., Slough, Bucks, have vacancies from time to time for electronic engineers to be engaged on Government projects; those wishing to be considered are invited to write fully to the Chief Engineer, Equipment Division. [0198

SENIOR Transformer Designer required to take charge of design office dealing with small transformers, power, audio, pulse, etc. Excellent prospects for an engineer with practical experience as well as academic knowledge. London area.—Box 3026. [4528

FOREMAN required for electronic company, small batch production of high-quality equipment; excellent prospects in expanding organisation for person with ability and drive. —Rivlin Instruments, Ltd., 7a, Maitland Park Villas, London, N.W.3. Gul. 2960. [4688

ELECTRONIC engineers required for a new research project on Automation of Machine Tools, at a large Midland factory; there are excellent prospects for enthusiastic and capable men; commencing salary £600-£800 per annum. —Box 4103. [4729

EXPERIENCED sound engineers required immediately for servicing cinema and sound reproducer equipment in Manchester area.—Write, giving details of experience, to the British Thomson-Houston Co., Ltd., Construction Department, 15, Quay St., Manchester, 3. [4587

INDEPENDENT TELEVISION NEWS, Ltd., the company responsible for news programmes for all programme contractors appointed by the Independent Television Authority, invites applications for television transmission engineering staff in the following categories for shift work in central London:
1. OPERATION and maintenance engineers, applicants should have sound knowledge of fundamentals and experience of image-orthicon and/or vidicon camera equipments.
2. ELECTRONIC cameramen/technical assistants; applicants should be either electronic technicians with photographic or cine interest or photographers or cinematographers with electronic interest.
APPLICATIONS, with full details of experience, should be addressed to: The Secretary, Independent Television News, Ltd., Ingersoll House, Kingsway, London, W.C.2. [4800

TECHNICAL Publications.—Electronic Development Engineers, Senior and Junior, with a leaning towards Technical Writing to undertake the preparation of Instruction Manuals for Radar and like projects. A working knowledge of Pulse Circuitry and Microwave Techniques essential.
SENIOR Illustrator required, with experience of preparation of circuits, block diagrams, perspective and exploded views.—Apply, giving full details of experience, age, etc., to the Personnel Manager, The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry.

TRANSFORMER Designer required for development projects involving audio-frequency power transformers, pulse transformers, oil-filled units, etc.—Apply, stating age, qualifications and experience, to The Personnel Manager (Ref. R.G.), The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [0260

METALLURGICAL factory in Buckinghamshire requires male laboratory assistant with some experience of electronics for operation of direct reading spectrograph, on shifts; training on the instrument will be provided; apply, stating age and experience, to—Box 3410. [4630

SALES assistant; old-established British company in Bangkok requires sales assistant for department handling radio, cinema, TV and associated items; age 23-27; good education; sales experience more important than technical competence.—Write Box MA/152, c/o 95, Bishopsgate, E.C.2. [4746

TELEVISION field and bench service engineers required immediately for modern service department of leading radio retailers in East London; wages up to £14 per week or according to ability; permanent position.—Apply for interview to Leytonia Radio, Ltd. Tel. Leytonstone 1396. [4271

RADAR and radio mechanics are required by the Electronics Division of Microcell, Ltd., which is now being established. The work is interesting and experienced men will be paid good rates.—Applicants are invited to write full details of past experience to the Manager, Electronics Division, Microcell, Ltd., 56, Kingsway, London, W.C.2. [4694

EXPERIENCED engineers are invited to apply for a position where energy, initiative and skill will be well rewarded. The work relates to the development of television circuits, and the design of components for large scale production. Experience of television receiver design is required in respect to means of scanning and focussing of the design of R.F. and I.F. circuits. The position is a permanent one which offers scope for advancement to a senior position. The commencing salary will be in accordance with experience, based on a generous and progressive scale.—Write, giving full personal particulars to the Personnel Manager, The Plessey Company, Limited, Ilford, Essex.

