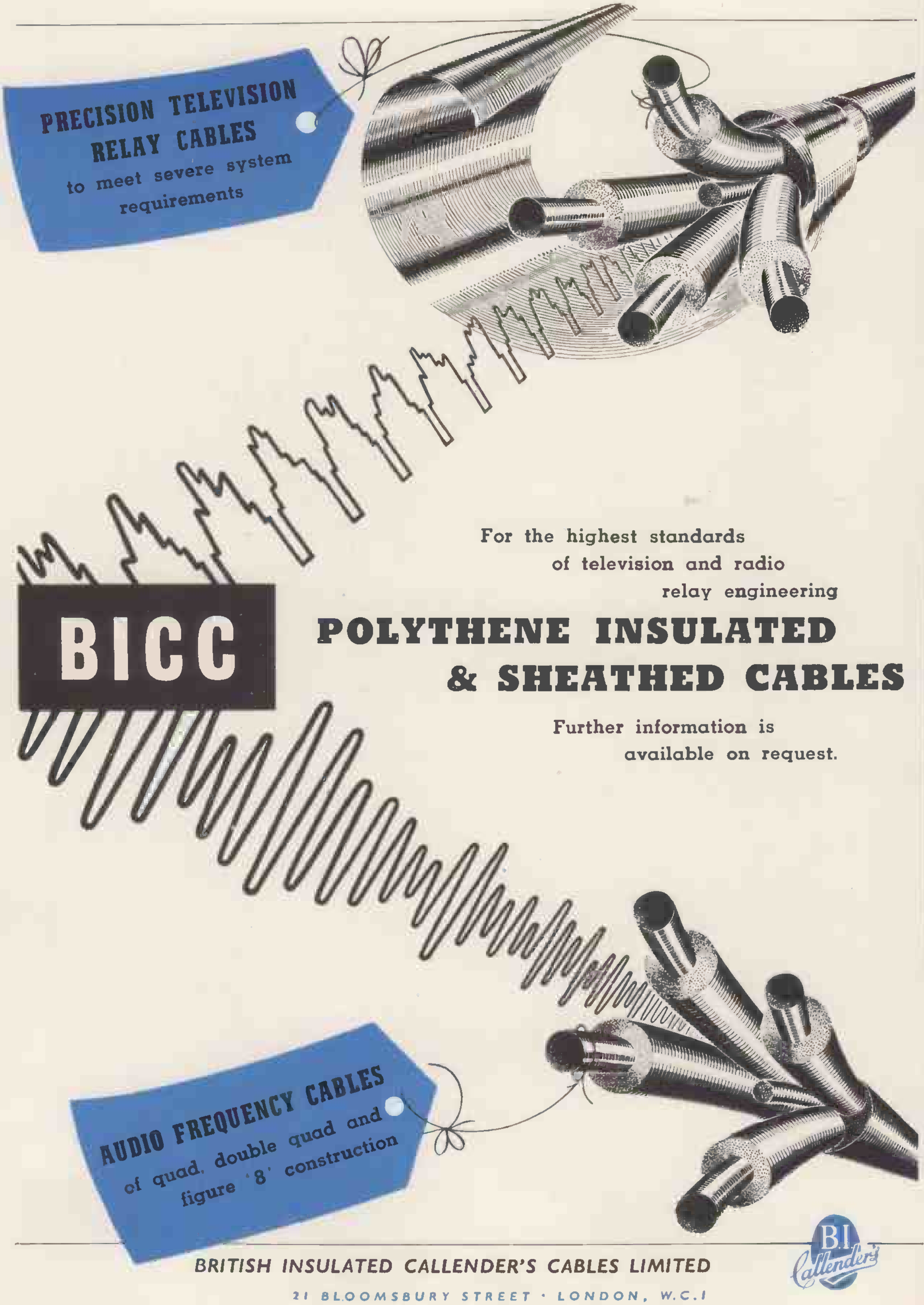
AUGUST 1956 TWO SHILLINGS

Wireless World

ELECTRONICS
Radio · Television

FORTY-SIXTH YEAR OF PUBLICATION


PRECISION TELEVISION RELAY CABLES
to meet severe system requirements
BICC
For the highest standards of television and radio relay engineering
POLYTHENE INSULATED & SHEATHED CABLES
Further information is available on request.
AUDIO FREQUENCY CABLES
of quad, double quad and figure '8' construction
BRITISH INSULATED CALLENDER'S CABLES LIMITED
21 BLOOMSBURY STREET · LONDON, W.C.1
BI Callender's

Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: H. F. SMITH
Assistant Editor. F. L. DEVEREUX, B.SC.

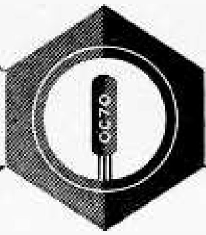
AUGUST 1956

In This Issue

VOLUME 62 NO. 8
PRICE: TWO SHILLINGS

FORTY-SIXTH YEAR
OF PUBLICATION

PUBLISHED MONTHLY (4th Tuesday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* "Ethaworld, Sedist, London." *Annual Subscription:* Home and Overseas £1 12s. 6d. U.S.A. and Canada $5.00. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *COVENTRY:* 8-10, Corporation Street. *Telephone:* Coventry 5210. *GLASGOW:* 26B, Renfield Street, C.2. *Telephone:* Central 1265. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. OVERSEAS OFFICES: *U.S.A.:* 111, Broadway, New York, 6, N.Y. *Telephone:* Digby 9-1197. *CANADA:* 74, College Street, Toronto, 2 Ontario *Telephone:* Walnut 4-5631

Transistors  at Small Signals (h-Parameters)

The most convenient way of describing the electrical characteristics of a transistor, like any other electronic device, is by means of a set of static characteristic curves. These graphs show how the voltage or current at the input electrode varies with the voltage or current at the output electrode.

The primary function of transistor static characteristic curves is to enable the circuit designer to choose the direct voltage and current for the working point. In the second place these graphs are used for designing circuits where large signals occur, for example in output stages or pulse amplifiers. However, for applications where the signal is small in comparison with the direct voltages and currents it is possible to calculate performance accurately from the slopes of the characteristic curves at the working point. Under small signal conditions the transistor never moves far away from this point and hence the characteristics in the immediate neighbourhood can be taken as linear. It is generally impracticable to read the slopes with sufficient accuracy from the graphs given, and so they are quoted in transistor data for some nominal working point such as collector voltage —2V and collector current —3mA. The h-parameters are the slopes of a particular set of characteristic curves but are in fact measured by small-signal a.c. methods.

In transistor data, this set of four characteristic curves consists of:—(1) the input characteristic giving the variation of input current I_1 with input voltage V_1, for constant output voltage: slope $= h_{11}$; (2) the output characteristic showing the relation between the output current I_2 and the output voltage V_2 for a series of fixed input currents: slope $= h_{22}$; (3) the transfer characteristic giving the variation of output current I_2 with input current I_1 for a fixed output voltage: slope $= h_{21}$; (4) the feedback characteristic showing the connection between the input voltage V_1 and the output voltage V_2 for a series of fixed input currents: slope $= h_{12}$.

By drawing the axes of the static characteristic curves and using the subscripts 1 and 2 to refer to the input and output electrodes, the notation h_{11} etc. can easily be explained and three of the h-parameters are seen to be related simply to parameters in the Mullard system. Thus h_{11} is the ratio of two quantities measured at the input electrode, hence it is the slope of the input characteristic, and is equal to r_{in}. V_1, I_1 represent the direct voltage and current at the input electrode and V_2, I_2 similarly apply to the output electrode. The a.c. quantities are v_1, i_1 and v_2, i_2. The formal definition of h-parameters is then as follows:—

$h_{11} = v_1/i_1$ = slope of input characteristic
= input impedance for constant output voltage
= input impedance for output short-circuited to a.c.
= r_{in} (in ohms or kilohms)

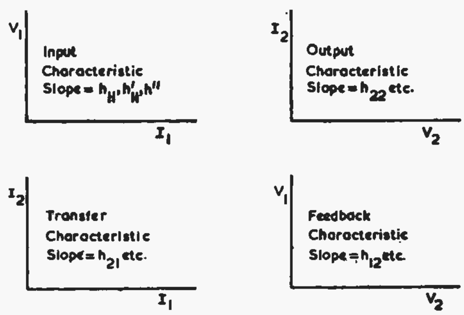
$h_{22} = i_2/v_2$ = slope of output characteristic
= output admittance for constant input current (= reciprocal of output impedance)
= output admittance with input open-circuited to a.c.
= $1/r_{22}$ (usually in micro-mhos)

$h_{21} = i_2/i_1$ = slope of transfer characteristic
= current gain for constant output voltage
= current gain with output short-circuited to a.c.
= a (a ratio, that is, a pure number)

$h_{12} = v_1/v_2$ = slope of feedback characteristic
= voltage feedback ratio for constant input current
= voltage feedback ratio with input open-circuited to a.c.

In defining the h-parameters the transistor is treated as a 'black box' with an input and output, paying no regard to whether the transistor is in a common base, common emitter or common collector configuration. In an actual circuit the values of these slopes will depend on which configuration is used. Thus the undashed terms such as the a.c. current gain h_{21} are reserved for grounded base applications, whereas a single prime as in h'_{21} shows the value required for calculations on grounded emitter circuits, and h''_{21} etc. apply to grounded collector circuits.

Grounded Base	*Grounded Emitter*	*Grounded Collector*
$h_{11}=r_e+(1-\alpha)r_b=r_e+\frac{r_b}{1+\alpha}$	$h_{11}'=(1+\alpha)h_{11}$	$h_{11}''=h_{11}'$
$-h_{21}=\alpha=\frac{\alpha}{1+\alpha}$	$h_{21}'=\alpha$	$-h_{21}''=1+h_{21}'$
$h_{22}=1/r_c$	$h_{22}'=(1+\alpha)h_{22}$	$h_{22}''=h_{22}'$
$h_{12}=r_b/r_c$	$h_{12}'=h_{22}'r_e$	$h_{12}''=\frac{1}{1+h_{12}'}$



Grounded base: e = 1, c = 2.
Grounded emitter: b = 1, c = 2.

2709

AUGUST 1956
Vol. 62 No. 8

Wireless World

P ogress on V.H.F.

DUE to the chaotic conditions prevailing on the medium- and long-wave bands, sound broadcasting on v.h.f. has become a virtual necessity in several European countries. In some of them, large sections of the population are unable to get a tolerable signal, particularly after dark. But, as was stressed in an article which we printed last month, v.h.f. has often been regarded as an "unwelcome complication"; the growth rate has hardly been spectacular.

This applies to some degree in Great Britain, though it would be unreasonable to expect a vast increase in the number of v.h.f. listeners as yet. After all, only some 38 per cent of the population have a service at present. But by the end of the year the figure will have risen to 84 per cent, according to a B.B.C. statement. Can we expect a rapid rise in the number of v.h.f. listeners?

Many of those who stand to benefit from the service have no idea of the advantages to be gained from it. But the knowledge must be spreading, particularly now that the B.B.C. is using its powerful machinery to publicize v.h.f. Then it seems probable that the more attractive receivers which may be expected to make their first appearance at the forthcoming National Radio Exhibition will exert an appeal. There can be no doubt that many of the present sets have their shortcomings. Of these, frequency drift must be one of the most annoying, but in some designs it seems to have been reduced to negligible proportions at no great cost.

Then there is the question of tuning. To us, and no doubt to many of our readers, the right system of channel selection for a three-programme service is by means of a switch or push-buttons. Fiddling with continuous tuning for such a purpose is surely an anachronism. It must be admitted though, that it is not too easy to fit switch tuning into a receiver in which v.h.f. is merely an adjunct to the normal wavebands. That is one of the reasons why we think v.h.f.-only sets should prove attractive to many people, and we hope their number will increase.

Can we learn from the United States anything useful on means of popularizing v.h.f.? In that country the service has for some time been in decline but it now appears to be undergoing a revival. The ever-increasing American interest in high-quality reproduction is apparently responsible, and it seems that the more important surviving stations are concentrating their efforts on programmes of high-class music. According to a report in the American journal *Audio* the listenership for these so-called "music stations" is already large and shortly there will be four of them in New York and six in Boston. But that is not to say the future of v.h.f. in Britain lies in special programmes; conditions are different here and the service must be used mainly to reinforce transmissions on the normal wavebands.

Though the British v.h.f. service cannot be conducted entirely or even mainly for those whose principal interest is in high-quality reproduction of music, their needs should be borne in mind. They are, in a sense, the pioneers of the service and, up to the present, constitute a large proportion of the audience. The B.B.C. has already given assurances that, subject to land-line limitations, the transmissions will permit a substantial improvement in receiver performance, both in frequency range and dynamic range. It should be borne in mind, too, that the quieter background makes all of us—not only the quality enthusiasts—much more critical. In the long run, quality will attract an ever-growing number of listeners.

An interesting proof of the way in which the critical faculty is stimulated by v.h.f. broadcasting has recently come to our notice. When the B.B.C. cut down the frequency range of the Wrotham transmitter, a surprisingly large number of readers observed the falling-off in output and wrote to tell us about it. Here is the explanation of the cut, provided by the B.B.C. engineering department:

"The audio-frequency bandwidth of the transmissions broadcast by B.B.C. v.h.f. stations is, in general, limited by that of the line network connecting the studios with the transmitters in various parts of the country. In the case of broadcasts from local studios a greater range is possible, but it has been found desirable, for the present, to restrict the upper limit to 10 kc/s. Filters have recently been put in at Wrotham to achieve this, and the effect has been observed by keen-eared readers of *Wireless World*. This is a temporary measure, pending the investigation of the causes of a type of distortion that has occasionally been observed in the highest frequency range. It is hoped that the filters will be removed in the fairly near future."

Junction Diode A.F.C. Circuit

A Simple Circuit for Reducing Tuning Drift in F.M. Receivers

By G. G. JOHNSTONE*, B.Sc.

THE junction diodes, such as the Mullard OA10 and G.E.C. SX641 now becoming available are primarily intended for rectification and detection at low frequencies, but in addition they have a property which makes them suitable for entirely different applications.

This property concerns the capacitance between the two electrodes; if a junction diode is biased to non-conduction, the capacitance varies with the applied voltage, being approximately inversely proportional to the square root of this voltage. Thus the diode provides a very compact and simple method of controlling a capacitance by adjustment of a voltage. There are a number of applications for such a facility. An obvious one is the provision of a.f.c. in receivers and this article describes in detail one method of using a junction diode to provide a.f.c. in an f.m. receiver where, in spite of the simplicity of the circuit, it is as effective as a conventional reactance-valve. Another application is the provision of remote tuning for f.m. or other receivers, or the provision of a very fine or " inching " tuning control. It could also be used for f.m. modulation of an oscillator in a transmitter or a wobbulator and no doubt other applications will occur to radio engineers. An effect of this kind is also exhibited by a junction transistor at low frequencies and the amplification of the device could perhaps be used to enhance the effect.

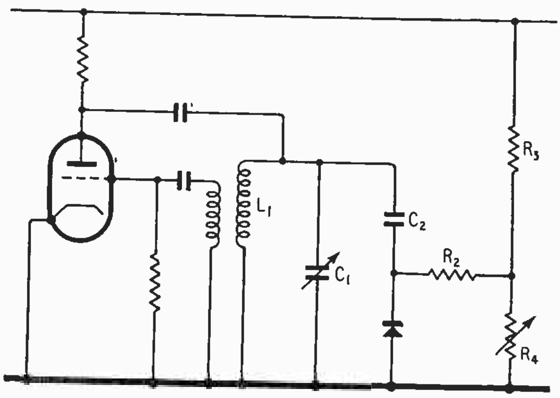


Fig. 1. Circuit used for test purposes.

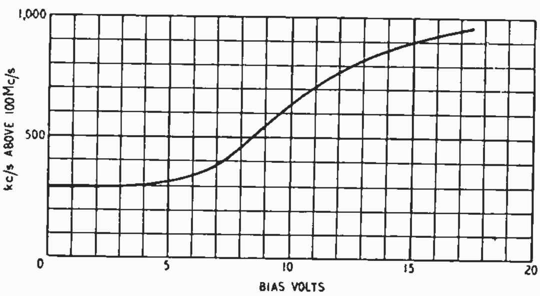


Fig. 2. Frequency shift v. bias for Mullard OA10 germanium diode. Reference frequency 100 Mc/s.

The manufacturers of the OA10 quote the capacitance as less than 30 pF at −0.5 volts bias and less than 10 pF at −3.0 volts bias. These figures apply at low frequencies and it was not expected that they would hold at frequencies as high as 100 Mc/s, such as apply in f.m. receivers. To determine the suitability of the junction diode for providing a.f.c. in such a receiver the circuit shown in Fig. 1 was used. An OA10 is in effect connected directly across the frequency-determining circuit L_1C_1, the 50-pF capacitor C_2 being included to permit application of bias to the diode. The resistor R_2 was included to simulate the internal impedance of the source of control voltage in an a.f.c. circuit, but in addition it prevents undue shunting of the oscillatory circuit and it also behaves as a diode load when the oscillator output voltage exceeds the bias; this has an effect on the shape of the characteristic obtained and is discussed later. The bias voltage is obtained from the potential divider R_3R_4 connected across the h.t. supply and can be varied by adjustment of R_4. To apply the bias in the correct sense to the diode, the diode lead marked in red (which corresponds to the cathode in a thermionic diode) is connected to the positive terminal of the bias voltage.

By varying R_4 and measuring the oscillation frequency the curve shown in Fig. 2 was obtained; at the centre of the characteristic the curve has a region of maximum slope of approximately 100 kc/s per volt, which is of the order of magnitude of control obtained with a conventional reactance-valve circuit. The curvature of the characteristic for low control voltages is due to conduction of the diode, the rectified voltage developed by the diode across R_2 opposing the bias voltage and therefore reducing the change in capacitance. The diode damps the oscillator and in the particular experiment the oscillator output fell from 8.5 volts to 6.0 volts peak value when the diode was connected. This particular characteristic was obtained with a germanium junction diode OA10, but the experiment has been repeated with silicon junction diodes type SX641 which give a curve of substantially the same shape. No doubt other types of junction diodes would also give successful results.

Three silicon diodes were availble for testing and their frequency/bias-voltage characteristics are shown in Fig. 3. They show divergences at low bias voltages where rectification occurs, but are in substantial agreement at other bias voltages. The curves were made to agree with each other at −10

* B.B.C. Engineering Training Department

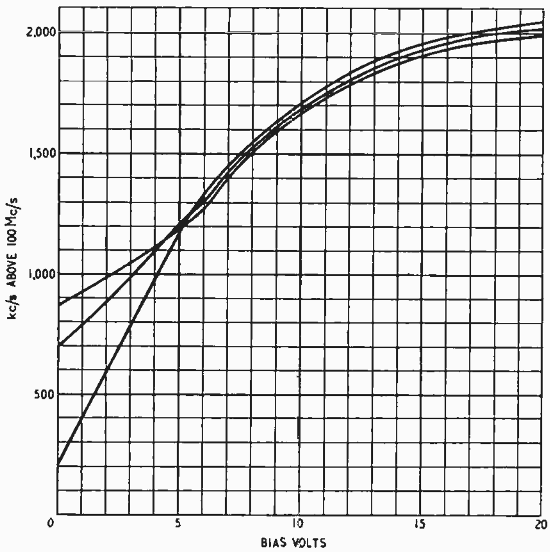


Fig. 3. Frequency shift v. bias for three G.E.C. type SX641 silicon diodes. Reference frequency 100 Mc/s.

volts bias by adjustment of the tuning capacitor C_1. It is not recommended that the region of low bias voltages should be used because there is increased damping of the oscillator circuit and marked divergences of curve shapes.

The experiments showed that the junction diode would operate satisfactorily at 100 Mc/s without undue loss of oscillator amplitude and the next step was to use the diode in an f.m. receiver. The receiver employed is that described in *Wireless World* for May, 1955, and the relevant part of the circuit is reproduced in Fig. 4. It has much in common with Fig. 1, R_{33} and R_{34} being used to provide standing bias for the diode. For most effective a.f.c., and to keep oscillator damping at a minimum, the standing bias should coincide with the centre of the linear portion of the characteristic. This was obtained by making R_{33} = 100 kΩ and R_{34} = 5.6 kΩ and returning R_{33} to the oscillator h.t. supply point of the feeder unit.

The control voltage is derived from the ratio detector and must be filtered of a.f. signals before application to the junction diode, otherwise negative feedback is obtained and there is a loss of a.f. output. Filtering is achieved by the 470 kΩ series resistor R_{37} and the 0.1-μF shunt capacitor C_{48}. The series resistor forms a potential divider with the diode back resistance causing a reduction in the effectiveness of the circuit and the value of the series resistor must not be made too high for this reason.

A readjustment of the oscillator fixed capacitance is necessary when the a.f.c. circuit is added to the feeder unit because of the standing capacitance of the junction diode. For an OA10 this capacitance is approximately 1.6 pF and can be allowed for by replacing the 8.2-pF capacitor C_9 by a 5-pF component and by advancing the trimmer capacitance C_{13} to restore the original calibration.

The 47-kΩ resistors R_{35} and R_{36} are included to isolate the diode and to prevent oscillator output from entering other parts of the receiver.

When the a.f.c. circuit is added to the receiver it may tend to reduce oscillator tuning errors or to increase them. Three factors determine the behaviour. They are:—

(1), the sense of the discriminator or ratio detector output; (2), whether the oscillator frequency is above or below the signal frequency; and (3), whether the control voltage is applied to the diode anode or cathode.

If the a.f.c. circuit tends initially to increase the tuning error, it may be made to work correctly by alteration of one of the parameters listed above. It is most convenient to apply the control voltage to the diode anode, because this requires the cathode to be returned to a source of positive voltage which can readily be obtained from the h.t. supply. If the control voltage is applied to the diode cathode, the anode must be returned to a negative potential, which is inconvenient to produce; thus alteration of factor (3) is not really practicable. It is inconvenient to alter the oscillator circuit frequency to the other side of the signal frequency because this may upset the frequency coverage or the ganging of the receiver. If the a.f.c. circuit does tend to increase tuning errors it is best to reverse the connections to the ratio detector diodes and the associated electrolytic capacitors to put matters right.

The circuit illustrated gives a reduction in mistuning of approximately 3 : 1. Tuning the receiver with the a.f.c. system operative is somewhat disconcerting because signals appear to have a large spread, and the error-reduction makes the location of the correct tuning point difficult. It may be desirable, therefore, to include a means of removing the a.f.c. whilst tuning the unit. This may be done by the inclusion of a single-pole switch across C_{48} as shown dotted in Fig. 4. A non-locking type is preferable for this application to ensure that the a.f.c. is not permanently defeated!

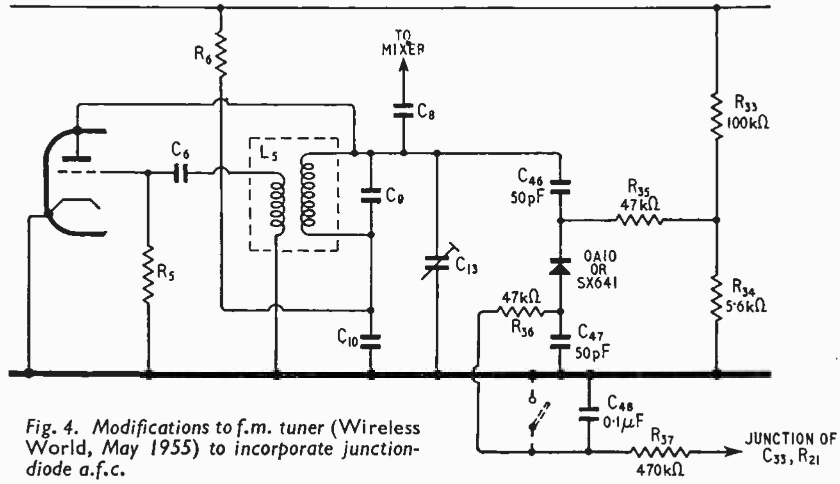


Fig. 4. Modifications to f.m. tuner (Wireless World, May 1955) to incorporate junction-diode a.f.c.

WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

Marine V.H.F.

WRITING in *Wireless World* last October on the subject of the P.M.G.'s announcement that f.m. is being adopted by the U.K. for marine v.h.f., R. I. T. Falkner, of Pye Marine (champions of a.m.), said, "If the new P.M.G. can restore confidence and show sincerity by positive action we would be the first to support him." It is interesting, therefore, to note that Pye have, in fact, secured the contract for supplying and installing the first frequency-modulated v.h.f. coastal radio-telephone station to be set up by the G.P.O.

The station, which will be located south of Rothesay, on the Isle of Bute in the Firth of Clyde, will open in the autumn and will provide radio-telephone communication between telephone subscribers in this country and suitably equipped ships operating within a radius of up to thirty-five miles of the station.

The station will operate on the frequencies tentatively agreed for "marine v.h.f. public correspondence"—157.4 Mc/s (receive) and 161.9 Mc/s (transmit). It is hoped that these and the other frequencies recommended at the Gothenburg Conference (*see W.W.*, April, 1956) will be approved at the next international conference.

It was stated by Mr. Falkner that in consequence of the adoption of f.m. the a.m. station on Shooters Hill, London, for the Thames Radio Service would eventually be scrapped.

Amateur Recording Contest

IT is hoped that this year a greater number of British entries will be received for the Concours International du Meilleur Enregistrement Sonore (C.I.M.E.S.) which is organized by the leading amateur recording associations of the world to find the best examples of recording technique as applied to a variety of subjects. Valuable prizes are offered, and in past years many of the entries have subsequently been broadcast.

Copies of the rules and entry forms (English version) are in the hands of the British Sound Recording Association and can be obtained from H. J. Houlgate, 12, Strongbow Road, London, S.E.9 on receipt of a stamped addressed envelope. The closing date is September 15th.

I.E.C. Meeting

STANDARDIZATION of electronic equipment and components was one of the many subjects discussed at the 21st general meeting of the International Electrotechnical Commission. The meeting, held at Munich from June 26th to July 6th, was attended by a number of British delegates representing industrial firms, trade and research organizations and Government departments. In this country the British Standards Institution is responsible for participation in the work of the I.E.C., which is a non-government association of electrical manufacturing and power-producing and consuming industries of 33 countries.

Valve Prices

THE British Radio Valve Manufacturers' Association (B.V.A.) announced on July 2nd reductions of from 10 to 33% in valve prices—the first change since 1950. Reductions of from 14 to 17½% are also made in c.r.t. prices. It is, however, stressed by the B.V.A. that these reductions apply only to current makes of valves and tubes bought by the general public and will not necessarily affect the cost of receivers.

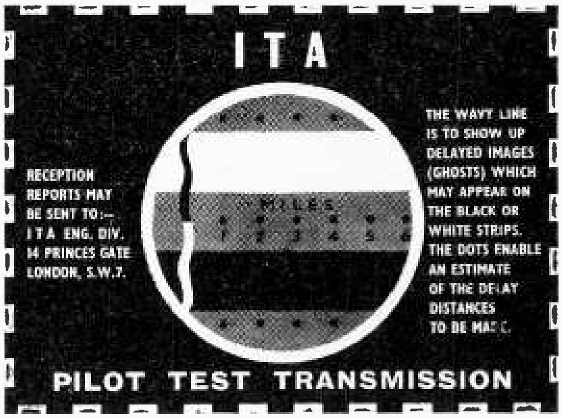
The vice-chairman of the Association, G. A. Marriott, has stated that the reductions have not been introduced because the Monopolies and Restrictive Practices Commission is investigating the supply of valves but because of economies resulting from extensive capital expenditure on plant. These economies, incidentally, will not affect the cost of production of obsolescent valves, the prices of which may even have to be increased.

We learn from manufacturers who are not members of B.V.A. that their prices have been similarly reduced.

"Transistorized" Car Radio

BY USING transistors in the output stage and for the generation of h.t. for the preceding valves, the drain on the car battery has been considerably reduced in the new Pye TCR16 car radio receiver.

The transistors are new power types (Pye V30/20P), and two in push-pull give an output of four watts. A third (V30/10P) is used as a high-frequency relaxation oscillator, the output of which



TEST CARD now being transmitted from the site of I.T.A. station on Emley Moor, Yorks., due to open in the late autumn. The card helps in locating sources of reflection causing "ghosting". Times of test transmissions are: Monday-Friday: 10 a.m.-12.30 p.m., 2-5.30 p.m., 6-7 p.m. Saturdays: 10 a.m.-12.30 p.m.

is stepped up in a ferrite-cored transformer to give, after rectification and smoothing, 10mA at 100 V.

A frequency changer valve (12BE6) is followed by a single i.f. stage (12BA6), germanium diode detector and a triode-pentode (PCL83) first a.f. amplifier and driver for the Class B output transistors. To assist in achieving thermal stability a thermistor is included in the transistor base circuit.

I.L.S.-S.B.A. Decision

ALTHOUGH the standard pilot-interpreted approach aid in Europe is I.L.S. (instrument landing system), there are a number of aerodromes in the United Kingdom still equipped with S.B.A. (standard beam approach). This is obviously undesirable as it may entail an operator having to carry two sets of airborne equipment. The Ministry of Transport and Civil Aviation is, therefore, withdrawing S.B.A. from its civil aerodromes as soon as this can be done without causing undue inconvenience to those operators who use it.

S.B.A. is, however, being retained at some of the aerodromes not directly the responsibility of the M.T.C.A., as for instance on the Isle of Man where it is stated it "will not be withdrawn until the aid is no longer fitted in the majority of the smaller aircraft."

PERSONALITIES

Sir George H. Nelson, Bt., has relinquished the position of managing director of the English Electric Company in order to devote the whole of his time to the duties of executive chairman of the company. His son, **H. G. Nelson,** M.A.(Cantab.), M.I.E.E., who has been deputy managing director since 1949, has been appointed managing director. He is 39 and has been a director of the Marconi companies since they joined the English Electric group in 1946. Sir George, who is this year's president of the I.E.E., is a member of the governing body of the Imperial College of Science and Technology.

W. H. Stephens, head of the guided weapons department of the Royal Aircraft Establishment, Farnborough, since 1953, has been appointed deputy director (equipment) of the R.A.E. on the retirement from Government service of Dr. F. E. Jones. Mr. Stephens, who was with the Ministry of Aircraft Production during the war, was for three years a member of the British Scientific Mission in Washington. It will be recalled that his lecture on guided weapons to the Radar Association during the last session formed the basis of an article in our February issue.

E. W. Chivers, B.Sc., has been appointed principal superintendent of the electronics division of the Armament Research and Development Establishment (M.o.S.) at Fort Halstead, Sevenoaks, Kent. Mr. Chivers, who is 49, held a number of Government scientific appointments during the war and was for two years superintendent of the General Physics Committee of the Scientific Advisory Council. He became superintendent at the Radar Research and Development Establishment at Malvern in 1947 and on the fusion in 1953 of R.R.D.E. and T.R.E. into the Radar Research Establishment was appointed deputy director of ground radar. His rank in the Scientific Civil Service is deputy chief scientific officer.

R. E. Burnett, M.A.(Oxon), A.M.I.E.E., A.Inst.P., has succeeded J. M. Furnival, M.B.E., who has retired, as general manager of Marconi Instruments. Mr. Burnett, who joined Marconi's in 1950 as principal of Marconi College and manager of education and technical personnel, was appointed deputy general manager of Marconi Instruments last November.

In order to co-ordinate television engineering development Marconi's have created the post of chief television engineer, to which **V. J. Cooper,** B.Sc., A.C.G.I., M.I.E.E., M.Brit.I.R.E., has been appointed. His deputy is **G. E. Partington,** B.Sc., A.M.I.E.E. For the past eighteen months Mr. Cooper, who has been with the company since 1936, has been chief engineer, advanced development. Mr. Partington joined Marconi's in 1938 when he attended a post-graduate engineering course at the Marconi College. Since 1947 he has been in charge of the development of television studio equipment. Under this scheme of unification Marconi's have formed three television development groups under **E. Davies, N. N. Parker-Smith,** B.Sc., A.M.I.E.E., and **J. E. Nixon,** B.Sc., A.C.G.I., A.M.I.E.E., and an audio development group with **S. J. Gooderham** in charge.

V. J. COOPER

G. E. PARTINGTON

C. G. Mayer, M.I.E.E., has been appointed chairman and managing director of R.C.A. Great Britain, Limited, on the resignation of P. A. Turnor, who will continue to serve as a director and executive of the company. Mr. Mayer, who has been European technical representative of the parent company, Radio Corporation of America, since 1947, was responsible for the recent formation of Laboratories R.C.A., Limited, in Zurich, Switzerland, of which he became president and managing director. He will continue as a consultant to the Laboratories.

Joseph R. Pernice, who has been chief of the electronics section of N.A.T.O.'s production and logistics division for the past six years, has been appointed managing director of Collins Radio Company of England, Limited, the recently formed subsidiary of Collins Radio Company, of Iowa, U.S.A. He took up his new appointment on July 1st and will be responsible for all Collins' operations in Europe.

Brian Cape, Associate I.E.E., has been appointed technical services manager to Kelvin and Hughes (Aviation), Ltd., in succession to John Rivaz who recently joined Smiths Aircraft Instruments, Ltd. After seven years in the R.A.F., where he specialized in airborne radar equipment, Mr. Cape became manager of the radio department of Flight Refuelling, Limited. He joined Kelvin and Hughes in 1947 as a development engineer, working principally on airborne navigation equipment. He is 38.

H. Henderson, B.Sc., A.Inst.P., who, in this issue, contributes an article on the theory of colour, is a senior lecturer in the engineering training department of the B.B.C. where he lectures on this subject during the short colour television courses organized by the Corporation for its senior technical staff. After three years as an experimental officer with the Admiralty Signals Establishment, Witley, he spent six years as physics master at grammar schools in London and Leeds before joining the B.B.C.

NATIONAL RADIO EXHIBITION

(Earls Court, Aug. 22nd—Sept. 1st, 11 a.m.—10 p.m.)

WIRELESS WORLD SHOW NUMBERS

September: Show Guide (publication date August 21st*). Plan of the stands with stand-to-stand guide to the exhibits.

October: Show Review (publication date September 25th). An analysis of design trends in television and sound receivers.

* Note advanced publication date.

OBITUARY

E. A. Richards, M.B.E., B.Sc., A.C.G.I., M.I.E.E., formerly chief rectifier engineer of Standard Telephones and Cables, Limited, died on June 20th, aged 71. His engineering career began with Siemens Brothers. In 1929 he joined the European Commercial Department of the International Standard Electric Corporation; was transferred to S.T.C. two years later and from 1934 until 1936 was chief engineer of Broadcast Relay Services. Returning to S.T.C. in 1936, he took charge of the engineering and development groups of the rectifier division, pioneering in the United Kingdom the selenium metal rectifier. It was for his work on increasing the production and improving the manufacture of selenium rectifiers during the war that he was appointed an M.B.E.

IN BRIEF

More than half the 2,617,429 holders of **receiving licences** in the London postal area now operate television receivers—1,315,921. There were 14,293,902 broadcast receiving licences—including 5,863,473 for television and 299,749 for car radio—current in the U.K. at the end of May.

Additional sound and vision transmitting equipment has been installed at the **I.T.A.'s Lichfield station.** Although at present available as a standby in the event of a breakdown, when certain ancillary equipment has been installed early in the autumn it will be utilized to increase the transmitter's e.r.p. from 50 to 200 kW.

Professional Engineers' Pensions.—A scheme to provide continuous pension cover for a professional engineer throughout his career, whatever changes of employment take place, is to be launched in the autumn by the Engineers' Guild (78, Buckingham Gate, London, S.W.1). It will be open to all members of the institutions of electrical, civil and mechanical engineers.

1957 Audio Fair.—It is announced, by the organizing committee of London's first Audio Fair held in April, that the 1957 exhibition will be held at the Waldorf Hotel, London, W.C.2, from April 12th to 15th—immediately following the R.E.C.M.F. Components Show (April 9th to 11th). The scope of the Fair is to be extended—including a day reserved for overseas and trade buyers—but the plan of the show will be unaltered, each exhibitor having at his disposal a demonstration room.

The scope of the Instruments Exhibition, which has been sponsored in previous years by five trade associations (including the British Electrical and Allied Manufacturers' Association and the Scientific Instrument Manufacturers' Association) is being broadened, and the 1957 show will have the title **"Instruments, Electronics and Automation."** It is being promoted by the same five associations, and will be held at Olympia, London, from May 7th to 17th. The organizers are Industrial Exhibitions, Limited, 105-106, New Bond Street, London, W.1.

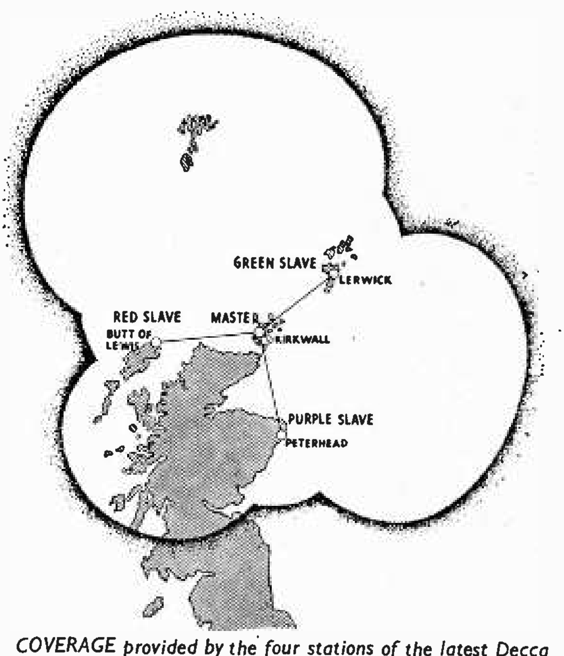
The theory, preparation, properties and applications of **Ferrites** will be covered at a convention to be held at the Institution of Electrical Engineers, Savoy Place, London, W.C.2, from October 29th to November 2nd. The convention will be open to non-members on payment of a registration fee of £1. Registration forms and further particulars are obtainable from the Institution.

I.E.E. Officers.—Sir Gordon Radley, K.C.B., has been elected president of the I.E.E. for 1956/57 and G. S. C. Lucas, O.B.E., chief electrical engineer of B.T-H., is a vice-president. The new chairman and vice-chairman of the Radio and Telecommunication Section are, respectively, Dr. R. C. G. Williams, B.Sc., chief engineer of Philips and G. Millington, M.A., B.Sc. (Marconi's). New ordinary members of the section committee are W. J. Bray, B.Sc. (Post Office), H. A. M. Clark, B.Sc. (E.M.I.), C. W. Earp, B.A. (S.T.C.) and V. J. Francis, B.Sc., F.Inst.P. (G.E.C.).

"CABMA Register" is published annually for the Canadian Association of British Manufacturers and Agencies whose object is to develop the Canadian market for British goods through the British trade centres in Toronto, Vancouver and Montreal. The 1956/57 edition of the Register, issued jointly by our publishers and Kelly's Directories, includes a buyers' guide, listing alphabetically some 4,000 British products, and directories of over 4,500 British manufacturers, proprietary names and trade marks. It costs two guineas (postage 2s).

An appeal has been received from the secretary of the Wembley and District Group of the Multiple Sclerosis Society, asking for receivers for sufferers from multiple or disseminated sclerosis (previously known as "creeping paralysis"). They are also in need of sound recording equipment for gatherings organized by the Group. Offers of help should be addressed to the Honorary Secretary, R. A. L. Dumsday, 75, Rugby Avenue, Wembley, Middlesex.

Since the **advertisement pages** went to press Metropolitan-Vickers have asked us to point out that the supply voltage quoted in the specification of their miniature oscilloscope on page 86 is for overseas models. Those for the home market are for 200/250V, 50c/s supplies.



COVERAGE provided by the four stations of the latest Decca Navigator Chain—the North Scottish—which was inaugurated at the end of June, is shown on this diagram.

The address of the **Radio Advisory Service** (established by the Chamber of Shipping and the Liverpool Steam Ship Owners' Association), of which Capt. F. J. Wylie, R.N.(Retd.), is director, is now 7th Floor, 12-20 Camomile Street, London, E.C.3. (Tel.: Avenue 6941.)

WHAT THEY SAY

"**Electronics** is rapidly taking over electrical engineering education. Ten years from now electrical engineering will be synonymous with what to-day we call electronics. Electrical engineering of the pre-war era which concentrated its attention on phenomena at 60 cycles in general, and rotating machinery in particular, will be regarded as a small part of the broad subject of electronic science. Whether we will call it electrical engineering or electronics ten years from now I do not know."—Frederick E. Terman, Stanford University, California, in *Proc. I.R.E.*, June, 1956.

"**Wanted.**—TV aerial, preferably with fringe. Phone . . . . "—Advertisement in Provincial newspaper.

"**Resistor** fixed variable linear."—Label on box containing potentiometer in Ministry store.

BUSINESS NOTES

R. B. Pullin and Co., Ltd., of Great West Road, Middlesex, have concluded an agreement with the Kearfott Company, of America (a subsidiary of the General Precision Equipment Corporation), for the manufacture in this country of a range of Kearfott products, including servomotors and electronic components.

Substantial contracts for supplying the Services with equipment for testing drive units, transmitters and receivers for h.f. point-to-point communication systems have been awarded to **Marconi Instruments.**

James A. Jobling and Company, of Sunderland, the manufacturers of Pyrex heat-resisting glass, are producing Multiform glass parts for c.r.t. electrode assemblies and glass-to-metal seals. The Multiform process of manufacture from specially treated glass powders compressed in moulds and subsequently fused to form a uniform opaque glass was originally developed in the United States.

Closed-circuit industrial television equipment was recently installed by **Marconi's** at the Steel Company of Wales works at Port Talbot to facilitate the handling of ingots at the rolling mill.

The maintenance vehicles operated by four of the North Western Gas Board's South Lancashire groups (Manchester, Liverpool, Wirral and St. Helens) are now equipped with radio telephones. The latest installation, at St. Helens, by **Automatic Telephone & Electric Co.,** includes six mobile stations and a fixed station, the aerial for which is on top of a 225-foot gas holder.

Donvin Instruments, Limited, of Electrin Works, Winchester Street, Acton, London, W.3 (Tel.: Acorn 4995), now a member of the Pullin group of companies, is to specialize in the speedy repair and recalibration of all types and makes of indicating and measuring instruments.

Shandon Automation & Electronics, Limited, of 6, Cromwell Place, London, S.W.7, has been formed to produce industrial and scientific electronic equipment. It is associated with the Shandon Scientific Company of the same address (Tel.: Kensington 9001).

Permanently impregnated marking of customers' own p.v.c., rubber or Neoprene sleeving is undertaken by **Permark Service,** of Devon House, High Street, Cranleigh, Surrey. (Tel.: Cranleigh 499.)

The telephone number of **Aero Research, Limited,** Duxford, Cambridge, has been changed to Sawston 2121.

Cosmocord, Limited, have closed their Enfield factory and are now concentrated at their works at Eleanor Cross Road, Waltham Cross, Herts. (Tel.: Waltham Cross 5206.)

Standard Telephones & Cables have opened regional offices at Leeds (Norwich Union Buildings, City Square) and Glasgow (49, Queen Street, C.1).

Cementation (Muffelite), Ltd., manufacturers of anti-vibration mounts, have moved from 39 Victoria Street, S.W.1, to 20 Albert Embankment, London, S.E.11. (Tel.: Reliance 6556.)

The address of the **Willesden Transformer Company, Ltd.,** is now Manor Works, Manor Park Road, Harlesden, London, N.W.10 (Tel.: Elgar 5445).

OVERSEAS TRADE

A new monthly record of radio and electronic exports totalling nearly £3.4M in May is announced by the Radio Industry Council. The overseas sales of transmitting and navigational equipment totalled nearly £1.4M. The next highest of the five groups within the industry was sound reproducing equipment which totalled £731,000.

A report on the market for sound and television receivers in **Portugal** issued by the Export Services Branch of the Board of Trade shows that in 1954 (the last year quoted) Germany and the Netherlands supplied between them nearly 85% of the country's £600,000 radio imports. The United Kingdom's share dropped from 14% in 1951 to 7.5% in 1954 whilst during the same period Germany's share rose from 14% to 45% and by so doing displaced the Netherlands as the main supplier.

Switzerland.—An order for s.h.f. radio equipment to provide 600 telephone circuits between Berne and Geneva over a single radio channel has been placed with Standard Telephones & Cables through their associates, Standard Telephone et Radio S.A., Zurich. One repeater station, at Chasseral, will be used for the system which will be capable of being extended to provide additional r.f. channels either for telephone or television circuits.

Substantial quantities of radio-telephone equipment are being provided by Redifon for the **Iraq** police force. In addition to the equipment already supplied to the Baghdad police, which includes mobile four-channel v.h.f. transmitter-receivers and base stations, a number of h.f. transmitter-receivers (GR250) has now been ordered.

U.S.A.—Manufacturers contemplating participation in the World Trade Fair, which will be held in New York next April, are advised by the Board of Trade to get in touch with the London representative of the Fair, A. P. Wales, Dudley House, Southampton Street, London, W.C.2.

Transmitting equipment for three stations for air-to-ground communications on trans-polar air routes has been supplied by Marconi's for installation in **Greenland.** Each station is being equipped with two HC205 transmitters (one being a standby) which are designed to radiate up to three simultaneous telegraph or telephone transmissions on separate crystal-controlled h.f. channels.

The supply and installation of sound reproducing equipment in the six-storey General Hospital at Colombo, **Ceylon,** is being undertaken by Hadley Telephone and Sound Systems, of Smethwick, Birmingham. The installation will provide a four-channel service to 320 beds.

An agency for a low-priced five- or six-valve all-dry battery receiver of United Kingdom manufacture is being sought by Narseys, Limited, P.O. Box 145, **Suva,** Fiji. It should cover the short-wave bands between 16 and 37 metres and be fully tropicalized.

Colour Fundamentals

PRINCIPLES OF COLORIMETRY WITH PARTICULAR REFERENCE TO TELEVISION

By H. HENDERSON,* B.Sc., A.Inst.P.

A NUMBER of articles have appeared in *Wireless World* in the last few months on the subject of colour television. The American N.T.S.C. system modified to British standards has so far received major attention. This is largely due to its being a two-way compatibility system which the Americans felt was essential to the successful launching of a new and expensive service. Such a requirement may not assume the same importance here and other systems are being tested. Whichever is finally chosen a full understanding of its operation will demand a knowledge of colorimetry and colorimetric terms. It is also true to say that a knowledge of the theory of colour is essential so that one may clearly recognize which equations derive from colour considerations and which are pure circuitry relations; these are often confused.

The Visible Spectrum.—There are at least 50 octaves in the electromagnetic spectrum. Visible light occupies less than one and extends from about 4,000 to 7,500 Angstrom units (1 Angstrom unit (Au) = 10^{-8}cm). The actual limits depend upon the observer and the intensity of the light. In practice the limits are taken as those wavelengths where the eye response is 10^{-5} of peak value, i.e., 3,800-7,800 Au.

The eye is not equally sensitive to the wavelengths present in this band but has a peak of sensitivity in the yellow-green as shown in Fig. 1. This curve may be obtained by measuring the energy required for each wavelength to match a given brightness, then plotting the reciprocal of energy required against wavelength. A photocell with a filter having an overall response of the same shape as the luminosity curve would give equal outputs when illuminated by lights of different colours which are judged by the eye to be equally bright. Once a standard luminosity curve for the average eye is agreed, such photocells may be used for photometric work with much greater convenience.

A black and white television camera should have such a colour response if it is to transmit brightness information faithfully.

Colour Perception.—It is useful to assume that the eye contains three wideband receptors, one sensitive to the middle region of the spectrum, one to the blue and one to the red end. The colour sensation produced in the brain depends upon the relative excitations of these receptors. It follows that any colour, whatever the mixture of wavelengths in its composition, can be matched by suitable mixtures of three colours, red, green and blue, each stimulating the appropriate receptor to the same extent as the matched colour. These three colours are referred to as the primaries and they may be monochromatic or wideband. For colorimetry the primaries are monochromatic and are generally red (7,000 Au), green (5,461 Au) and blue (4,358 Au). In colour television the three primaries used for colour matching are the three phosphor colours found in the colour receiver. Suitable activation and combination of the light output from these phosphors may produce any colour match and it is the camera's function to produce signals of suitable amplitudes to achieve this.

Additive and Subtractive Mixing.—The process of combining coloured lights referred to above is known as additive colour mixing and for this purpose the primaries are red, green and blue. The mixture colours obtained by combination of these primaries may be represented qualitatively by means of a triangle as shown in Fig. 2.

As blue and yellow together in suitable amounts match white they are referred to as complementary colours. Other complementary colours are red and cyan, green and magenta.

Where the colours of pigments and filters are involved—that is, things which have no colour in their own right—the process of mixing is a subtractive one. For example a yellow filter is one which absorbs blue from light falling upon it and allows red and green to pass. It is often referred to as a "minus blue" filter. Similarly a magenta filter is a "minus green" and a cyan filter is a "minus red." Yellow, magenta and cyan are the primaries of subtractive colour mixing. If a yellow filter is followed by a cyan filter and white light falls on the system, yellow subtracts blue, cyan subtracts red, and only green emerges.

In this sense cyan and yellow make green. The colours obtained by subtractive processes are indicated in the triangle shown in Fig. 3.

Colorimetry.—Colour is measured by first matching the chosen colour with a suitable mixture of red, green and blue light and then quoting the amounts of each primary present in the mixture. The ratio of the three amounts specifies the colour. Doubling each primary contribution does not change the colour but only its brightness.

Two units are available for the measurement of the amount of each primary in the match. One derives from photometry and is the lumen. The other is the trichromatic unit, which will be dealt with later. A lumen of any colour appears equally bright. It follows from the luminosity curve (Fig. 1) that a lumen of yellowish-green light contains least energy. A standard candle, treated for the moment as an omnidirectional point source of light, gives off light at the rate of 4π lumens. This may be taken as the definition of the lumen. The photocell with the eye-response filter mentioned earlier will give outputs directly proportional to the number of lumens falling on it.

Supposing white were to be matched by light from the three cathode-ray tube phosphors (as

*Engineering Training Dept., B.B.C.

used at present), it might be found that 1 lumen of white is matched by 0.3 lumens of red plus 0.59 lumens of green plus 0.11 lumens of blue. This may be written

1 lumen of white ≡ 0.3(R)+0.59(G)+0.11(B).

Notice that the luminance of the mixture colour is the sum of the luminances of its components. These quantities are important and continually recur in colour television literature. If different phosphors are used they will need modification.

Because of the unequal values assigned to the amounts of red, green and blue to match white,

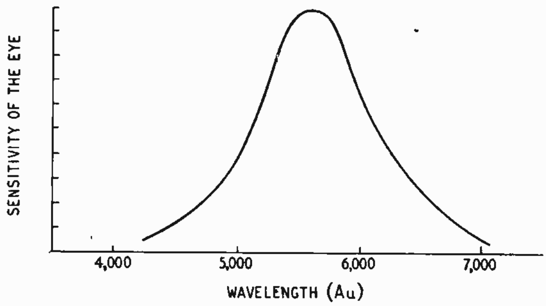
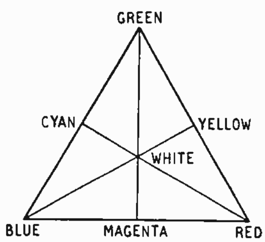
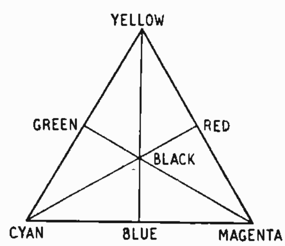


Fig. 1. Curve showing the sensitivity of the eye with different wavelengths of light (in Angstrom units).



Left: Fig. 2. Colour triangle illustrating the additive mixing of coloured lights.



Right: Fig. 3. Colour triangle illustrating the subtractive mixing of colours by filters.

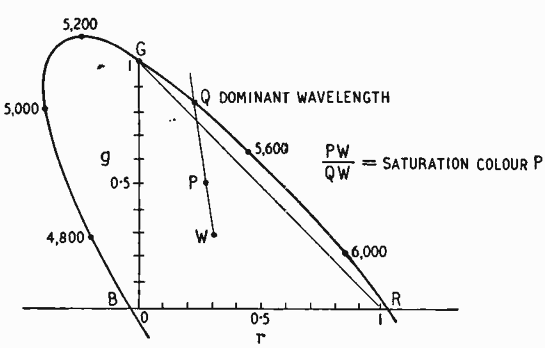


Fig. 4. Spectrum locus diagram. Note that white (point W) occurs at r=g=0.33.

which is regarded as unbiased to any particular colour, a different unit is favoured, and is of particular convenience in colour television. This unit is defined by the statement that 1 unit of red+1 unit of green +1 unit of blue match 1 lumen of white

or 1 lumen of white ≡ 1(R)+1(G)+1(B).

These units are referred to as trichromatic units or T-units. To preserve the law of additivity 1 lumen of white is taken as equal to 3 T-units

∴ 1 T-unit of white ≡ 0.33(R)+0.33(G)+0.33(B).

If we are still thinking of the same white as above and the c.r.t. phosphors it follows that

1 T-unit of red = 0.3 lumens
1 T-unit of green = 0.59 lumens
1 T-unit of blue = 0.11 lumens.

When a colour is quoted as matched by so many T-units of red, green and blue, its brightness can be found by multiplying the red T-units by 0.3, the green by 0.59 and the blue by 0.11 and adding.

At present the electrical outputs from the red, green and blue camera tubes are adjusted to be equa. when the camera is looking at the standard whitel The camera outputs are in effect then in T-units. To obtain a signal proportional to brightness it is necessary to multiply the red output by 0.3, the green by 0.59, the blue by 0.11 and add. Thus we have the often recurring equation

Luminance signal $E_Y = 0.3\,E_R + 0.59E_G + 0.11E_B$

where E_R, E_G and E_B are the camera outputs when looking at the particular colour and they would be equal if the colour were standard white.

Standard White.—There is unfortunately no single standard white. Equal-energy white is the white observed when all spectral colours are present with equal energy—this is somewhat blue. What is known as Illuminant B is the white of direct sunlight while Illuminant C is the white of sky-scattered sunlight. Illuminants B and C may be obtained by placing suitable filters in front of a tungsten lamp—known as Illuminant A. The figures quoted above refer to Illuminant C.

The Colour Triangle.—If a colour be matched by R T-units of red, G T-units of green and B T-units of blue, this may be written:—

(R + B + G) T-units of colour ≡ R(R) + G(G) + B(B)

or 1 T-unit of colour ≡

$$\frac{R}{R+B+G}(R) + \frac{G}{R+B+G}(G) + \frac{B}{R+B+G}(B)$$

Now write

$$r = \frac{R}{R+B+G}, \quad g = \frac{G}{R+B+G} \text{ etc.}$$

then 1 T-unit of colour ≡ r(R) + g(G) + b(B)

where $r + g + b = 1$

The values of any two coefficients, say r and g, specify the original colour without any reference to its brightness. These two quantities can be plotted and a colour triangle based on the primaries chosen is obtained. If now each colour of the visible spectrum is treated in this way and its colour point is plotted as in Fig. 4; a continuous line is obtained which is called the spectrum locus. It will be observed that many r and g values appear together greater than unity and some are in fact negative. What is the significance of negative colour? Here the truth must be revealed that it is in fact not possible to match all colours by suitable mixtures of three primary colours. Taking sodium light as a single example, it is possible to come fairly close to a match with red and green primary mixtures. If blue is added to the sodium light, however, a match can be obtained. Thus:

sodium yellow + blue ≡ red and green

or allowing mathematical processes to intrude

sodium yellow ≡ red + green − blue

the amounts of the three primaries being measured in T-units.

In fact all colours lying outside the RGB triangle cannot be matched by the three chosen primaries and no real colour can exist outside the spectrum locus. Between the red and blue end lie the purples, the non-spectral colours which are mixtures of red and blue.

Properties of the Colour Triangle.—If two colours represented by two points on the diagram are mixed, the mixture colour lies on the line joining these points. Where it lies depends on the relative amounts of each colour used. Colours lying at the extremities of a line passing through white are called complementary colours, for suitable mixtures of complementary colours match white.

A colour may be specified on such a diagram by drawing a line through the colour point (P), and white (W), and producing it to cut the spectrum locus at a point (Q), corresponding to some particular wavelength called the dominant wavelength. The ratio of the distance of the point from the white point to the distance from the spectrum locus to the white point measures the purity or saturation of the colour. Dominant wavelength and saturation specify the colour. A suitable mixture of white and the dominant wavelength would match the colour. The presence of white in a colour desaturates it—it becomes paler; for instance red tends to pink. Dominant wavelength and saturation thus offer an alternative means of specifying colour.

Colours of No Brightness.—Once negative amounts of colour are accepted it must follow that there are points on the diagram corresponding to colours having no brightness. The brightness, it may be remembered, may be obtained by multiplying the T-units of each primary by the appropriate factors (0.3, 0.59 and 0.11).

i.e., brightness $= 0.3r + 0.59g + 0.11b$

If this is zero we have:—

$$0 = 0.3r + 0.59g + 0.11b$$

but $r + g + b = 1$

$$\therefore 0 = 0.3r + 0.59g + 0.11(1 - r + g)$$

i.e., $0 = 0.19r + 0.48g + 0.11$

This is the equation of a straight line. Colours lying on this line have no brightness. The line is called the alychne and will have importance in the later development of the subject. Fortunately this line does not pass through the region of real colours so that we are not faced in practice with colours of no brightness. They would no doubt be singularly difficult to detect! Below this line lie colours of "negative brightness."

Colours of Surfaces.—A surface is coloured by virtue of the light it reflects after selective absorption of the incident illumination. Because the spectrum locus is fairly straight between greenish-yellow and red it follows that mixtures of spectral colours in this region will themselves be on the spectrum locus. A wide spectral band may be reflected from a surface, i.e., it will appear bright, and yet it can have a saturated colour if the reflected colours lie between greenish-yellow and red. Yellow and orange are in consequence usually bright saturated colours.

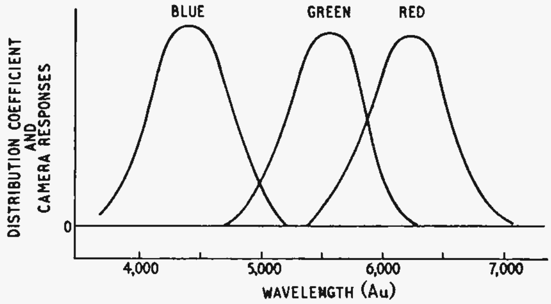


Fig 5. Red, green and blue distribution coefficients.

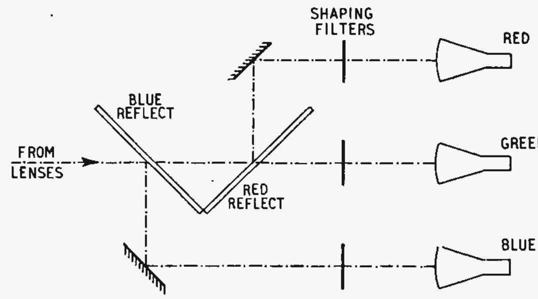


Fig. 6. Method of splitting light into three colour components in a colour television camera.

Because the spectrum locus in the green region of the spectrum is so convex it follows that any wide band of reflected light in this region of the spectrum will inevitably produce a mixture colour which lies within the spectrum locus, i.e., a desaturated colour. Thus, bright greens are invariably desaturated greens. Saturated greens are very dull. At the blue end of the spectrum the eye sensitivity is falling away and saturated blues are also very dull colours. These facts are important when choosing the primary colours to be used for matching. It is more important to be able to match saturated yellows and oranges than greeny blues as the last-mentioned only occur at very low brightness levels.

Colour Analysis.—The colour television receiver should produce a coloured picture which matches at every point the colour of the original scene. This means that the camera outputs must control the point by point magnitudes of the red, green and blue phosphor brightnesses. A close connection must therefore exist between the colours of the primary phosphors and the colour filters used in the camera.

To obtain the overall camera response curves, the standard white is imagined split up into a large number of narrow spectral bands and each band in turn is matched by measured amounts of red, green and blue primary. A plot of these amounts (distribution coefficients) against wavelength give curves of the sort shown in Fig. 5. As the addition of all the wavelengths gives the standard white so the areas under the three curves are equal, for equal quantities of red, green and blue are, by definition, required to match this white. The colour responses of the red, green and blue cameras must have the shape of these curves.

It is not, of course, possible to cater for the negative-going portions of the response curves in the

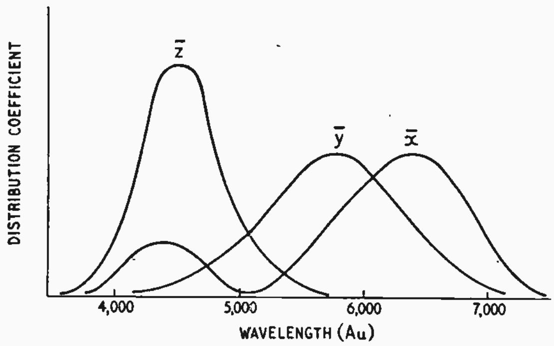


Fig. 7. Plot of distribution coefficients $\bar{x}$, $\bar{y}$ and $\bar{z}$.

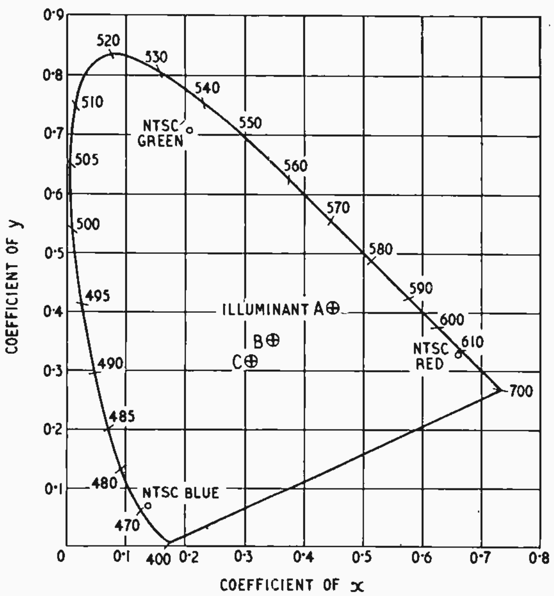


Fig. 8. C.I.E. trichromatic co-ordinates with spectrum wavelengths in millimicrons, Illuminants A, B and C, and N.T.S.C. primaries.

present state of the art. This implies, as has been stated earlier, that only colours lying within the RGB triangle formed by the phosphor colours can be accurately matched.

The light falling on the colour camera may be split into three components by devices known as dichroic mirrors, as shown in Fig. 6. One mirror reflects the blue end of the spectrum and transmits the rest. The second reflects the red end of the spectrum and transmits the remainder which is a band in the middle of the spectrum. The reflection (or transmission) wavelength characteristic of the dichroics multiplied by the camera's characteristic may approximate quite well to the desired response for analysis. In general, however, further filters are required and they are known as shaping filters.

International Colour Specification.—Colour points and triangles referred to earlier depend entirely on the original choice of the three primary colours. Figures mentioned have been derived from primaries which are the phosphors at present in use in colour tubes. For accurate and reproducible colour measurement such primaries would be undesirable and in practice monochromatic colours from the red, green and blue regions of the spectrum are chosen (7000Au—red, 5461Au—green and 4358Au—blue).

These colours are not easy to produce at any great level of brightness or with simple apparatus and many experimenters would prefer to use different primaries. It is clear, however, that no comparison of the work by one experimenter with that of another is possible unless the results of one can be translated from one set of primaries to another.

The three monochromatic colours mentioned above might well have been chosen as the basis of international colour specification and all those desirous of communicating their results to others would have translated their practical observations taken with their own primaries to the international ones. This is a straightforward process once it is known where one set of primaries lie on the RGB diagram of the other; it is just a question of mathematics.

As any such transformations are possible it was decided to choose three primary colour points for the international specification of colour which would dispose of negative values for colour co-ordinates; i.e., the triangle formed by three such points must completely enclose the spectrum locus. The points must therefore lie outside it and will represent imaginary or super-saturated colours. This triangle is referred to as the XYZ triangle. X and Z lie on the alychne and are therefore "colours" of no brightness. Y is chosen so that the line YX lies along the straight portion of the spectrum locus. This means that many spectrum colours are specified by YX values alone.

By means of a change of axes the XYZ triangle can be made a right-angled triangle and the white point (this time equal-energy white) arranged to be at $x = 0.3$, $y = 0.3$. This is the C.I.E. chromaticity diagram and represents the international reference frame for colour specification.

A plot of the distribution coefficients $\bar{x}$, $\bar{y}$ and $\bar{z}$ gives curves as shown in Fig. 7 (the bars over the letters being used to distinguish distribution coefficients from trichromatic coefficients). It may be observed that the $\bar{y}$ curve has the shape of the luminosity curve referred to at the beginning of this article. This implies that X and Z values contain no brightness information and this is a consequence, of course, of choosing X and Z to lie on the alychne.

No negative-going portions exist as the whole of the spectrum locus lies within the XYZ triangle. Filter photocell arrangements can be made to have responses of the shape of the $\bar{x}$, $\bar{y}$, $\bar{z}$ curves shown in Fig. 7. With three such cells nothing is easier than to determine the C.I.E. chromaticity of a particular light source. The output of each cell when illuminated with equal-energy white (obtained by means of a suitable filter over a tungsten lamp) is made equal (electrically—say by means of a variable meter shunt). Each cell is then illuminated with the colour to be measured and the X, Y and Z outputs noted. Y gives the relative brightness of this colour to the white. The chromaticity co-ordinates are then

$$x = \frac{X}{X + Y + Z}, \quad y = \frac{Y}{X + Y + Z},$$

$$\text{and } z = \frac{Z}{X + Y + Z}$$

and the x, y values are plotted. A number of points obtained in this way are shown on the diagram Fig. 8.

Looking at Square Waves

A Direct Approach to the Interpretation of Distortion

By T. D. CROOK

THE advanced textbooks on electronic subjects apply mathematical analysis to the question of what happens to a square wave in passing through an amplifier, and fill their pages with exponentials; or perhaps soften up the problem by a determined brandishing of mathematical atom bombs in the shape of Laplace transforms, or Heaviside operators—all of which leave the average not-too-mathematical enthusiast trudging along miles behind, and very likely regarding the whole business as akin to devilry, or as just clever examples of "Senior Wrangling." The real "amateurs' books," on the other hand—and particularly two modern American ones—sometimes include in their illustrations examples of square-wave distortion that never were on land or sea, and also provide interpretations which are often quite erroneous.

It is possible, however, to explain the process of square-wave distortion in an amplifier by simple physical methods, and though (apart from "Cathode Ray's" famous series of articles) descriptive explanations may seem to be rather *infra dig.* in a paper such as *Wireless World*, an attempt in this direction may perhaps not come too much amiss, particularly when augmented by diagrams which show the amount of variation in frequency response and phase-shift indicated by different degrees and kinds of wave-form distortion. Therefore, leaving the mathematicians to their fun and games I will endeavour to explain to fellow readers the results of much reading and a few experiments.

As is so well known that I am repeating it here, all regularly recurring wave-forms—square, triangular, pulsed, or as "wiggly" as you please—can be shown to be built up from sine waves, and a Fourier series shows that to produce a square wave of amplitude A and frequency f, the following recipe is essential:—

1. A sine wave of frequency f and amplitude $4A/\pi$.
2. Another sine wave of frequency $3f$ and amplitude $4A/3\pi$.
3. Another sine wave of frequency $5f$ and amplitude $4A/5\pi$

and so on using all the odd harmonics of f in the proportions indicated, theoretically up to infinity.

Incidentally all the sine-wave harmonics must be in phase with the fundamental; if one takes the same recipe but adds the harmonics in antiphase the resulting concoction is a sharply peaked wave-form—a culinary *contretemps* which would puzzle Philip Harben no end!

If such a square wave is pushed through an amplifier which either attenuates or accentuates the higher harmonics, it is obvious that its wave shape will be somewhat changed in the process—but in what way, and why?

A rough physical idea of the how and why is gained by concentrating on the "verticals" of the square wave. The quotes here have their common ironical significance, since the "verticals" are never truly vertical: if a good square wave is produced on a c.r.o. screen, and then the time base is speeded up sufficiently, these verticals will be found to have a decided slope, showing that they take a definite time (as represented by distance along the horizontal axis) to be traced out. This "rise-time" is, of course, the standard test of an amplifier's high-frequency response. Now if the verticals are thought of as being produced by one "side" of a sine wave with a frequency 100 times (say) that of the square wave and of the same amplitude, it is obvious that at a time-base speed slow enough to show several complete square waves the "sides" of the sine wave would be indistinguishable from a vertical trace, though there would, of course, be fifty of them to each horizontal of the square wave. Thus it seems physically more than likely that it is the higher harmonics of the square wave that are together responsible for the verticals, despite their continual decrease in amplitude with increasing frequency. In fact, if we draw a bow at venture and claim that attenuation of the higher harmonics of the square wave will reduce the straight upright part of the verticals, and accentuation will lengthen them, a practical test shows that we are toxophilites of no mean order, for this is just what does happen: attenuation of the square wave's higher harmonics rounds off the leading (left-hand to you) edge of the wave-form to an increasing degree till eventually, with large attenuation, no vertical part remains; accentuation lengthens the verticals, producing pronounced peaks, or over-shoots, which very rapidly drop back to their proper horizontal level. The two effects are shown in Figs. 5 and 6 respectively.

The above reasoning may seem to be a rather shady piece of "Junior Wrangling"—more *post hoc* than *propter hoc*, in fact—but it is generally true,

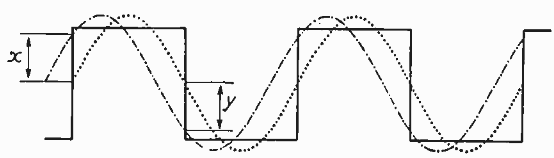


Fig. 1. Square wave with its sine-wave fundamental (dotted line), and the same fundamental with a phase-lead (dashed line).

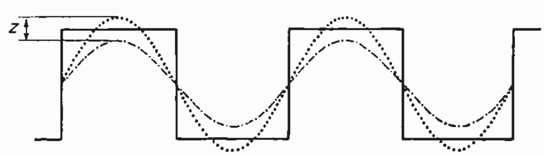


Fig. 2. Square wave with its sine-wave fundamental (dotted line), and the same fundamental after attenuation without phase-shift.

though of course the problem is complicated first by the fact that *all* the harmonics above the amplifier's turn-over point are affected, and, secondly, by the co-existence of phase-shift, which has its own undetermined effect.

However, at the low-frequency end the effects of variation in response and of phase-shift are quite distinct, and both amenable to a direct diagrammatic explanation.

A possible square-wave frequency for a low-frequency test might be 50 c/s, and if such a square wave is injected into an amplifier so decidedly "Low-Fi" that its response begins to fall off at 5 kc/s (the 100th harmonic of 50 c/s), the verticals and edges of the wave will still be reproduced in all their pristine perfection, since all harmonics up to the 99th are being fully catered for. On the other hand, since the square wave contains no frequencies below its fundamental, provided this is passed through without phase-shift or amplitude variation, the output square wave will be a replica of the input. Thus if the amplifier included a fantastic filter which allowed it to have perfect response at 50 c/s, but negligible response with appalling phase-shift at 45 c/s, it would still reproduce perfectly a 50 c/s square wave. This fact is emphasized because more than one book which deals with this subject implies or states that square-wave distortion gives an indication of amplifier response below the square-wave frequency. One could, by extrapolation from existing distortion, deduce the probable response below the square-wave frequency, but extrapolation can be a snare (cf. Scroggie's "Radio Laboratory Handbook," p. 355). As an example, one Williamson amplifier had a small peak at around 10 c/s: a test with a 15-c/s square wave might show perfect response, whereas 10 c/s would reveal the slight peak. If then the amplifier has phase-shift or change in amplification at 50 c/s, what sort of distorted square wave will come out of its spout? And why?

Phase-shift

First, the effect produced by phase-shift. Fig. 1 shows a square wave on to which has been superimposed as a dotted line its sine-wave fundamental, whose amplitude is $4/\pi$ times that of the square wave. The two wave-forms are of course exactly in phase with each other. If after passing through the amplifier the phase of the fundamental is given a lead of 5°, say, without any appreciable variation in gain (as would normally be the case), its new position would be as shown by the dashed line. Incidentally with only 5° phase-shift at the fundamental, the amount taking place at the 3rd harmonic (150 c/s) would be nearly negligible. The result of this shift in the position of the fundamental relative to the original square wave will obviously be to lift the leading edge by the amount x, and to drop the trailing edge by the amount y, and in actual fact all other points on the horizontal are similarly raised or lowered to such a degree that the horizontal remains quite straight, but tilts, as shown in Fig. 3(a). The actual amount of tilt for 5° shift is about 12% —i.e., the corners are lifted or dropped by an amount equal to 12% of the whole vertical side of the wave. In just the same way a phase-lag—shifting the fundamental to the right on the diagram—would cause the same amount of tilt, but in the opposite direction. The shift shown in the diagram has of course been

Fig. 3. Diagrams showing square-wave distortion when the fundamental is attenuated (with phase-shift) to the following degrees: (a) negligible attenuation; (b), 0.9 (−1 dB); (c), 0.8 (−2 dB); (d), 0.7 (−3 dB); (e), 0.6 (−4.5 dB); (f), 0.5 (−6 db); (g), 0.4 (−8 dB); (h), 0.3 (−10.5 dB).

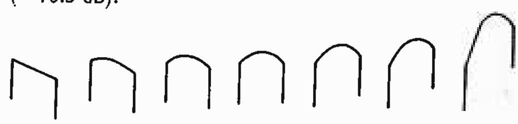


Fig. 4. Diagrams showing square-wave distortion when the fundamental is accentuated (with phase-shift) to the following degrees: (a), "flat" condition; (b), 1.2 (+1.5 dB); (c), 1.4 (+3 dB); (d), 1.6 (+4 dB); (e), 1.8 (+5 dB); (f) 2 (+6 dB); (g), 3 (+9.5 dB).

exaggerated for clearness. As a detector of phase-shift the method is very sensitive, and as little as 1° shift causes a noticeable tilt.

Secondly, amplitude attenuation or accentuation. Fig. 2 shows a square wave with its normal sine-wave fundamental, but this time the fundamental (dashed line) has been reduced in amplitude but not shifted in phase (unlikely, but assumed for clearness). If only the fundamental is affected, the result will be to lower the middle of the horizontal by the amount z, leaving the ends unaffected, and also to lower all other points so that the horizontal now curves downwards. This concave curvature is the indication of falling response at the fundamental, and when this is so large that some drop also occurs at the 3rd and perhaps 5th harmonic as well, the wave-form begins to take on an exponential shape, as shown in Fig. 3(e). If there is accentuation of the fundamental it is also apparent that the curvature will be convex, instead of concave.

Normally, of course, the two effects appear together, but phase-shift always shows up first. As stated above, a 5° phase-shift gives 12% tilt, which is very easily seen, but the change in amplification that accompanies this in a normal R-C-coupled amplifier can be shown to be about $\frac{1}{2}$%, or 0.04 dB, which would produce a quite undetectable amount of curvature in the horizontals. Fig. 3(b) shows the amount of curvature produced by a 1-dB drop at the fundamental: it is quite small, but the tilt for the corresponding phase-shift is pronounced. The normal falling-off in low frequency response due to the increasing reactance of coupling capacitors causes a phase lead, whereas the normal "bass-lift" tone-control causes a phase lag: the latter effect can be seen in Fig. 4, where, owing to the bass-lift circuit, the normal phase-lead produced in the "flat" position is overridden and eventually turned into a large phase lag, with a tilt in the opposite direction.

If a band-stop filter is included which removes a narrow band of frequencies centred on f, one gets practically the same result as for normal l.f. attenuation, with the difference that the loss at f is very high, whereas that occurring at $3f$, $5f$, etc., is much less than would take place when the falling response was due to normal R-C couplings. In this case the horizontals show a deep central dip which slopes evenly up to the corners. If the band of frequencies removed is situated at the h.f. end, the horizontals have a sharp narrow dip near the leading edges. There may be a mathematical explanation or analysis of this, but I doubt if it can be explained in physical terms.

The above descriptive explanations may be debatable, and perhaps of limited interest, but it is hoped that the diagrams may prove to be of practical value.

Measurement of phase-shift is of less importance in audio work, since the ear is insensitive to it, and in any case equalizers and tone-controls necessarily produce phase-shift—though surely a perfect record characteristic equalizer should restore the correct phase relations that were altered by the circuits used in the recording process. Since, however, the main amplifier should cause minimum phase-shift, square waves can easily be used to ascertain the amount it does produce by applying the formula: Sin $\theta = \pi x/4$, where θ is the phase-shift in degrees at the testing frequency, and x is the fraction of the whole vertical side of the square wave that any corner is moved away from its normal position by the phase-shift tilt.

Fig. 5. Diagrams showing square-wave distortion when there is 6 dB loss at the stated multiples of the square-wave frequency (f): (a) 10f; (b), 5f; (c), 3f; (d), 2f; (e), at f.

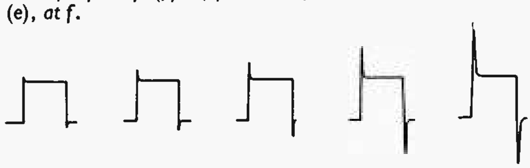


Fig. 6. Diagrams (except e) showing square-wave distortion when there is the stated amount of over-amplification at 10 times f: (a), 1.1 (1 dB); (b), 1.2 (1.5 dB); (c) 1.4 (3 dB); (d), 2 (6 dB); (e), 2 (6 dB) at 5f.

Amplitude Variations

More important are variations in amplification over the audio band. Unfortunately it is impossible to apply any method for measuring the actual curvature produced, owing to the simultaneous phase-shift effect, and to the fact that the curves soon take on an exponential shape. Therefore a series of tracings were made from a c.r.o. screen under specified conditions, and these do give a fairly accurate idea of the amount of gain or loss involved.

The equipment used for this purpose was—apart from a sine/square-wave generator—part of a pre-amplifier having the Williamson low-pass sharp-cut filter (used in its "flat" position), and the Baxandall tone-control. Tests showed that these circuits had only about 1 dB loss at 25 kc/s, and the output connections to the c.r.o. were taken direct to the Y-plate, under which conditions the c.r.o. would produce perfect square waves at 10 c/s and 20 kc/s. In any case small deficiences in the whole set-up could be corrected at the start of each measurement by very small adjustments to the tone control: actually the correct "flat" position of the control could best be found, especially on h.f. tests, by ensuring that a good square wave was produced. The Baxandall tone-control has a peak in its response well above the audio range, and to ensure that this did not vitiate the results the h.f. tests were carried out mainly at 1 kc/s, using up to about 3 kc/s when a large "drop" or "lift" was required. In any case the diagrams are intended to be useful only for audio work when the normal types of R-C voltage amplifiers would be used.

Procedure at l.f. was as follows. A 50-c/s square wave was passed through the amplifier and into the c.r.o., and the bass control adjusted to its "flat" position. The resulting trace, Fig. 3(a), shows that there was considerable phase-shift, but no visible attenuation, as the slopes are quite straight. The square wave was then changed to a sine wave, also at 50 c/s and the c.r.o. tracing adjusted to give a peak-to-peak reading of 10 divisions on the calibrated screen, the tone control was then moved to reduce the response at this frequency to 9 divisions, a drop of about 1 dB. The wave-form was then returned to a square-wave shape, and the actual wave-form on the screen was traced through transparent paper, giving the result shown in Fig. 3(b). The whole process was repeated, with the bass control adjusted to reduce the gain at 50 c/s from 10 to 8 divisions, and the resulting wave-form again traced, as in Fig. 3(c). Other values down to 10.5 dB drop were also obtained as shown. The same procedure was used to deal with given values of "lift" at 50 c/s, as in Figs. 4(a)-(g).

The diagrams are, of course, independent of frequency, although actually made at 50 c/s, and in the cases where they represent only a small attenuation at the square-wave frequency, it can be assumed that there is a drop at this frequency only, and none at 3*f* even; where there is a large drop at *f*, there is likely to be some drop at 3*f* too, but in any case the response curve is that of a typical tone control, and should apply with a minimum of error to any normal audio amplifier. Therefore, in order to test the l.f. response of an amplifier, one need only pass through it a square wave of 75 c/s, say, adjusting the c.r.o. sweep speed so that the wave-form is about the same size as that in the diagrams, and reduce the freqency until a suitable amount of curvature is produced, when the attenuation at the test frequency can be estimated with reasonable accuracy from the diagrams given.

H.F. Response

The procedure at the upper end of the audio band is more complicated, and the results unfortunately less certain in their significance, since in this case *all* the square-wave harmonics above the amplifier's turn-over point are attenuated to a steadily increasing degree, and at a rate depending on the nature of the response curve above that point. Luckily the response usually falls off at about the same rate for normal types of amplifier, but it may possess a noticeable rise at supersonic frequencies, as when negative feedback is applied over a transformer. Nevertheless, I think that the appended diagrams for h.f. response would have a general application.

To produce the diagrams, first a 1-kc/s square wave was used, and the treble control adjusted slightly to give a good square-wave shape. The input was then changed to a 9-kc/s square wave, and the output set to give a 10-division trace, as before, which was reduced by the treble control to 5 divisions—a drop of 6 dB at 9 kc/s. The original 1-kc/s square wave was then again injected, and the new wave-shape traced, as in Fig. 5(a), showing the effect of a 6 dB drop at the 9th harmonic of the square wave, with an increasing drop above that frequency. Similar tests produced the diagrams in Figs. 5(b) to (e), for a 6 dB drop at 5 kc/s, 3 kc/s, 2 kc/s and 1 kc/s, respectively, when using a 1-kc/s square wave. Actually, as mentioned above, a slightly higher square-wave frequency had to be used when the tone-control was unable to give sufficient drop, but the *proportions* between the square wave and the harmonic frequency at which the attenuation was taken were kept the same, and the resulting change in amplifier response to the much higher square-wave harmonics (only 1 dB down at 25 kc/s as stated above) should not have made any really marked changes in the wave-shape. Note that with the 6 dB drop occurring at $2f$, the output square-wave amplitude was about 13/14ths of its original value, since there was also a few dB drop at f as well; also with 6 dB drop at the fundamental, f, the amplitude of the output (now far from square) was about 0.7 of its original value. It is also worth noticing the difference between the square-wave distortions produced by attenuating the fundamental 6 dB when working at the l.f. end, and so having only small simultaneous attenuations at $3f$ and perhaps $5f$, but full reproduction of all harmonics from $7f$ onwards (Fig. 3(f)), and attenuating the fundamental 6 dB, and *all* higher harmonics to an increasing degree, as when working at the h.f. end (Fig. 5(e)).

The effects caused by "top-lift" were traced in the same way, except that four values of "lift" were used at 9 kc/s, and one at 5 kc/s, giving the results shown in Figs. 6(a) to (e).