SITUATIONS VACANT

ELECTRONIC engineer required to design and develop electronic instruments and test gear; experience in this field essential; good salary and excellent prospects for advancement in expanding company.—Rivlin Instruments, Ltd., 7a. Maitland Park Villas, London, N.W.3. Gul. 2960. [4690

INSPECTOR required for small batch production of electronic equipment; adequate technical knowledge and ability to work with minimum supervision; excellent prospects for right person in expanding company.—Rivlin Instruments, Ltd., 7a. Maitland Park Villas, London, N.W.3. Gul. 2960. [4689

DRAUGHTSMEN required Electro-Mechanical work of varied nature. Knowledge of circuitry an advantage but not essential. Salary in accordance with age and experience. Pension scheme.—Write giving details of experience, etc. (quoting Ref. STK.199), The General Electric Co., Ltd., Union Works, East Lane, Wembley, Middlesex. [4813

TRANSFORMER Design Engineer, with experience in mass production of small transformers for electronic industry, required by progressive firm in West Country; applicant must have initiative, ability to control staff, and ambition to take departmental responsibility; write, with full details of age, experience and salary required to—Box 4371. [4806

ELECTRONIC engineers are wanted in large Midland engineering plant, the positions are progressive and interesting requiring qualified and experienced electronic engineers, senior and junior for rapidly expanding laboratory engaged upon measurement and control problems.—State age, qualifications and experience fully, in confidence to Box 3686. [4678

CHIEF Inspector required by radio component manufacturers to take charge of mechanical inspection of piece parts and final electrical testing; knowledge of loudspeakers an advantage—Write, giving details of past experience and salary required, to Electro Acoustic Industries, Ltd., Stamford Works, Broad Lane, Tottenham, N.15. [4826

TEST gear design engineers and maintenance engineers required with practical experience of this class of work, based on sound knowledge of electronic principles; these vacancies are permanent and progressive; a company pension scheme in operation; London area.—Please write, in confidence, giving full details of qualifications, to Box 3996. [4715

DEAF aids.—Wanted for West End, first-class prototype craftsman able to make up apparatus to very high standards and familiar with machines for doing this; electrical knowledge an advantage but not essential; high salary paid to suitable applicant, only first-class craftsmen need apply.—Reply in confidence to Box 3957. [4713

PYE, Ltd. Radio Works, Cambridge, invites applications for positions as technical authors and illustrators for the compilance of maintenance handbooks dealing with radio equipment: applicants must possess command of English and some technical knowledge.—Applications in writing to Assistant Personnel Officer. [4704

AN Assistant Development Engineer is required who is accustomed to telephone practice, including simple automatic systems; he should have some knowledge of audio frequency electronics and of acoustics; the salary would be in the range £550—£650 p.a.—Apply to Chief Engineer, Winston Electronics, Ltd., 1, Park Rd, Hampton Hill, Middlesex. [4628

ELECTRONIC engineers are wanted in large Midland engineering plant, the positions are progressive and interesting requiring qualified and experienced electronic engineers, senior and junior for rapidly expanding laboratory engaged upon measurement and control problems.—State age, qualifications and experience fully, in confidence, to Box 3082. [4534

VACANCIES exist for engineers in radio and radar field at our various depots; applicants should possess 1st class P.M.G. wireless certificate or Ministry of Transport certificate; applications from long service naval personnel welcomed.—Reply to, W. H. Smith & Co., Electrical Engineers, Ltd., 68, Grosvenor Street, Manchester, 1. [4648

YOUNG men required for assembly, wiring and testing of electronic apparatus, some experience with scientific instruments an advantage, technical school education, must have completed National Service; pension scheme 5-day week, canteen; Camden Town district; salary according to age and experience.—Please apply, stating age and experience, to Box 3589. [4625

ELECTRONIC engineer required for strain gauge department to assist in maintenance and development of equipment for the measurement of vibration and stress in helicopters and fixed-wing aircraft; applicants should be of degree standard and should write to the Personnel Manager, The Fairey Aviation Co., Ltd., Hayes, Middlesex, under reference R.D.T.