Again, as suggested for the l.f. end, if a 1-kc/s square wave is passed through an amplifier, and the frequency increased until the corners become rounded, about as in Fig. 5(a), it can be assumed that there is about 6 dB drop at $9f$, if the response curve above that point falls off at a normal rate, as would usually be the case. As an illustration of what happens when the response curve is abnormal, a test was made with a 5-kc/s square wave which was reproduced quite well when all controls were in the "flat" position, but when the sharp-cut filter was switched to its 12-kc/s position, the square wave was converted to a somewhat triangular-shaped sine-wave. In this position of the filter there was 6 dB drop at 12 kc/s with an attenuation of some 30 dB per octave above this frequency, and a slight rise at a considerably higher frequency: the more-or-less complete removal of the 5th and higher harmonics of the square wave completely destroyed its shape.

Luckily no normal "straight" amplifier or pre-amplifier has this kind of h.f. response curve: one gets it only by the use of parallel-T networks, negative feedback, and expensive 1% resistors and capacitors—and then, if like me you are no connoisseur of antique 78 r.p.m. records, you hardly ever have occasion to use it!

"Unconventional F.M. Receiver"

Correction.—On page 261 of the June issue the core of B4 Ferroxcube should be list No. FX.1146 (as in Fig. 6). The list No. FX.1595 refers to the B2 Ferroxcube core tried as an alternative.

TELEVISION PICTURE QUALITY

This comparison of the relative definitions offered by different television systems appeared as an Editorial in the July number of our associated journal Wireless Engineer.

ALTHOUGH there is no immediate prospect of a colour television system coming into operation in this country, there is a good deal of discussion going on about the standards which should be adopted. There is a school of thought which considers that compatability with the present black-and-white television service is unnecessary and that when colour does come it can be, or even should be, on different standards.

A view which is quite often expressed is that Great Britain should adopt the same colour standards as the Continent and there is good reason to believe that this means a 625-line version of the American N.T.S.C. system. There is, of course, no suggestion that the present 405-line system should be abandoned so far as monochrome transmission in Bands I and III are concerned. The suggestion is that no attempt should be made to introduce colour into these but that colour should be developed as a parallel service in Bands IV and V.

Although superficially attractive, there are a good many objections which can be raised against such a scheme. We do not propose to discuss them now, however, for we are more concerned with the underlying idea that 625 lines is a more suitable standard for television than 405 lines. In some circles, it seems to be taken for granted that it is greatly superior. The fact that the Continent only adopted 625 lines after a lengthy examination of our 405-line and the American 525-line systems is often thought to be evidence of its superiority.

We ourselves think that they made a mistake in choosing their standards. We thought so at the time and, having seen 625-line television, we still think so. We do not mean that the 405-line system is better than the 625-line. What we do mean is that the 625-line system does not make the best use of the 5-Mc/s bandwidth allotted to it. We feel strongly that, for this bandwidth, the number of lines should be around 500 and that this would give better pictures than either 405 or 625 lines.

The important factors concerned with this matter of lines are not always as clearly realized as they should be. We propose, therefore, to compare them for the two existing systems.

First of all, in the 405-line system there are 377 active lines; that is, lines conveying visible picture information. In the 625-line system there are 575 active lines. There is no doubt at all that, in respect of vertical definition, the 625-line system is $575/377 = 1.53$ times as good as the 405-line. This improvement of 53% in vertical definition is accompanied by a proportional reduction in the visibility of the line structure, which is in itself a good thing. Too much importance should not be attached to it, however, for methods exist (e.g., spot-wobble) by which the visibility of the line structure can be reduced.

In the horizontal direction, the definition depends on the velocity of the scanning spot and the bandwidth. It is quite usual to assess horizontal definition in terms of a chess-board type of pattern. The fundamental component of the waveform produced by scanning such a pattern is a sinusoid of which one cycle corresponds to two adjacent elements of the chess-board. If the duration of the active part of a line is τ_1 and there are n elements per line, the duration of one cycle of this sine wave is $2\tau_1/n$. The frequency is thus $n/2\tau_1$ and this is taken as the upper limit of the video bandwidth.

This is rather an arbitrary relation, but it is practically useful and, in any case, it is valid for comparing different systems. With 405 lines, the frequency is 3 Mc/s and τ_1 is 80.95 μ sec. Therefore, $n = 2 \times 3 \times 80.95 = 485.7$ elements per line. With 625 lines, the frequency used is 5 Mc/s and τ_1 is 52.32 μ sec, so $n = 2 \times 5 \times 52.32 = 523.2$ elements per line. The horizontal definition is thus $523.2/485.7 = 1.075$ times that of the 405-line; that is, an improvement of 7.5%.

The facts are thus, that 625 lines gives 53% better vertical and 7.5% better horizontal definition than 405 lines. For this, it requires a greater bandwidth. The video bandwidth is greater in the ratio of $5/3 = 1.66$ and the channel bandwidth (i.e., the band occupied by both sound and vision transmissions) in the ratio $7/5 = 1.4$.

The aspect ratio is 4/3 in both cases. With 405 lines, there are $485.7 \times 3/4 = 364$ elements in the same linear distance as the 377 active lines. The definition is thus virtually the same in both the vertical and horizontal directions. With 625 lines, there are $523.2 \times 3/4 = 392$ elements in the same linear distance as the 575 active lines. The vertical definition is thus $575/392 = 1.46$ times as good as the horizontal.

It is clear that the 625-line system gives better definition than the 405-line but at the expense of 40% more channel width. The improvement is almost entirely in vertical definition. For practical purposes the two are virtually the same in horizontal definition.

If the bandwidth is kept constant, altering the number of lines improves the definition in one direction across the picture at the expense of the other. It is clear that there must be an optimum number of lines and it is not unreasonable to suppose that it occurs when the definitions in the two directions are the same, as in the 405-line system. If the two are not the same, in which direction should the definition be the better? We ourselves feel that horizontal definition is more important.

In support of this view, we instance the following:—

(a) In the cinema, the tendency is all to wide screens, emphasizing the horizontal direction.

(b) In laboratory tests of 405-line and 625-line pictures, each having the bandwidth of its particular standard, we find it hard to say with certainty which is which, unless there is a direct comparison.

(c) In laboratory tests of the 405-line system with unrestricted bandwidth against 625 lines with 5-Mc/s bandwidth, we find that the 405-line system gives the better picture.

In the 625-line system, the extra 2 Mc/s of bandwidth is used almost entirely to increase the vertical definition. It is this that we think wrong. We think that 405 lines with a 5-Mc/s bandwidth would give a better picture. We do not say, however, that the proper number of lines for this bandwidth is 405. Probably the right thing to do is to keep the definition in both directions the same and, for 5-Mc/s bandwidth, that means about 500 lines, as we said earlier.

It should be unnecessary but, in view of the figure of 500, perhaps we should point out that this does not mean that we think the American 525-line standard is the right one. That has a 60-c/s frame frequency and a 4-Mc/s bandwidth and gives inferior horizontal definition to the 405-line system.

In saying all this, we are not advocating any change of standards by anyone. So far as monochrome television is concerned, that is impracticable. What we are concerned about is that, if the introduction of colour is made on standards other than 405 lines, the new standards should be the right ones. If it is practicable to have different standards for colour, we do not think that 625 lines with 5-Mc/s bandwidth is right. For this bandwidth, 500 lines or so would be better but, better still, would be 625 lines with the 7.4-Mc/s bandwidth necessary to equalize the definition in the two directions.

W. T. C.

Four-speed Record Changer

A NEW version of the "Monarch" automatic record changer (type UA8) has been introduced with a choice of four turntable speeds including 16⅔ r.p.m. for "talking book" records. The new mechanism includes a neutral position in which the jockey wheel is disengaged from the motor spindle, and particular attention has been given to the reduction of "rumble." There is provision for manual operation of single records and the playing weight of the pickup arm is adjustable. Power consumption of the 4-pole motor is 8 watts at 240 V, 50 c/s.

The makers are Birmingham Sound Reproducers, Ltd., Old Hill, Staffordshire.

B.S.R. type UA8 four-speed record changer.

Servo Tuning System

A great deal has been heard about servomechanisms recently in connection with electronic control devices for automatic factories. This article gives an example of how a servo system is designed for a particular application, and has added interest because the application is in the field of radio.

Remote Position Control of Transmitter Tuning Elements

By D. SMART

THE ground-to-air radio communications system of an airport has to be arranged so that any of the frequencies allocated for aircraft approach or landing control can be used without delay. This could be done by having a number of transmitters tuned to the different predetermined frequencies. By far the most economical solution, however, is to use a single multi-tuned transmitter with remote selection facilities. An example of this is a 1-kW transmitter designed by Redifon which can be pretuned to ten frequencies in the 2-26 Mc/s range, any one of which may be selected from a remote operating position. The maximum distance between the remote control point and the transmitter is limited only by the loop resistance of the single pair of control wires required for remote switching, modulating and keying. This loop resistance must not exceed 1,000 ohms, which means that control distances up to 25 miles can be achieved.

Fig. 1 shows a simplified diagram of the r.f. circuit. A ten-position crystal oscillator feeds into an aperiodic buffer stage, ensuring maximum frequency stability. This is followed by another buffer stage with tuned anode load which feeds a driver stage for the power amplifier. Crystal and waveband selection are carried out by solenoid-operated switches. Within each band, however, a two-to-one frequency coverage is needed, and this involves continuously variable elements. It can be seen from Fig. 1 that three such elements are involved, viz., driver tuning capacitor, p.a. tuning coil, and aerial loading capacitor. For automatic tuning to any of ten preset channels some means of accurately resetting these three variables had to be devised.

The difficulties entailed in engineering a purely mechanical system with the necessary degree of accuracy and reliability, coupled with simplicity required for production, were judged too great. It was therefore decided to concentrate on an electro-mechanical servo system which combined accuracy and simplicity.

A simple remote position-control servo system of the form shown in Fig. 2 was finally adopted. This is commonly known as a self-balancing bridge system. The two potentiometers R_s and R_f connected across the voltage supply form the bridge. The amplifier input is connected across the potentiometer slides and constitutes the bridge load. When the bridge is balanced there is no potential across the slides. Under these conditions there is no input to the amplifier and no resultant motion of the motor and load. When the slider of the setting potentiometer R_s is moved from its initial position, a potential is developed across the input of the amplifier. This is amplified and drives the

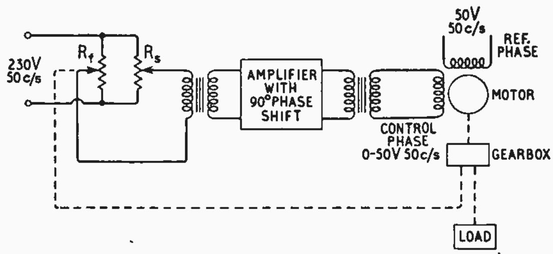


Fig. 2. Schematic of the remote position-control servo system used for tuning.

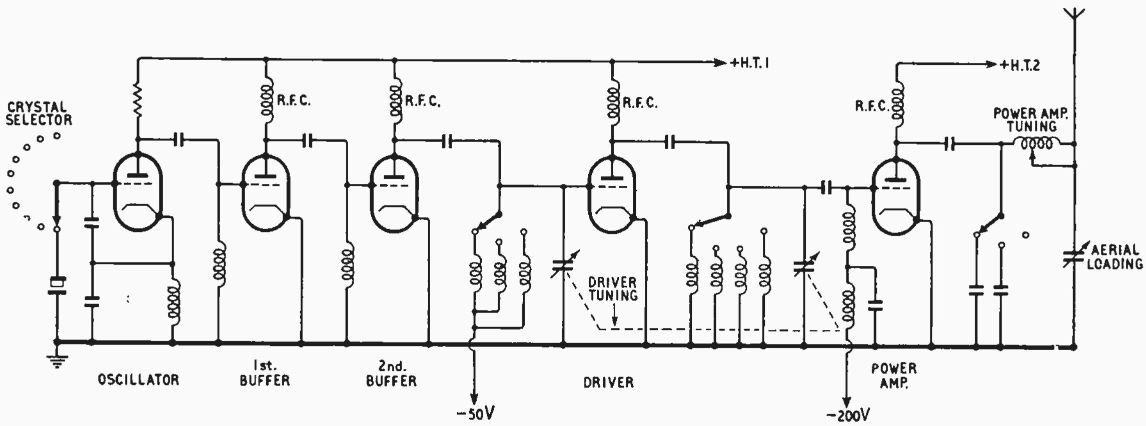


Fig. 1. Simplified diagram of the r.f. circuit of the transmitter.

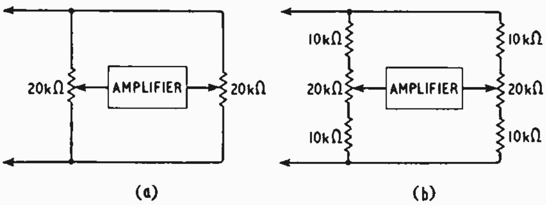


Fig. 3. Angular- to voltage-error translator: (a) simplified bridge network: (b) actual circuit.

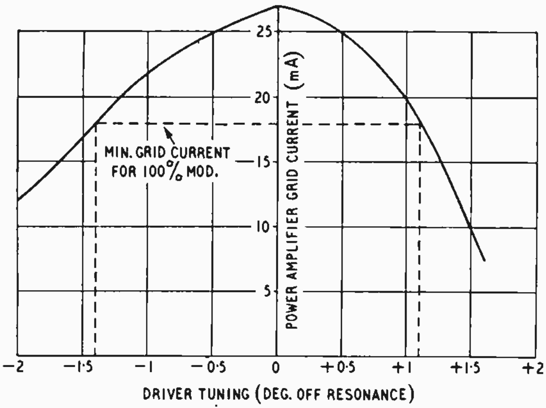


Fig. 4. Curve showing variation of power-amplifier grid current with angular error in the driver tuning of the transmitter.

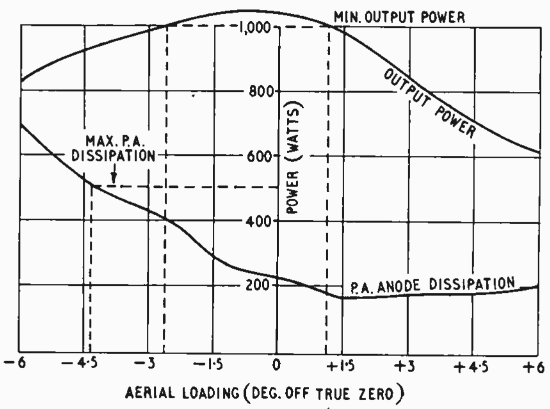


Fig. 5. Variation of output power and p.a. anode dissipation with angular tuning error in the aerial loading of the transmitter.

motor, gearbox and load. The follow-up potentiometer (R_f) slider is mechanically coupled to the gearbox and therefore moves in such a way as to restore the bridge to balance. It can be seen that by sufficient amplification this sytem can be made very sensitive to potentiometer setting, thus achieving the high degree of accuracy required for tuning applications. Furthermore, by having ten setting-up potentiometers and switching from one slider to another, it is possible to make the load move to any of ten predetermined positions or tuning points.

Any remote position-control servo system can be broken down into a number of basic elements. As they operate by virtue of an intial positional

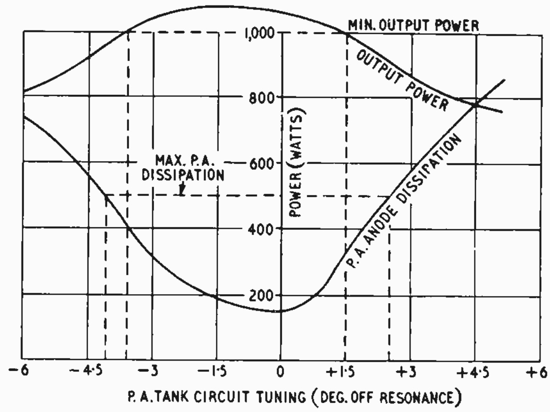


Fig. 6. Variation of output power and p.a. anode dissipation with angular tuning error in the p.a. tank circuit of the transmitter.

error between the input and output members, there must always be some error-measuring device. This angular error can be written down as

$$\theta = \theta_i - \theta_o \quad .. \quad (1)$$

where θ_i = input angle, θ_o = output angle and θ = error angle

and is converted into a voltage error, the magnitude and phase of which must correspond to the magnitude and direction of the angular error. The angular- to voltage-error translator is shown in Fig. 3; (a) is the bridge network in a simplified state, while the actual circuit is at (b). The object of the 10-kΩ series resistors is to keep the impedance presented to the amplifier at balance more constant. This makes the system sensitivity more constant over the potentiometer range. With the values shown the impedance varies by 25%. The higher the value of R the smaller will be the percentage variation in impedance. This, however, calls for a larger voltage supply across the bridge or greater amplifier gain for a given sensitivity. The bridge is energized by 230 volts, 50c/s, which is the most convenient supply available. Although the use of a higher frequency supply, e.g., 400 c/s, would have considerably eased the design of the amplifier, this was not considered important enough to offset the disadvantage of having to provide a 400-c/s generator in an equipment where the servos are an important but small part of the whole.

The follow-up potentiometers are ten-turn wirewound helical potentiometers having an effective angle of rotation of 3,600°. They consist of 11,500 turns of resistance wire, giving a very good voltage resolution combined with compactness. This makes them very suitable for coupling to a gearbox. It can be seen that the error voltage is developed at a rate of 30 mV/degree.

The thirty setting-up potentiometers are again ten-turn wirewound helical potentiometers with an effective angle of rotation of 3,600°. They have slightly poorer voltage resolution, consisting only of 6,500 turns of resistance wire. This, however, affects only the accuracy of the initial setting-up, which can be made very great with care.

The equation of motion of any remote position control servo can be set up from a knowledge of the accelerating and retarding forces. The accelerating force is $K\theta$, where K = controller factor, i.e., output torque per unit angle error in oz-ins/radian. The retarding forces are given by the product of the output moment of inertia and output angular acceleration $\left(J \frac{d^2\theta_o}{dt^2}\right)$, plus the product of the friction coefficient and output speed $\left(F \frac{d\theta_o}{dt}\right)$, where J = output moment of inertia in oz-ins^2 and F = friction torque per unit output speed in oz-ins sec/radian.

$$\text{Thus } K\theta = J\frac{d^2\theta_o}{dt^2} + F\frac{d\theta_o}{dt} \quad \ldots \quad \ldots \quad (2)$$

θ_o increases linearly with time at a rate determined only by the motor speed and gear ratio: thus

$$\theta_o = \omega_o t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$\therefore \frac{d\theta_o}{dt} = \omega_o \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

$$\text{and } \frac{d^2\theta_o}{dt^2} = 0 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Substituting (4) and (5) in (2) we have

$$K\theta = F\omega_o$$

$$\therefore \theta = \frac{F\omega_o}{K} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Equation (6) gives the steady state error in terms of output speed and system parameters. It would appear that by sufficient amplification, i.e., making K large, θ can be made very small. There is a limit, however, to how large K can be made without incurring instability. This can be seen by examining the transient solution to equation (2). This is not dealt with in this article because of its length and complexity. In practice K was made variable and adjusted to achieve a compromise between accuracy and prolonged oscillation.

The design procedure applied to all three servos was as follows:—

(1) Knowing θ, F and ω_o, K was calculated from equation (6).

(2) Knowing the error volts per radian and the motor torque per volt, the required amplifier gain was calculated.

It was first necessary to determine the resetting accuracy required of all three servos. Figs. 4, 5 and 6 show how p.a. grid current, power output and p.a. anode dissipation vary with angular error in tuning. From these it is possible to determine the maximum error permissible in each case. These are:

± 1.08° for aerial loading capacitor servo.

± 1.1° for driver tuning capacitor servo.

± 1.5° for p.a. tuning coil servo.

We shall consider only the aerial loading capacitor servo in detail. One important requirement was that the time required to change channels should be as small as possible. This means that the servos should have fairly high output speed. In the case of the aerial loading capacitor, with an angle of rotation of 180°, the gear ratio was made 400 : 1 between motor and load. This results in a maximum operating time of 5 seconds for a motor speed of 3,000 r.p.m.

The static friction in the system, mainly introduced by the follow-up potentiometer and gearbox, determines the minimum starting torque, hence the size of motor required. It was found to be 2 oz-ins. A two-phase servo motor with the following characteristics was chosen: moment of inertia, 0.16 oz-in^2; stalled torque, 4 oz-ins; reference phase, 50 volts 8.6 watts; control phase, 50 volts 11 watts.

Fig 7, curve (b), gives the torque *v.* speed characteristic of this motor. It can be seen that the friction damping introduced by the motor

$$F = \frac{\Delta T}{\Delta S} = \frac{4 \text{ oz-ins}}{3{,}000 \text{ r.p.m.}} = \frac{4}{3{,}000 \times 2\pi/60}$$

$$= 0.012 \frac{\text{oz-in}}{\text{rad/sec}}$$

or $0.012 \times 400^2 \frac{\text{oz-ins}}{\text{rad/sec}}$ at the output shaft.

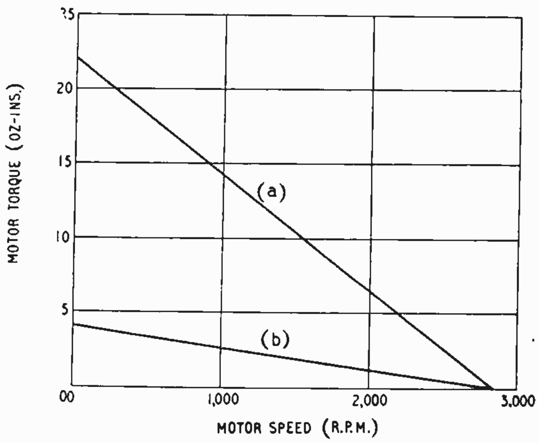


Fig. 7. Torque/speed characteristic of the electric motor used in the servo system.

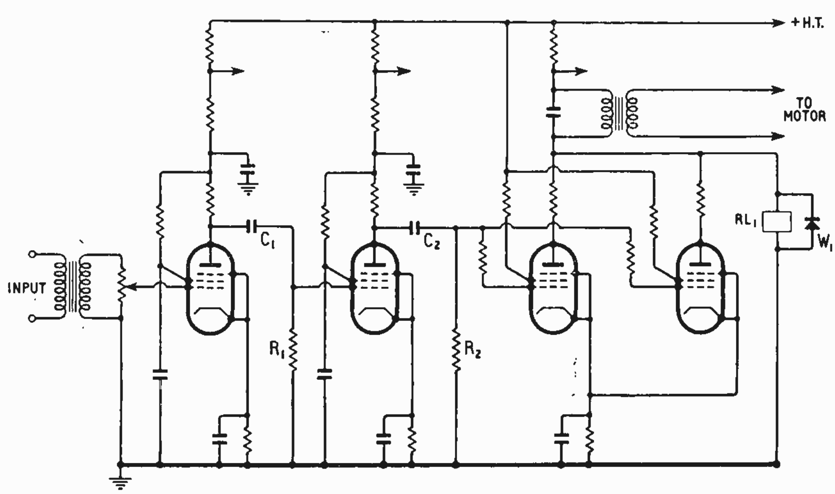


Fig. 8. Circuit of the 10-watt servo amplifier.

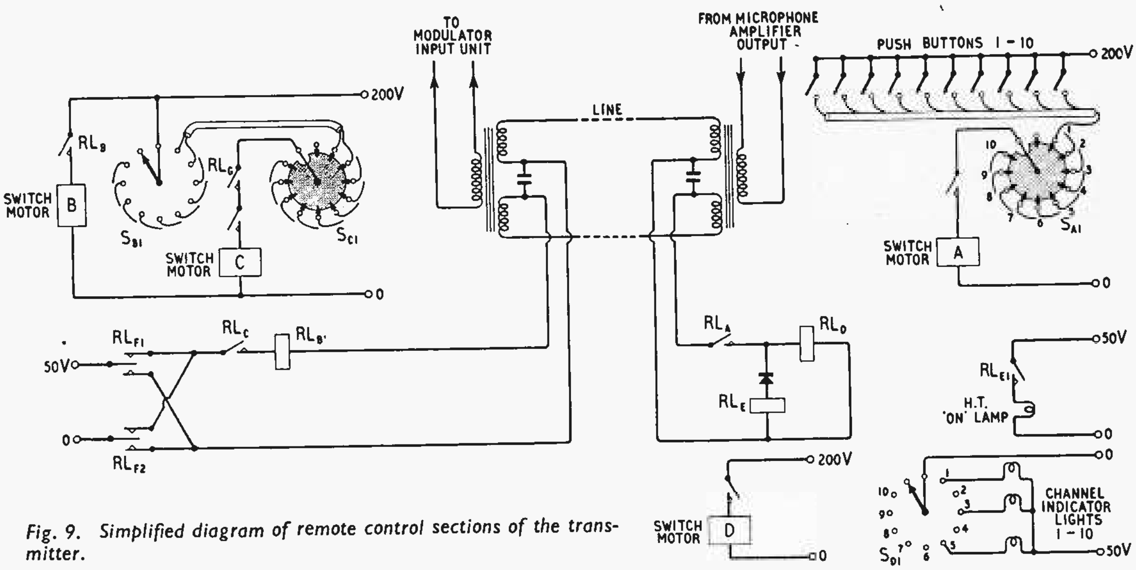


Fig. 9. Simplified diagram of remote control sections of the transmitter.

The output speed was $\omega_o = 0.785$ rad/sec. Knowing F, ω_o and θ

$$K = \frac{0.012 \times 0.785 \times 400^2}{0.019} = 7.93 \times 10^4 \frac{\text{oz-ins}}{\text{rad}}$$

The error volts are 30 mV/degree or 1.72 volts/rad. The motor torque is 0.08 oz-ins/volts or 0.08 × 400 oz-ins/volts at the output shaft. Therefore

$$\text{amplifier gain} = \frac{7.93 \times 10^4}{0.08 \times 400 \times 1.72.} = 1{,}440.$$

The amplifier circuit is shown in Fig. 8. It can be seen to consist of two pentode voltage amplifiers driving a power output stage consisting of two valves in parallel. The noise level is 60dB below full output of 10 watts. The interstage coupling components C_1R_1 and C_2R_2 are arranged to introduce a 90° phase shift at the operating frequency (50 c/s). This ensures that the reference phase of the motor can be fed from the mains via a step-down transformer without the need of a phase-shifting network. The relay and rectifier (RL_1, W_1) form part of an arrangement for switching off the h.t. from the p.a. during the tuning operation. It ensures that no h.t. is applied until all three servos are stationary. In practice the servo comes to rest with two overshoots and one undershoot, and the resetting accuracy is greater than anticipated.

Fig. 9 shows a simplified diagram of the remote control sections of the transmitter. Use is made in these of similar solenoid-operated rotary switches, to those employed for waveband selection. Two modes of operation are possible with these switches. In the first, application of the operating volts to a suitable contact on the " homing wafer " causes the switch to " motor " round to the desired position, when the supply is broken and the switch comes to rest. In the second mode, the solenoid is pulsed by suitable current pulses. Both these modes of operation are used in the remote control section.

Assuming the normal switching-on procedure has been carried out, the remote selection of frequency is carried out as follows. Switch motor A at the remote end is made to " motor " to the position (1—10) selected by depressing an appropriate push-button switch (1—10). In doing so its associated relay contact RL_A keys the line. Relay RL_B, at the transmitter end, is energized by the pulses produced by relay RL_A. Relay RL_B " pulses " switch motor B to the desired position. After a short delay switch motor C is made to " motor " to the same position by means of a wafer on switch motor B and delayed relay contact RL_G. In doing so its associated relay RL_C keys the line again. The pulses are used to energize relay RL_D which " pulses " switch motor D to the appropriate position. The latter part of the operation is merely " signalling back " that the correct position has been selected at the transmitter.

Switch motor B also controls a similar switch, the master selector switch, which controls all the tuning potentiometers' sliders and wavechange switches. This master selector switch can also be controlled locally by means of a switch on the front panel of the transmitter power supply bay. Full local control is thus possible in the event of line failure, etc.

When all the tuning operations have been carried out, after a short delay the h.t. is applied. The p.a. cathode current which flows operates a relay ($RL_{F1\cdot 2}$) which reverses the polarity of the 50 volts d.c. on the line. This causes relay RL_E at the remote end to be energized and indicates that the transmitter is operating satisfactorily. All the normal overload protection methods are, of course, also included.

Thermistor Thermometer

FOR medical research the low heat capacity and rapid response of the thermistor, when connected to measure temperature, has obvious advantages, and much interest was shown in a brief description of an American instrument which appeared in our April issue (p. 164).

We understand that a British-made thermistor skin thermometer is in production by Chapman Anderson, Ltd., 7, Oak Hill Park, London, N.W.3. The basic element is the S.T.C. Type F thermistor and the instrument is designed for use with ordinary flashlamp batteries. An industrial version for measuring surface temperatures is also available with a scale calibrated from 0 to 300°C.

LETTERS TO THE EDITOR

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

"*Unconventional F.M. Receiver*"

CONGRATULATIONS to Mr. Scroggie (and to *Wireless World*) on again breaking new ground even though the a.f.c. method may call for second thoughts. I don't think Mr. Banks' method (February issue) is the answer either; devices where the error signal itself applies the correction are inherently unstable and tend to oscillate (or "hunt" as the control instrument engineer would word it).

I don't mean that Mr. Banks' device does not work. Merely that the circumstance that it does not hunt is almost certainly fortuitous and consequently is not readily reproduced.

Could it be, therefore, that the real answer to this a.f.c. problem lies with the voltage sensitive capacitors mentioned in the April issue (p. 175) and may we have some more details regarding them?

Hornchurch, Essex. L. D. STUART.

Unconventional Interference

I REALLY must protest at what M. G. Scroggie refers to as "a less awkward band," when explaining his choice of a local oscillator frequency in his article on an unconventional f.m. receiver in the June issue.

If my mathematics are correct, this would be the band between 29.33 and 31.33 Mc/s, part of which is in the ten-metre amateur band.

With propagation m.u.fs on the increase due to the rise in the sunspot cycle, this band provides no less a measure of enjoyment to many hundreds of British amateurs than does v.h.f. to those who have adopted this method of receiving B.B.C. programmes. I suggest Mr. Scroggie might be reminded that tolerable receiver oscillator radiation in the various bands of the radio frequency spectrum have been conventionally agreed by the industry.

The harmful interference radiated by this unconventional receiver (the author admits this with respect to Band I television), arises from a very inferior design which can have no place in the present advanced state of this branch of science.

The distasteful way in which the interference is deliberately removed from a broadcast to a non-broadcast band is no credit to the writer, and *Wireless World* is cheapened by the publication of such material.

London, S.E.25. DAVID DEACON (G3BCM).

The Author Replies:

I AM sorry that the description of my precautions against interference should have been open to such misinterpretation as that put on it by David Deacon. May I therefore call attention to the following points:

(1) I did not admit that the type of receiver I described "radiates harmful interference."

(2) Even if, as a result of its being designed contrary to my recommendation, it were to do so on Band I, this would not necessarily mean that the design described interferes in the 29.32-31.45 Mc/s band. The vulnerability of Channel I televiewers to oscillation in the band 44-47 Mc/s, to which I referred, is far greater than that of amateurs to oscillation between 29.32 and 31.45 Mc/s, in the following respects:

(a) The strength of radiation is likely to be substantially greater. As I pointed out, use of the lower frequency "still further reduces radiation."

(b) Whereas radiation on *any* frequency between 44 and 47 Mc/s inevitably comes within the reception band of *every* Channel I receiver, only about one-sixth of the 29.32-31.45 Mc/s band comes within only about one-fifth of the 10-metre amateur band, and at any given time occupies only one of perhaps 20 telephony channels within that fifth.

(c) The number of Channel I televiewers is vastly greater than the amateurs necessarily working within that particular one-fifth of that particular band.

(d) Television receivers, being usually present in the same house, and often only a few feet away on the other side of a party wall, are liable to be affected by a source of radiation that would be inappreciable even a dozen yards away.

(3) No reason has been given for concluding that this "very inferior" unconventional receiver radiates any more than conventional types; in fact, quite the contrary.

(4) An oscillator is not one of the unconventional features of my receiver; it is included in almost every receiver in the world. Millions of receivers, products of "the present advanced state of this branch of science," have no r.f. stage to separate the frequency changer from the aerial, and their continuously tunable oscillators sweep across the whole of the amateur 7 and 14-Mc/s bands. Why does Mr. Deacon not turn his fire on them? By contrast, my receiver has a r.f. stage, an exceptionally low oscillator frequency for a Band II receiver, and a much higher ratio between the receiving and oscillator frequencies than any conventional type. Moreover its oscillator works only on a few spot frequencies.

On the whole, then, I feel there is no immediate cause for alarm.

M. G. SCROGGIE.

Two-channel Stereophonic Sound Systems

IN reply to the questions raised by P. B. Vanderlyn and Ian Leslie in the July issue the following comments may help to clarify the situation.

First, the statement in the above article that "the reproduced sound image is more accurately positioned if arrival time differences are overruled and the sound image is positioned by intensity differences only" was not meant to apply to the sounds actually at the two ears of the listener. What was meant was that the sounds at the loudspeakers should differ only in intensity level and that for the best stereophonic effect the listener should be seated so that there is no overall time difference between the sounds from the loudspeakers for the hearing mechanism as a whole. The fact that there must be a small time difference between the sounds at the individual ears when the sound image is not in the centre was not meant to be included in this statement. That such a time difference is produced, with unequal intensities at the loudspeakers, is well appreciated. For off-centre listening this criterion obviously no longer holds, but it has been found that fairly satisfactory compensation can be applied, as was shown in the article.

Secondly the theory underlying P. B. Vanderlyn's remarks, although apparently straightforward, does not in practice appear to agree very well with the results obtained experimentally using speech or other sounds of a very irregular nature. This is not altogether surprising since the hearing mechanism is not at all simple in its operation. The fact that only a difference in the sound level at the loudspeakers of between 12 dB and 18 dB is necessary to give the impression of "hard over" to one side is certainly not confirmed by this theory. Experimental results of other investigators[1,2] confirm this finding. An alternative theory[3], although with limitations, is also in agreement. The figure of 12 dB difference for "hard over" used in obtaining the microphone responses was sufficient to give this sensation for all the subjects tested.

Referring to Ian Leslie's comment about the controversy over loudspeakers, it is agreed that this difference should be settled. The results given in the article agree quite closely with the work of other investigators[1,2,4] and although the results might be subject to experimental error it is felt that the specified correction is definitely needed. To obtain this correction by using directional loudspeakers, although simple, cannot be said to be perfect; but it does result in very much improved results.

Tone controls are still needed to correct for scale distortion due to different listening levels to the original and to compensate for the acoustics of the listening room. Also, studio engineers are after all only human and it is nice to be able to correct for differences of opinion between them and oneself.

Ruislip, Middx. D. M. LEAKEY.

REFERENCES

[1] W. B. Snow, *J. Acoust. Soc. Amer.*, Nov. 1954.
[2] V. L. Jordan, *Acustica* Vol. 4, No. 1, 1954.
[3] J. C. Steinberg and W. B. Snow, *Electrical Engineering.*, Jan. 1934.
[4] H. Haas, *Acustica*, Vol. 1, No. 2, 1951.

Three Minutes' Silence

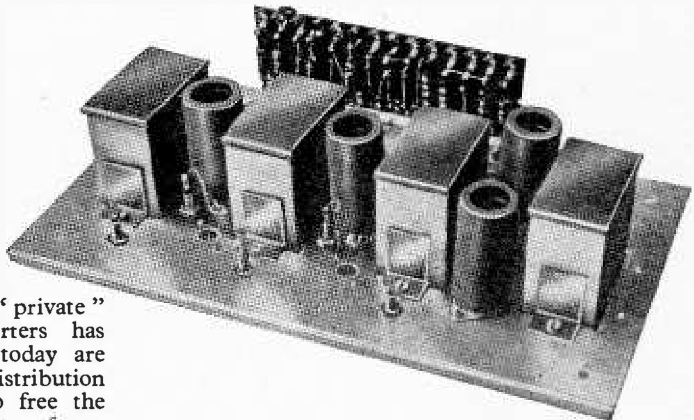
THOUGH not a professional marine radio operator, I have done a good deal of listening on the 500-kc/s channel and so can make an unbiased comment on "Free Grid's" observations (May issue) about alleged non-observance of the three minutes' silence. My experience is that a fairly pronounced silence descends on the channel at 15 and 45 minutes past the hour. In fact, if anyone is looking out for "600-metre Dx," as I still do, these silence periods are very profitable.

AS3.

Wide-Band Linear R.F. Amplifier

For Use in Ships' Communal Aerial Systems

By B. F. DAVIES,* A.M.I.E.E.



SINCE the last war the need for the "private" broadcast receiver in the crew's quarters has been recognized and many new ships today are planned to be fitted with an aerial distribution system. In many cases this is done to free the ship's superstructure from the multiplicity of unsightly wires that would otherwise appear as more of the crew obtained receivers. In a small ship a multiplicity of "private" aerial wires may constitute a positive danger by altering the calibration of the d.f. loops and in oil tankers there is a fire hazard if sparking occurs in a badly installed aerial when the ship's MCW transmitter is working.

The obvious solution is to install one "official" aerial for broadcast reception and to serve all receiving points through a wide-band r.f. amplifier and coaxial cables.

Basic Requirements.—Considering the aerial first, it will be appreciated that the position, height and length of the aerial will be largely dictated by the layout of the ship and the position of the transmitting aerials. Difficulties are greater on the smaller ship and resort has often to be made to a smaller active length of aerial wire. It has not been uncommon with a transmitter of 500 watts and a main aerial length of 200ft to obtain with a receiving aerial of 100ft about 50 volts of r.f. across the 75-Ω coaxial cable termination. From statistics available this high voltage is to be found at transmitting frequencies somewhere in the region of 6 Mc/s. Length of aerial and spacing will modify this resonance considerably. At other frequencies usually less than 1 volt will be induced for the same transmitted power. No amplifier can handle 50 volts of input, and in practice a limit of about 25 volts would be set, adjusting aerial length or position to keep the "resonant" voltage down.

Some means of rejecting the transmitting frequencies has to be adopted and a standard form of filter was used. Assuming the worst case of 25 volts on the aerial coaxial lead-in cable and a minimum filter attenuation of 36 dB, the amplifier must handle 0.4 volt. From Table 1 it will be appreciated that

TABLE I.

MARINE TRANSMITTING BANDS

415 —525 kc/s	M.F. Band
1.6 —3.8 Mc/s	I.F. Band
4.063—4.238 ,,	H.F. Band
6.20 —6.357 ,,	,,
8.195 —8.476 ,,	,,
12.33 —12.714 ,,	,,
16.46 —16.952 ,,	,,
22.00 —22.400 ,,	,,

* Formerly with the Marconi International Marine Communication Company Limited.

considerable band filtering would be required. It was decided that the standard amplifier should incorporate two band-stop filters covering the M.F. and I.F. bands only. In regions of dense shipping, transmissions in these two bands from ships close by can give rise to a total r.f. voltage on the aerial of as much as 50 mV. A filter unit for the H.F. bands used by the ship's transmitter would be separate and would be an optional extra. Where H.F. band transmissions are likely to be few in comparison with those in other bands, such a filter unit could be saved by using a remotely controlled relay to disconnect the aerial completely in order to keep high voltages out of the amplifier input during periods of transmissions in the H.F. bands.

To cover all the broadcast bands, the amplifier should possess a sensibly flat frequency response between 150 kc/s and 25 Mc/s. The input impedance to suit the aerial coaxial cable should be 75Ω and the outputs also suitable for feeding into 75Ω coaxial cables. The method of distribution is shown in Fig. 1, from which it is evident that although the loading, and consequent slight mis-match at each outlet point, is quite small a large number of receiver outlets could load the cable and introduce a cabling loss. The input impedance of each receiver differs considerably at any one frequency according to the tuning of the receiver and consequently the summation of all the loading effects is modified. It was decided to cater for up to 20 outlets and that four amplifier outlets would give a good economic compromise. In standardizing on equipment the circuit complexity and reliability have to be weighed against the average demands. In isolated cases, as indicated by present market demands, a ship requiring more than 80 outlets could be covered with two or more amplifiers working in parallel.

The amplification required was fixed at approximately 15 dB. As will be evident later, this again was a compromise between producing voltages at the receiver outlet points identical with that on the aerial terminated with 75Ω and keeping spurious responses within the amplifier to a minimum. In practice the overall gain of the system between aerial and the input terminals of the receiver also takes into account the fact that the aerial fitted for the distribution system will have a greater effective height than the average length of wire that can be slung haphazardly. Thus the equivalence of voltages at aerial and receiver can be disregarded. Emphasis was laid on making available in the cabin a " clean " signal free from machine noise interference, spurious responses, etc.

Effects of Amplifier Non-linearity.—The term a " linear amplifier " is, of course, only relative, but it does imply that in addition to producing an amplifier with a wide-band response attention has also been paid to obtaining the maximum degree of linearity. The wide-band amplifier suffers from the inherent disadvantage that in amplifying many signals simultaneously any non-linearity will produce other signals at the output. A power series can be used to represent the " curvature" and is in the familiar form $ax + bx^2 + cx^2$. This is equivalent to saying that the amplifier is capable of producing, as in audio techniques, the second and third harmonics of a fundamental sine-wave input. The two input signals are represented by $p \sin \alpha$ and $q \sin \beta$, and where one is considered to be modulated, p becomes $p\,(1 + m)$ where $m \not> \pm 1$. Analysis shows that the first term can be neglected, but the second term produces the expression bpq $[\cos(\alpha - \beta)t - \cos(\alpha + \beta)t]$. Thus the original carriers α and β have produced spurious carriers $(\alpha - \beta)$ and $(\alpha + \beta)$ both of which are dependent on the product $p\,q$. This means that modulation of either original carrier will produce modulation of the spurious carriers. This is called inter modulation (I.M.).

The third term produces the expressions $3cp^2q$ $[\sin \beta\, t - \frac{1}{4}\sin\,(2d + \beta)t + \frac{1}{4}\sin\,(2\alpha - \beta)t]$ and $3c\,p\,q^2$ $[\sin \alpha\, t - \frac{1}{4}\sin\,(\alpha + 2\beta)t - \frac{1}{4}\sin\,(\alpha - 2\beta)t]$. The second and third terms in each of the brackets are similar to the I.M. terms discussed above except that the spurious responses are at different frequencies and that the spurious carrier modulation is proportional linearly to one original carrier and to the square of the other. This would mean that for low levels of original modulation the spurious carrier modulation would be double that for modulation of either p^2 or q^2 compared with modulation of p or q. Thus if p carrier is modulated the spurious carrier modulations at $(2\alpha + \beta)$ and $(2\alpha - \beta)$ will be double that at $(\alpha + 2\beta)$ and $(2\beta - \alpha)$. For modulation levels over 50%, severe distortion will be present in the spurious modulation of the first two frequencies. To discriminate between the two forms of inter modulation caused by the b and c coefficients in the power series expression, they will be called first-order intermodulation (1st I.M.) and second-order intermodulation (2nd I.M.) respectively.

The first parts of the third term expressions show that the original frequencies α and β are being produced, but whereas the modulation of carrier α was represented by an amplitude variation of p, this spurious response, at the same frequency, has

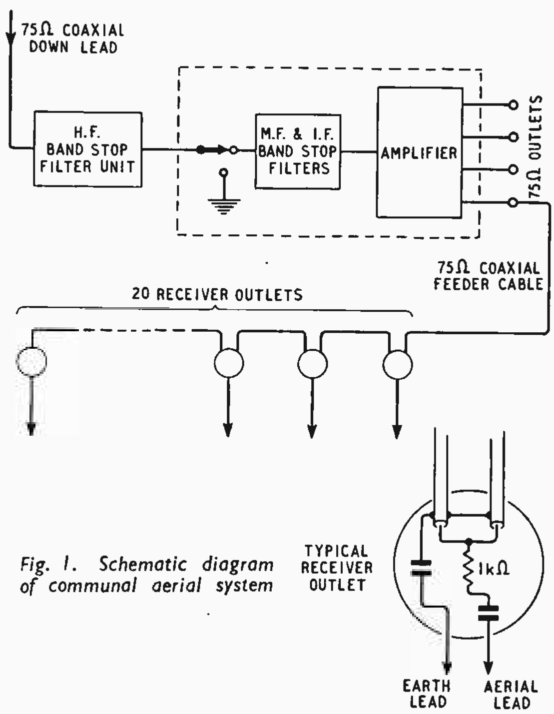


Fig. 1. Schematic diagram of communal aerial system

a modulation proportional to q^2. Thus the modulation of one carrier has become superimposed on the other. This effect is known as cross-modulation (X.M.). In this instance the unwanted effect will not be measured as the amplitude of an unwanted carrier, that would be coincident with a true carrier signal, but as the amount of background modulation existing on a true carrier having its own modulation.

In order to assess the linearity of an amplifier for this application, a limit on the unwanted responses enumerated above has to be set and a criterion based on the interpretation of test results has to be laid down. These matters will be referred to later.

Calculations have shown that in terms of the ultimate performance criteria laid down for I.M. products, the amplifier linearity is such that at the maximum voltage levels concerned, the 2nd harmonic production would be 0.0025% and for the 3rd harmonic 0.0004%. Although these figures are theoretical, they give some idea of the order of linearity required. Adoption of negative feedback methods would entail a considerable amount of feedback over the amplifier which, coupled with satisfying the Nyquist stability criterion over a very wide band, would be extremely difficult. The use of large valves working over a small portion of their characteristics would be most uneconomic if taken to the stage where linearity could be considered acceptable.

Current Amplification.—The amplifier circuit finally developed is actually one that amplifies the input current although to all intents and purposes it may look like a variation of a voltage amplifier.

The basic amplifier circuit is that of the grounded grid triode, as shown in Fig. 2. The input impedance at the cathode is $R_c' = \frac{r_a + R_L}{1 + \mu}$. Now if $R_L \ll r_a$, R_c' becomes $\frac{r_a}{1 + \mu}$ or approximately $1/g_m$ for a high-μ value. Now if the cathode is fed from a constant-current source ($Z = \infty$) any non-linearity of the $I_a - V_g$ characteristic resulting in a non-linear R_c', will have no effect and V_0 will be truly proportional to the input current. If now the impedance R_c' is presented to a valve, as in Fig. 3, and the impedance presented to the first triode is low compared with its r_a, then there is a good approximation to a constant-current feed. If V1 were a pentode, the approximation would be very good, but for reasons to be discussed later the pentode must be discounted. Further still, if the impedance in the cathode of V2 is high, the effective output impedance of V2 will become $r_a + (1 + \mu)R_c$, where R_c is the impedance in the cathode. If, say, for V2 the anode load to V1 is $r_a/10$, then the output impedance of V2 becomes $r_a + (1 + \mu)\frac{10r_a}{(1 + \mu)} = 11r_a$

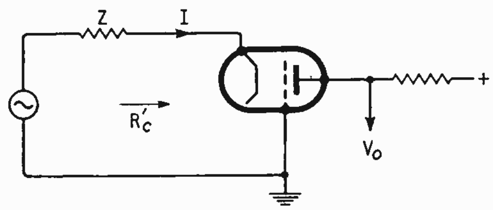
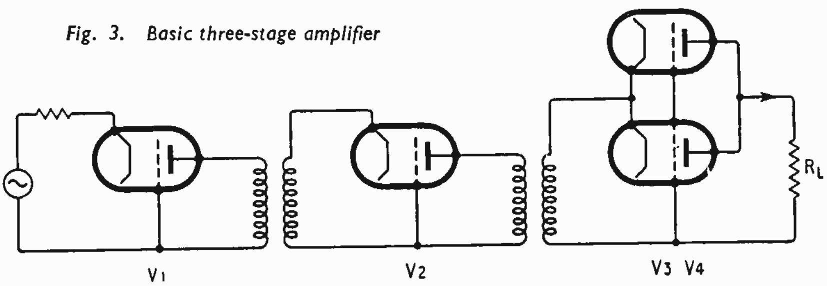


Fig. 2. Triode in the grounded-grid connection

Fig. 3. Basic three-stage amplifier



The effect of R_c in V1 and the anode load in V2 is neglected for simplification. It should be noted that as the cathode and anode currents are one and the same thing in each valve, the amplification, as such, takes place in each transformer which serves to step up the current between valves. The amplification being substantially independent of the valve parameters, stability of h.t. and heater volts is unimportant; nor is the amount of h.t. ripple voltage, within reason, of any great importance. In the final circuit (Fig. 4) it was decided to use a push-pull arrangement because (a) greater linearity would be expected, (b) the circuit would be inherently more free from extraneous noise pick-up (i.e. mains borne interference), (c) it could provide means of adjusting the "balance" of the circuit and thus permit of some correction of dissimilar valves, and (d) the impedance presented to a previous stage would be held more constant.

As already mentioned, the pentode would appear to offer a very good approximation to a constant current source and might successfully be used as a grounded-grid amplifier in preference to the triode. Used in that manner the cathode current would be the sum of the screen and anode currents and any input current would be divided between screen and anode. In addition to reducing the current gain in the circuit (the screen circuit acting as a partial current bypass) the output current at the anode would no longer be truly proportional to the input current. Inspection of valve characteristic curves shows that the ratio of anode current to screen current is not constant for variations of grid-to-cathode potential and non-linearity would obviously be present.

Linearization Factor.—This term has been introduced as a way of expressing the capability of the circuit in reducing non-linearity of the valves. In Fig. 2, a generator of internal impedance Z is used to feed a current into the non-linear impedance R_c'. The greater Z compared with R_c', the smaller the effect of variation in R_c' will be on the relationship between I and E. The linearization factor is defined as $\frac{Z + R_c'}{R_c'}$ and if $Z = 9\,R_c'$ we can expect harmonic distortion products to be reduced by 10.

Circuit Considerations.—From the point of view of economy, the four 75-Ω outputs were arranged to be fed from one output stage. Only one output

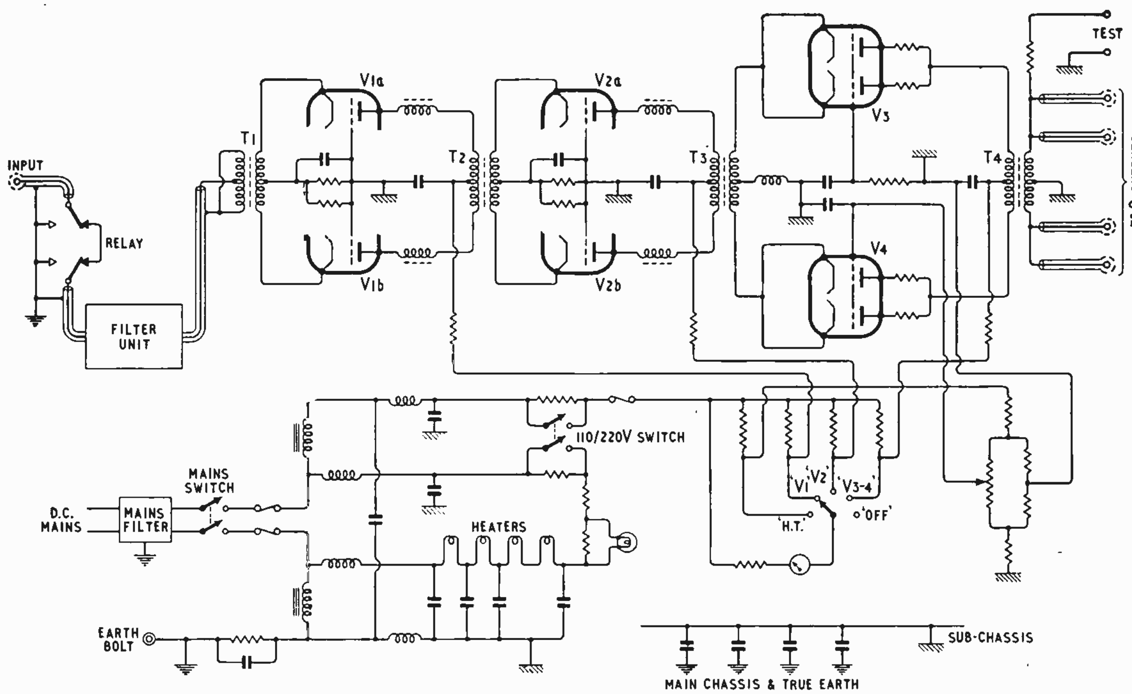


Fig. 4. Complete circuit diagram of final design

transformer was therefore required, but to obtain sufficient power gain in the last stage, a parallel push-pull arrangement of valves was adopted. Actually this meant a lower effective load impedance on the secondary of T3 and consequently a higher current amplification in the transformer could be obtained. This practice of paralleling valves to obtain greater current amplification by the preceding transformer cannot be carried out indefinitely owing to other limitations due to circuit capacities. The use of PCC84 valves enabled the whole amplifier to be constructed using four valves, which permitted the chassis to be packed in a very small space.

The success of the amplifier largely depended on the r.f. transformers which should have (a) good frequency response, (b) an effective high shunt loss impedance, and (c) freedom from non-linear hysteresis losses. An obvious choice of core material was Ferroxcube which proved to be very satisfactory. Shunt capacities across transformer primaries will serve as a current bypass at the anode of each valve with the result that at high frequencies the amplifier gain will be reduced. This effect sets an upper limit to the reflected primary impedances and, consequently, the turns ratio. From this basic consideration the gain per stage can be derived for the type of valve in question, and finally, the overall gain of the amplifier, which was calculated to be 15.2 dB.

It will be realized that shunt losses on the transformers will serve to bypass some of the current fed from the preceding valve with the result that the "constancy" of the current feed is impaired and the linearization factor will suffer. Alternatively, the impedance feeding the following valve is lowered. It is interesting to note that the linearization factor for the output stage, calculated for the valves alone, was 72.5. The transformers do not permit this figure to be fully realized in practice, but it indicates the measure of linearization that takes place.

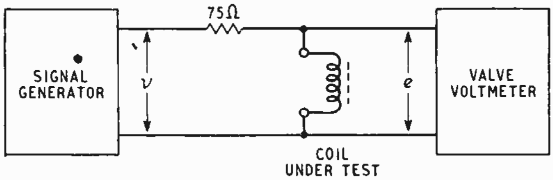


Fig. 5. Test circuit for effective shunt loss impedance

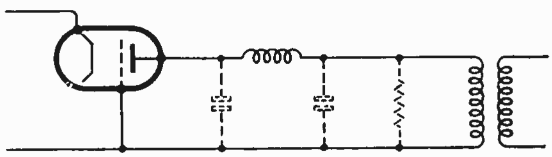


Fig. 6. Use of inductance to improve the gain at high frequencies

To assess the effective shunt loss impedance caused by core losses, a test circuit as shown in Fig. 5 was set up. Tests on various core and windings were carried out by measuring the change of voltage across the test terminals when the coil was connected in parallel. Shunt losses are of no particular consequence in T1 and T4 as they do not reduce the linearization factor by bypassing current fed into the cathode of a following amplifier. The shunt losses were found to be remarkably constant up to 30 Mc/s. In order to reduce the effects of winding capacities, which would be in parallel with the shunt losses, no secondary was coupled to the test winding.

When winding the transformers, care was taken to ensure a high coupling coefficient. Frequency response tests showed that up to 25 Mc/s, under conditions that were not as favourable as those in the valve circuit, the responses were within ± 1dB of the 1 Mc/s response.

As already mentioned, shunt capacities will cause loss of gain at high frequencies and to mitigate this compensating coils were introduced in the second stage. Fig. 6 shows the circuit capacities between which a coil of a few microhenries can give a useful "lift" up to 25 Mc/s.

The balance control in the grids of the output valves provides a differential bias voltage of ± 0.2 volt which was found adequate to deal with all normal dissimilarities between valves.

Amplifier Details

It was found on test that the signal-handling capacity of the amplifier was improved by introducing a high impedance into the common cathode connection. This results in the two cathode input impedances on each side of the circuit being in series instead of effectively in parallel. To explain the beneficial action of the choke, consider Fig. 7(a) in which a transformer is shown with series loss resistances across which must be developed a voltage proportional to the input current of the valve. Any non-linearity of R_c' will produce harmonic voltage components e_1 and e_2 across r_1 and r_2. From the point of view of even harmonics, if the valves were indentical e_1 would cancel e_2, but with dissimilar valves a difference voltage would exist. Now with the secondary centre tap earthed, a difference vcl.age (e_1—e_2) acting in one cathode will effectively be applied between the cathodes (Fig. 7(b)), and will cause a current to circulate round the push-pull circuit. With a high impedance to earth from the centre tap, the resistances can be considered as being in series with the constant-current source on the primary side and will have no effect other than to cause half the difference voltage (e_1—e_2) to appear across the choke. Although conclusive proof of this explanation, as to the advantageous effect of the choke, has yet to be established, the practice appears to be sound. The introduction of 10Ω into one cathode, for instance, was found to reduce considerably the signal handling capacity where 2nd harmonic distortion products were concerned.

The meter circuit enables the valve currents and the h.t. to be monitored, while various dropper resistances serve to reduce the voltages when working on 220 volt d.c. mains. The total consumption from the mains on 220 volts was 82 VA.

The amplifier was constructed as a small sub-chassis and mounted at the four corners by four v.h.f. type, bush-mounted, mica condensers. The amount of chassis work at d.c. mains potential was considerably reduced, while at the same time a satisfactory r.f. bypass to the main chassis at true earth potential was ensured. In addition to the r.f. chokes, a standard all-wave mains filter was incorporated to reduce the likelihood of mains-borne interference reaching the amplifier. The sub-chassis, measured overall, was 10½in. long, 6in wide and 4in deep. The greater part of the main chassis and space within the case was taken up with components associated with supply circuit and filtering arrangements.

The r.f. double band-stop filter circuit in Fig. 8 is conventional, each half consisting of a full constant-k section bounded by two half m-derived sections, having $m = 0.6$. Each band-stop filter has nine coils, a number which it was not possible to reduce, owing to the necessity of having to maintain a certain minimum attenuation between the resonant peaks. By judiciously laying out the filter to reduce magnetic coupling between the dust-iron cores to negligible proportions the filter was constructed within a box measuring 10in × 4in × 2in high.

(*To be concluded.*)

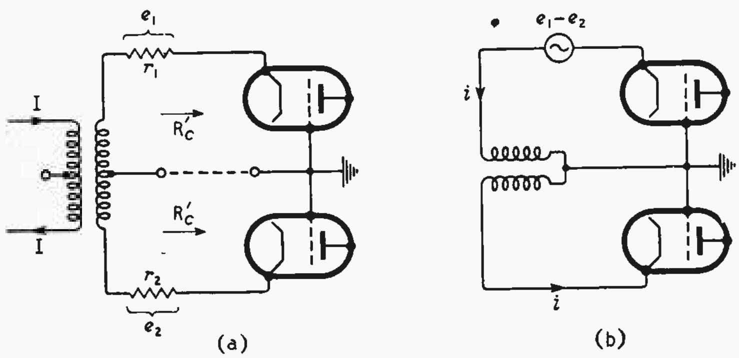
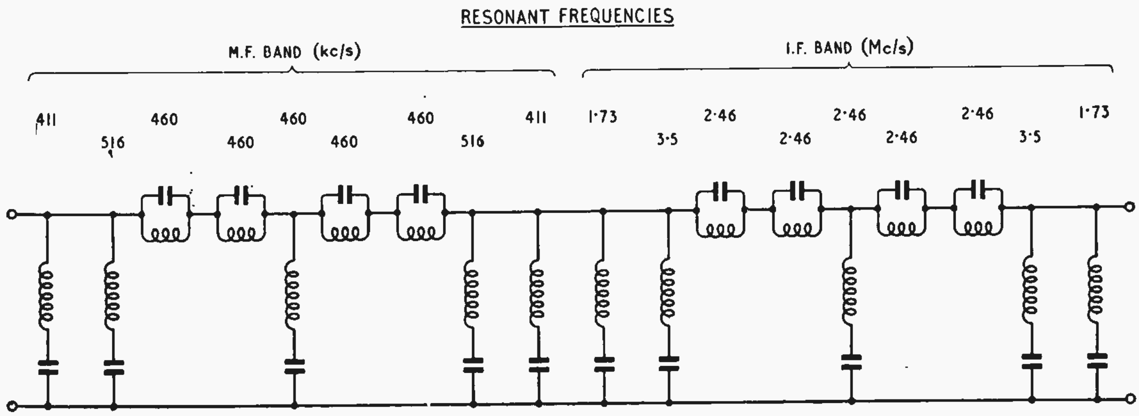


Fig. 7. Explaining the action of the cathode choke

Fig. 8. Outline of double band-stop filter



Broadcasting in the U.S.S.R.

FROM A CORRESPONDENT

SOME DETAILS OF THE SOUND AND VISION SERVICES

IN the Soviet Union, broadcasting is primarily the responsibility of the Ministry of Culture. This is the programme body; its transmitting equipment and engineering staff is provided by the Ministry of Communications for which, in turn, much of the technical development work is done by the Ministry of Radio Engineering.

The internal sound service radiates three programmes. The first is of mixed material, rather like our Home Service; the second is essentially artistic, with music and literature mixed, while the third is all music, with no talks. Some 85-90% of all material radiated is from recordings, so studios are provided accordingly; in this respect there is a marked difference between Russian and British practice. Ribbon, moving-coil and condenser microphones are used, depending on the nature of the programme material being recorded or broadcast.

Another difference is to be found in the choice of wavelengths for the internal sound services. Due to the vast distances to be covered, extensive use is made of short waves. Long waves are used for intermediate ranges, while medium-wave transmitters cover the main cities and the areas surrounding them.

A typical medium-wave transmitter is rated at 100 kW, and feeds a mast radiator slightly over 500 ft in height. High-level Class B anode modulation is employed with 20 dB negative feedback. A long-term frequency stability of ± 3 c/s is claimed; harmonic distortion at 95% modulation is given as 2%. Overall efficiency is 35%.

The short-wave transmitting centre, about 40 kilometres from Moscow, is something quite exceptional, combining as it does more or less the functions of our own Daventry and Rugby stations rolled into one. There are at present eight high-power broadcasting transmitters (80-120 kW) and twenty-five medium-power transmitters (15-50 kW) for telegraph and telephone traffic. The site, which covers 2,000 acres, provides space for 36 aerial arrays for broadcasting and about 60 rhombic aerials mainly for telegraphy and telephony, though some are used for broadcasting. The transmitter buildings, together with the houses and flats for the staff, make up something more like a town than a radio station. Shops, a school and a bank are all on the site.

A typical high-power short-wave transmitter has five r.f. stages, all being push-pull except the first. The last two stages use water-cooled valves, only the final being earthed-grid. The modulator, working in Class B, has four stages of amplification, with water cooling in the last two. Transmitter-to-aerial switching is largely remotely controlled, though there is still a certain amount of manual switching.

Energetic steps are being taken in the U.S.S.R. to build up a frequency-modulated v.h.f. service, though few transmitters are as yet in operation. The incorporation of sound broadcasting channels in television receivers is being encouraged: the transmission characteristics for both services are identical. V.H.F. broadcasting is being introduced because of congestion on other bands and to allow regional areas to be served with signals of better quality.

Generally speaking, v.h.f. stations are of rather lower power than those operated by the B.B.C. Most are of 5 kW, with aerial gains of between 5 and 10. These stations are said to give good reception up to 60 km and tolerable signals up to 120 km, depending on the terrain. The transmitters work on frequencies just above our Band I; frequency spacing between transmitters on the same site is 2.25 Mc/s. Contrary to the practice in this country, v.h.f. sound broadcasting aerials are not mounted on the television masts: this is thought likely to give trouble from interaction between the two transmissions.

For feeding all these stations there is an extensive network of high-quality landlines between Moscow and the various main cities of the Soviet Union. Screened pairs are generally used for distances up to 4,000 km, but plans are being made to change over to the use of two or three channels of the co-axial or screened pair carrier systems. To lighten the load on the lines, tape recordings are often sent to distant cities.

As already stated, recordings are more widely used than here. Magnetic tape is almost universal; the advantage offered by discs for taking rapid excerpts is considered unimportant and the quality obtainable from tapes has been a deciding factor. All the Soviet recording and reproducing equipment now follows the C.C.I.R. standards.

Three types of tape recorder are used: studio, two-channel mobile and midget portable. The studio machines run at either 15 or 30 inches per second, the slower speed being generally used. The mobile equipment, installed in a 30-cwt van which serves as a small studio, runs at 15 in/sec. Midget recorders ($7\frac{1}{2}$ in/sec) are now being manufactured in large numbers for use in news reporting or on-the-spot commentaries.

In studio work it is usual to record the master tape with a dynamic range of the order of 56 dB and the producer has seldom to adjust his volume control. This wide-range master tape is then used to make a tape for broadcasting, "dubbed" down to the required 22 dB dynamic range. The Soviet librarians have not encountered any difficulties over deterioration of master tapes, which are stored at a temperature of 15°C and a humidity of 50-60%.

Wired distribution plays an important part in Soviet broadcasting in the big cities. Out of a total of 35 million sound licences, some 25 million are "on the relay" though a number of these use radio reception as well.

The type of receiver to be supplied to the public is decided mainly by the Ministry of Communications after discussion with the Ministry of Radio Engineering. Roughly speaking, sets cost the same as in England, but without the purchase tax. Transistors are not in general use for domestic purposes, but it is considered important that their application should be developed rapidly, as many listeners still have no mains supplies.

Television in the Soviet Union began to develop rapidly only during the last year or two. At present there are 15 "centres"; this number will be increased to 75 during the next five-year plan, ending in 1961. A television centre comprises a transmitter and a source of programmes—studios, film scanners, O.B. units, etc., depending in extent and number on the importance of the centre.

In the principal cities the hours of transmission are from 7 p.m. to 11 p.m. every day, except Thursdays, when the stations close down for maintenance work. Extra transmissions are radiated during public holidays and broadcasts of topical events are made at various times outside the normal programme hours.

The system corresponds very closely on the video side to the C.C.I.R. 625-line standards.* Stations operate on the frequencies set out in the accompanying table. Radiation is horizontally polarized. The sound transmission is frequency modulated with a deviation of 75 kc/s.

Channel	Band Limits (Mc/s)	Vision Carrier Frequency (Mc/s)	Sound Carrier Frequency (Mc/s)
1	48.5–56.5	49.75	56.25
2	58 –66	59.25	65.75
†	66 –73	—	—
3	76 –84	77.25	83.75
4	84 –92	85.25	91.75
5	92 –100	93.25	99.75

†V.H.F. sound broadcasting

The main Moscow transmitter (there is also a low-power experimental station) has a peak power of 15 kW and an aerial gain of the order of 3. Allowing for feeder losses this means that the e.r.p. is about 40 kW. The accompanying sound transmitter is stated also to have a power of 15 kW. High-power modulation is used in the vision transmitter and all the high-powered valves are water cooled in both vision and sound transmitters.

Television transmitting aerials are of the bat-wing type with three such aerials stacked one above the other. These aerials are carried by self-supporting towers of about 500 ft in height. The most-recently built mast (at Kiev) is of unconventional design, being made up of tubular members which provide an economical, effective and very good-looking structure.

At a range of 70 miles these main stations are said to provide a field strength of the order of 200 μV/m which produces a satisfactory picture on the ordinary Soviet receiver when used with a receiving aerial having one reflector and one director. But a field strength of 500 μV/m is considered necessary for a first-class picture when using such a three-element receiving aerial. Much of the land around Moscow is almost flat so the transmitter has a not-too-difficult job in putting down a satisfactory signal at the edge of the service area.

In the 1,500-sq ft studio of the Moscow television centre 5 cameras are installed, all with image iconoscope tubes. Electronic viewfinders with 5-in tubes are in general use in the Soviet equipment. The film scanners at Moscow are 35-mm machines, optically multiplexed on two iconoscope-type cameras. Each machine has its own associated optical sound head. Two transparency scanners, each with its own iconoscope camera, are used for producing test cards and captions. This equipment is shortly to be replaced by new gear using image iconoscopes.

In the Soviet image iconoscope the cylindrical part of the envelope containing the mosaic is about 5 in in diameter. The mosaic is about 3 in $\times$ 2¼ in and the photo-cathode is 1¼ in in diameter. It has a short scanning gun with an external neck diameter a little less than 1 in; overall length of the tube is about 9 in.

In Moscow there are two outside broadcast units of Soviet manufacture. Each of these consists of two vehicles adapted from standard omnibuses. In one vehicle is housed the camera control unit producer's desk and switching system, picture monitors and power supplies. The other vehicle contains the sound equipment only, the rest of the space being available for carrying cameras, radio link equipment and cables, etc. The O.B. cameras employ image orthicon tubes of Soviet manufacture. The camera itself is compact, measuring, with viewfinder, 12 $\times$ 12 $\times$ 20 in. Weight, without lenses, is about 100 lb.

The latest type of radio link used for O.B. work operates on 300 Mc/s and employs frequency modulation. A klystron in the output stage delivers 100 mW with a frequency deviation of 1.5 Mc/s to a dish aerial of about 5-ft diameter. This equipment is stated to give a useful range of about 13 miles. The sound channel works on the same carrier frequency, but the aerial polarization is at right angles to that of the vision aerial.

With the exception of a temporary co-axial cable between Moscow and Kalinin (140 km), there is at present no system for linking together the various stations. Some 6,000 miles of two-way link, partly radio and partly cable, is due to be provided during the course of the present five-year plan.

Television receivers on sale in the shops employ 7-in, 14-in and 17-in tubes. It is stated the 7-in set is no longer in production, but at present the majority of sets have that size of tube. The prices of the sets in Moscow are, respectively, 1,275, 1,900 and 2,300 roubles. To give a basis for comparison with our own receiver costs, it may be said that a skilled workman earns about 2,000 roubles a month, while the basic worker's wage is 800 to 1,000 roubles.

Most observers agree the Soviet receivers provide a most excellent interlace, but, judging by brightness and contrast of the picture, the tubes are not aluminized or else the e.h.t. is rather low. The general policy on future television receiver design at present seems to provide for the inclusion of three v.h.f. sound channels.

* Details are given in the Appendix.

Domestic receiving aerials are very much as in Britain, except for the difference in polarization. Near the transmitters simple dipoles are used, and as one goes farther towards the limits of the service areas the aerials become more complex.

For domestic power supply the Soviet Union has adopted 220 volts, 50 c/s. But at present there are large areas, including most of Moscow, on 127 volts. For this reason it is not possible to standardize television receivers with series-connected valve heaters. This has, in turn, had some influence on valve design. Most of the valves used in domestic receivers are octals based on the American types. A series of miniature valves based on the Philips "E" series is also in production. Germanium diodes are to be used for rectifying anode supplies in the new television and sound receivers becoming available to the public later this year.

The number of television receivers in use in the Moscow area is given as 600,000 to 700,000; in Leningrad 100,000 and in Kiev about 70,000. It is expected that by the end of the five-year plan there will be a total of 40 million. The annual licence fee for a television receiver is 120 roubles, for a sound broadcast set 36 roubles and for connection to the wired relay system 60 roubles (which does not include the loudspeaker).

Transmissions from film and outside broadcasts take up more of the Soviet television programme time than here; more than half of the time seems to be occupied by films. That explains why the studio space is relatively small.

So far as colour television is concerned, the experimental frame sequential system has been abandoned and development work has begun on a 625-line simultaneous colour system. Experimental transmissions are expected to begin in about two years' time; a regular service might start within the period of the present five-year plan. It is thought possible that, unless the C.C.I.R. come to a quick decision on a standardized colour system for Europe, the Soviet Union might well work on independent lines, introducing the system thought best for their needs. Transmissions would probably be on frequencies corresponding to our Band III.

Television is being given high priority in the next five-year plan, with the emphasis on getting a service into the homes of the people without too many technical "frills." There can be no doubt that Soviet research workers, development engineers, manufacturers and technicians will be able to produce and operate the gear needed to fulfil the plan.

APPENDIX

Soviet Television Standards

THE width of the line synchronizing pulse is 8% of the total line time (approximately 65 microseconds); the front porch is 2% and the total line blanking period 12½% of the line time. The frame synchronizing signal consists of five equalizing pulses followed by five broad pulses, which in turn are followed by fifteen equalizing pulses giving a total frame blanking of 12½ lines (the exact number of these pulses cannot be guaranteed). The transmitted picture/sync ratio is 75:25, the picture modulation being negative going. The radio-frequency bandwidth is 8 Mc/s. The spacing between sound and vision carriers is 6.5 Mc/s, giving a video bandwidth of approximately 6 Mc/s.

Battery-driven Record Player

IT is estimated that 1,500 sides of 7-in, 45-r.p.m. records can be played at a cost of 2s 4d for four standard U2 cells on the "Transistor" record player recently introduced by Philco. A pull-pull output is provided in the three-stage transistor amplifier which is built by the printed circuit technique, and the motor-driven turntable and pickup is of Garrard design and manufacture. The motor switch is incorporated in the pickup arm and is operated when the arm is moved to and from its rest position.

Storage space is provided for up to 16 records in their covers or 24 without covers. There are three controls; namely, volume, motor voltage compensation and circuit function, the last with the following four choices.

A. Normal record reproduction, either from the built-in pickup and turntable or, through sockets at the rear, from an external pickup and turntable for, say, existing 78 r.p.m. records.

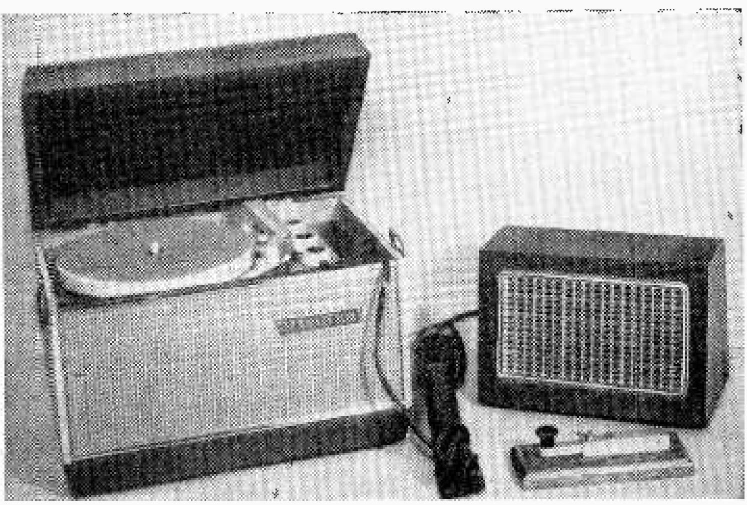
B. Morse practice oscillator, with key connected to the sockets.

C. With a microphone "speech unit" connected to the input sockets the amplifier and loudspeaker can be used as a "baby alarm."

Under quiescent conditions the standby current is only of the order of 5 mA.

D. The internal loudspeaker acts as a microphone and the "speech unit" is used as an extension loudspeaker for an "intercomm." system. By returning the switch to position C for the reply, a two-way conversation is possible.

The price of the Philco "Transistor" excluding batteries and accessories is £26 5s, inclusive of purchase tax.



Philco "Transistor" combined battery portable gramophone, Morse practice set and "intercomm." system.

Electronic Machine-Tool Control

SYSTEMS NOW FINDING THEIR WAY INTO INDUSTRY

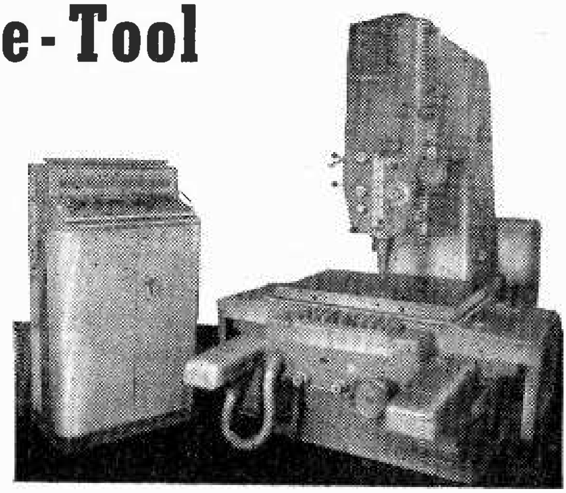


Fig. 1. Electronic positioning equipment by Mullard applied to a Coventry Gauge and Tool jig boring machine. The row of signal lights are situated at the top of the control console.

WHAT is generally meant by electronic machine-tool control is the control of operations such as drilling, turning or milling by numerical information supplied by magnetic or paper tape, punched cards, or hand settings on control knobs. In this respect it is distinct from copying methods in which the machining information comes from jigs or templates taking the actual form of the work to be reproduced (although it must be admitted that many copying systems do, in fact, employ electronics).

The main purpose of this numerical control, like many other such techniques in the field of "automation," is to save expensive man-hours of human labour. But it is applicable only when small quantities of parts are to be machined. In large-scale production it is worth while making expensive jigs and templates because their cost is shared out between a great number of parts reproduced by semi-skilled labour and adds very little to the cost of each one of them. With small-quantity production, however, the use of jigs becomes uneconomic, especially if precision work is being done. The other alternative, of using a skilled machinist to turn out the small number of parts individually, is also expensive and time consuming.

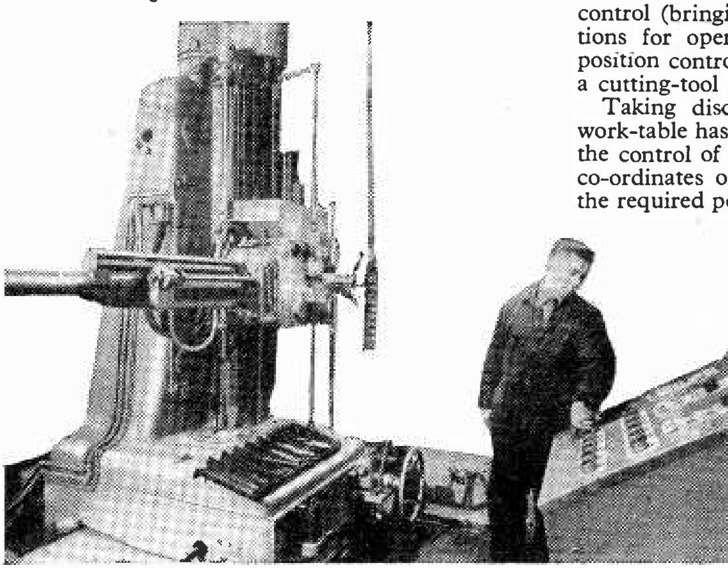
Numerical control, on the other hand, requires neither jigs nor skilled craftsmen. It certainly involves an extra process—that of translating the spatial information from the drawing-board into numerical control signals—but the time taken for this is quite short compared with the slow, head-scratching progress inseparable from careful craftsmanship. And once the translation is done the electronic control system will carry the job straight through with the maximum speed at which the machine tool is capable of operating.

Positioning Methods

Most of the control systems in use have already been described in *Wireless World* but on the occasion of the recent International Machine Tool Exhibition it was possible to see all of them together, in their latest stages of development, and to get an impression of how they are actually being applied in the machine-tool industry. Several methods of control were to be seen in operation and these could be divided into two distinct groups: discrete position control (bringing the work to a series of fixed positions for operations like drilling), and continuous position control (moving the work continuously past a cutting-tool for processes like milling).

Taking discrete position control first, here the work-table has to be moved in two dimensions under the control of numerical information on the x and y co-ordinates of, say, the hole to be drilled. When the required point is under the drilling bit the work-table stops. In most systems this is done by a form of servo-mechanism. For each co-ordinate, the distance to be moved by the work-table is set up manually in digital form on a series of control knobs which produce an error signal, either in electrical or mechanical form. The appropriate lead-screw of the work-table is driven by an electric motor and at the same time the distance moved is measured by an electro-mechanical or electro-optical device. This device

Fig. 2. B.T.-H. position control system used on a Kearns horizontal boring machine.



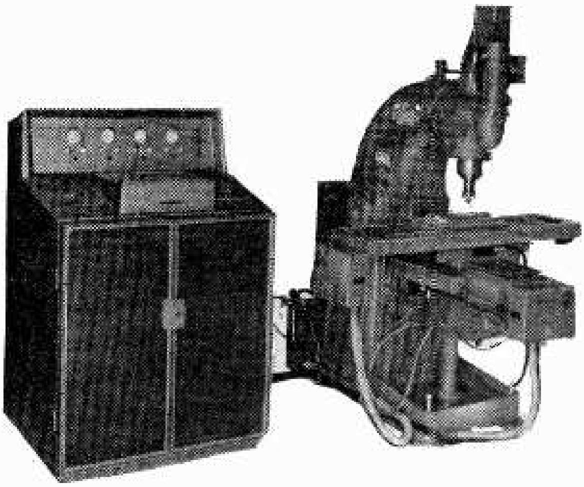


Fig. 3. Ferranti equipment for controlling a Kearney and Trecker milling machine. The magnetic tape is "played back" in a compartment on the top of the control console.

generates a corresponding signal which is arranged to cancel the original error signal. When the cancellation is complete—that is, when the work-table has moved the distance specified by the error signal —the driving motor is stopped.

For example, in the Ferranti system (displayed on their own stand at the exhibition) the required dimension, or error signal, is established by the initial positions of the glow discharges in a series of Dekatron tubes forming an electronic counter. The work-table movement is measured by an electro-optical interference-pattern system which produces a pulse for each ten-thousandth of an inch of displacement, and these pulses cancel the number set up on the Dekatrons by causing the initial glow discharges to move backwards step by step to zero. The system has been described fully in our January, 1955, issue.

Another system using an electronic counter and an electro-optical displacement measuring device has been developed by Mullard and was shown at the exhibition controlling a jig boring machine on the stand of the Coventry Gauge & Tool Company (see Fig. 1). Here, however, the equipment has not yet reached the stage of fully automatic positioning. When the error signal is reduced to zero a lamp lights up and an operator has to press a button to stop the work-table drive. The optical measuring system (also described in the January, 1955, issue) makes use of a scale of alternate opaque and transparent bars, an image of which emerges from behind a vertical edge as the work-table moves. The number of bars revealed (representing displacement) is then counted by means of a flying-line scanner and photocell arrangement.

The required dimension for each ordinate is set up by a series of 10-position dials on an electronic counter (of the four-stage binary type, with feedback). Pulses from the photocell are fed to the counter which, at the end of each scan of the flying line, registers the difference between the number set up on the dials and the actual distance (in ten-thousandths of an inch) which the work-table has moved. The output from the counter then passes through a matrix circuit to a series of cold-cathode trigger tubes which are used to switch on indicating lamps.

The purpose of the matrix circuit is to break down the difference or error numbers into groups. Thus, if the error is 100 ten-thousandths or more one of the lamps lights. If between 50 and 99 units the adjacent lamp lights, and so on in steps of decreasing size, until, as the correct setting is approached, indication is given in steps of one ten-thousandth. The error is in fact displayed on a row of 17 lamps, with the centre one for zero and the end ones for an error of 100 or more ten-thousandths in either direction.