SENIOR and junior design draughtsmen reqd. for interesting work in connection with electronic equipment, commercial radio and television and/or light electro-mechanical engineering; London area; the positions vacant offer ample scope and opportunity for future advancement to men of good ability; a high salary will be paid to the selected candidates; all recognized staff privileges available.—Please reply, giving full details of experience, to Box 4293. [4772

SITUATIONS VACANT

ELECTRONIC Laboratory Assistant required for experimental work and electrical measurements; superannuation scheme; write, stating age, qualifications and/or experience and salary required to—Personnel Manager, The The Telegraph Condenser Co., Ltd., North Acton, W.3. [4724

A. H. HUNT (Capacitors), Ltd., require Draughtsmen, preferably with mechanical and electrical experience, for work on special purpose machines. Write giving age and previous experience to Personnel Manager, A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garratt Lane, Wandsworth, S.W.18. [0057

HATFIELD INSTRUMENTS, Ltd., who are now expanding their laboratories, required senior and junior electronic engineers with experience in the design and test of high grade radio and industrial laboratory equipment.—Apply in writing, in the first instance, stating age, experience and salary required, to Hatfield Instruments, Ltd., 175, Uxbridge Rd., Hanwell, W.7. [4452

DEVELOPMENT engineers required in departments covering the design and construction of high-grade television transmission equipment and a wide range of electronic equipment; good fundamental knowledge required and some practical commercial experience desirable; pension scheme, 5-day week, good canteen.—Write, stating age, experience and salary required, to career, etc., to Box A. 110, c/o Central News, Ltd., 43, London Wall, E.C.2.

LINESMEN (construction and maintenance of underground and overhead circuits) and Service Inspectors (maintenance of machines). Permanent pensionable staff posts in London, available for young men 20/24 yrs. of age, in connection with teleprinters and ticker tape machines. Some experience preferred.—Write age, particulars of career, etc., to Box A. 110, c/o Central News, Ltd., 43, London Wall, E.C.2.

ELECTRONIC/ELECTRICAL engineer required by London manufacturers of radio components to take charge of measurements laboratory and test gear design; experience of measurement of capacitors or telecommunication cables essential; salary range £750 to £850 p.a., company rapidly expanding; write details of qualifications, experience, age and present salary.—Box 3778. [4687

ELECTRONIC Engineer with good knowledge of H.F. measurements and interference suppression required for work in connection with measurement of radio and television interference; superannuation scheme; write giving full details of age, qualifications, experience and salary required to—Personnel Manager, The Telegraph Condenser Co., Ltd., North Acton, W.3. [4722

SENIOR Development Engineers required for development of radio receivers and radiogramophones, television receivers, printed circuit and transistor receivers. The positions are progressive and offer a good salary. Applications, stating qualifications experience and salary required, should be forwarded to the Chief Development Engineer, T.V. Manufacturing, Ltd., Oulton Works, Lowestoft. [4695

JUNIOR Electronic Engineers/Radio Mechanics wanted for installation, maintenance and operation small radio transmitting stations in U.K. and abroad; candidates must have good basic training in radio and some industrial experience; must be single and medically fit and prepared to travel abroad; excellent prospects; U.K. salary up to £500 after training and very much more abroad.—Write Box 4017.

RADIO technicians required by International Aeradio, Ltd., for overseas service; permanent and pensionable positions, inclusive salary from £894 per annum to £1,373 per annum, tax free, according to marital status; free accommodation; kit allowance; free air fares; generous U.K. leave.—Qualified candidates to whom replies only will be sent please write quoting RT to Personnel Officer, 40, Park St., W.1. [0262

A VACANCY exists for an Electronic Instrument Development Engineer in the Telecommunications Laboratory of British Insulated Callender's Cables, Ltd., at Kirkby, Nr. Liverpool; candidates should hold a degree in physics or engineering and have previous experience in the design and development of electronic instruments; applications, quoting reference P/60/54, should be addressed to—The Staff Officer, B.I.C.C., Ltd., Prescot, Lancs. [4725

DEVELOPMENT Engineers.—A leading Manufacturer of Radio and Television Receivers has vacancies in its Laboratories for Electronic Engineers with experience in the Design and Development of this tpye of equipment. Situated in the Midlands Salaries according to qualifications and experience.—Those interested should write, giving details of career and salary expected to the Personnel Manager (Ref. GLB.) Box 2541. [4427

SYSTEM test engineer; an electronic engineer is required to assist in final tests on part of a missile system; some theoretical knowledge useful but several years practical experience necessary; ex-Service wireless or radar technician with National Certificate of City & Guilds would be preferred (ref. 153)—Write in detail quoting Ref. No. to The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [4691

SITUATIONS VACANT

DESIGNER (25-55 years) required by old-established firm of electrical component manufacturers in N.W. London. Applicants must possess sound knowledge of radio frequency circuits, pulse forming networks and experience in the electronic, radio and/or television industry would be an advantage. Superannuation scheme.—Write, stating age, experience and salary required, to Personnel Manager, Box 3M S4590, A.K. Advg., 212a, Shaftesbury Ave., W.C.2. [4665

THE BRITISH THOMSON-HOUSTON Co., Ltd., has a vacancy in its research laboratory at Rugby for a qualified electrical engineer or physicist for work on radio interference problems; the work covers investigation of the mechanism, measurement and suppression of radio interference over a wide and interesting range of sources; applicants should write to The Director of Research, British Thomson-Houston Co., Ltd., giving their age and qualifications, and quoting the reference RIS. [4693

DRAUGHTSMEN.—An expanding production programme has created a number of vacancies for mechanical designers, senior draughtsmen and detail draughtsmen; situated in the Midlands; the work involves the complete engineering of electronic apparatus for Government contracts and of domestic radio and television equipment.—Applicants interested in this type of work, with or without experience, are invited to apply, giving details of career and salary expected to the Personnel Manager (Ref. GLB.), Box 2438. [4398

BRITISH ACOUSTIC FILMS, Ltd., invite applications for the position of development engineer to work on development of film processes, photographic and magnetic, also on preparation of test films. Previous experience of sound recording and knowledge of optics an advantage, suitable qualification include an H.N.C. or O.N.C. in Electrical Engineering. Permanent appointment.—Apply by letter, stating age, qualifications and experience, to Personnel Manager, British Acoustic Films, Ltd., Woodger Rd., Shepherd's Bush, W.12. [4745

ELECTRONIC wiremen and radar mechanics are required by Decca Radar to fill positions as technical assistants in their research division; these positions carry excellent rates of pay and the possibility of promotion to staff appointments; the work is of a varied and interesting nature, concerned with the development of modern navigational aids; there are good canteen facilities; British nationality essential.—Write, quoting reference RLA 101, to Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey. [4753

DECCA RADAR, Ltd., invite applications from young men, preferably of H.N.C. standard or above, who would like to become microwave engineers working in the modern wide field of navigational aids; training will be given to suitable applicants to fit them for a progressive career; there is a pension scheme in operation; British nationality essential.—Write, giving full personal details and quoting RLA 105, to Decca Radar, Ltd., Radar Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey [4751

THE TELEGRAPH CONSTRUCTION & MAINTENANCE Co., Ltd, require a Technical Assistant to be concerned primarily with the design of all types of cables; candidates should preferably have some experience of manufacture of cables and must have a knowledge of electrical engineering to a standard of at least Inter-B.Sc. or O.N.C.; salary £550 upwards according to qualifications and experience; pension scheme, 5-day week and all welfare facilities; write details to—Personnel Manager, Telcon Works, Greenwich, S.E.10. [3176

ELECTRONIC engineers.—Young engineers, possessing initiative and a desire for responsibility, and technical training up to degree standard (physics or electrical engineering), are required to assist in the development and testing of guided weapon control systems; some experience of the design and use of analogue computers desirable but not essential, good salary and bonus, pension scheme.—Apply, quoting ref. WW/58, to The Assistant Manager, The Fairey Aviation Co., Ltd., Weapon Division, Heston Aerodrome, Hounslow, Middx. [4707