In the B.T.-H. system of discrete position control (shown operating on boring machines by H. W. Kearns and Company, see Fig. 2, and The Newall Engineering Company) a magnetic system is used for the distance measurement on the work-table. For each direction of motion the scale consists of a bar of magnetic material (fixed to the work-table) with a series of holes bored at exactly one-inch centres and filled with non-magnetic material. As the work-table moves this bar varies the flux in a differential pick-up head mounted (but movable) on the fixed part of the machine. The coils of the head are connected to an electronic circuit which detects the difference of flux in the two magnetic paths, and this difference is amplified and used to control the servo motor driving the lead-screw so that the difference is reduced to zero. As a result the measuring bar becomes automatically positioned with one of its filled holes in exact alignment with the pick-up head.

Two-stage Positioning

It is, in fact, the initial placing of the pick-up head relative to the bar which provides the error signal on which the system partly depends. The required dimension is actually set up manually on six dials as a row of digits, for example 11.3054. The four dials corresponding to the "decimal" portion of the dimension operate a system of synchros and a servomechanism which positions the pick-up head in accordance with that part of the dimension. The two dials displaying the "integer" portion of the dimension, however, operate another synchro system which controls the lead-screw drive until the work-table is within ¼in of its correct position. Control of the drive is then transferred to the differential pick-up head, which operates as described above. Positioning is completed when the poles of the pick-up head are symmetrically placed relative to the nearest hole in the scale bar.

Incidentally, the initial setting-up of dimensions on this B.T.-H. equipment can also be done from information on punched cards. A mechanical card-reading device senses the positions of the holes in the cards and automatically positions the setting dials by means of a clutch and detent mechanism. The two sets of co-ordinates are fed in simultaneously.

While the accuracy of the measuring devices used in all the above systems is as high as 0.0001 inch, the overall accuracy of the positioning depends on a number of factors and may be somewhat less. In all cases, however, it is appreciably better than half a thou' which is quite sufficient for most engineering purposes.

Compared with discrete position control the contrain to an accuracy of one pulse. Actually an overall accuracy of 0.0002 inch is claimed for the equipment.

The E.M.I. system for continuous position control (see Fig. 5) is somewhat simpler and does not include the intermediate stage of passing the numerical information through a computer. The sets of co-ordinates define marker points at regular intervals of $\frac{3}{8}$ inch round the contour to be cut, and these measurements are punched into a paper tape (in code form) which is used to control the machine tool directly. When the tape is "read" the co-ordinates of a few successive marker points are held in a temporary storage system, and since the tape movement is controlled by the cutting speed of the machine tool the information held always refers to points on either side of the cutting point. The dimensions from the store are then applied to a simple analogue circuit which derives interpolation points lying on a smooth parabolic curve between the marker points. The complete information—marker and interpolation points—is then used to control the servo-mechanisms (using displacement-measuring devices) which position the slides of the work-table.

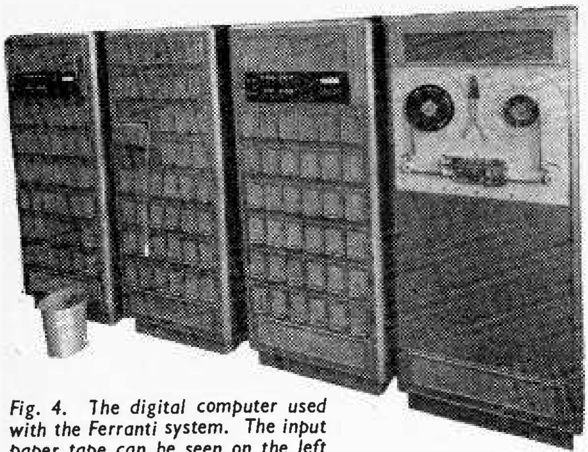


Fig. 4. The digital computer used with the Ferranti system. The input paper tape can be seen on the left and the magnetic tape recording the output signals on the right.

tinuous position control systems are a great deal more complicated. Here the general principle for, say, milling a piece of metal to a certain contour is that the numerical input information provides sets of co-ordinates of marker points defining the contour while a computer interpolates the points between in suitable curves.

In the Ferranti system (demonstrated on their stand, see Fig. 3) the information taken from the original drawing consists of co-ordinates of points of change on the contour and specifications of the types of curves between them. With a semi-circular part of the contour, for example, it is necessary to have the co-ordinates of the points where the semi-circle begins and ends and the co-ordinates of its centre point. This kind of information is put on to a planning sheet, then punched into a paper tape in the form of a code pattern of holes.

The punched tape is fed into a digital computer (see Fig. 4) and the information is "read" group by group by the machine, which has circuits for "recognizing" the dimensions and the instructions for particular curves as they appear. The output of the computer consists of two sets of pulses recorded on magnetic tape which constitute command signals to the two lead-screw drives of the machine tool. These pulses specify completely the contour to be cut in terms of increments of distance in two directions from a given reference point. Each pulse represents a work-table movement of 0.0001 inch and the density of the x-direction pulses relative to the y-direction pulses is indicative of the type of curve which is being traced.

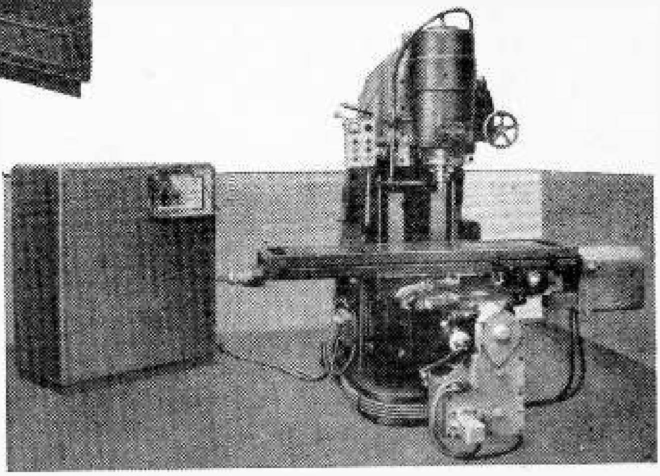


Fig. 5. E.M.I. control equipment used in conjunction with a Cincinatti milling machine. A built-in analogue computer performs the interpolation between the input marker points.

Overall Accuracy

The completed magnetic tape carrying the command pulses is then played back into the electronic control mechanism of the milling machine. The method of control (described in our January, 1955, issue) involves a servomechanism in which the work-table driving motor is stopped every time a pulse from the interference-pattern displacement-measuring device cancels a command pulse from the magnetic tape. In this way the train of pulses from measuring device is locked to the command pulse

In this system the accuracy of the information from the control equipment is better than 0.001 inch. At the exhibition the equipment was shown controlling milling machines on the stands of Cincinatti Milling Machines and H. W. Kearns and Company, but because the displacement-measuring devices here were operating from the lead-screws and not directly from the slides of the work-tables the overall accuracy of positioning was probably somewhat worse than this 0.001 inch.

The general impression gained from the exhibition was that although electronically controlled machine tools have aroused a great deal of interest by their novelty, they are not taking on like wildfire and creating a revolution in the industry. There are several possible reasons for this—the limited application of such equipments, their present high cost, practical problems still to be overcome, prejudice against electronics and innate conservatism. In these conditions one must expect the initial progress to be rather slow.

More Effective Speech

Peak Clipping to Increase Average Modulation

By O. J. RUSSELL, B.Sc., A.Inst.P.

THE "communication effectiveness" of speech transmitters is often enhanced by some form of clipping or limiting device. This is frequently employed in amateur transmitting stations and military communication systems; even in broadcasting stations limiters are used not only to prevent overmodulation on peaks, but also to boost the "commercial" speech level in sponsored broadcasts. As the transatlantic idiom has it, the "talk power" of propaganda stations is also boosted by clipping techniques in order to override jamming.

There is also the possibility of improving intelligibility by modifying frequency response and one often comes across references to "cutting the lows" and "boosting the highs" and to "concentrating on the intelligence-carrying portions of the speech spectrum." Examination of these ideas is clearly necessary. Thus *a priori*, the customary attenuation of frequencies below some 250 c/s would seem to serve no useful purpose if the amplitude of speech components were uniformly distributed over the frequency spectrum. Moreover, telephone systems approximating to a response sharply peaked at 1 kc/s have been used without any complaints of lack of intelligibility. A system peaked at 1 kc/s would clearly tend to overmodulate at the most favoured frequencies in the 1-kc/s region, while the rest of the speech frequency band would not reach overmodulation amplitudes. Hence it would seem that a level speech response curve is required to ensure that the modulation capability of a speech transmitter is not unduly degraded by some frequencies being preferentially boosted in amplitude. However, in a typical male voice the amplitude of the lower bass frequencies is much higher than the middle and upper register components. In fact the energy content of male voices sharply increases towards the low-frequency end of the audio spectrum. By attenuating the lower register below some 250 c/s these high-amplitude components can be reduced, and the intelligence-carrying middle and upper register frequencies may then be raised in amplitude to the maximum modulation capability of the transmitter.

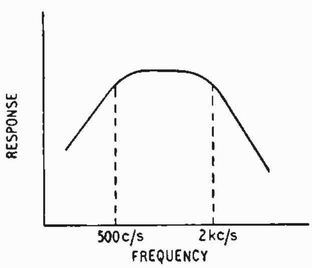


Fig. 1. Typical response curve for speech communication purposes.

That this process of bass attenuation may give useful gain is shown by the fact that some 60 per cent of the energy content of male speech waveforms lies below 500 c/s. Speech in which frequencies below 500 c/s have been removed, still has an articulation index of 95 per cent.[1] As the articulation index is determined on the basis of recognition of "nonsense syllables", and even high-quality systems are rated at an articulation index of 98 per cent, the figure of 95 per cent represents a well-nigh perfect communication system—particularly as plain speech, in contrast to arbitrary "nonsense syllables", has a high degree of redundancy.

The preferential boosting of the middle and upper register is useful, as the general speech level may be lifted once the high-amplitude bass frequencies are attenuated, thus giving an effective gain over a "wide range" speech system. Moreover, in practical communication systems operating under "competitive" conditions, as in amateur and military communications, the frequencies above some 4 kc/s may be omitted. The higher speech frequencies contribute little to intelligibility, and, with sharp tuning of receivers to minimize interference under "competitive" conditions, are in any case removed. Furthermore, an unduly extended upper register may cause severe sideband interference to adjacent communication channels.

The use of a limited speech frequency response (Fig. 1) does not imply that unnatural speech results. The ordinary domestic receiver removes frequencies above 4 kc/s most effectively. Moreover, due to re-synthesis of the missing bass frequencies in the ear from their harmonic components, the speech does not sound "thin" and the characteristic timbre and "personality" of a voice is remarkably well preserved.

Peak/R.M.S. Ratio

Speech clipping introduces further problems. Observation of voice oscillograms shows that sharp spiky peaks extend to an amplitude well above the general level. In fact the ratio of peak amplitudes to r.m.s. amplitudes may be between three and four for speech waveforms as contrasted to the $\sqrt{2}$ ratio for sinusoids. Clearly if the peaks can be clipped and removed without destroying intelligibility, the mean level of the speech waveforms could be increased some three or four times without overmodulation occurring, as compared with the level permissible with the peaks present.

The above reasoning suggests that an effective increase of "talk power" equivalent by some 10 dB could be achieved by incorporating a peak clipper

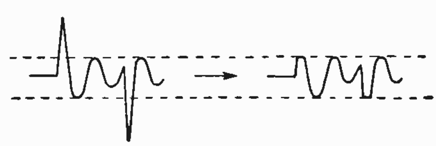


Fig. 2. Sharp peaks in speech waveforms may be clipped without serious effect on intelligibility.

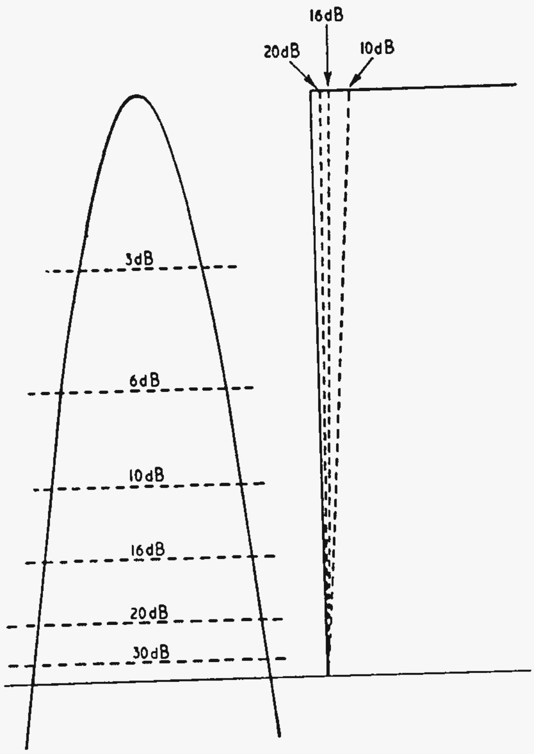


Fig. 3. Showing that as the degree of clipping is increased, a sine wave approaches a square waveform.

in an exisisting modulator. However, it is generally found that some degree of peak clipping takes place in the speech amplifier or modulator stage of an amateur transmitter. When an oscilloscope check reveals that no overmodulation occurs, reports are commonly given of apparent undermodulation. In fact the "full" modulation often heard as clean speech without noticeable "splatter" generally represents almost continuous overmodulation on speech peaks. Due to the sharp nature of the speech waveform spikes, however, the percentage of time during which overmodulation is occuring is small. Really gross overmodulation or speech amplifier non-linearities are necessary to produce obvious overmodulation on casual listening tests.

Clipper action is idealized in Fig. 2, which shows how peaks may be clipped in speech waveforms without affecting the signal quality noticeably. Speech clippers of the peak limiting type are commonly employed in broadcasting to prevent sudden orchestral transients from overloading the system, as well as to boost the "talk power" of the commercial announcements. Speech waveforms are often asymmetric,[2] with peaks of one polarity higher than the other. Thus it is possible to arrange the speech waveform polarity so that the highest peaks produce positive modulation levels exceeding the 100 per cent mark, while the negative peaks do not extend to the zero level. This gives a limited degree of enhanced speech levels in communications systems. It is uneconomic as the "oversize" modulator must be capable of handling the extreme peaks which may correspond to positive modulation levels of 200 per cent to 300 per cent.

Peak limiting within the speech amplifier is better, as the modulator and transmitter modulation capability need only conform to the usual requirements. However, clipping may be pushed much further than the removal of sharp peaks. It is possible to clip the main speech waveforms. Speech waveforms may be clipped so savagely as to reduce the signal to a series of "on and off" rectangular impulses . . . a sort of "super-morse". In fact speech waveforms may be applied to a trigger circuit to convert them into a series of rectangular pulses. Despite this, intelligible speech can be reconstituted from systems operating on an "infinite clipping" basis.[3] The only factor conveying intelligence in such systems being the crossover points where the polarity of the rectangular pulses change polarity. Practically "infinite" clipping is obtained when the ratio of peak waveform amplitude to clipping level exceeds some 30 to 40 dB. A sine wave clipped to this degree is virtually a square wave, as Fig. 3 indicates. Moreover with a high degree of clipping the speech level is highly compressed, so that the modulation level is virtually independent of the loudness of the speaker's voice, which can change by some 20 dB without the output level changing noticeably. This has the disadvantage that background and room noises are greatly accentuated. A background whisper may for example produce the same output as a speaker close to the microphone.

High clipping levels imply the introduction of a high level of harmonic distortion. It also entails a high level of intermodulation products. Fig. 4 illustrates the intermodulation effect for a weak h.f. speech frequency in the presence of a strong low-frequency component. There are two approaches to the problem of dealing with the distortion products. The usual method is to follow the clipper stage by a low-pass filter attenuating sharply above some 3 kc/s. This prevents harmonics generated in the clipping process from reaching the modulator, so

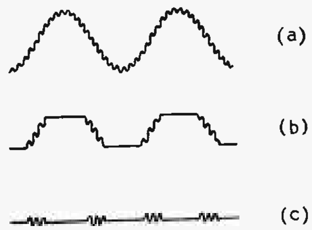


Fig. 4. (a) Small-amplitude h.f. component superimposed on a low-frequency component, (b) after clipping and (c) residual h.f. component.

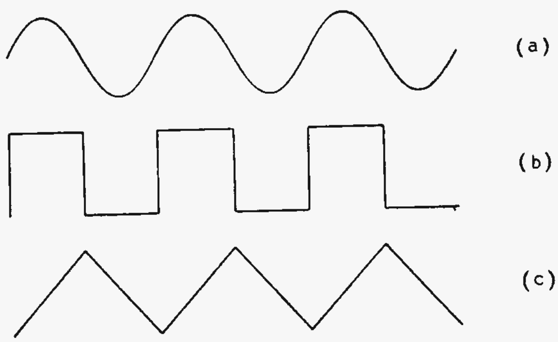
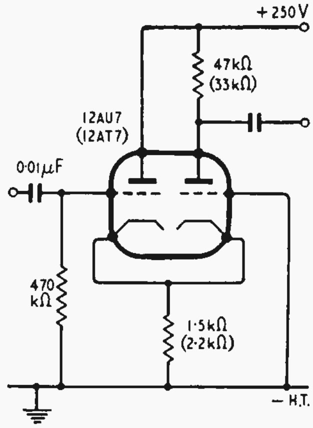


Fig. 5. The sine wave (a) assumes an approximately square shape after amplification and clipping (b). and is restored to a semblance of a sine wave (approx. 12 per cent harmonic distortion) by integration (c).

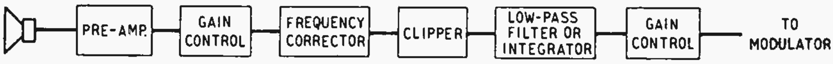


Left:—Fig. 6. Cathode-coupled clipping stage. The values in brackets should be used with a 12AT7 valve.

Below:—Fig. 7. Schematic diagram of typical clipping circuit sequence.

sideband distortion effects unless exalted-carrier receiving techniques are used. This follows because the transmitter operates virtually all the time at the 100% modulation level. When the carrier fades below the sidebands the effect is one of gross over-modulation. Thus a clean speech signal may change to a severely distorted one with a slight change in propagation conditions. The use of exalted-carrier reception methods is clearly the first step that leads logically to the use of single-sideband, suppressed-carrier techniques at the transmitting end. The combination of single-sideband operation together with speech clipping and limiting should provide about the most effective communication system possible for present-day amateur use.

However, while "clipped" speech methods may be used to convert speech into a still intelligible succession of "on-off" pulses, it is necessary to remember that "Vocoder" techniques[4] have shown that speech may be compressed into a few cycles per second of bandwidth by coding speech waveforms into the keying impulses for a small number of waveform generators. The ultimate adoption of such techniques by amateurs may well end the traditional rivalry between telephony and c.w. operators, as speech will then occupy about the same bandwidth as c.w.



that the sideband spread is not broadened by "hash" and "splatter". The use of a low-pass filter does not affect distortion products within the 3-kc/s pass band, although perfectly intelligible speech may be radiated with such a filter.

Another approach favoured in some quarters, does reduce distortion products within the pass band. This technique precedes the clipper stage by a differentiating circuit, so there is effectively a top boost of 6 dB per octave. The clipping stage is followed by an integrator stage, which may be regarded as restoring the original frequency balance. Harmonic distortion products are attenuated. This is illustrated (Fig. 5) for a sine wave input. The square wave resulting from the clipper is integrated to a triangular wave. As far as the final result is concerned there is remarkably little difference between a sine wave and a triangular wave, as can be observed when a sine wave of increasing amplitude is fed into such a clipper integrator system. In terms of harmonic distortion, the square wave represents some 50% harmonic distortion, while a triangular wave corresponds to some 12% distortion. Intermodulation products will also be reduced in some cases by the integrator.

The clipping stage may employ many types of circuit such as the classical biased diodes, valves with low anode voltages to limit simultaneously at grid and anode, and so on. One convenient circuit is the so-called "transient-less" clipper shown in Fig. 6. The values shown gave good symmetrical clipping action with 12AU7 and 12AT7 valves. The shorter grid base of the 12AT7 results in the limiting action starting at lower signal inputs than a 12AU7. The simplicity of this circuit, and the symmetry of clipping without critical circuit values are features of some interest.

Circuits of clipping systems are best adjusted with the aid of an oscilloscope. The overall schematic of a clipper system is shown in Fig. 7. The gain control following the clipper stage enables the audio output to be set at a level which does not overmodulate the transmitter. The gain control preceding the clipper stage enables the input to the clipper to be varied from slight clipping action up to the limit set by pre-amplifier gain. In practice it is doubtful whether an apparent effect of more than 10 dB of gain is achieved. Moreover, under conditions of selective fading a heavily clipped system is liable to severe

REFERENCES

[1] "Radio Designer's Handbook," pp. 628-9. (Iliffe & Sons.)

[2] "Amplitude Modulation Up to Date," O. J. Russell. *Wireless World*, March, 1943.

[3] "Effects of Amplitude Distortion Upon the Intelligibility of Speech," J. C. R. Licklider. *Journal Acoustical Society of America*, vol. 20, p. 42, 1948.

[4] "Remaking Speech." H. Dudley. *Journal Acoustical Society of America*, vol. 11, p. 169, 1939.

Pressurized Valve Factory

AS part of the precautions against airborne dirt which Hivac have adopted at their new Ruislip valve factory, the atmospheric pressure in the air-conditioned assembly shop is kept above normal to ensure that no dust can enter from outside. The same principle is used on some of the individual assembly benches, which are enclosed and have glass shields in front to prevent any moisture from the assemblers' breath from condensing on the electrode components.

The hospital-like nature of the factory is further enhanced by polished wood-block floors, a self-supporting roof structure to avoid dirt-collecting stanchions and girders, and white nylon overalls and head scarves for the girl operatives. All supplies of electricity, gas, water and "vacuum" are piped into the main shop from a specially constructed basement so that contaminating oil fumes and dust-harbouring pipes and wires are eliminated.

The factory is mainly concerned with manufacturing subminiature valves, and the precautions are particularly necessary when work is being done on "special quality" types in this category.

Economy in Receiver Design

Simple Superhet with an Unconventional Smoothing Circuit

By S. W. AMOS,* B.Sc.(Hons.), A.M.I.E.E.

THIS article describes a small medium-wave receiver for a.c. mains operation suitable for use as a second receiver, e.g. in a dining room or a bedroom. It does not require an external aerial but is nevertheless capable of receiving Hilversum, Brussels and a number of provincial Home Services when used in the London area. The receiver is economical of components but it has a.g.c. operating on two valves and the gain control incorporates variable negative feedback. A 5-inch diameter loudspeaker is used and although the upper frequency response is limited by the selectivity of the i.f. transformers, the quality is smooth and pleasant due to reduction of harmonic distortion in the a.f. amplifier by the feedback.

The circuit described here uses international octal valves namely 6K8 (frequency changer), 6K7 (i.f. amplifier), 6Q7 (detector and 1st a.f. amplifier), 6V6 (output valve) and 6X5 (rectifier). The circuit is, however, not at all critical of the valves used and the only component value likely to require adjustment if other types of valve are used is the bias resistor of the output valve. The author has made a receiver of this type using modern B7G and B9A valves namely 12AH7 (frequency changer), 9D6 (i.f. amplifier), EABC80 (detector and 1st a.f. amplifier) and N78 (output); no changes in component values were required other than that mentioned.

Economical Smoothing

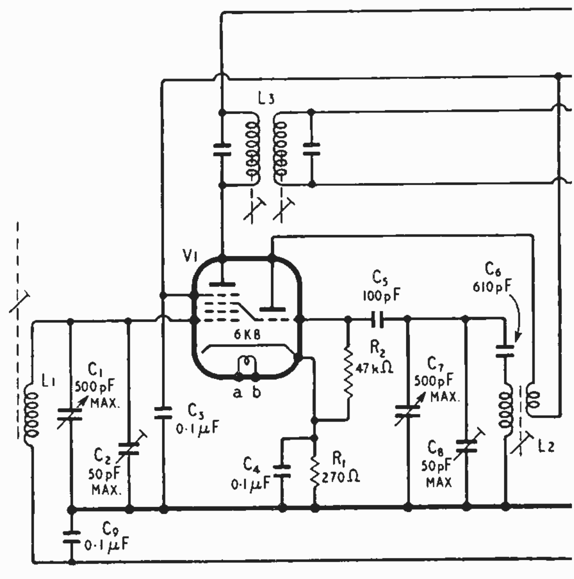
The circuit diagram of the receiver is given in Fig. 1 and the first feature of interest is the smoothing circuit and the method of supplying h.t. to the valve electrodes. The full-wave rectifier circuit is conventional but the anodes of the output stage, i.f. amplifier and frequency changer are all fed directly from the rectifier cathode. At this point the h.t. supply is 260 volts from a mains transformer secondary winding supply 250-0-250 volts. By adopting this technique the current in the smoothing resistor R_9 is reduced to a small value which comprises the screen-grid currents of the output valve, i.f. amplifier and frequency changer together with the anode currents of the oscillator triode and the 1st a.f. amplifier triode. This current amounts to approximately 12 mA, approximately 1/5th the total h.t. current of the receiver. With such a small current the smoothing resistor can have a value as high as 5 kΩ yet still giving a smoothed supply of 200 volts for the screen grid of the output stage and the anode of the 1st a.f. amplifier.

A supply of approximately 100 volts is required for the screen grids of the i.f. amplifier and frequency changer and the oscillator anode; this is obtained from the 200-volt smoothed supply via a series resistor R_{12} of 10 kΩ; a 0.1-μF capacitor C_3 has proved adequate for decoupling the 100 volt supply so obtained.

This simple h.t. supply circuit has proved entirely successful and gives a very low level of hum. This is to some extent due to the use of a pentode as output valve and a triode as 1st a.f. amplifier as illustrated in the following calculations. A 100-c/s ripple voltage can occur at the anode of the output valve (giving hum in the loudspeaker) from three mains sources:

(1) By direct modulation of the anode current of the output stage by ripple on the h.t. supply. If the output valve is a triode this voltage is 2/3rds that at the rectifier cathode because the optimum load of a triode is twice the anode a.c. resistance. Hum due to this cause is reduced by using a pentode because the anode a.c. resistance of this type of valve is of the order of 50 kΩ, 10 times the optimum load (assumed 5 kΩ). Thus the ripple voltage at the anode of a pentode is only 1/11th that at the rectifier cathode. The ripple voltage at the rectifier cathode can be simply calculated as shown in the Appendix: for this particular circuit the voltage is 20 volts peak-to-peak. Thus a triode output stage will give 16.7 volts ripple at the anode and a pentode less than 2 volts.

If a feedback voltage is taken from the anode of the output valve the effective reduction in anode a.c. resistance of the pentode increases the ripple. This can be avoided by taking the feedback voltage from the secondary winding of the output trans-

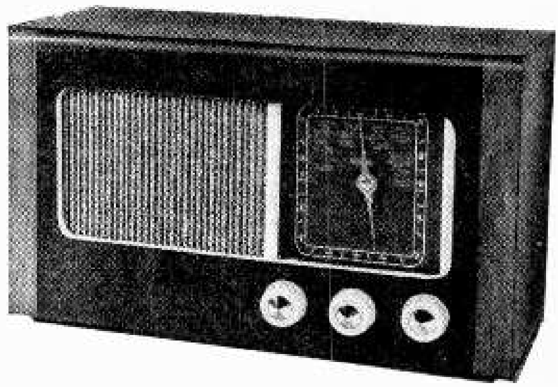


* B.C.C. Engineering Training Department.

former, when the feedback is effective in reducing hum. This has the additional advantage of reducing any harmonic or attenuation distortion occurring in the transformer. The inclusion of the output transformer in the feedback loop increases the tendency towards oscillation at a frequency outside the passband. The measures adopted to prevent this possibility are discussed later.

(2) By modulation of the anode current of the output pentode by ripple on the h.t. supply to the screen grid. This effect can produce serious hum and smoothing of the screen-grid supply is essential to minimize it. The smoothing circuit employed is, in fact, more than sufficient to reduce hum from this souce to negligible proportions. The smoothing resistor is 5 kΩ and the smoothing capacitor 32 μF. The latter has a reactance of 50 ohms at 100 c/s and the 100 c/s ripple on the 220-volt supply has therefore 1/100th the amplitude at the rectifier cathode, and is only $20/100 = 0.2$ volt peak-to-peak value. The voltage gain of an output pentode from screen grid to anode is less than 5 under normal conditions and the ripple is thus unlikely to generate more than 1-volt at 100 c/s at the anode. The smoothing was introduced primarily to reduce the hum described under (3) below and also to minimize the possibility of impressing 100 c/s on the r.f. signals in the frequency changer and i.f. amplifier valves. The 100 c/s ripple on the 200-volt supply is applied at nearly full amplitude to the screen grids of these valves and modulation hum from this cause is a possibility unless the ripple is kept to a small amplitude.

(3) By modulation of the anode current of the output stage by ripple applied to the control grid. This ripple is applied via the anode load resistor R_7 (220 kΩ) and the anode a.c. resistance (say 80 kΩ) of the triode a.f. amplifier which together form a fixed potential divider across the 200-volt supply. The step down ratio is 4 : 1 and the ripple at the control grid is thus $0.2/4 = 0.05$ volt. If



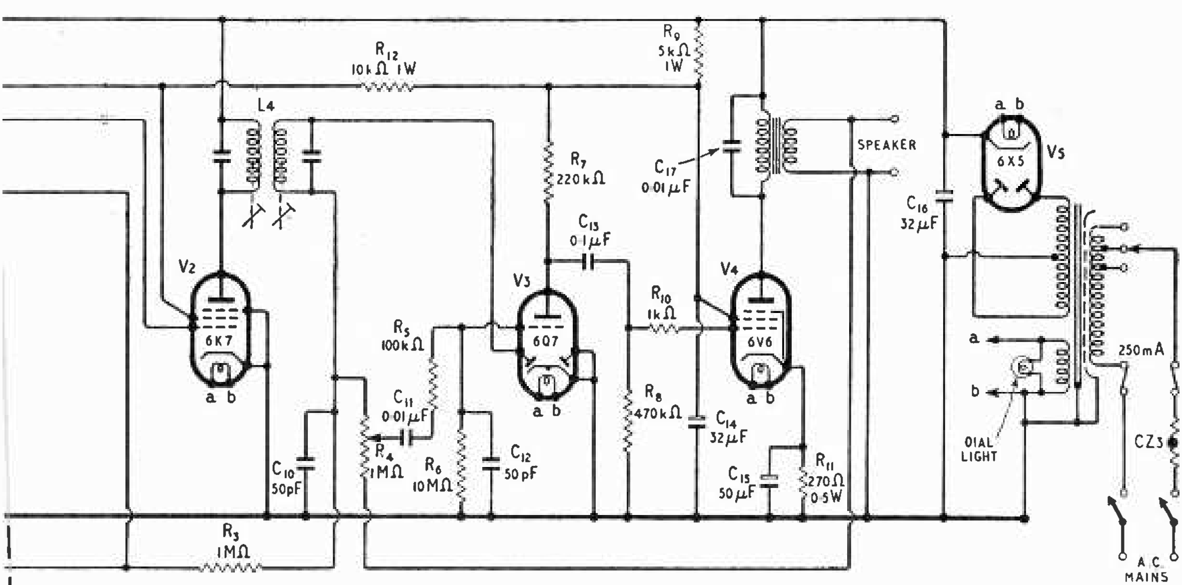
Front view of the receiver.

the gain of the pentode is 30, the ripple at the anode from this source has an amplitude of $0.05 \times 30 = 1.5$ volt peak-to-peak, less than that due to direct modulation of the anode current by the ripple at the rectifier cathode. If the 1st a.f. amplifier had been a voltage-amplifying pentode with an anode a.c. resistance of 1 MΩ, the ripple at the pentode anode would have been 5 times greater, i.e., 7 volts, possibly sufficient to produce audible hum.

These calculations show that by using the types of valve specified the hum can be kept to negligible proportions in spite of resistance smoothing and without the need for an additional smoothing section for the h.t. supply to the triode anode. The calculated ripple voltages at the pentode anode apply when the gain control is set at maximum, for there is then no negative feedback. When the gain control is turned down for reception of a strong signal, negative feedback is automatically applied and the ripple voltage is less than calculated above. In practice the hum level is negligible at all settings of the gain control.

We shall now consider the design of the valve circuits in detail, beginning with the mains equip-

Fig. 1. Complete circuit diagram of receiver. All resistors are rated at ¼ watt unless otherwise specified. L_1, 40 turns 9/45 Litz wound to occupy 1⅛ in length on paper sleeve on Mullard "Ferroxcube" rod, type FX 1247; L_2, Osmor type QO8; L_3, L_4, Eddystone type 851 or Wearite type M800.



ment which is conventional, except for the provision of the Brimistor CZ3 in the primary circuit of the mains transformer. This is included to reduce the magnitude of the surge current immediately after switching on, so prolonging the life of the valves and the dial light. It also permits the use of 250 mA mains fuses; without the CZ3 the fuse rating would need to be raised to at least 1 amp to stand the surge current.

Grid-current Bias

The a.f. amplifier consists of the triode voltage amplifier V3 and the pentode output stage V4. The two valves are RC-coupled and V4 has a bias resistor R_{11} and decoupling capacitor C_{15}. V3 is biased by grid-current flow in R_6 which has the high value of 10 MΩ. This saves the cost and bulk of a cathode decoupling capacitor. If a triode valve of a type different from that specified is to be used, it is necessary to check that it is suitable for biasing in this manner. The diode load resistor R_4 functions as gain control and the components R_5 and C_{12} are an i.f. filter. These components are placed subsequent to the gain control deliberately. If placed between the diode output and the gain control, it would not be possible to remove the feedback completely at the maximum setting of the gain control.

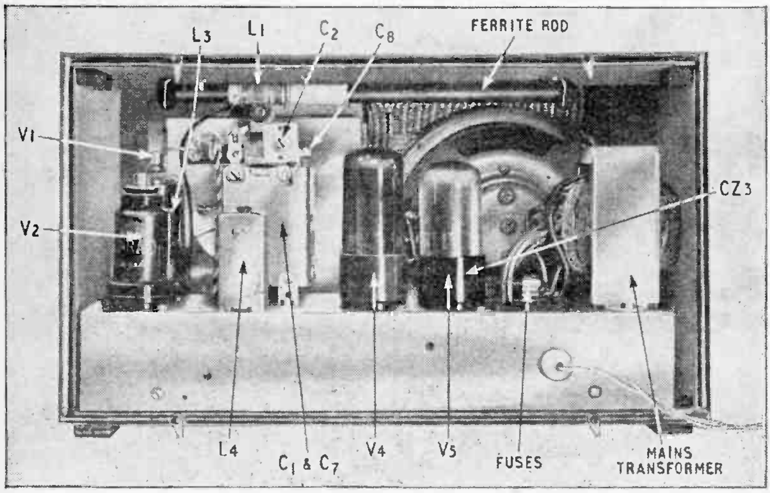
To receive weak signals the full gain of the receiver may be necessary, but for local-station reception, where the full gain is not required, it is possible to employ negative feedback to improve quality by reducing harmonic distortion. In the feedback circuit used by J. L. Osbourne[1] the gain control is used simultaneously to control the magnitude of the signal applied to the a.f. amplifier, and also the feedback factor. He achieved this by returning the gain potentiometer to the junction of two resistors connected in series across the secondary winding of the output transformer, the resistance values being chosen to avoid any possibility of oscillation at a very high or very low frequency. However, it was found possible to avoid instability by suitable design of the a.f. amplifier and the two resistors are unnecessary. Thus the volume control can be returned to one end of the secondary winding and, at zero setting of the volume control, the whole of the secondary voltage is used for feedback. The use of the volume control for two purposes alters its effective law and a linear control gives smoothest control of volume; a logarithmic control tends to be fierce near its maximum setting.

Instability tends to occur in a feedback amplifier at frequencies outside the passband, in an a.f. amplifier at very low frequencies such as 1 or 2 c/s (an effect known as motor-boating) or at a high frequency such at 50 kc/s. Oscillation at such high frequencies is, of course, inaudible but can nevertheless ruin the performance of the amplifier by causing excessive noise or low power output. This oscillation is perhaps best detected by an a.c. meter connected across the output; a steady reading is obtained even with no input to the amplifier. Instability is caused by phase shifts in the amplifier and can be avoided by correct choice of the time constants controlling the phase shift. At very low frequencies the significant time constants are R_6C_{11}, R_8C_{13} and the anode circuit of the output valve. The latter time constant is given by the quotient of the primary inductance of the output transformer (say 8 henrys) and the load resistance (say 5 kΩ) and is equal to $L/R = 8/(5 \times 10^3)$ second = 1.5 milliseconds. As shown by Brockelsby[2] the instability can be avoided by making the other two time constants large compared with this; in this way two of the phase-shift circuits are made wide-band and the third is narrow-band. The values chosen are $R_8 = 470$ KΩ, $C_{13} = 0.1\ \mu F$ giving a time constant of 50 milliseconds and R = 10 MΩ C = 0.01μF giving a value of 100 milliseconds and have proved effective in avoiding instability in three receivers all using different makes of output transformer. The intervalve time constants are much larger than is necessary purely from considerations of frequency response. If feedback were not used it would be quite satisfactory to have time constants as small as 0.006 second (e.g., 680 kΩ and 0.01 μF), for this corresponds to 1 dB loss at 50 c/s.

The phase shift in the a.f. amplifier at frequencies immediately above the passband occurs principally at three points in the circuit; in the anode circuit of V3, in the output transformer and in the circuit which includes the gain control and i.f. filter. The circuit controlling the phase shift at the first point comprises the anode load resistance of V3 in parallel with the anode a.c. resistance of the valve and the stray capacitance shunting the two resistances. The phase shift in the output transformer is a function of the leakage inductance, the shunt capacitance in the primary winding and the loudspeaker impedance and is by no means simple to calculate. If no additional components are introduced to control phase shift at this point in the circuit, the time constant is likely to be of the same order as that due to

(*Continued on page 391*)

Rear view of receiver with back removed showing the ferrite rod and method of mounting.



V3 anode circuit. The phase shift introduced by the gain control and i.f. filter is also of the same order as the two previous circuits and, when conventional component values are used, the overall phase shift generally gives continuous oscillation around 50 kc/s when the gain control is near zero setting. To obtain stability it is necessary to give one of these three phase-shift circuits a larger time constant. We have then satisfied the criterion of Brockelsby that two of the phase-shift circuits give wide-band responses and the third is narrow-band. One way of achieving this is to connect a capacitor in parallel with the primary winding of the output transformer. A value of 0.01 μF has proved suitable.

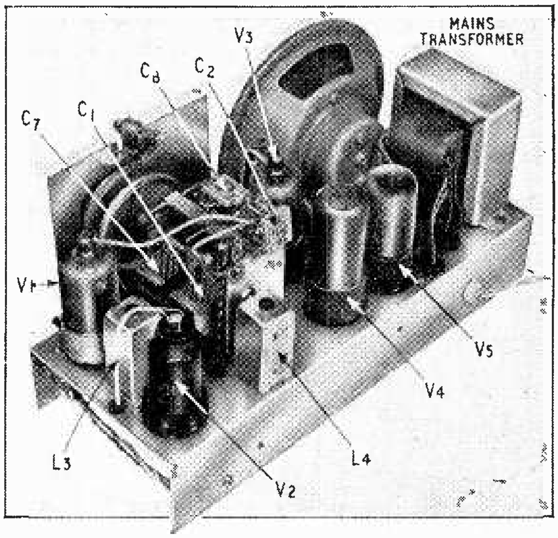
At the frequencies at which instability is likely to occur the components effectively controlling the phase shift are the anode a.c. resistance of the output valve (say 50 kΩ) and the capacitor C_{17} giving a time constant of $0.01 \times 10^{-6} \times 5 \times 10^{4}$ second = 500 microseconds, very large compared with that of the other two phase shift circuits. This value of capacitance does not cause any perceptible loss of " top " when the gain control is advanced to maximum setting where there is no feedback. This value of C_{17} has given unconditional stability in a number of receivers employing this circuit and constructed with different types of output transformer.

I.F. Stages

The gain and selectivity of a superhet receiver are determined almost entirely by the properties of the i.f. transformers and these must therefore be well designed. The space available for these components is limited and miniature types 13/16-inch square were used. The types listed under Fig. 1 must be used if the performance of the original receiver is to be duplicated. An interesting feature of some of these transformers is that the coupling between the windings is both inductive and capacitive. These two forms of coupling can aid or oppose and thus there may be a significant change of gain on reversing the connections to one winding. In particular it was found that higher gain can be obtained from Eddystone transformers in this particular receiver if the connections to one winding are reversed relative to those indicated on the can.

The cathode of the i.f. amplifier is directly earthed no automatic bias components being included. This economy is justified because there is a standing bias of -1 V on the a.g.c. line from the signal diode and this provides grid bias in the absence of a signal.