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Allesley, Coventry, requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments for work on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager, Ref. R.G. [0259

MINISTRY OF SUPPLY, Radar Research Establishment, Malvern, Worcs, requires electrical engineers and physicists for research and development work, mainly on radar and electronic equipment. Work ranges from fundamental research on circuitry and physics of solids to devising and developing, in collaboration with industry, electronic devices for the armed forces. Ample scope for initiative and originality over very wide field, concerned mainly with electronics. Quals.: Higher School Certificate (Science) or equivalent but possession of H.N.C. or degree in Physics or Electrical Engineering may be an advantage. Salary within ranges: Experimental Officer (minimum age 26) £715—£880; Assistant E.O. £288/10 (age 18)—£640. Women somewhat less.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D.231/5A. Closing date July 9, 1955. [4736

SITUATIONS VACANT

THE General Post Office has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster-General's First Class Certificate of Proficiency in Radiotelegraphy; selected candidates will be considered later for permanent pensionable posts.—Application should be made to The Inspector of Wireless Telegraphy, Radio and Accommodation Department, Wireless Telegraph Section, Union House, St. Martins le Grand, London, E.C.1. [4635

MICROWAVE engineers are required by Decca Radar, Ltd., for work on advanced microwave and millimetric aerial design in a rapidly expanding aerial group; applications are invited from electrical engineers and physicists of H.N.C. standard or above, having practical experience in microwave components; the prospects for men of ability are considerable; there is a pension scheme in operation; British nationality essential.—Please write, quoting reference RLA 108, to Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey.

CIRCUIT design engineers are required by Decca Radar for positions created by the continued expansion of their research laboratories; these cover work in a wide field, embracing high and low pulse, receiver, A.F.C., radar display, and test equipment design in standard and sub-miniature form; applicants should preferably be of degree or H.N.C. standard, and have had previous experience in this field; a pension scheme is in operation; British nationality essential.—Please write to Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey, quoting reference RLA 103. [4750

MANAGER required for a unit of a well-established engineering company engaged in large-scale production of radio and television; the successful candidate will have a specialised knowledge of this class of work and will be capable of advising and supervising the design laboratories, tool design, planning and machine and assembly departments; this vacancy offers ample scope and opportunity to a man with high administrative ability; salary up to £2,500 per annum; London area.—Please reply, in confidence, giving full details, to Box 3083. [4535

SENIOR Design and Development Engineers required for work of an interesting nature in connection with microwave, electronic and mechanical development of guided weapons and associated equipment; the vacancies offer ample opportunity for advancement in a modern laboratory; the positions are permanent and the commencing salaries will be in accordance with experience and will be based on a generous and progressive scale; degree or H.N.C.—Please reply, in confidence, giving full particulars to The Personnel Manager, The Plessy Company, Limited, Vicarage Lane, Ilford, Essex. [4777

JUNIOR engineer required for interesting work on a variety of problems including the use of resins and thermal moulding materials for component protection, printed circuit techniques and heat treatment of metals. This is an excellent opportunity for a keen young engineer interested both in practical and theoretical work; applicants should preferably have a degree or H.N.C. in physics or chemistry, and previous experience.—Full details, quoting reference WW/11, should be sent to The Assistant Manager, The Fairey Aviation Co., Ltd., Weapon Division, Heston Aerodrome, Hounslow, Middx. [4706

TEST Engineers are required by a Leading Midlands manufacturer for: (1) Testing and Fault-Finding on Radar Units and other Electronic Devices. (2) Construction and maintenance of Test Equipment. (3) Testing and Fault-Finding on domestic Radio and Television Receivers. These progressive positions cover a wide range of activities and selection will be made not only on experience but also on ability to respond to further training. Ex-Service technicians are particularly suitable.—Applicants should write, giving details of career to date and salary expected, to the Personnel Manager (Ref. GLB.), Box 2540. [4426

MINISTRY of Transport and Civil Aviation.—Radio technicians (men only) required at aerodromes and radio stations in various parts of U.K.; special training courses for keen technicians with basic quals.; interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids; prospects of permanent pensionable posts and advancement; rates of pay (London) from £342/10 at age 19 to £467/10 at 25, rising (subject to qualifying test) to £565; rates slightly lower in provinces; shift and night duty allowances from 2/- to 5/- also payable.—Candidates aged 19 or over with practical experience in maintenance of radio or radar equipment should apply to any Employment Exchange, quoting Westminster 6627.

LABORATORY technicians required for development work in connection with an interesting range of electronic equipment, including communications, computers, transistors, and measuring and test apparatus. Applicants should have, as a minimum, the Ordinary National Certificate or appropriate C. and G. Certificates, and in addition, several years experience in the manner of operation, construction and testing of electronic or other light current equipment. Applicants with shorter experience but in possession of Higher National Certificates in radio or other light current subjects will be considered; these posts carry attractive salaries and conditions of employment including Pension and Life Assurance Scheme, 5-day week.—Apply, Mr. G. A. Taylor, Personnel Officer, Mullard Research Laboratories, Cross Oak Lane, Salfords, near Redhill, Surrey. [4733

SITUATIONS VACANT

AIRCRAFT radio aerials.—Gloster Aircraft Co., Ltd., Gloucester, have a vacancy for an electronic engineer (H.N.C. or equivalent) to work on the development of suppressed aerials for aircraft; the work involves theoretical and practical knowledge of measurements from "H.F." to "X" bands and of the properties of different types of suppressed aerials. A SMALL laboratory is being established for the work; an elementary knowledge of aircraft design and construction would be an advantage. —Applications, stating age, previous employers and experience, etc., should be addressed to the Employment Officer. [4533

APPLICATIONS are invited from senior project engineers with a specialised knowledge of the manufacture of electrical and mechanical products; applicants should have a good practical engineering background and a sound technical experience of tool design and planning and be capable of putting new projects on a sound production basis; these vacancies offer excellent opportunities to men seeking permanent and progressive positions; London area.—Applications, which will be treated in confidence, should give full details of experience and salary required, and be addressed to Box 3085 [4537

MULLARD, Ltd. (valve division), require a junior technical assistant, preferably aged 20-25, for their technical service dept. in London to help with the preparation of valve and tube data, replacement lists and similar publications; this position offers an opportunity for someone who has O.N.C. and is studying for H.N.C. to obtain a general grounding in all applications of valves and similar devices prior to specialisation in a particular field; salary range £450 to £550 p.a. with good prospects of advancement.—Write stating age and giving full details of education, training and previous experience to the Personnel Officer, Century House, Shaftesbury Ave., London, W.C.2. [4768

FERRANTI, Ltd., Edinburgh, have a vacancy for an Electronic Engineer in the capacity of a Technical Author to prepare technical, operational and maintenance publications; applicants should have qualifications to degree standard; technical authors join the design engineers, participate in field trials and assist with service introduction in order that they may have a full understanding of the design and operational use of the system on which they are preparing a publication, irrespective of whether this system is ground, airborne, or seaborne. Authors are responsible for the entire publication, ensuring that the appropriate illustrations, artists' impressions and line drawings are prepared.

APPLICATIONS, quoting Ref. 59/TA/TID, should be addressed to the Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5.

JUNIOR development engineers are urgently required to assist in the development of precision electronic laboratory instruments; successful applicants will be engaged on interesting long-term projects concerned with the development of a wide range of equipment; the appointments are permanent and carry considerable technical responsibility; applicants should have had previous development experience preferably in the instrument field; academic qualifications ranging from H.N.C. to degree standard are preferable; salaries are dependent upon age, qualifications and experience.—Apply stating full details to the Personnel Manager, Furzehill Laboratories, Ltd., Boreham Wood, Herts. [4609

SENIOR methods engineer required by a large and progressive engineering company situated in the London area; applications are invited from men with good engineering qualifications and experience in the manufacture of radio, television and services equipment; the accepted candidate will have extensive experience of this class of work and will be acquainted with the most up-to-date production methods, including work study and standard costs; for a man with the required knowledge, initiative and drive, this vacancy provides excellent prospects; salary range from £800 to £1,500 per annum.—Please reply, in confidence, giving full details of previous experience, to Box 3084. [4536