The frequency changer circuit is conventional and here it was found that automatic bias is essential because the 6K8 gives maximum conversion conductance with approximately -3.0 volts on the control grid. The oscillator circuit is a tuned-grid type, C_8 and C_6 being trimming and padding capacitors respectively. The value of the padding capacitor proved to be unexpectedly critical and it is recommended that this component should have a tolerance of no more than $\pm 2\%$. This is partly due to the use of a ferrite-rod aerial in the signal-frequency circuit. The Q value of this circuit is very high—about 300—and even a small tracking error results in a significant loss. The tuning of a superhet receiver is, of course, fixed by the i.f. and oscillator circuits and tracking errors result in a loss due to mistuning of the signal-frequency circuit. At



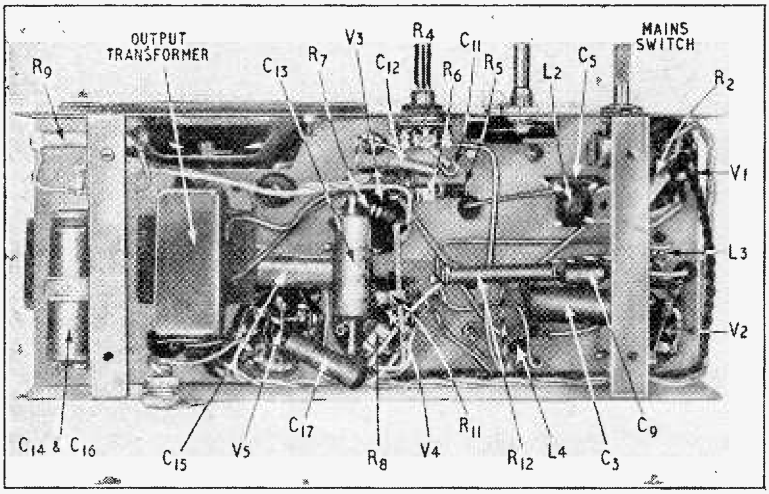
View of upper side of chassis showing layout of valves, mains transformer, tuning capacitor and i.f. transformers.

1 Mc/s a tracking error of as little as 5 kc/s results in a loss of 10 dB if the Q value is 300. Tracking error must thus be minimized and the authors carried out a series of experiments, using different values of padding capacitance, to determine the capacitance for least loss averaged over the medium waveband. The reduction of these losses to a minimum requires correct choice of alignment frequencies as well as correct padding capacitance and it was found that best results were obtained by aligning at 1530 kc/s and 620 kc/s and by using a padding capacitance of 610 pF. This gave zero loss at 1050 kc/s and at the alignment frequencies with maximum losses of 6 dB at 550 kc/s, 850 kc/s, 1300 kc/s and 1600 kc/s.

The signal-frequency circuit consists simply of a Litz winding on a ferrite rod 8 inches long and $\frac{3}{8}$ inch diameter (Mullard type FX 1247). The coil consists of 40 turns of 9/45 Litz wound to occupy a winding length of $1\frac{1}{8}$ inches on a paper sleeve which is free to slide along the rod. With this number of turns the normal position of the sleeve is approximately 2 inches from one end of the rod and a slight movement of the coil produces a comparatively large change of inductance. This movement is used in aligning the receiver at the low-frequency end of the band. Alignment at the high-frequency end is achieved by variation of the trimmer C_2 which is mounted in a vertical position on the rear section of the two-gang tuning capacitor so that it can be adjusted when the receiver is in the cabinet.

Alignment

Adjustment of the i.f. and oscillator sections of the receiver can be carried out with the receiver on the bench but in the models constructed by the author the ferrite rod is mounted in the cabinet and the receiver must be in the cabinet for adjustment of the signal-frequency circuits. With the receiver on the bench adjust a signal generator to give a modulated output at 465 kc/s and apply the output to the receiver; the output may be connected directly across L_1. With the receiver gain at maximum adjust the level of the signal-generator



Under-chassis view identifying the principal components.

output until the modulation is barely audible. Adjust the two dust-iron cores of both i.f. transformers to give maximum output from the receiver. As the receiver output increases, decrease the output of the generator to keep the receiver output barely audible.

To align the signal-frequency circuits, a different form of coupling is required between generator and receiver. A method which has proved successful is to connect the generator output to the ends of a small coil, which need consist only of a few turns, looped over the ferrite rod at the end remote from the winding L_1. Set the generator to give a modulated output at 1600 kc/s, the receiver tuning to 187 metres and tune the signal in by adjustment of C_8. Now set the generator to 545 kc/s, the receiver tuning to 550 metres and tune the signal in by adjustment of the dust-iron core of L_2. Retune the generator to 1600 kc/s, the receiver to 187 metres and repeat the adjustment of C_8. Now return to the low-frequency end of the band and repeat the adjustment of L_2. Continue these adjustments until no further change in setting of C_8 or L_2 is required. The frequency range of the receiver is now correct and the indications of the tuning scale should be accurate. At this stage it is a good plan to check the accuracy of scale readings at a few points in the band, e.g., 750 kc/s (400 metres), 1000 kc/s (300 metres), 1200 kc/s (250 metres) and 1500 kc/s (200 metres). Any slight errors can sometimes be minimized by re-setting the pointer with respect to the tuning capacitor and re-aligning.

Aerial Adjustment

The receiver must now be mounted in the cabinet in order to align the aerial input circuit. Set the signal generator to 1530 kc/s and tune in the signal by rotating the tuning control to approximately 196 metres. Adjust C_2 to give maximum output from the receiver. Set the signal generator to 620 kc/s and tune in the signal by rotating the receiver tuning capacitor to approximately 484 metres. Slide L_1 along the ferrite rod to the position which gives maximum receiver output. Retune the generator and receiver to 1530 kc/s and repeat the adjustment of C_2. Repeat the adjustment of L_1 at the low-frequency end of the band and continue these two adjustments until no further re-setting of C_2 or L_1 is required. The alignment is now completed and the paper sleeve carrying L_1 should be secured to the ferrite rod.

The receiver is housed in a wooden cabinet measuring 11½ inches by 7 inches by 5 inches and the steel chassis supplied with the cabinet measures 10½ inches by 4 inches by 1¾ inches. The chassis was intended for a 3-valve t.r.f. receiver using a metal rectifier and was modified for the superhet by punching two large holes for the additional two valves and a number of smaller holes for the two i.f. transformers. The layout of the receiver is evident from the photographs and except for the provision of a small screen and the method of supporting the ferrite rod does not require detailed description. The screen is necessary to prevent slight instability and shields the grid lead of the first i.f. transformer from the anode pin of the i.f. amplifier. The ferrite rod could be supported by brackets mounted on the chassis, permitting the receiver to be completely aligned on the bench but in the model illustrated the rod is supported by two rubber grommets held in position by short lengths of wire which fit into the grooves and are secured by short wood screws to the underside of the top of the cabinet. The wire loops must not form closed loops around the rod for these, if closely coupled to the tuned winding, may reduce the effective Q-value. The ferrite rod should be handled with great care because it is extremely brittle and will almost certainly break if allowed to fall more than a few inches on to a hard surface. The ferrite rod is directional, giving maximum signals when broadside on to the direction of the transmitter. It may happen if the rod is mounted parallel to the long dimension of the chassis as shown in the photographs that the signals from the local station are at a minimum with the receiver placed in the desired position. This difficulty can be avoided by arranging for the ferrite rod to be at an angle to the long dimension of the chassis. The angle cannot exceed approximately 30 degrees but this may be sufficient to avoid the difficulty. The choice of position for the ferrite rod is further complicated by a hum which becomes apparent on strong signals when the rod is situated near the mains transformer. This effect may be confused with modulation hum but appears to be due to the properties (possibly non-linearity) of the ferrite rod and can be minimized by suitable choice of position.

References

[1] J. L. Osbourne. "Midget Sensitive T.R.F. Receiver." *Wireless World*, April, 1954.

[2] C. F. Brocklesby. "Negative Feedback Amplifiers." *Wireless Engineer*, February, 1949.

APPENDIX

THE voltage across the reservoir capacitor connected across the output of a rectifier consists of a series of exponential rises, coinciding in time with the periods of conduction of the rectifier, alternating with exponential falls due to discharge of the capacitor by the current taken by the load. To simplify calculation of the amplitude of this ripple, we can assume that the voltage has a sawtooth form, rising instantaneously to the maximum value when the rectifier conducts and falling linearly in the intervening periods. The assumption of a linear fall in voltage is justified if, as is usually true in practice, the fall is a small fraction of the maximum voltage across the capacitor. If the load current is assumed to have a constant value i during discharge periods, the charge q lost by the capacitor in one of those periods is it, t being the duration of the period. This produces a fall in voltage given by q/C, i.e., it/C.

For a full-wave rectifier the discharge period t is half that of the alternating voltage supply and is thus given by $1/2f$.

Substituting for t in the above expression gives the general result—

$$\text{Ripple voltage (peak-to-peak value)} = \frac{i}{2fC}$$

For the receiver described in the article $i = 60$ mA, $f = 50$ c/s and $C = 32\mu$F. Substituting these values in the general expression—

$$\text{Ripple voltage} = \frac{60 \times 10^{-3}}{2 \times 50 \times 32 \times 10^{-6}} \text{ volts}$$

$$= \frac{60 \times 10^{3}}{2 \times 50 \times 32}$$

$$= \frac{60 \times 10^{3}}{64 \times 50}$$

= 20 volts approximately (peak-to-peak)

COMMERCIAL LITERATURE

Standing-Wave Indicator (for waveband centred on 3.2 cm); rotary attenuator, 3.2 cm, using nichrome-coated glass vanes; and monitor diodes for 3.2 cm and 10 cm. Leaflets for their catalogue of microwave instruments from Elliott Brothers (London), Elstree Way, Borehamwood, Herts. Also a price list and a leaflet on power supplies for klystrons.

Silvering Glass and Ceramics to provide a surface for soft-soldering. Two-coat method using silver pastes, described in Electrical Engineering Data Sheet 1300:473 from Johnson, Matthey and Co., 73-83, Hatton Garden, London, E.C.1.

Non-Destructive Testing of engineering materials. Booklet on electronic methods from A. E. Cawkell, 6-8, Victory Arcade, The Broadway, Southall, Middlesex.

Thermistors, as used in receivers for surge suppression, picture-height correction, temperature compensation, etc. Leaflet giving technical data, equivalents, prices and list of receivers in which Mullard Varite types are fitted, available to dealers from Mullard, Century House, Shaftesbury Avenue, London, W.C.2.

Bench-Type R.F. Heater, 750-W, for "pre-heating" plastics powders before they are put in moulds. Will plasticize at rate of up to 8oz per minute. Has air-cooled triode oscillator (35-36 Mc/s) and xenon rectifiers, with process timer and automatic lid opening. Leaflet from Radio Heaters, Eastheath Avenue, Wokingham, Berks.

Instrument A.C.-D.C. Converter, using thermocouple, for precise measurements of a.c. voltages and currents with d.c. potentiometers. Voltage ranges from 7.5 V to 300 V and current ranges from 18 mA to 5 A; accuracy $\pm 0.05\%$ over frequency range of 25 c/s to 10 kc/s. Leaflet from the Croydon Precision Instrument Company, 116, Windmill Road, Croydon, Surrey. Also a leaflet on **Precision Instrument Switches.**

Components and Accessories; the July, 1956, illustrated catalogue from Radiospares, 4-8, Maple Street, London, W.1.

Direct Reading Magnetometer, for measuring fields of transformers, electric motors, focusing electromagnets, etc. Three ranges: 0-5, 0-50 and 0-500 oersteds, using one probe. Short-term accuracy better than $\pm 1\%$. Calibrating solenoid available if required. Leaflet from Newport Instruments (Scientific and Mobile), Newport Pagnell, Bucks.

High Quality S.R. Equipment; amplifiers, pickups, loudspeakers and cabinets, control units, tuners, gramophone motors, tape recorders and other accessories by well-known makers. Also suggestions for equipment combinations, with prices. Illustrated catalogue from the Classic Electrical Company, 352-364, Lower Addiscombe Road, Croydon, Surrey.

Band-III Television Pre-amplifiers, for fringe areas, using earthed-grid low-noise stage followed by neutralized triode stage, giving a gain of 20 dB at full bandwidth. Two aerial inlets, for Band I and Band III, with changeover switch; also a gain control. Leaflet from Spencer West, Quay Works, Great Yarmouth, Norfolk.

Crystal Calibrator for communications receivers. Usable range to 55 Mc/s with check points at every 100 kc/s. Also a Codan squelch unit, a mechanical filter adapter and two loudspeakers. Leaflet on accessories designed specifically for Hammarlund communication receivers, from the Hammarlund Manufacturing Company, 13th East 40th Street, New York 16, N.Y., U.S.A.

Small Direction Finding Aerial (marine) weighing only 17oz, for mounting on hand bearing compass. Can be used with any communications receiver covering beacon signals (290-310 kc/s) and includes a sense finder. Range 50 miles with 20 μV receiver sensitivity. Descriptive leaflet from Brookes and Gatehouse, Shirley Holms, Lymington, Hants.

Waveguide Attenuators, fixed and variable, high-power impedance meters, tees, fixed and sliding terminations and u.h.f. coaxial directional couplers are among the new items in a catalogue of u.h.f. and microwave test equipment from the Narda Corporation, 160, Herricks Road, Mineola, L.I., New York, U.S.A. British representative at 86, Holly Road, Uttoxeter, Staffs.

Resistance Boxes with low, constant switch contact resistance and bifilar windings to reduce inductance. Three or four dials provided, with resistance coil values from 0.1 Ω to 100 kΩ. Accuracy of adjustment 0.1%. Also Wheatstone bridges—precision, portable and self-contained types. Leaflet from the Doran Instrument Company, Stroud, Glos.

Composite Band-I/Band-III Television Aerials with Band-I dipole element "electronically coupled" to Band-III resonator, thereby eliminating coupling bars, so avoiding impedance mismatching, and utilizing Band-I elements on both bands. Leaflet, among others, from Antiference, Bicester Road, Aylesbury, Bucks.

Tape Recorder, two-speed, with 10-inch elliptical loudspeaker in detachable lid. Facility for mixing two inputs, and amplifier which can be used separately for reproduction from tuner units, etc. Leaflet on the Wyndsor Regent from the Magnetic Recording Company, 99, Shacklewell Lane, London, E.8.

Communications Receiver with expanded tuning scale, enabling frequency to be read very accurately, and facility for choosing L/C ratios of tuned circuits for optimum performance. Coverage of amateur bands from 1.8 Mc/s to 30 Mc/s in six ranges. Detailed description of the Eddystone Model "888" from Stratton and Company, Alvechurch Road, Birmingham, 31.

Clip-on Voltmeter-Ammeter, measures current without breaking circuit by means of magnetic induction in current-transformer core. Five current ranges, from 0-10 A to 0-1000 A a.c. and two voltage ranges 0-150 V and 0-600 V a.c. Also a high-frequency model (up to 400 c/s, 2.5 kc/s or 20 kc/s depending on current). Leaflet from Ferranti, Hollinwood, Lancs.

SEMI-CONDUCTORS—2

Another Step on the Way to Transistors

By "CATHODE RAY"

QUITE clearly we will all have to become acquainted with transistors—those who are not already. And one cannot go far without at least some notion of what goes on in the materials of which they are made—semi-conductors. Last month we got the length of seeing why semi-conductors semi-conduct. Unlike metals, which are good conductors of electricity because all their atoms have active or "valency" electrons that are free to drift about as electric currents, semi-conductors' valency electrons are in fixed jobs, linking up with their mates in adjoining atoms to form a regular lattice-like structure that we know as a crystal. Unlike perfect insulators on the other hand, these permanently employed electrons are not altogether immune from being tempted into absenteeism. Typical tempters are heat and light. At ordinary room temperatures an appreciable proportion—getting on for one in a million—of the valency electrons in germanium have shaken loose and are available for electric currents. It is the relative fewness of these absentee electrons that accounts for the "semi." In silicon they are fewer still, unless the temperature is considerably higher.

The atoms from which electrons have gone ("holes") are minus one negative charge. Minus negative is the same thing as plus positive, so electrically these deprived atoms are positive charges. Unlike the freed electrons, they are fixed parts of the crystal structure. But when an electron moves from a complete atom A to a hole B it is just as if the hole moved from B to A. The point of looking at it like this is that a very large number of short electron movements can often more easily be described as perhaps only one long hole "movement." So if, for instance, an electron shook loose in the middle of a crystal of germanium, to the ends of which a battery was connected, the electron would be attracted to the positive terminal, constituting a tiny electric current; at the same time the hole left behind might quickly be filled by an electron from a near-by atom on the negative side; that hole might be filled by one still nearer the negative terminal; and so on, the net result being the same as if the original hole had moved to the negative terminal, constituting another tiny electric current to add to the electronic current. Rather surprisingly, it is found that holes in semi-conductors can move about half as fast as electrons.

That was as far as we got last month, and before going on it would be as well to make quite sure of this hole business, and especially what is meant in transistor literature when it said that holes move. A thing to remember is that only the electrons *really* move; strictly speaking the holes are fixed, but some kinds of electron movement have the same electrical effect as if holes moved, and are more conveniently described and calculated as such. Fig. 1 is a picture of a dozen people forming a queue (a), for whom the management have thoughtfully provided seats. No. 6 is called in first, so he leaves his seat and goes forward (b), thus creating a vacancy or "hole." This vacancy, strictly speaking, is a fixed seat; but if, in the natural desire to get as far forward as possible, No. 7 moves into it, then No. 8 moves into the newly created vacancy, and so on; the final result is as if the influence that induced the forward movement of person No. 6 also had the effect of repelling the "hole" to the rear (c). The total human current is the movement of a man from position 6 to the left hand or positive end, plus all the short movements of Nos. 7 to 12 inclusive; but the latter part can be described much more concisely as the movement of a vacancy from position 6 to the right-hand or negative end, *or* as the movement of a person from 12 to 6.

Holes, then, are imaginary positive charges, about half as mobile as electrons, used for convenience as an alternative way of describing certain real but complicated movements of electrons in the opposite direction.

Intrinsic Conductivity

So far we have an explanation for the small but appreciable conductivity of pure semi-conductors such as silicon and germanium, and also for its fairly steep increase with rise of temperature; because the normal state of these materials is full employment of electrons on fixed sites, they tend to be insulators; but except at very low temperatures this state is upset by a small proportion of electrons being freed by heat energy. The actual proportion depends on the temperature (the higher the greater) and on the structure of the atoms (i.e., on the material; the proportion is much greater in germanium than silicon). In a given material at a given temperature it cannot be altered. So it is called the *intrinsic* conductivity* of the material.

That doesn't get us very far towards transistors, or even crystal rectifiers, for intrinsic conductivity is no more than an incidental nuisance. It means that an e.m.f. always causes some current through semi-conductor devices, even when they are supposed to be biased to "cut-off." And the increase with temperature means that germanium devices are more or less out of action at the temperature of boiling water, though silicon can still be used—hence the development effort being put into silicon at the present time.

Light has been mentioned along with heat as a disturbing influence in semi-conductor crystalline structure and, therefore, a causer of conductivity. But it is a simple matter to keep light out where it

* Does anyone wonder what is the difference between conduction and conductivity? It is rather like the difference between production and productivity: a production of 1,000 tons of coal doesn't tell one whether it was obtained efficiently or not; for that one needs to know the productivity, which is the production per man per week or shift. Conductivity is the proper figure for comparing the conductions of different materials, in amps per volt per metre (or centimetre) cube.

isn't wanted (in ordinary transistors) and to let it in where it is—in photo-transistors, which enable a current to be controlled by light. So we are not going to bother about light just now.

Why use materials such as germanium, when they are subject to this intrinsic conductivity nuisance? Well, it happens that atomic structure which is liable to have the odd electron knocked off here and there by heat energy is also the kind that enables rectifiers and transistors to be made. That comes about in a curiously indirect sort of way. The only hint so far lies in a word you probably overlooked—"pure." When the semi-conductors are not pure, the picture becomes much more complicated. And for this purpose the standard of purity is so high that it would make the best "pure water supply" look like a cesspool. The uninitiated might suppose that if there were no more than one impurity atom to every 100,000,000 of germanium the material would reasonably pass as "pure." The chemical analyst would have no doubts about it. Yet this incredibly small impurity is enough to have quite an effect on the conductivity.

Cuckoo in the Nest

As it happens, the main natural impurity in germanium is arsenic, which is No. 33 in the list of elements. Germanium, you remember, was 32, so each of its atoms has 32 electrons, of which (as we saw last month) all but four—the valency electrons—can for our purpose be lumped in with the nucleus to form a body having a net positive charge equal to four electron units. So we simplified the diagram of a normal neutral germanium atom down to Fig. 2(a)—the augmented nucleus with its net charge of +4 surrounded by its four valency electrons each with a −1 charge. These are the electrons that link up with four neighbouring atoms to form the crystal lattice. On the same basis, as we might expect, the diagram of an arsenic atom looks like Fig. 2(b).

Now the interesting thing is that the arsenic atoms present in a piece of germanium find themselves accepted as units in the crystal lattice, just like a young cuckoo in a nestful of sparrows. But, of course, only four of the five electrons can find fixed employment; the odd one has to seek his fortune elsewhere. So in germanium with arsenic impurity there are free electrons, over and above any that are released by heat energy. The conductivity is

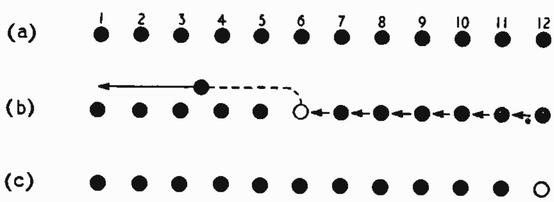


Fig. 1. (a) Queue of people waiting in seats. (b) No. 6 is called forward. (c) Apparent movement of his vacant seat backwards.

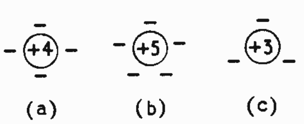


Fig. 2. Simplified diagrams of atoms: (a) tetravalent; (b) pentavalent; (c) trivalent.

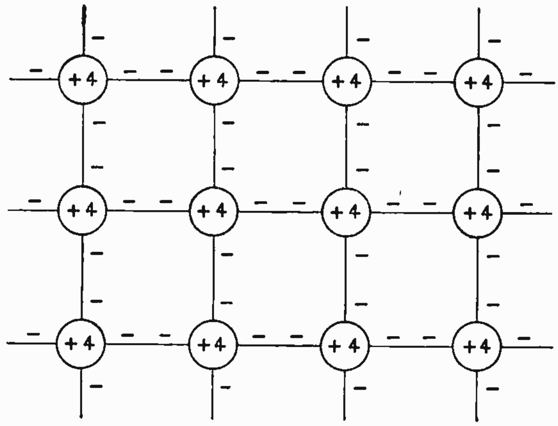


Fig. 3. Diagram of pure crystal lattice built up of Fig. 2(a) atoms.

consequently greater. Even with what would be considered chemically an insignificant amount of impurity the conductivity might be 100 times greater. In silicon, the effect would be even more marked if one could compare it with really pure silicon, which unfortunately is difficult to obtain.

And so another of the peculiarities of semi-conductors—the widely varying conductivities of "chemically pure" samples—has been accounted for. But it still doesn't seem to get us very near transistors.

However, arsenic (or phosphorus, or antimony, whose atoms also can be represented as in Fig. 2(b)) is not the only kind of impurity that can get into the semi-conductor crystal lattice. There is gallium, which, being element No. 31, looks like Fig. 2(c). Others in the same group are aluminium and indium. These come with only three valency electrons per atom, so when they are in the lattice they resemble germanium atoms from which an electron has been shaken out by heat—except that the nucleus has only three units of positive charge instead of four, so the atom as a whole is neutral. But they are, in effect, holes.

Vital Minority

Being familiar with the nomenclature of valves according to the number of their electrodes, we do not have to be Greek scholars to see why the atoms diagrammed in Fig. 2 are referred to as tetravalent, pentavalent and trivalent respectively.

The position, then, is that when either of the tetravalent elements germanium or silicon is contaminated by even minute proportions of a pentavalent element such as arsenic its electrical conductivity is increased well above the intrinsic conductivity of the pure element, because of the presence of one surplus electron per impurity atom. And with trivalent impurity much the same thing happens because of the presence of one hole per impurity atom. In the first case the conduction is by electrons; in the second it is (or, if you are a stickler for accuracy, *appears* to be) by holes.

We are now getting to the heart of the matter. And for quick reference to these two different impurity materials there are some technical terms, which can easily be remembered by noting the occurrence of the letters *n* and *p*. Pentavalent atoms, which provide spare electrons, which are negative charges, are called donors; and a semi-conductor containing them is *n*-type. Trivalent atoms, which are holes, or positive charges, ready to receive electrons, are called acceptors; and a semi-conductor containing them is *p*-type. Note very particularly that calling a material *n*-type does *not* mean that as a whole it is negatively charged. Both *n* and *p* materials are normally neutral; the letters refer only to the loose charges.

And now we can carry the simplification of our atom and lattice diagrams a stage farther. We saw last month that a perfect germanium (or silicon) crystal consists of a lattice of Fig. 2(a) atoms, each one holding on to four others, as shown diagrammatically in Fig. 3. Each atom is electrically neutral and fixed—except for the small minority disturbed by heat, which we are going to ignore for the time being. So electrically the material hardly exists; Dr. Shockley has in fact drawn an analogy between it and the vacuum in a valve. It merely provides a space for the impurity electrons and holes to play about in. We are going to omit it entirely from our following diagrams in order to concentrate attention on the very small but vital minority of impurity atoms. These of course are scattered at random throughout the crystal, so form no particular pattern. And only the net electrical charge of each unit will be shown. There is first the loose electron, shown as before by a single minus sign. Then there is the hole which, although not truly movable, does (owing to successive transfers of electrons) virtually move nearly as readily as an electron; it is represented by a plus sign. Then a donor atom (Fig. 2(b)) having lost its one unemployed electron is a fixed unit positive charge, represented by a plus sign in a ring; and lastly an acceptor atom (Fig. 2(c)) is a fixed negative charge, represented by a minus sign in a ring. Fig. 4 shows a sample of each.

It would be a good idea at this point if you would make sure that the meaning of *n* and *p* material, and the conventional symbols just explained, have been grasped, by drawing diagrams of samples of these two materials using the symbols. And then checking that they agree with Fig. 5. Remember that these diagrams show *only* the impurities; the millions of times as many germanium and silicon atoms are there but not shown. And whereas the minus signs in Fig. 5(a) represent real electrons floating around, the plus signs in Fig. 5(b) represent only the fact that *p*-type material behaves very much as if there were real positive charges, analogous to electrons, floating around. The real cause of this —and I am sorry if my insistence on this point is becoming a bore—is the movements of electrons from one acceptor to another.

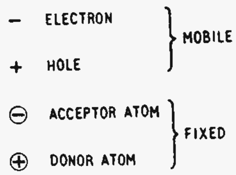


Fig. 4. Standard symbols for charged particles in semi-conductors.

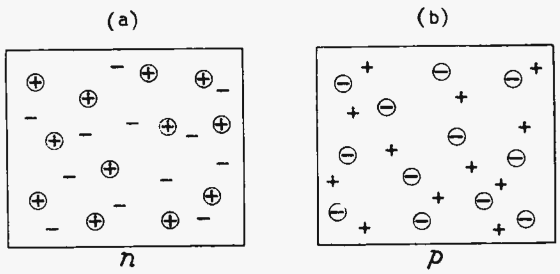


Fig. 5. Diagrams of (a) n-type and (b) p-type semi-conductor, using Fig. 4 symbols. Only the impurity atoms are shown; the atoms of germanium or silicon, which are usually millions of times more numerous, are omitted for clarity.

P-N Junctions

There is an important point to clear up before at long last getting to the uses of all this. It has probably occurred to you that impurities of *both* types would almost inevitably be present to at least the minute extent that is significant electrically; and what then? As one might guess, the opposite effects neutralize one another, so that if there are exactly equal quantities of opposite impurities the material behaves electrically as if it were pure; its conductivity is no more than the intrinsic conductivity of the material at that temperature. The neutralizing effect is called *compensation.* This might seem to be a short cut past the obvious difficulties of purifying anything to better than 1 part in 10^9. But if one were to try "purifying" germanium containing 1 part in 1,000 of arsenic—not very bad, by ordinary chemical standards—by adding an equal proportion of gallium, the problem of ensuring that the amount added was correct to 1 in a million might be worse than the problem being dodged. Anyway, in practice the germanium is purified in the proper straightforward way and the desired impurity added later; rather as crude iron is freed from carbon and then sufficient is added to make the grade of steel required. However, *over*-compensation is used to convert *n*-type to *p*-type or vice versa.

None of these three types of material—*n, p* or *i* (for "intrinsic")—is particularly useful on its own; it is when *n* and *p* types are brought closely into contact that results become really interesting. Just bringing two different pieces together is not good enough; in practice a single piece is caused to have *n* and *p* regions by introducing the appropriate impurities. The boundary between the regions—or often the whole combination of two kinds of material —is called a *p-n* junction.

The tendency of any concentration of electrons or holes is to scatter so as to fill the whole available solid uniformly. This movement is called diffusion, and is quite apart from movements caused by electric fields. So when the free electrons in the *n* half of a *p-n* junction look across the boundary and see the absence of electrons in the *p* half, they start drifting across. Similarly the holes in the *p* half start diffusing into the *n* region. Opposite charges moving in opposite directions are electric currents moving in the *same* direction—conventionally, the direction the positive charges (in this case, holes) move. However one looks at it, the *n* region, previously neutral, is becoming positively charged, and the *p* region negatively charged. The result is the growth of a potential difference between the regions. This p.d. tends to put a stop to the diffusion; the electrons that have

(*Continued on page* 397)

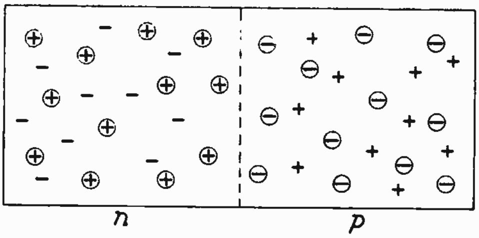


Fig. 6. A p-n junction, showing how the p side of the boundary becomes negatively charged because holes there are neutralized by electrons diffusing across from the n region. Similarly the n side becomes positively charged.

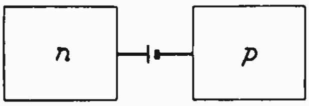


Fig. 7. The potential difference between the two sides of the boundary in Fig. 6 can be represented symbolically by an imaginary cell. But it must be realized that its voltage alters if an external e.m.f. is applied, as in Figs. 8 and 9.

already diffused, having no accompanying positive charges to neutralize them, form a negative charge that repels those coming on behind ("like charges repel"). Similarly with the holes.

Perhaps you think the trespassing electrons have plenty of positive charges around—a whole regionful of holes—to neutralize them. But in so far as these holes combine with the electrons and cancel them out, they themselves are cancelled out and can no longer balance the acceptor atoms (which are fixed negative charges). So either way the diffusing electrons make the *p* region go negative. Similarly the diffusing holes make the *n* region positive. On the assumption that the diffusing bodies disappear by combining with their opposite numbers, the general effect can be represented as in Fig. 6. The charged atoms cause a positive excess on the *n* side of the boundary and a negative excess on the *p* side. When this p.d. is just enough to balance the tendency to diffuse, the process stops. The situation can be represented even more simply as in Fig. 7, the p.d. being indicated by an imaginary cell.

The Junction Rectifier

The next thing is to see what happens when an external e.m.f. is applied in the direction + to *n* and − to *p*, as in Fig. 8; that is to say, in series opposition to the imaginary e.m.f. in Fig. 7. This charges the *n* region still more positive by attracting more electrons out of it; similarly the *p* region is made more negative. And again, after a very small temporary flow of current a balance is reached in which there is no current (except for intrinsic conductivity, which we are still neglecting so as not to become confused by trying to take in more than one thing at a time). In the Fig. 7 style of diagram, the result would be represented by an increase in the number of imaginary cells, sufficient to balance the diffusion tendency plus the externally applied e.m.f.

Unlike either of the *n* or *p* pieces separately, the combination appears to be a non-conductor.

After a pause to tick off yet another piece of previously incomprehensible behaviour on the part of a semi-conductor, we reverse the battery. Its e.m.f. is now series-assisting the internal p.d., tending to make current flow. Electrons and holes trespass more or less freely on one another's regions; many of them annihilating one another no doubt, but the external battery replenishes the supply (Fig. 9). So in this direction current flows easily. The Fig. 7 "e.m.f." has meantime almost if not entirely disappeared, to represent the fact that the fixed junction charges shown in Fig. 6 are neutralized by the mobile charges.

In brief, a *p-n* junction is a rectifier.

According to the simplified theory just outlined, a *p-n* junction rectifier would be perfect—at least, in the reverse or no-current direction, because there really would be no current. How much resistance, if any, there would be to current in the forward direction does not appear. There would, presumably, be a bit of a bottom bend while the applied forward voltage was overcoming the junction p.d. indicated variously in Figs. 6 and 7, and after that the steepness would be greater the more the impurities present to contribute current carriers. The forward-current characteristic does in fact conform pretty well to that guess. It is the reverse behaviour that is more complicated.

First let us combine the impurity theory with the intrinsic theory. Then instead of Fig. 6, with nothing but donors and electrons on the *n* side and acceptors and holes on the *p* side, we would have to show a few heat-released electrons and holes on both sides. Some of the holes on the *n* side would no doubt be cancelled by electrons, which would be in a majority (they are, in fact, officially termed *majority carriers*, the holes being minority carriers), but those near the junction would find the p.d. there to be of the right polarity for carrying them across it to where they would be in a majority. Similarly, there would be a small current of electrons from *p* to *n*. This double current would tend to destroy

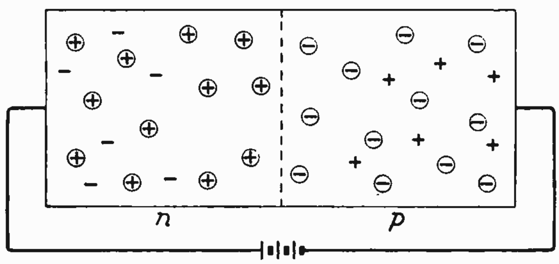


Fig. 8. An external e.m.f. of this polarity (" reverse ") increases the p.d. shown in Figs. 6 and 7, and little or no current flows.

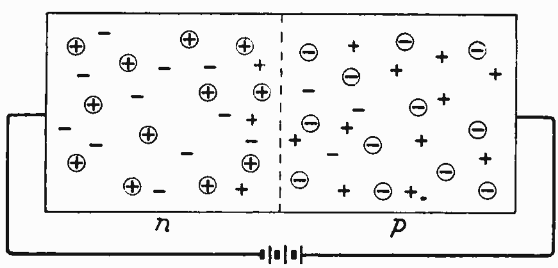


Fig. 9. An e.m.f. with "forward" polarity causes a relatively large current by enabling electrons and holes to flow freely across the junction.

the junction p.d., but if it did so the p.d. would be restored by diffusion. So instead of our previous picture of a balance with no current crossing the junction we have to substitute one with equal and opposite (and, at reasonable temperatures, relatively small) currents. Which for practical purposes comes to the same thing.

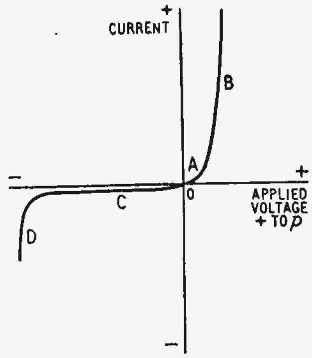


Fig. 10. Typical current/voltage characteristic of p-n *junction.*

When the reverse e.m.f. is applied (Fig. 8) the junction p.d. no longer depends for its existence on diffusion current, which comes to a stop. But the intrinsic current carries on regardless, for the p.d. actually assists the minority carriers across the frontier. Therefore there is some reverse current, not much affected by the amount of applied voltage once that has become sufficient to stop the diffusion current. This is an example of intrinsic conductivity being a nuisance. And, as we know, it increases with temperature, so if a germanium rectifier gets hot for any reason it may pass so much reverse current as to be useless for the purpose. Silicon, which requires greater heat energy to break up its co-valent bonds, is not so bad.

But that is not all. If the reverse e.m.f. continues to be raised a point is reached (sooner, if the proportion of impurities is large) at which the electric field strength due to it is sufficient to break up the co-valent bonds and release electrons and holes on a catastrophic scale. When that happens the crystal has practically no resistance at all and one says it has broken down. The large current that flows is known, by the way, as Zener current.

Putting together all the things we now know, we should have no difficulty in accounting for the shape of a *p-n* junction current/voltage characteristic, which is something like Fig. 10. A is the bottom bend, where the applied e.m.f. is busy overcoming the junction p.d. B is the steep current rise when it has succeeded. C is the nearly constant but small (if you are lucky) reverse current due to intrinsic conduction. And D is Zener current, plunging to its doom.

Still nothing about transistors, I fear. But Fleming's diode was soon followed by De Forest's triode, and history repeated itself after a fashion with semi-conductor devices.

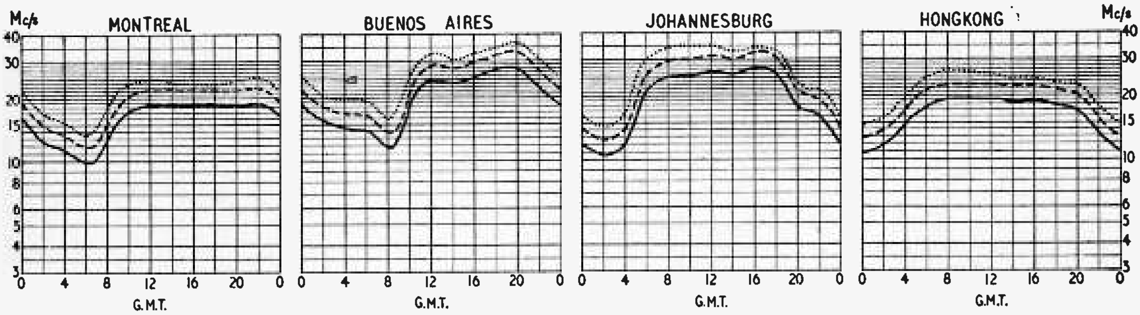
New Life for the "Personal" Portable?

THERE has always been a strong public demand for the small "personal" portable receiver and nothing is more certain than that many more would have been sold were it not for the fact that running costs have hitherto been high. Battery power in the form of miniature high-tension units is necessarily expensive—much more so than in the form of batteries made up of larger cells.

The obvious solution is to use transistors, which dispense with filament heating and can also be operated entirely from inexpensive low-tension cells. Already the transistor has ousted the valve in hearing aids, and at least one portable radio receiver has appeared with transistors in all its stages. This is quite an achievement as it is not so easy to match valve performance at high frequencies with the junction transistors.

Another solution, which has been adopted in the Grundig "200" portable, is to use valves for the r.f. and i.f. stages and transistors in the output stage. In any receiver the output stage accounts for the greater part of the power consumed and if this drain can be transferred from the h.t. to the l.t. battery, running costs are materially reduced. In the Grundig circuit the valve h.t. consumption totals only 3.5 mA from a 67.5-V battery. This is divided between the DK96 frequency changer (1.77 mA), DAF96 i.f. amplifier (1.07 mA) detector and 1st a.f. amplifier (0.055 mA) and DF97 driver (0.6 mA). In the output stage two OC72 transistors in push-pull require a standing quiescent current of 1.7 mA from the 6-V l.t. battery and an interesting feature is the use of a thermistor in parallel with one of the bias stabilizing resistors to help in compensating for changes in ambient temperature. The output stage would take about 15 to 20 mA on average music, and the filaments about 25 mA.

SHORT-WAVE CONDITIONS *Predictions for August*



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 August.

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

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

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

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

BOOKS RECEIVED

Color Television Receiver Practices. Edited by C. E. Dean. Based on a series of lectures given to visiting engineers by the Hazeltine Corporation (U.S.A.) covering basic concepts, the colour television signal, display devices, three-gun shadow-mask tubes, decoders, colour synchronization, i.f. and video amplificaation and test equipment. Includes selected references to the literature. Pp. 200 + vii; Figs. 96. Price 36s. Chapman and Hall, 37, Essex Street, London, W.C.2.

Elements of Pulse Circuits, by F. J. M. Farley, M.A., Ph.D. Monograph, addressed to physicists and research workers with an elementary knowledge of radio valves and circuits, covering all the well-known pulse forming and amplifying circuits and explaining their action on a physical rather than a mathematical basis. The concluding chapter deals with applications in television, radar and nuclear research. Pp. 143 + viii; Figs. 74. Price 8s 6d. Methuen and Co., Ltd., 36, Essex Street, London, W.C.2.

MK Buizen Handbook. International valve manual covering American and Continental types, in which the relevant information is displayed, for rapid reference, in circuit-diagram rather than tabular form. Quick access to sections on diodes, triodes, tetrodes and pentodes, output valves, frequency changers, combined valves, thyratrons, crystal diodes and transistors, and cathode-ray tubes is given by colour-coded pages. Pp. 334 with numerous diagrams. De Muiderkring, Bussum, Netherlands. British agents, The Modern Book Company, 19-23, Praed Street, London, W.2. Price 15s.

Definitions and Formulæ for Students—Modern Physics (3rd Edition). Compiled by L. R. B. Elton, Ph.D. Selection of memorable data including electronic and atomic constants, electron and field equations, the photoelectric effect, etc. Pp. + v. Price 2s. Sir Isaac Pitman and Sons, Ltd. Parker Street, London, W.C.2.

Contribuicao para o Estudo de Antenas Lineares—Teoria e Projecto de Antenas Rombicas by A. A. de Carvalho Fernandes, A.M.I.E.E., M.I.R.E. Comprehensive treatise (in Portuguese) on the theory of rhombic aerials, which includes formulæ for the intensity of the radiated field, taking into account components with both vertical and horizontal polarization. Practical data is given for the design of arrays of stacked, and stacked and interlaced rhombics. Pp. 415; Figs. 119. Price Esc. 150. Coimbra Editora, Lda., Avenida do Arnado, Coimbra, Portugal.

Studien über einkreisige Schwingungssysteme mit zeitlich veränderlichen Elementen by B. R. Gloor, Dr. Sc. Techn. An exhaustive study of the basic principles underlying the operation of super-regenerative receivers and an account of experimental work in verification of the theory. Pp. 234; Figs. 156. Price, Swiss Fr. 15. Verlag Leemann Zürich, Arbenzstrasse 20, Zürich 34.