ELECTRO-MECHANICAL Engineers, Senior (ref. WW/56) and Junior (ref. WW/57) required for interesting work on the laboratory preparation and subsequent field trials of guided missiles. Applicants should have experience of one or more of the following: small pneumatic servos; gyroscopes; D.C. amplifiers; electro-mechanical instruments and pick-offs; preferably together with H.N.C. or equivalent (elec. or mech.). There are excellent prospects of advancement in this rapidly developing field which offers very good salaries and bonus. Pension Scheme.—Apply, quoting reference above, to the Assistant Manager, The Fairey Aviation Co., Ltd., Weapon Division, Heston Aerodrome, Hounslow, Middx. [4794

A VACANCY occurs for a development engineer in a design group concerned with a wide range of small transformers and inductors of types used in radio equipment and electrical appliances; preference will be given to applicants having experience of this class of work, but young engineers with a sound basic trainging and limited experience will be considered, and if successful, will have the opportunity of gaining practical knowledge of design problems met in fulfilling commercial and military specifications; an attractive salary is offered together with good future prospects; the company's extensive laboratory and production facilities are situated in the London area; please reply, giving details of qualifications and experience to—Box 4278. [4763

SITUATIONS VACANT

SERVICE engineers required with experience of electronic computor mechanisms and allied equipment; a good electronic technical background essential, at least to intermediate City and Guilds standard; housing assistance provided for suitable applicants after trial period.—Apply in writing, giving full details of experience and qualifications, to Personnel Officer, REDIFON, Ltd., Manor Royal, Crawley, Sussex.

B.B.C. requires Engineering Staff (British, minimum age 20) for operations and maintenance duties at transmitter, studio, recording and television centres. Must be willing to serve anywhere in U.K. and have completed or been exempted from National Service. Experience in radio engineering desirable. Essential qualifications include university degree, Higher National Certificate or equivalent in electrical engineering, or success in examination for C. & G. Final Certificate in Telecoms. or Full Technological Certificate or Graduateship of I.E.E. or Graduateship with maths. of Brit. I.R.E. Promotion prospects. Starting salary £620, rising by five annual increments to £830.—Requests for application forms (enclosing addressed envelope and quoting Ref. EX.25, W.W.) should reach Engineering Establishment Officer, Broadcasting House, London, W.1, within seven days. [4743

SITUATIONS WANTED

FREE lance designer requires additional work; V.H.F., including antennas, a speciality; own laboratory and transport.—Box 4212. [4755

TECHNICAL TRAINING

LEARN it as you do it—we provide practical equipment combined with instruction in radio, television, electricity, mechanics, chemistry, photography, etc.—Write for full details to E.M.I. Institutes, Dept. WW.47, London, W.4.

CITY and Guilds (Electrical, etc.) on "No Pass—No Fee" terms; over 95% successes.—For full details of modern courses in all branches of Electrical Technology send for our 144-page handbook, free and post free. B.I.E.T. (Dept. 388A), 29, Wright's Lane, London, W.8. [0117

TUITION

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SESSION 1955-56.
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APPLICATIONS invited for entry to next three-year full-time course commencing September, 1955, from those requiring comprehensive training to an advanced level in electronic engineering, qualifying for technical posts in radio, telecommunications, television and industrial electronics. Syllabus will cover requirements of City and Guilds, Brit.I.R.E., and I.E.E. examinations. Entry age 16 or over. APPLICATION forms and further information from Principal, Coventry Technical College.

NOTHING succeeds like success! What we have done a thousand times we can do again for you—see the B.N.R.S. advt. page 150. [0172

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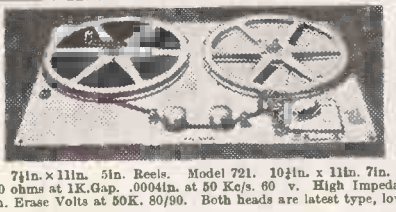

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