Time-saving Network Calculations, by Harry Stockman, S.D. General advice on the approach to mathematical solutions of network problems with examples of the use of Thévenin's theorem, the potentiometer method and other techniques applied both for the transient and steady states. Pp. 120; Figs. 36. Price $1.75. SER Company, 543, Lexington Street, Waltham, Mass., U.S.A.

Abacs or Nomograms, by A. Giet. Written for engineers rather than mathematicians and shows how abacs for routine calculations may be constructed to correspond with formulæ involving any number of variables. Pp. 235; Figs. 152. Price 35s. Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

Solution of Problems in Telecommunications, by C. S. Henson, B.Sc.(Eng.), A.C.G.I., A.M.I.E.E. Worked examples taken from papers of University of London B.Sc.(Eng.) and Graduate I.E.E. examinations to illustrate the application of basic theory to specific cases. Pp. 258 + x; Figs. 122. Price 25s. Sir Isaac Pitman and Sons, Ltd., Parker Street, London, W.C.2.

Radio Electronics, by Samuel Seely, Ph.D. Mathematical analysis applied to the elements of communication systems and to the general problems of information theory and the effects of noise. Pp.487 + vii; Figs. 438. Price 52s 6d. McGraw Hill Publishing Co., Ltd., 95, Farringdon Street, London, E.C.4.

Maintaining Hi Fi Equipment, by Joseph Marshall. Guide for service technicians to current American practice in high-quality sound reproducing systems, with practical hints on the tracing and elimination of distortion, hum, etc. Pp. 223; Figs. 135. Gernsback Library No. 58. Obtainable from Modern Book Company, 19-23, Praed Street, London, W.2. Price 23s.

Public Address and Sound Distribution Handbook. Advisory editor Alex. J. Walker. Description of amplifiers, microphones, loudspeakers, etc., used in p.a. work, and an analysis of typical complete installations. Pp. 160; Figs. 145. Price 21s. George Newnes, Ltd., Southampton Street, London, W.C.2.

RANDOM RADIATIONS

By "DIALLIST"

F.C.C. and Receiver Radiation

YOU may recall that I suggested a while ago that there couldn't be much interference radiated from the line timebase or otherwise by American television receivers, and that a Baltimore reader wrote that this was in fact the case. The position has now been cleared up by an article in the June number of *Radio-Electronics*, which describes a certification scheme for sound and vision broadcast receivers which is now being made compulsory by the F.C.C. This body, which has in some ways even greater powers than those given to our G.P.O. by the Wireless Telegraphy Act, regulates radio communications of all kinds, including broadcasting, in the United States. With the co-operation of most American radio manufacturers it has now brought out permissible radiation limits for receivers of every kind working on frequencies from 0.45 to 1,000 Mc/s. Every set sold after a certain date will have to be provided with "a distinctive seal or label" on which the manufacturer certifies that it complies with the F.C.C.'s radiation regulations. The scheme is progressive. The rule became applicable on May 1st this year to all kinds of v.h.f. receivers; u.h.f. sets put into production after December 31st must fall into line, and from the beginning of July next year no uncertified receiver of any kind may be offered for sale.

Can't We, Too?

The F.C.C. schedule of the maximum permissible field strength of the radiation by any receiver is the result of five years of close consultation between the U.S. government and industry. It is much to be hoped that something of the kind will be done in our country. It shouldn't take anything like five years, though, for much work has already been done and we have the American figures—the results of a vast amount of investigation and experimental work—to help us. If, for example, the maximum permissible field strength of receiver radiation between 25 and 70 Mc/s has been found in America to be 32 μV/m, that between 70 and 130 Mc/s to be 50 μV/m, and that between 174 and 260 Mc/s to be 50-150 μV/m, those figures should be suitable here for television and f.m. sets. There can be no great manufacturing difficulties about turning out receivers which comply with such limits, for the American radio industry has accepted them most enthusiastically. Couldn't some of our manufacturers give a voluntary lead by guaranteeing that their sets don't and won't interfere with other people's reception?

"Bournemouth Effect"

YOU remember the "Bournemouth Effect," which I recorded recently in these notes? A reader gave an f.m. receiver to his parents, then living in an apartment near the top of a large block of flats in Bournemouth. It worked perfectly; but when they moved later to a flat on a lower floor and the feeder was lengthened accordingly, he was told that they now heard the "chuffs" of every locomotive as it left the station. My best thanks to the many readers who wrote to me about this queer effect. All agree that the lengthening of the feeder provides the key to the problem. The increased attenuation brought signal strength down to a point at which the limiter was normally only just working; a very small further fall, whatever the cause, would put it temporarily out of action and produce the chuffing. Several letters suggest that aeroplane flutter may be responsible; but I understand that the noise occurred when a train was actually leaving. The clouds ejected from the funnel consist largely of steam and hot gases at high pressure. One correspondent suggests that these might give rise to an electrostatic effect and mentions that interference with v.h.f. reception has been noticed in launches driven by compression ignition engines.

Tough Luck

HOW easy it is, as things are, for the best of good citizens to become a nuisance to his neighbours is shown by a letter I've had from a Yorkshire reader, who lives in a semi-detached house. His hobby is wireless; he likes receiving distant stations and he has spent quite a lot of money on suitable receiving sets and aerials. Not long ago he began to suffer severely from unwanted noises and concluded that the receiving set, which he had had for some years, was packing up. Having bought a new one of a more sensitive type he was not a little surprised to find the unwelcome noises worse than ever; they were in fact strong enough to make reception of any station but the local one quite impossible. He then discovered that the noises occurred only when the occupier of the other half of the "semi" was using his television receiver, an instrument of reputable make, bought in all good faith, and in good working order. The matter was reported to the G.P.O., but their engineers explained to my correspondent that they can't go into action unless interference spoils reception of the B.B.C.'s local station. And he couldn't honestly say that it did so.

Sunspots and Dx

DURING the next few months we shall probably reach the period of maximum activity in the present sunspot cycle. Spots and flares have already been responsible for some queer effects, including the big radio blackouts which occurred earlier this year. At or near previous maxima television reception has been recorded at times at almost uncanny distances. The Alexandra Palace transmissions were received on occasion in the United States, and, if I remember rightly, in South Africa. At the last sunspot maximum period there were few TV transmitters in action and receivers numbered only a tiny fraction of the present total; but during that period which we are now nearing when a huge number of transmitters will be in action and millions of receivers in use in different parts of the globe, I shouldn't be surprised if some remarkable Dx feats were recorded.

A Cry Over Spilt Milk

BEING one of those in favour of higher-definition television, I can't help feeling that it's perhaps a pity that we didn't decide to devote Band III entirely to 819-line television, clearing the whole of it from end to end and dividing the available channels between the B.B.C. and the I.T.A. The B.B.C. could have put on either its proposed second programme, or an 819-line version of its Band I transmissions. We'd have had vastly better television. We'll get that better television one day, of course; but there are so many snags in the way that it is not likely to come now until much water has flowed beneath the bridges. The French were luckier, as well as wiser. Very few 441-line receivers were in use when the 819-line system began to take shape and fate lent a hand a while ago when the 441-line station on the Eiffel Tower was burnt out.

UNBIASED

By FREE GRID

Mastering Morse

IT is not often that I omit to mention jubilees and centenaries of wireless landmarks but I am reminded by an article in the May issue of the *R.S.G.B. Bulletin* that I forgot all about the centenary of the international morse code in 1951.

This highly informative article points out that Morse's original code was compiled in 1837 and revised a year later. Both these codes used variable spacing between the elements of certain letter symbols but this practice was abandoned in the International code adopted by the Vienna Conference in 1851, and still in use.

An interesting point about the work of Morse is that he adopted the principles of what we now call information theory and arranged that letters in most frequent use—or in other words letters conveying the most information—should be given the shortest code symbols. He found that the letter E headed the list in the English language and so it was given the shortest code symbol. The Vienna Conference had to make compromises between the needs of the various languages. The letter O was apparently a stumbling block, being frequent in English but relatively infrequent in French and German. I wonder if the Polish delegate protested about the length of the symbol allotted for Z.

A curious point brought out by the author of the *R.S.G.B. Bulletin* article is that those learning morse get stuck at a speed of 7 to 10 words per minute. A writer in *W.W.* discussed this same problem fifteen years ago in June 1941 and I added a few remarks of my own in the October issue. He called it the "psychological pause," but differed slightly from the writer in the *R.S.G.B. Bulletin* as he gave a higher figure for it—about 15 w.p.m.

The real difference between the two writers, however, is in their remedies for overcoming this strange mental barrier. The writer in the *R.S.G.B. Bulletin* counsels perseverance or, in other words, hard work! Ugh! The *W.W.* writer gave a far more palatable remedy which was to get slightly drunk and he meant it in all seriousness. The effect of alcohol is to remove certain mental or psychological inhibitions which cause the speed barrier.

Similar tactics can be used to get over certain other brain and muscle co-ordination difficulties and it is possible for instance to dodge the drudgery of learning to type at high speed by the judicious use of alcohol. However, the system has never been adopted by the business colleges as, in certain of the more staid and reactionary City offices, girls who have learned to type rapidly in this manner are thought to be fast in more senses than one. I recollect once in my younger days dictating to a typist who—but there! readers of *W.W.* wouldn't be interested in personal reminiscences of a non-technical nature.

A morse miasma.

Triangular Television Wanted

TELEVISION screens seem to be getting bigger and bigger to cater for people who want to compete with the Jones's, for I cannot think people really want these big screens in the average small house. Big screens mean bigger cabinets with WX dimensions not only in the plane of the picture but in the fore and aft direction, too, as the tail end of the bigger C.R.T. has to be housed.

For the large family party I think the best type of set is one which I myself designed and built over three years ago for a Coronation viewing party at home. It was a console receiver modelled on the lines of Big Ben and had a moderate-sized screen on each of the four sides of the tower like the famous clock. Thus we were all able to sit round in a circle and view the long programme in comfort. The four tubes were all slightly different in their height above ground so that their tails didn't foul each other in the tower-like cabinet.

For ordinary family viewing I am at present using a set having two screens, one set at a slightly obtuse angle to the other so that each member of the family has a full-faced undisturbed view of the picture. This is much better than all crowding round a large screen with some people viewing the screen at an acute angle where they get an uncomfortable lop-sided view like the unfortunate rich people who patronize the boxes at a theatre. Here again, one tube is slightly higher than the other to avoid fouling of tails.

The ideal set for the ordinary man with a small family in a small house is one which will take up least room; namely, one with a triangular cabinet so that it will fit neatly into a corner. Why on earth some enterprising manufacturer doesn't produce such a set, I just don't know.

Car-Owners Corner

CERTAIN motoring experts seem recently to have discovered that cars which are, of course, insulated from the ground by their tyres acquire a static charge in dry weather which is said to cause car sickness. The result is that many dealers are selling small anti-static chains to trail behind cars.

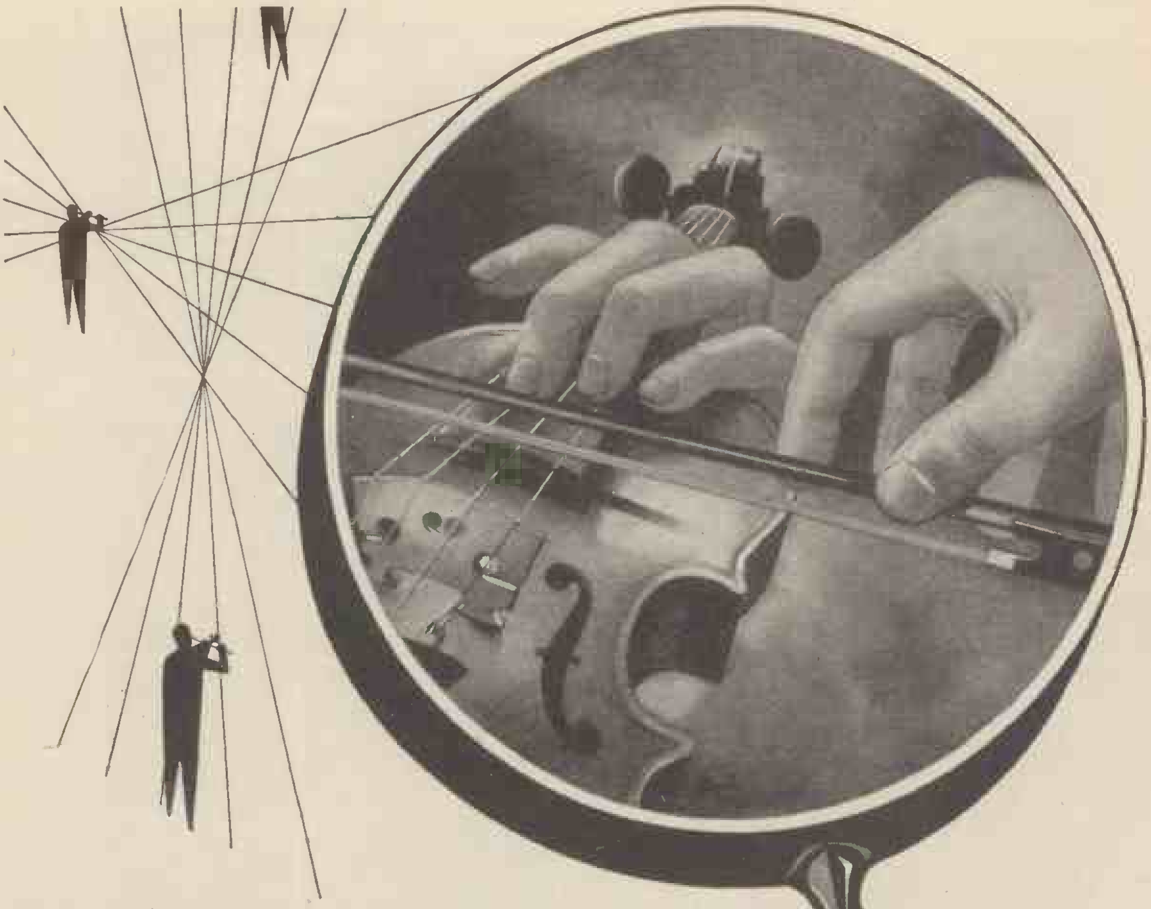
It is no concern of mine, writing in a radio journal, whether static charges do or do not cause car sickness but I do know from experience that this trailing lightweight chain, owing to the poor connection it makes with the ground, causes intermittent discharge of the static charge and therefore bad interference with the car's radio set when receiving weak signals.

The real remedy is to earth the chassis so firmly that no static can even accumulate and this can be done by affixing to the tyres the chains sold for use on snowbound roads. This will undoubtedly attract the attention of the police and cause much licking of pencils, but it is not an offence. By the way, what has happened to the special anti-static tyres which were available in pre-war days when I last touched on this subject? (*W.W.*, 8.12.38.)

Tele-Pictures in 1842

WE are all so accustomed to seeing pictures in our newspapers which have been transmitted by radio that we are apt to take them for granted. Yet most people would laugh to scorn any suggestion that the telegraphic transmission of pictures dated back to Victorian or even Edwardian days; it is regarded as essentially a modern invention.

Yet the basic idea goes back not only to the days of Queen Victoria but to within five years of the death of William IV. It was in 1842 that Alexander Bain first proposed a scheme for transmitting pictures electrically, using two pendulums of identical dimensions as transmitter and receiver, respectively, for synchronizing purposes. Synchronization is the whole essence of picture transmission as it is of television, and this basic principle was realized by Bain. Thus picture telegraphy was conceived almost as early as ordinary telegraphy, but its period of gestation proved many decades longer.



'Strad' or Fiddle?

The violinist needs no magnifying glass to discriminate, nor does an engineer, to distinguish R. & A. reproducers from any others — they also are unique in design and quality.

R&A

LOUD-SPEAKER MANUFACTURERS FOR THE RADIO INDUSTRY SINCE 1930

REPRODUCERS AND AMPLIFIERS LTD.
WOLVERHAMPTON · ENGLAND.
Telephone: 22241/2/3/4. Cables: AUDIO.

NOW dual dual trace

oscilloscope mark 2

. . . two input signals displayed for direct comparison and their characteristics accurately measured by the turn of a knob . . . such are the facilities and convenience afforded by the Mullard Dual Trace Oscilloscope, type L.101.

Well-engineered and reliable, the L.101 Oscilloscope is *the* oscilloscope where the demand is for a high grade general purpose instrument. It employs two identical amplifiers with bandwidths of 4 Mc/s irrespective of sensitivity. Each amplifier is aligned for good transient response, has a rise time of 0.1 μsec, and a maximum sensitivity of 20 mV pk-pk/cm.

The time base may be free running, synchronised or triggered. Its velocity is continuously variable between 0.1 μsec/cm and 10 msec/cm. Both time and voltage may be measured by the nul method and a well-regulated power supply preserves calibration accuracy.

mark 2 features

- **Post Deflection Acceleration** gives a brighter display at low repetition rates.
- **R. C. Probe** ensures that only negligible damping is imposed on high impedance circuits. (This probe is also available to users of the Mark 1 model.)
- **Improved Triggering Circuit** starts the time base with the minimum delay from either positive or negative signals of only 1½V amplitude.

Full details of the L.101 Mark 2 are readily available from Mullard at the address below or from any of their distributors.

Belfast: James Lowden & Co. Ltd., Tel. 57518. **Birmingham:** Gothic Electrical Supplies Ltd., Tel. CEN 5531. **Bristol:** T. Neesham & Co. Ltd., Tel. 22732. **Glasgow:** Land Speight & Co. Ltd., Tel. CEN 1082. **Manchester:** F. C. Robinson & Ptners. Ltd., Tel. Chorlton 5366. **Newcastle:** Electricals Ltd., Tel. 28617.
London: Mullard Equipment Division, Tel. CHA 8421.

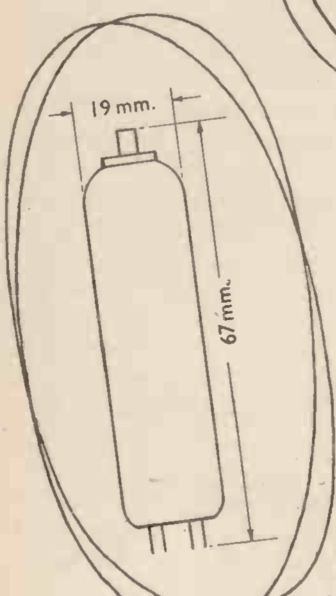
Mullard SPECIALISED ELECTRONIC EQUIPMENT

MULLARD LIMITED, EQUIPMENT DIVISION, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

ME589

SC1

G.E.C. CORONA STABILISER



A hydrogen filled gas discharge tube capable of providing a stable voltage source for such devices as Geiger-Müller Counter Tubes.

These devices are available for providing stable H.T. supplies of 400, 600, 800, 1000, 1200 and 1400 volts. For higher voltages any combination of tubes may be operated in series.

TYPICAL RATING

	SCI/600	SCI/1000	
Stabilised output	600	1000	V
I tube (max.)	300	300	μA
I tube (min.)	20	20	μA
Tube resistance	50	50	kΩ
Stability	1	1	%

For further information, write to the Valve & Electronics Dept.

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

Garrard

AUDIO PERFECTION

301 TRANSCRIPTION MOTOR

THE GARRARD MODEL 301 TRANSCRIPTION MOTOR

The Garrard Model 301 Transcription Motor is recognised as supreme in its class. With its introduction a hitherto unattainable standard in the manufacture of High Fidelity Gramophone Components has been reached. Features that the enthusiast will appreciate are the suppression of switch clicks, the extra heavy balanced turntable and the very fine degrees of speed control available . . . multi-speed can be adjusted by approximately 2½%.

Wow and Flutter have been reduced to the minimum, being less than 0.2% and less than 0.05% respectively. The unit is equipped for dual voltage ranges of 100 to 130 and 200 to 250 volts, 50 or 60 cycles according to the motor pulley fitted.

The Model 301 is finished in high quality grey tone enamel, is fully tropicalised and is supplied complete with a plastic stroboscope, a tube of special grease, all fixing screws, washers, template and instruction manual. . . . . see your Dealer now.

GARRARD SWINDON

THE GARRARD ENGINEERING AND MANUFACTURING CO., LTD.

Swindon, Wilts, England

50%

EXTRA PLAYING TIME

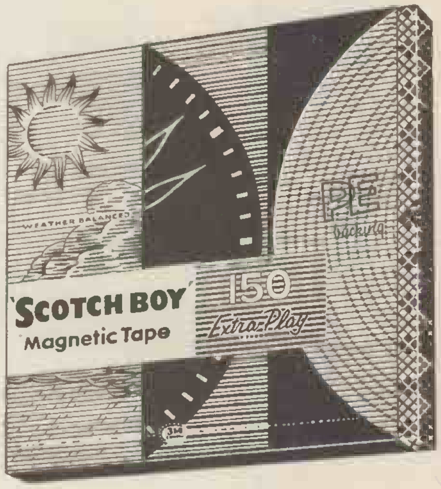
with this new tape!

For greater convenience and vastly improved performance, get 'SCOTCH BOY' *Extra Play* magnetic recording tape, No. 150. The new polyester base film is one-third thinner—*and still it is stronger!*—than other bases. That is why a reel carries half as much tape again, and gives you 50% EXTRA PLAYING TIME . . . 1800 feet of tape instead of the usual 1200 on a 7″ reel!

The specially developed oxide coating of 'SCOTCH BOY' 150 tape is also thinner than usual. This new, potent coating gives exceptionally crisp and clear reproduction. Response to the higher frequencies is particularly improved.

'SCOTCH BOY' *Extra Play* 150 tape is limp, flexible, strong, and easy to handle. It hugs the contours of recording heads, winds trimly, and tracks smoothly. It has an indefinite life in storage and is the ideal tape if you are an archivist.

'SCOTCH BOY' 111, *acetate-base tape, world-famous for faithfulness and clarity, is still available, of course, in lengths up to 1200 feet.*



GO FOR THE TAPE THAT GIVES YOU BETTER PERFORMANCE AND 50% *EXTRA PLAYING TIME*

SCOTCH BOY extra play

REGD. TRADE MARK

MAGNETIC RECORDING TAPE 150

with polyester base

PRODUCT OF 3M COMPANY RESEARCH

MINNESOTA MINING & MANUFACTURING COMPANY LIMITED

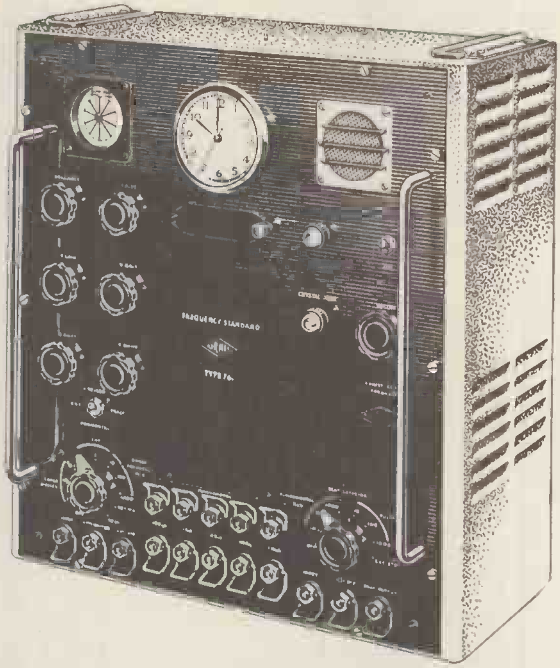
LONDON · BIRMINGHAM · MANCHESTER · GLASGOW

AIRMEC

FREQUENCY STANDARD

Type 761

- Standard signals provided at 100 c/s, 1 kc/s, 10 kc/s, 100 kc/s and 1 Mc/s.
- Outputs available with both pulse and sinusoidal waveform simultaneously.
- Complete built-in Oscilloscope provided.
- Heterodyne Amplifier and Loudspeaker incorporated.
- A built-in clock enables the equipment to be used as a time standard.
- Immediate delivery.



THIS instrument has been designed to fill the need for a versatile, self-contained, crystal-controlled frequency standard of moderate cost. Although relatively small in size a short-term frequency stability of better than 1 part in 10^6 is obtainable upon installation. This short-term stability improves with time and correct treatment up to a limit approaching 1 part in 10^7.

Sine wave and pulse signals are produced at five standard frequencies, the pulse waveforms being rich in harmonics, and since the instrument includes both an Oscilloscope and Heterodyning Circuit as indpendent facilities, it is extremely flexible in operation.

Full details of this or any other Airmec Instrument will be forwarded gladly on request

AIRMEC LIMITED

HIGH WYCOMBE, BUCKINGHAMSHIRE, ENGLAND

Telephone: High Wycombe 2060. Cables: Airmec, High Wycombe

COMPLETE COMMUNICATION SYSTEMS — *all the world over*

Over 80 countries now have Marconi-equipped communication systems. Many of these are still giving trouble-free service after more than 20 years in operation.

The lifeline of communication is in experienced hands

MARCONI

Complete Communication Systems

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX.

LC 17

HIGH FIDELITY plus HIGH VERSATILITY

Behind the new RCA High Fidelity Amplifier stands over a quarter of a century's skill and experience in designing professional sound reproducing equipment. This Amplifier includes several exclusive features entirely new to audio engineering, thus making it many years ahead of its time both in design and construction.*

The resulting performance will be found to give a new meaning to high fidelity reception and a new realism to recorded music.

The RCA High Fidelity Amplifier can be incorporated successfully into any existing home audio system. The versatility of its input and output facilities coupled with the wide measure of control afforded by the Pre-Amplifier means that it can be used in conjunction with most high quality audio equipment.

Pre-amplifier and Main Amplifier £48 . 0 . 0

New Orthophonic High Fidelity

RCA GREAT BRITAIN LIMITED

An Associate Company of Radio Corporation of America

Lincoln Way, Windmill Rd., Sunbury-on-Thames, Middx.

Telephone: Sunbury-on-Thames 3101.

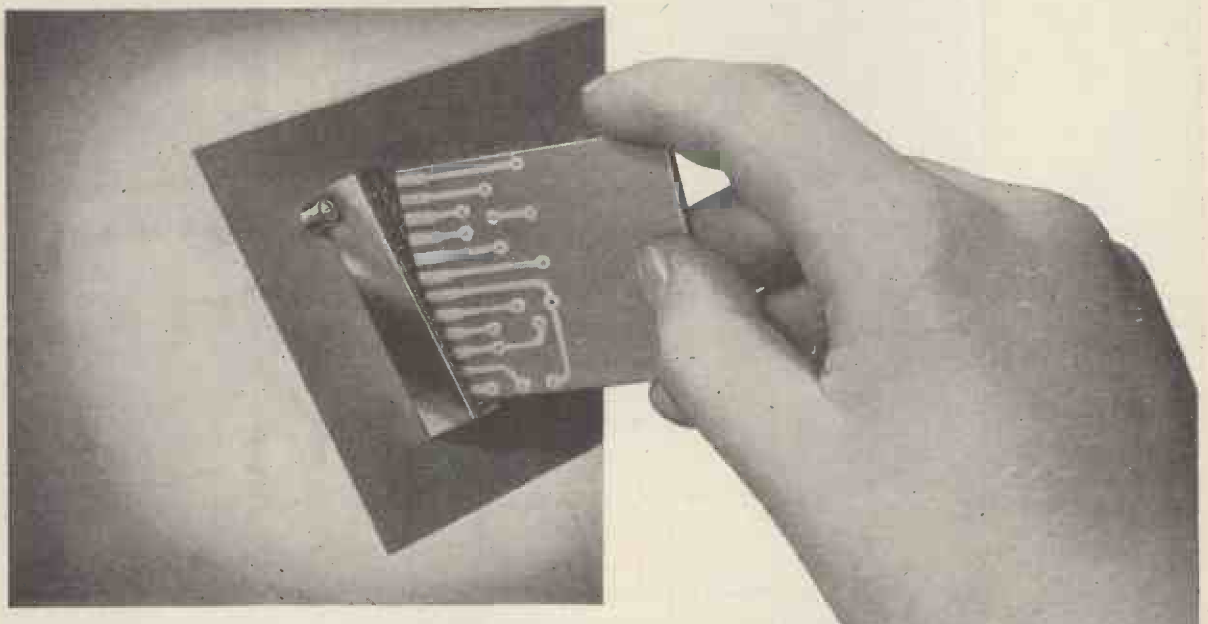
PRE-AMPLIFIER

INPUTS—*Magnetic Pickup*
B.78. 16 mv input for rated output. 300 c/s Turnover. 6 DB Roll-off at 10 Kc/s.
A.78. 14 mv input for rated output. 500 c/s Turnover. 16 DB Roll-off at 10 Kc/s.
L.P. 13.5 mv input for rated output. 500 c/s Turnover. 12 DB Roll-off at 10 Kc/s. Flattened LF at 50 c/s to + 13 DB.
R.I.A.A. 11.5 mv input for rated output. 500 c/s Turnover. 14 DB Roll-off at 10 Kc/s. 3 DB Flattening at 50 c/s.★
Crystal Pickup. .35 volt with inbuilt equalisation from constant amplitude to constant velocity output enabling switched replaying characteristics to be accurately employed.
Radio/Tape High Level 200 mv. Flat characteristic. Low level 50 mv. Flat characteristic.
Microphone 6.5 mv for rated output. Flat characteristic.
Mixer Facilities for microphone input, with radio/tape gramo inputs.★
OUTPUT. 1.2 volts from cathode follower stage.
TAPE RECORDING OUTPUT. 1.2 volts cathode follower independent of monitoring.
BASS & TREBLE. Plus and minus 14 DB at 50 c/s and 10,000 c/s.
VOLUME. Twin ganged control giving correct gradation.★
LOW-PASS FILTER. Switched 10 Kc/s, 7 Kc/s, 5 Kc/s and Flat.
HIGH-PASS FILTER. Inbuilt, attenuating below 20 c/s.
FILTER SLOPE. Variable to 35 DB per octave.
POWER REQUIREMENTS. 375 v/7 ma, 6.3 v/1 amp.

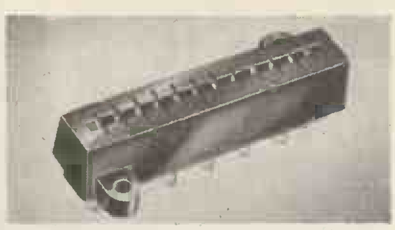
MAIN AMPLIFIER

OUTPUT. 12 watts rated. Peak in excess of 20 watts over 25-20,000 c/s.★
DISTORTION. Total harmonic less than .1% at 10 watts—700 cycles.
NOISE LEVEL. 85 DB below rated output.
DAMPING FACTOR. Variable from positive to negative values.
FREQUENCY RESPONSE. Within 0.2 DB 20—25,000 c/s ± 0.5 DB 10—60,000 c/s.
FEEDBACK. 40 DB total.★
OUTPUT IMPEDANCES. 4 ohms, 7 ohms, 15 ohms.
INPUT VOLTAGE. 1.2 v. for rated output.
ANCILLARY POWER SUPPLIES. 375 Volts 45 milliamps. 6.3 volts 2.5 amps available for VHF Tuner, Pre-amplifier and Tape Reproducer amplifier.
POWER CONSUMPTION. 130 VA at full load.
AC Input 100/150 and 200/250 volts.

PRINTED CIRCUIT CONNECTORS



Printed Circuit Connectors in high grade black moulded bakelite.
Six, twelve or eighteen way.
Specially designed not to damage printed circuit foil.
Silver plated Phosphor Bronze Contacts.
Current carrying capacity : 5A.
Polarising keys available, if required.
Insertion pressure : 175—200 grammes per contact.
Contact centres : 5/32″.
6 BA. fixing.



A.I.D & A.R.B — APPROVED

POWER CONTROLS
LIMITED

EXNING ROAD · NEWMARKET · SUFFOLK
TELEPHONE : NEWMARKET 3181·2·3 TELEGRAMS : POWERCON · NEWMARKET

Announcing

The first of the Elac

"ELMAG"

Series of High Fidelity Units

9 x 5 Elliptical Speaker Type 59T.

This unit is designed to give good quality at domestic volumes, it can be operated successfully in conjunction with a normally good receiver.

Where a Power Output Stage providing more than 4 watts is used, 2 or more speakers are recommended.

Flux Density, 8000 gauss (27,500 Maxwells) Frequency Response 40-12,000 Cps.

RETAIL PRICE.................38/2 inc. Tax
With Transformer ....49/4 inc. Tax

ELAC

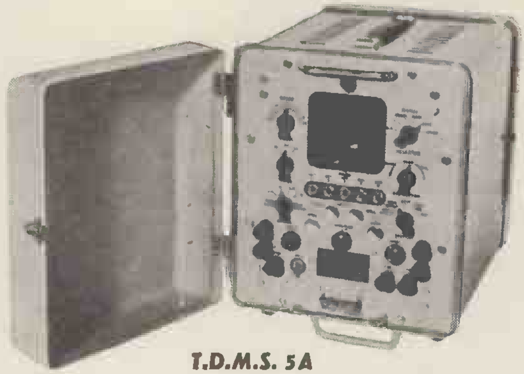
ELECTRO ACOUSTIC INDUSTRIES LTD

STAMFORD WORKS. BROAD LANE. TOTTENHAM, N.15 TEL: TOTtenham 0505-9

Distortion detected - Transmission unaffected

with the T. D. M. S.

The T.D.M.S. 5A and 6A are portable sets designed to measure distortion at any point in a radio teleprinter or line telegraph circuit without interfering with normal transmission. The equipment consists of two units each 18½" x 11½" x 13½" both mains driven and electronically controlled. Either may be used independently for certain tests or both may be used in combination to cover a comprehensive range of testing operations.



T.D.M.S. 5A

Sends an automatic test message, or characters, or reversals at any speed between 20-80 bands with or without distortion. The CRO has a circular time base for distortion measurements on synchronous signals only, or relay adjustment. Weight 37 lb.

For distortion measurements on working circuits without interrupting service. Each element of a start-stop signal appears separately on the spiral time base display. Adjustable speeds from 20-80 bands. Weight 33 lb. Higher speed versions can be supplied to order.

T.D.M.S. 6A

You are invited to apply for a copy of a descriptive leaflet.

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.,

RADIO AND TRANSMISSION DIVISION,
STROWGER HOUSE, ARUNDEL STREET, LONDON, W.C.2.
TELEPHONE : TEMPLE BAR 9262. CABLEGRAMS : STROWGEREX LONDON.

ATM REG'D TRADE MARK

AT14611-BX107

ADVANCE COMPONENTS LTD., ROEBUCK ROAD, HAINAULT, ESSEX. Telephone: HAInault 4444

7·5 to 250 Mc/s
ON FUNDAMENTALS
IN FIVE RANGES
SINE AND SQUARE WAVE MODULATION
R.F. OUTPUT
1 μV to 100 mV

Advance

MODEL Q1

V.H.F. SIGNAL GENERATOR

£45
(List price in U.K.)

This " Advance" V.H.F. Signal Generator covers 7.5 to 250 Mc/s, a range that embraces Bands 1 and 2 *and also the impending Very High Frequency Television Transmissions on Band* 3. Moreover, this instrument is available at a price well within the reach of every service man. In the traditional " Advance " manner, this instrument is designed for simple operation and with a versatility that not only fulfils present needs, but anticipates the even more exacting requirements to deal with the television test problems of tomorrow.

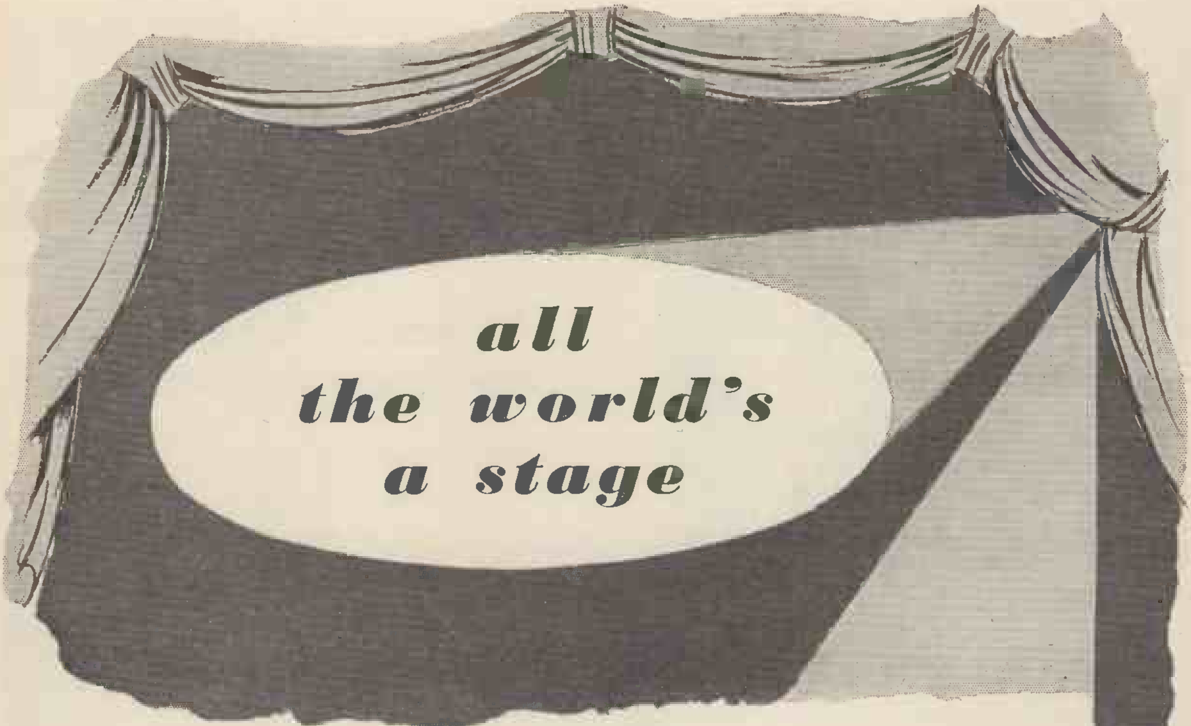
Below are some outstanding features :-

- WIDE RANGE—7.5 to 250 Mc/s
- SINE AND SQUARE WAVE MODULATION
- RELIABLE ATTENUATION
- LOW LEAKAGE—*less than 3 microvolts*
- TRULY PORTABLE—*weighs only 17lb.*
- COMPETITIVE PRICE

The Q1 provides the ideal complement to the Model E2. These together give complete coverage from 100 kc/s to 250 Mc/s.

Full technical details available in Folder W23 on request.

ADVANCE COMPONENTS LTD., ROEBUCK ROAD, HAINAULT, ESSEX. Telephone: HAInault 4444
GD



—and all (well, many of) the men and women Classic customers.

They have their fancies and their preferences, and each one in his time buys many parts. In his time—we never rush a customer, and if he knows what he wants, we never try to sell him something else. Our stocks are so wide, and the choice of high quality equipment so varied, that whatever he wants, it's more than likely that we have it in stock.

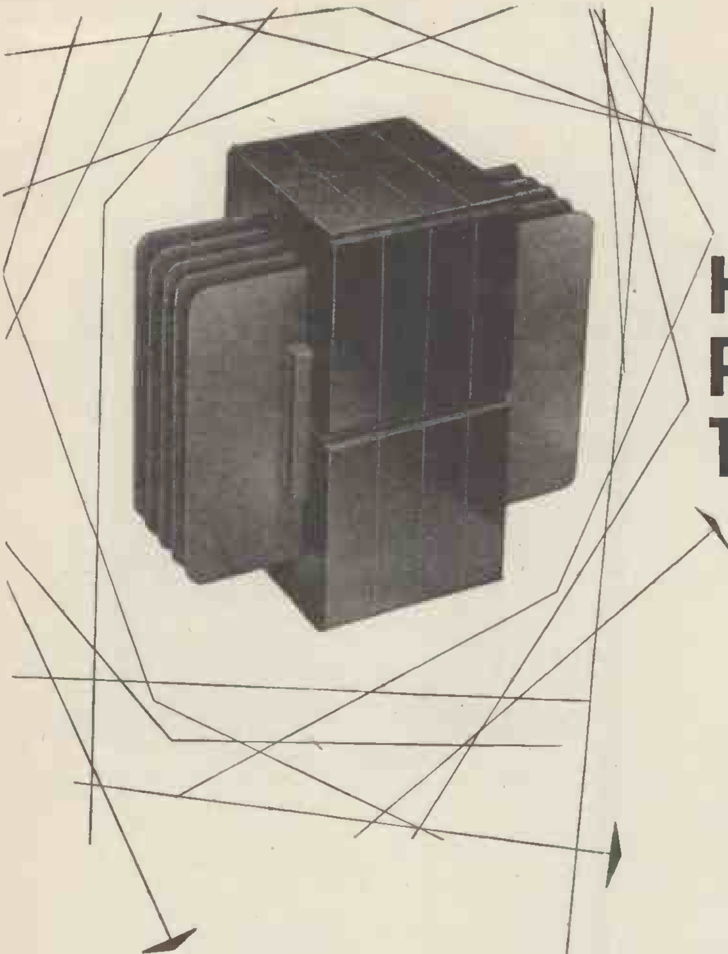
It is natural, though, that confronted with so wide a choice, customers often seek guidance, which we are well able to give. Our showrooms are equipped for note-for-note comparisons and we test everything so that we know exactly what equipment to choose for a particular result.

Wide and varied stocks of all the latest and best equipment—good advice when it is asked for and the promptest attention possible, particularly for export orders—these are some of the reasons why so many of the (record) players on the world's stage come to Classic. Send for our new 1956 catalogue, and you'll see what we mean.

CLASSIC ELECTRICAL COMPANY LIMITED

The Quality Specialists

352-364 LOWER ADDISCOMBE ROAD, CROYDON, SURREY Telephone: ADDiscombe 6061



H.F. POWER TRANSFORMERS

RATING . . . . UP TO 2 kW

FREQUENCY RANGE . . . . 2 Kc/s to 2 Mc/s

H.F. power transformers of outstanding efficiency are the latest additions to the Mullard range of high quality components designed around Ferroxcube magnetic cores.

Utilising the unique characteristics of Ferroxcube to the full, Mullard H.F. transformers are smaller, lighter, and less costly than transformers using alternative core materials. These advantages are particularly marked in transformers required to handle powers of up to 2kW, between the frequency range 2kc/s to 2Mc/s.

Mullard transformers are already finding wide use in applications as diverse as ultrasonic H.F. power generators and aircraft power packs operating from an aircraft's normal A.C. supply. In the latter application, the low leakage field of Ferroxcube can eliminate the need for external screening, thereby reducing the size and weight of the transformer even further.

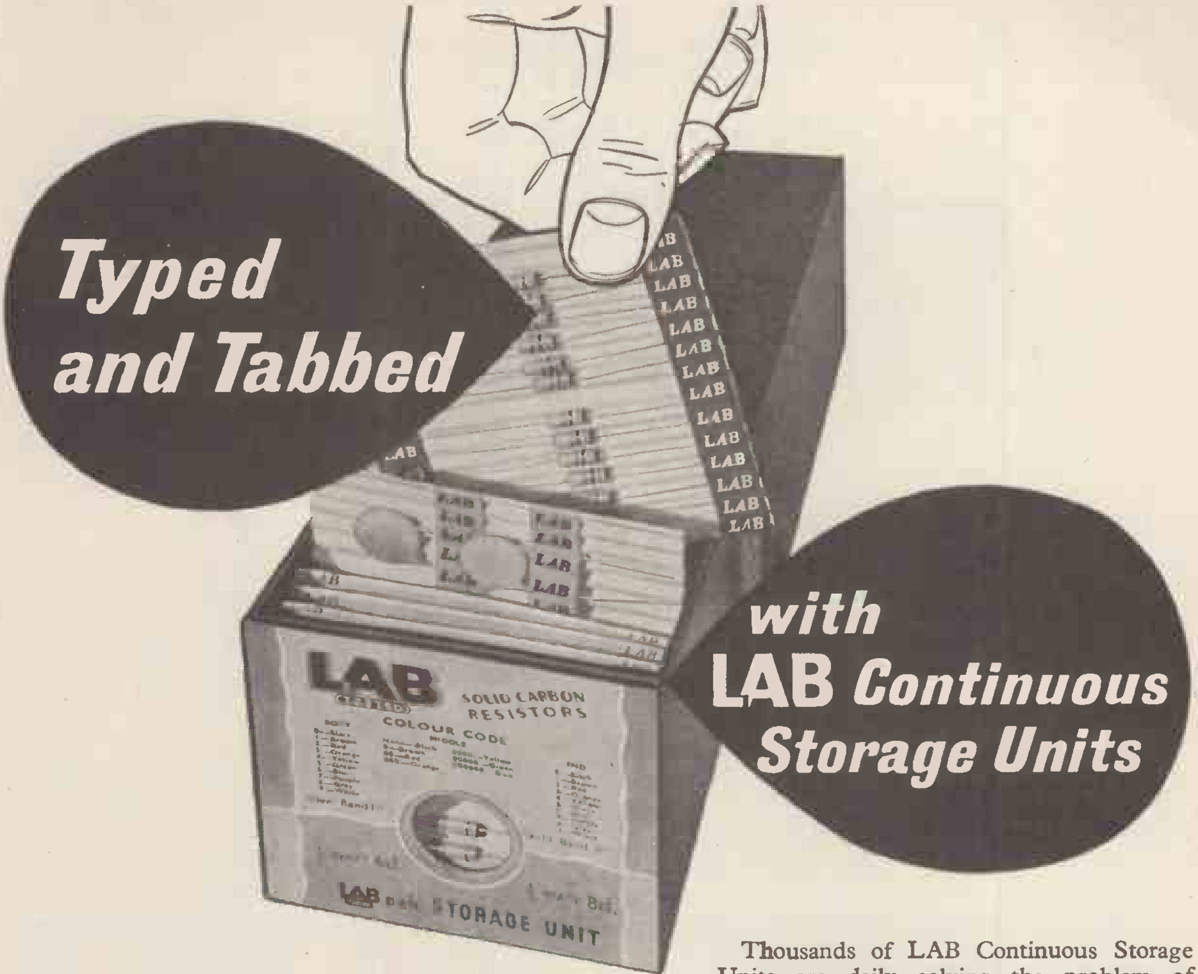
As with all Mullard high quality components, these H.F. power transformers are designed and built to engineers' individual specifications. Write now for details of the complete range of components available under this service.

Mullard

'Ticonal' permanent magnets
Magnadur ceramic magnets
Ferroxcube magnetic cores

MULLARD LTD • COMPONENTS DIVISION • CENTURY HOUSE • SHAFTESBURY AVENUE • WC2

MCIA



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%					

Thousands of LAB Continuous Storage Units are daily solving the problem of control and storage of the great range of resistors. Compact, and capable of storing up to 720 separate resistors, LABpak make selection positive, simple and speedy. Now that Ceramicaps, Histabs and Wirewound resistors have been added to the carded range the usefulness of LABpak storage units is enhanced.

FREE with any purchase of the LABpak range, these units are the complete answer to the storage problems of small production units, laboratories, etc.

MAKE UP YOUR ORDER TODAY — DELIVERY EX-STOCK

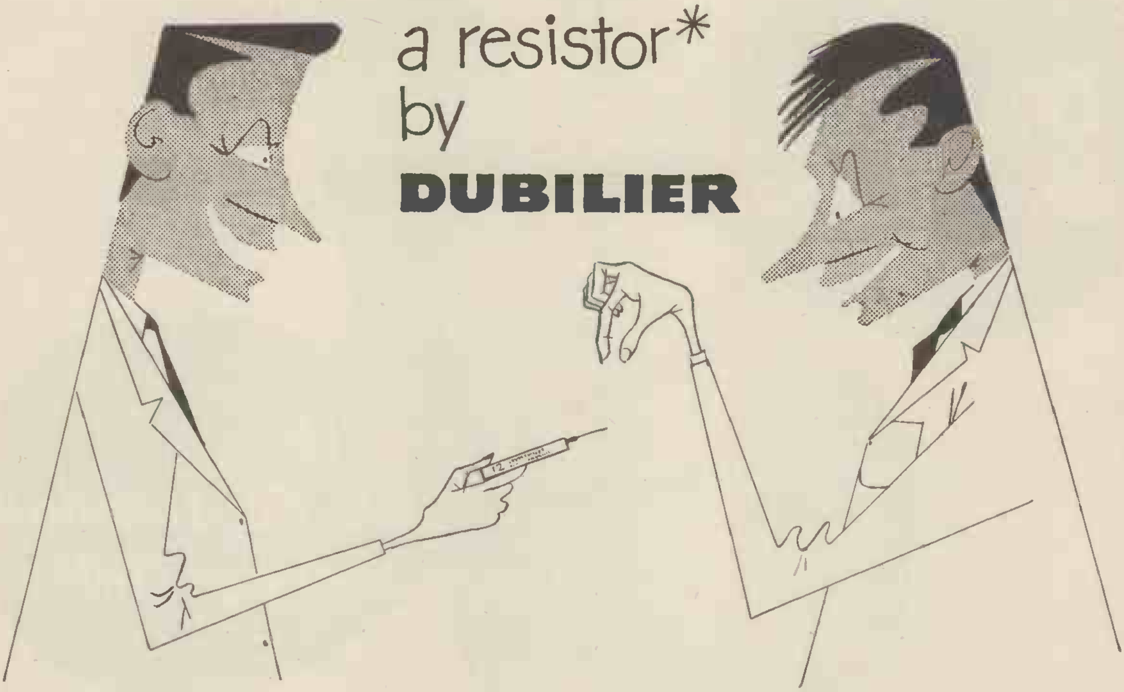
All LABpak resistors are carded in ohmic value, rating and tolerance, colour indexed and tabbed for easy selection.

The LAB Continuous Storage Units are available from your normal source of supply, but more detailed information and literature can be obtained from

THE RADIO RESISTOR COMPANY LIMITED

50 ABBEY GARDENS, LONDON, N.W.8 • *Telephone:* Maida Vale 5522

No engineer can resist a resistor* by DUBILIER



* An extremely wide range of Dubilier resistors is available both for development and production purposes. This range covers insulated wire-wound, power wire-wound, precision wire-wound, ultra high range, high stability, high voltage and high frequency resistors.

Type BT insulated resistors are completely protected by a phenolic resin housing which is sealed at the ends. Type BTS is rated at ½ watt and Type BTB at 1 watt at 70° C. Resistance range is 100Ω to 10MΩ (BTS) and 390Ω to 22MΩ (BTB).

Type BTS resistors are also available in attractive handy cartons of twelve. These cartons protect the resistors from dirt and permit easy storage and selection in the laboratory or workshop. Save time and trouble by ordering all your ½ watt resistors in the handy carton.

DUBILIER

DUBILIER CONDENSER CO. (1925) LTD., Ducon Works, Victoria Rd., North Acton, W.3. Telephone: ACOrn 2241. Telegrams: Hivoltcon Wesphone London

DN 159B

for the closest approach to the original sound

QUAD II

AMPLIFIER

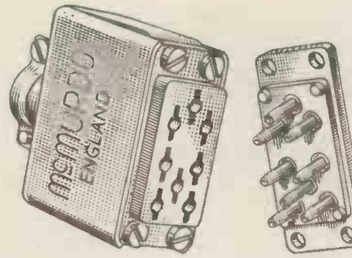
The criterion, as always, is that the reproduced sound shall be the closest approach to the original — that the enjoyment and appreciation of music may be unimpeded. This is reflected throughout the design of the QUAD II. It is reflected, too, in the straightforward and logical system of control, achieved without the sacrifice of a single refinement or adjustment capable of contributing to the final objective.

Send for further details and booklet:

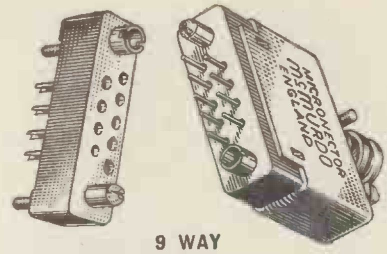
ACOUSTICAL MANUFACTURING CO LTD
HUNTINGDON · HUNTS · TEL: 361

VACANCIES FOR ENGINEERS

If you have a genuine interest in Audio Engineering and a sound technical background, we will be pleased to discuss the possibility of your joining our Company.



8 WAY



9 WAY

★ STANDARD CONNECTORS

in 8, 12, 18 and 25 way
Low priced Unitor
Natural colour Nylon-PF moulding
Silver plated contacts
Breakdown voltage 3.5 KV

★ MICRONECTOR

in 9, 18, 26 and 34 way
Precision miniature connector
Brown Nylon-PF moulding
Gold plated contacts
Breakdown voltage 2.4 KV

McMURDO *connectors*

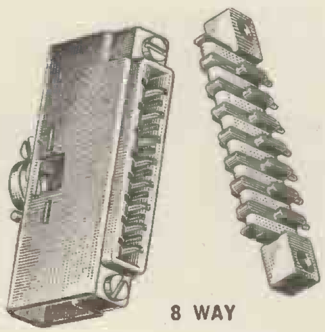
Covers can be supplied for either plugs or sockets or both in all these types.

★ STRIP CONNECTORS

in 2, 4, 6, 8 and 10 way
Inexpensive flat connector
for Printed Circuits
Woodflour-filled PF moulding
Cadmium plated contacts
Breakdown voltage 3.5 KV

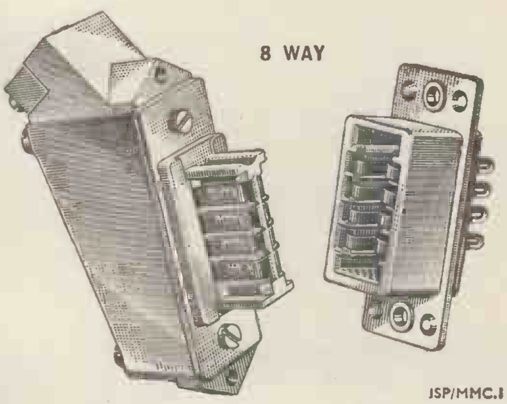
★ RED-RANGE CONNECTORS

in 8, 16, 24 and 32 way
Medium priced
Low insertion force — self-aligning
Red Nylon-PF moulding
Gold plated contacts
Breakdown voltage 3.0 KV



8 WAY

8 WAY



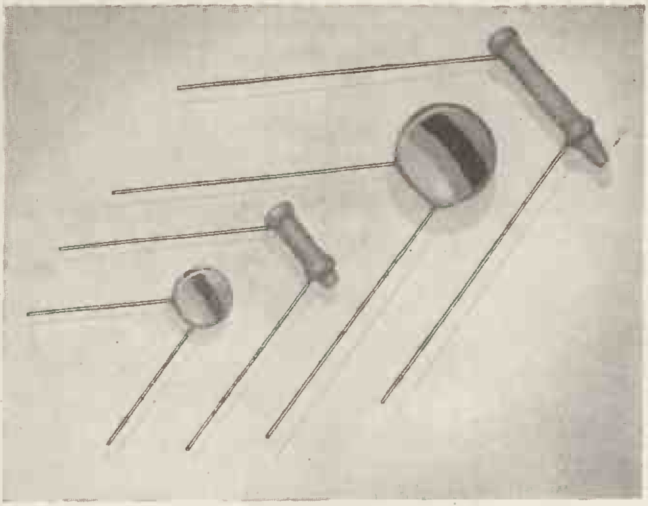
ISP/MMC.1

Full details on request

THE McMURDO INSTRUMENT CO. LTD. ASHTEAD, SURREY. *Telephone ASHTEAD 3401*

New!

Tubular and Disc Ceramics



Hunts announce their new ranges of Tubular and Disc Ceramics. Precise in their characteristics and robust in design, these capacitors are available in High-K, High-Q and Special Purpose Tubulars and in High-K Discs.

Full technical specifications on request.

HIGH-Q TUBULAR
STANDARD CAPACITANCE RANGES

Capacitance Range Picofarads	Length of Insulated Tube Millimetres
*Type P100. Temperature Coefficient $(+100 \pm 100) \times 10^{-6}$ pF/pF/°C	
1.5 to 7	11
7.1 to 11	13
11.1 to 16	16
16.1 to 26	21
26.1 to 33	26
33.1 to 40	31
40.1 to 50	36
50.1 to 60	41
*Type N33. Temperature Coefficient $(-33 \pm 60) \times 10^{-6}$ pF/pF/°C	
5.0 to 27	11
27.1 to 45	13
45.1 to 69	16
69.1 to 100	21
100.1 to 140	26
140.1 to 180	31
180.1 to 220	36
220.1 to 250	41
*Type N750. Temperature Coefficient $(-750 \pm 250) \times 10^{-6}$ pF/pF/°C	
10.0 to 80	11
80.1 to 110	13
110.1 to 180	16
180.1 to 240	21
240.1 to 350	26
350.1 to 450	31
450.1 to 550	36
550.1 to 650	41

*Capacitors with closer limits of Temperature Coefficient can be supplied by special arrangement.

HIGH-K TUBULAR
STANDARD CAPACITANCE RANGE

Capacitance Picofarads	Length of Insulated Tube Millimetres TB1000	Length of Insulated Tube Millimetres TB3000
470	11	—
680	11	—
800	11	11
1000	13	11
1500	16	11
2000	19	11
2200	19	11
3000	—	16
3300	—	16
4000	—	19
4700	—	19
5000	—	21

POWER CERAMICS

Ranges of Power Ceramics and Temperature Compensating types are also available.
Details on application.

HIGH-K DISC
STANDARD CAPACITANCE RANGE

Capacitance Picofarads	Type Number	Diameter (over insulation) Millimetres
470	CD8K/2	9
680	CD8K/2	9
1000	CD9K/2	10.5
1500	CD9K/2	10.5
2200	CD11K/2	12
3300	CD12K/2	13
4700	CD14K/2	14.5

MATERIAL EMPLOYED

The temperature coefficient graph of the material is such that the capacitance increases with temperature from 20°C until it reaches a peak at approximately 50°C. With a further increase of temperature the capacitance falls, reaching its 20°C value again at approximately 80°C.
Maintenance of capacitance is thus ensured from 20°C to 80°C.

REGISTERED TRADE HUNTS MARK CAPACITORS

A. H. HUNT (Capacitors) LTD.

WANDSWORTH, LONDON, S.W.18. BAT 1083-7

And in Canada HUNT CAPACITORS (Canada) LTD. AJAX. ONTARIO

Radiopage

an entirely new concept of staff location

Radiopage

locates key men instantly . . unerringly

Radiopage

calls are selective . . . private . . . exclusive

Radiopage

receives the spoken word clearly . . . infallibly

Radiopage

a complete solution to contact "elusive" personnel

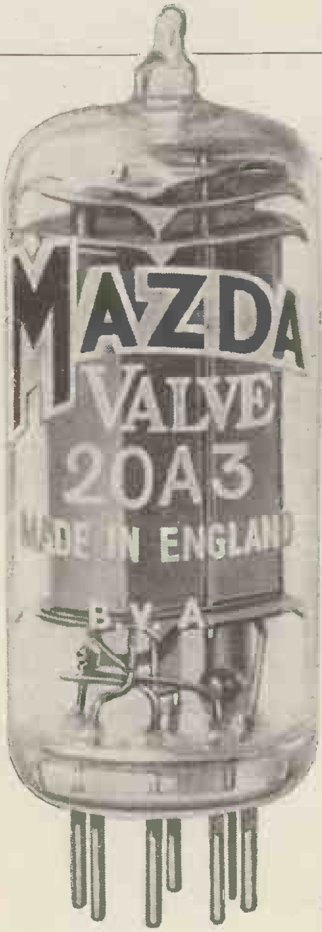
BCC

BRITISH COMMUNICATIONS CORPORATION LIMITED

Second Way, Exhibition Grounds, Wembley, England

Telephone: WEMbley 1212 Telegrams: BEECEECEE, WEMBLEY

20A3 MINIATURE TETRODE THYRATRON



The 20A3 is a miniature indirectly heated tetrode thyratron which can be used as a high speed relay. It has a high control ratio, low grid/anode capacitance and passes a very low grid current. Used in conjuction with a high resistance circuit, the 20A3 can be operated directly from a high-vacuum photo-cell.

RATING

Heater Voltage	6.3 volts
Heater Current	0.6 amps.
Arc Voltage Drop	8 volts
Max. Forward Anode Voltage	650 volts
Maximum Peak Invoice Anode Voltage	1300 volts
Max. Shield Grid Voltage	—100 volts
Max. Control Grid Voltage	—100 volts
Max. Peak Cathode Current	500mA
Max. Average Cathode Current	100 mA
Control Grid Circuit Resistance	0.01-10.0 MΩ
Control Ratio G1	250*
„ „ G2	1000†

BASE B7G MINIATURE

This valve is equivalent to the 2D21

LIST PRICE 15/-

NOTE.—All maximum ratings are absolute values, not design centres. Heater to cathode voltage must never exceed 25 volts peak. The heater must be switched on for a minimum of 10 seconds before the anode voltage is applied.
** Vg2=0; Rg1=0*
† Vg1=0; Rg1=0; Rg2=0

EDISWAN

M A Z D A

RADIO VALVES AND CATHODE RAY TUBES

THE EDISON SWAN ELECTRIC COMPANY LIMITED

155 Charing Cross Road, London, W.C.2

Telephone: Gerrard 8660 *Member of the A.E.I. Group of Companies* *Telegrams:* Ediswan, Westcent, London

HIGH GRADE INSTRUMENTS

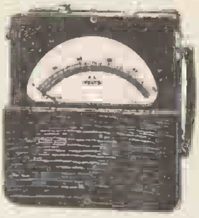
Left: B.P.L. Trans. Ranger. A portable Test Set with D.C. Transistor Amplifier—1 megohm/volt.

Right: Pulse Height Valve Voltmeter. 0-100 volts in 3 ranges. Model PV 812.

2½in. scale moving coil D.C. meter, square flush mounting. Type S.25.

3½in. scale moving coil. Centre zero meter. Round flush mounting. Type S.35.

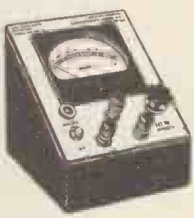
"Fulscale" meter 4in. dia. scale moving coil having 270° arc with a 9in. scale length.



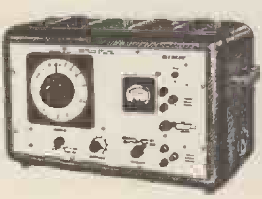
High torque moving coil portable meter. Precision grade to BS.89.

Multi-purpose test set for simultaneous measurement of current and voltage.

Universal multi-range test set for electrical and radio engineers.



Ohmmeter for the rapid and direct measurement of very low values of resistance. Model RM.155.



Left:
Audio and Supersonic Frequency Signal Generator covering a wide range of both frequency and voltage. Model LO.63G.

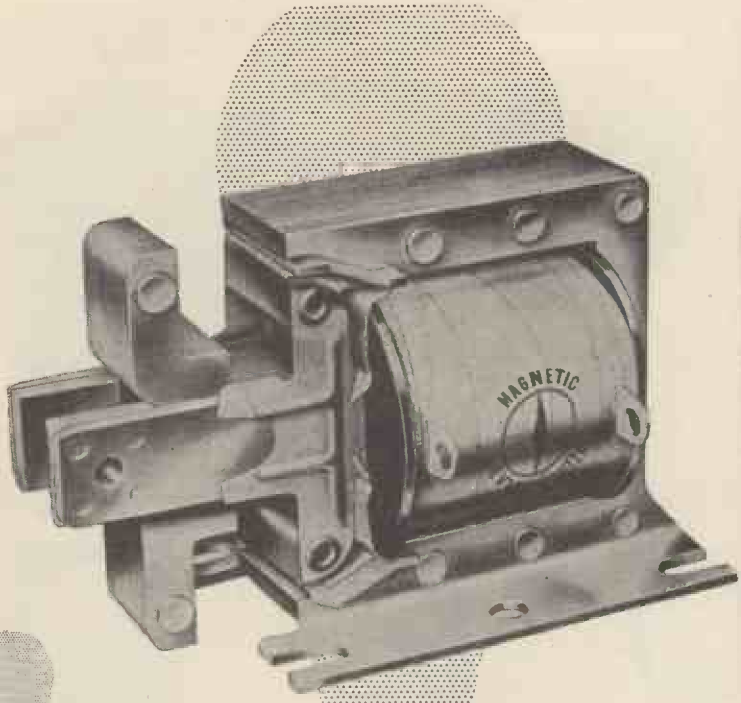
Right:
Electronic Frequency Meter providing direct measurement of frequency whilst being substantially independent of applied voltage and wave form. Model FM.406A.

BRITISH PHYSICAL LABORATORIES

Radlett, HERTS *Tel: RADLETT 5674-5-6*

London Stockist: M. R. SUPPLIES, 68, NEW OXFORD STREET, W.C.1

dmBP48



Solenoids!

For several years we have been studying user requirement of Solenoids and are now tooling on a CAREFULLY DESIGNED RANGE.
First types are available and we can supply a wide range of samples.
Your immediate enquiries will assist us to meet your precise needs.
If your requirements are unusual, we are interested in discussing tool costs.

Magnetic Devices LTD.

A.I.D. and A.R.B. approved.

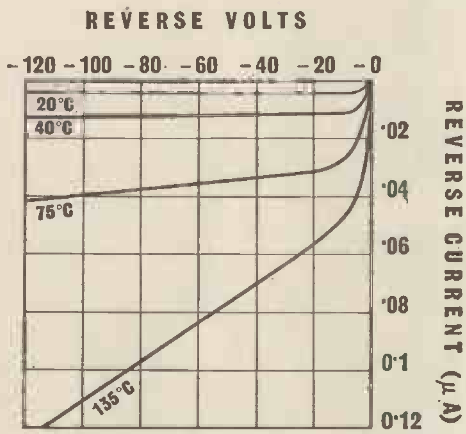
Magnetic Devices Ltd., Exning Road, Newmarket, Suffolk.
Telephone: Newmarket 3181-2-3. Telegrams: Magnetic Newmarket.

MD 13B

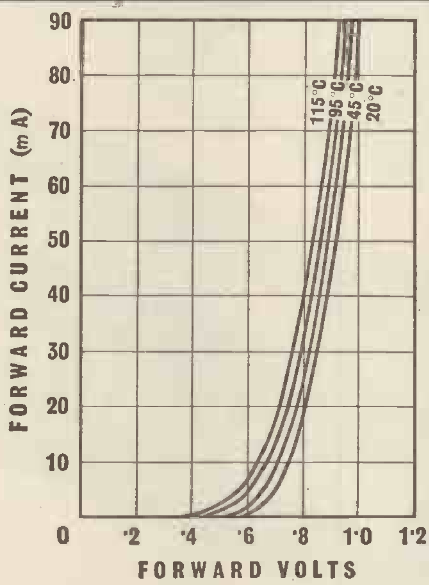
Now in production!

FERRANTI SILICON JUNCTION DIODES

TYPE No.:—		ZS10A.	ZS10B.	ZS20A.	ZS20B.
Max. P.I.V.		60	60	120	120 volts
Max. Voltage for 100mA. Forward Current		1·5	1·5	1·5	1·5 volts
Max. Reverse Current					
for — 50 volts at	25°C	0·05	0·5	—	— μA
	100°C	1·0	5·0	—	— μA
for — 120 volts at	25°C	—	—	0·05	0·5 μA
	100°C	—	—	1·0	5·0 μA
Max. Mean Dissipation at 20° C		150	150	150	150 mW
Max. Operating Temp.		150	150	150	150°C

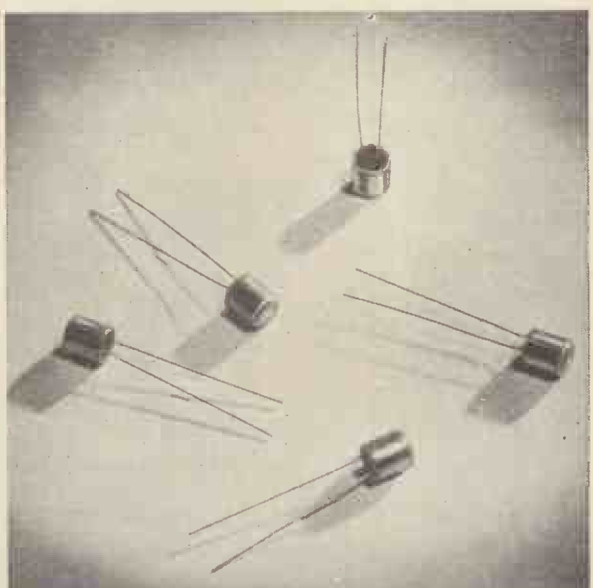


TYPICAL REVERSE CHARACTERISTICS



TYPICAL FORWARD CHARACTERISTICS

- LOW REVERSE CURRENT
- HIGH FORWARD SLOPE
- HIGH TEMPERATURE OPERATION
- SMALL PHYSICAL DIMENSIONS
- HIGH MECHANICAL STRENGTH

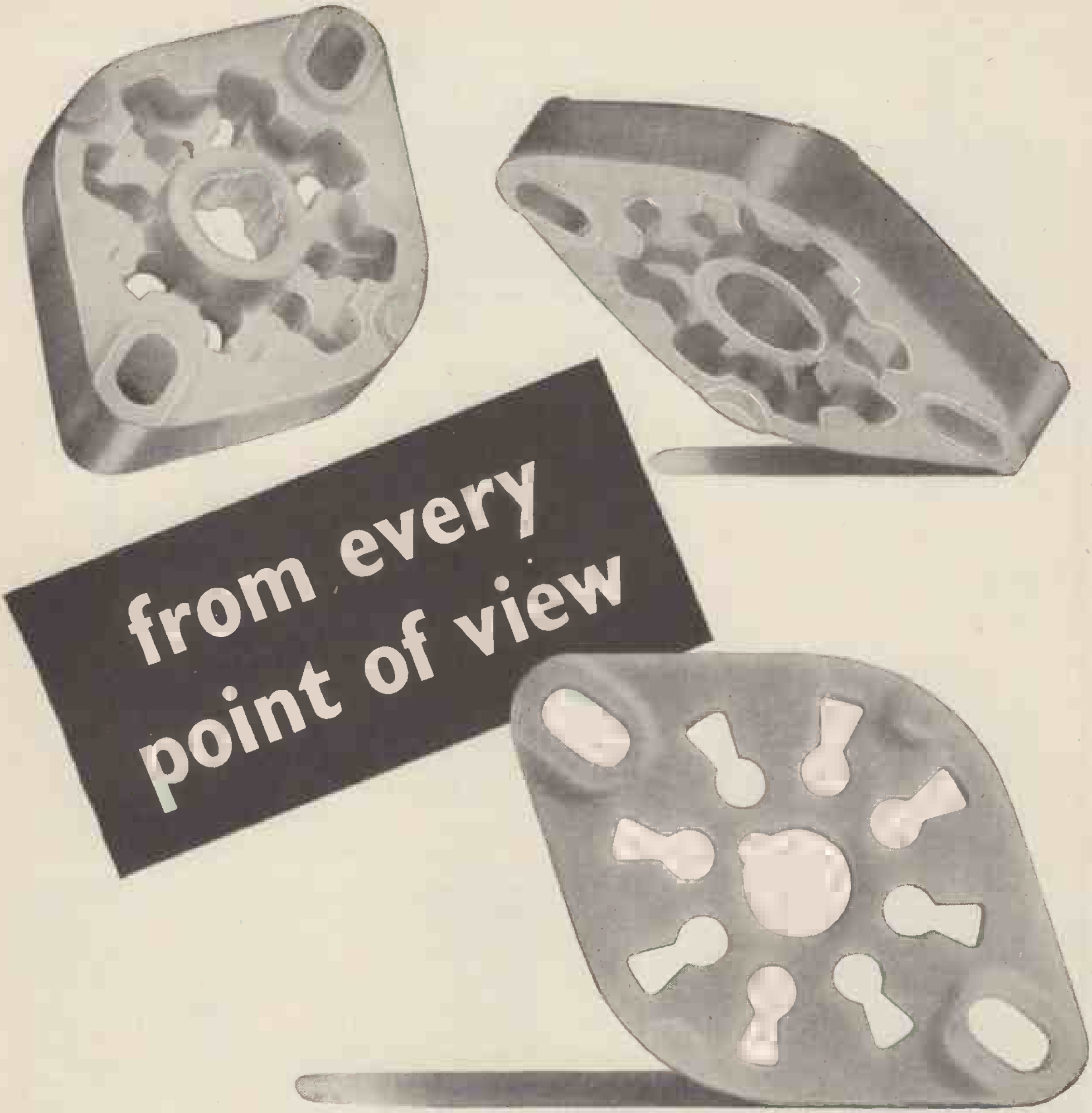


Overall length (including leads) 35 mm.

FERRANTI LTD · GEM MILL · CHADDERTON · OLDHAM · LANCS

London Office: KERN HOUSE, 36 KINGSWAY, W.C.2

FE165



'Frequentite' is the most suitable insulating material for all high frequency applications. Seventeen years ago we introduced the first British-made low-loss ceramic, and consultation with us before finalising the design of new components is a wise precaution.

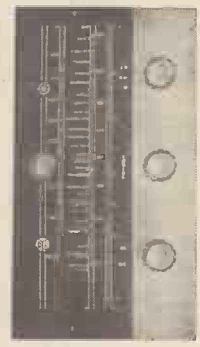
STEATITE & PORCELAIN PRODUCTS LTD.

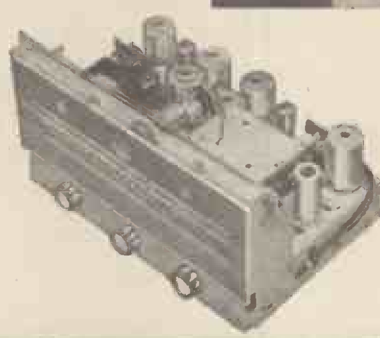
Head Office: Stourport-on-Severn, Worcestershire. Telephone: Stourport 111. Telegrams: Steatain, Stourport

S.P.76

"The ultimate fidelity of a sound reproducing system can be no higher than that of any one of its individual units."

Right The vertical scale model and, *below* the HFT111 in chassis form.





The Pye FM/AM Tuner (Model HFT111) has been critically designed to give true high fidelity reproduction when used with equipment of comparable quality. Features: built-in power pack; 8-valve chassis for good fringe area reception; stabilised permeability tuning; noise limiter and phase discriminator. Attenuators provided for both FM and AM outputs. In chassis form, with either horizontal or vertical scales, or housed in an elegant sycamore and walnut veneered cabinet (with built-in FM aerial)

HIGH FIDELITY SYSTEMS

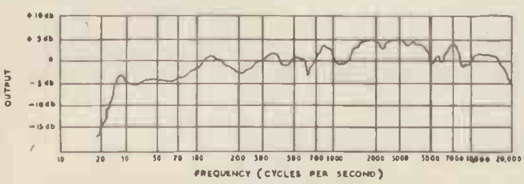
The New Sound in Home Entertainment

Pye Limited, Auckland, New Zealand;
Pye Canada Limited, Toronto, Canada;
Pye (Ireland) Limited, Dublin, Eire;
Pye Pty. Limited, Melbourne, Australia;
Pye Corporation of America, 270 Park Avenue, New York;
Pye Limited, Tucuman 829, Buenos Aires;
Pye Limited, Mexico City;
Pye Radio & Television (Pty.), Limited, Johannesburg, South Africa;
Pye Limited, Stuttgart, West Germany.

PYE LIMITED · CAMBRIDGE · ENGLAND

HARTLEY-TURNER "315" LOUDSPEAKER

Power Handling Capacity	15 Watts Peak A.C.
Flux Density	14,000 Gauss
Voice Coil Impedance	4 or 15 ohms. (Please state on order)
Fundamental Resonance	30 c/s
Frequency Coverage	25 c/s-15 Kc/s.
Chassis	Die Cast non-magnetic alloy
Overall diameter	12$\frac{1}{8}$in.
Overall Depth	6$\frac{1}{2}$in.
Nett weight	7 lbs. 9 ozs.
Packed weight	9 lbs. 9 ozs.



Retail Price 10 Guineas

(Carriage paid in Great Britain)

Hartley Equipment will be on show at the Siemens Ediswan Stand No. 19 at the Radio Show, Earls Court.

H. A. HARTLEY CO. LTD.

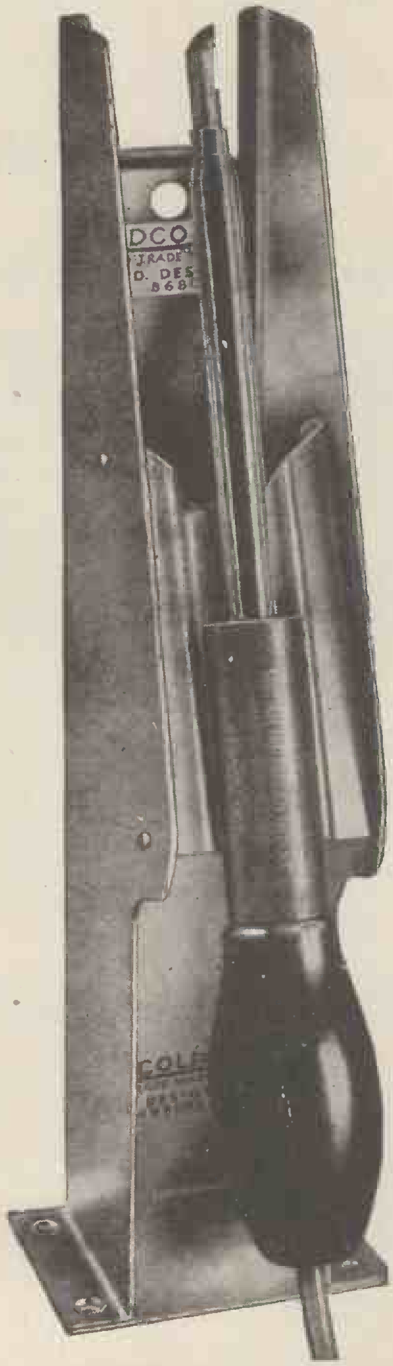
66, WOODHILL, WOOLWICH, LONDON, S.E.18.

Phone : Woolwich 2020. Ext. CB32

ADCOLA

(Regd. Trade Mark)

SOLDERING INSTRUMENTS & ALLIED EQUIPMENT



ILLUSTRATED

DETACHABLE $\frac{3}{16}$" BIT MODEL LIST No. 64

Protective Shield List No. 68

CATALOGUES HEAD OFFICE SALES & SERVICE

ADCOLA PRODUCTS LTD., GAUDEN ROAD, CLAPHAM HIGH ST., LONDON, S.W.4.

TELEPHONES: MACaulay 3101 & 4272

High quality, stable characteristics, robust construction, proven performance, are inherent features of the quartz crystal units developed and manufactured by S.T.C.

Crystals in hermetically sealed cans to meet the rigid Inter-Service specification; crystals in evacuated glass envelopes with wire ends or with valve base; G.T. Cut crystals for absolute frequency standards; high frequency Overtone crystals for V.H.F. applications . . . these are the principal types in the S.T.C. range.

There is almost certain to be an S.T.C. quartz crystal unit to meet your specification . . . if not, our engineers are ready to discuss your special requirements.

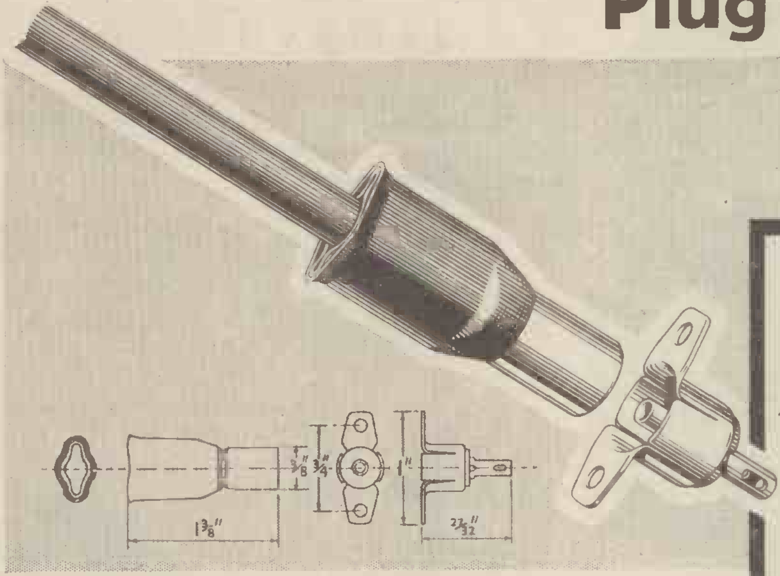
The quartz crystal units illustrated are in hermetically sealed cans equivalent to the Inter-Service Style "D" or the American HC6U. This unit has been widely adopted for use in modern equipments.

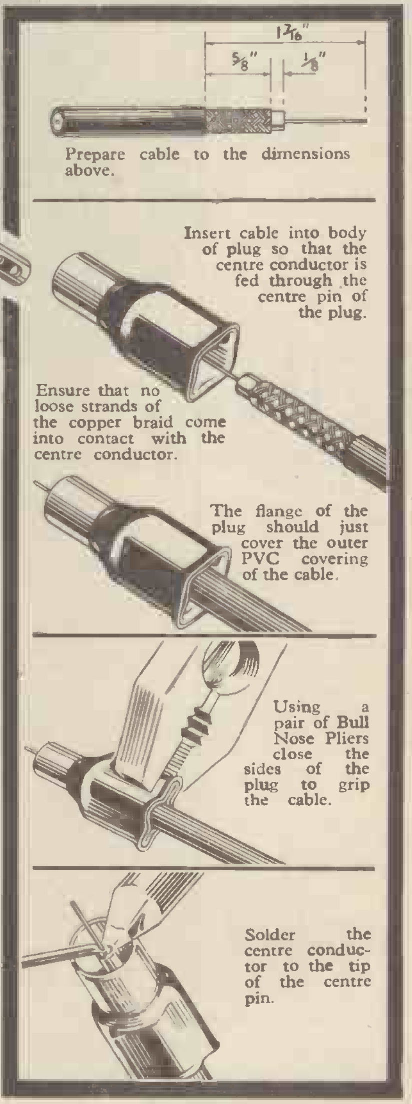
Standard Telephones and Cables Limited

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

TELEPHONE LINE DIVISION: NORTH WOOLWICH · LONDON · E.16

THE ANTIFERENCE STANDARD Plug & Socket FOR CO-AXIAL CABLES





The illustrations above show the extremely simple and speedy method of fitting the plug.

- **CONFORMS TO R.E.C.M.F. SPECIFICATION**
- **ROBUST CONSTRUCTION**
  The Plug is constructed as a " one-piece " unit with no small parts to dismantle.
- **SIMPLE TO FIT**
  After preparation of the co-axial cable the plug can be fitted in a few seconds.
- **EFFICIENT IN OPERATION**
  The plug pin is mounted in a permanently housed POLYSTYRENE interior which has low-loss V.H.F. properties, and is not affected by heat when soldering to the same extent as polythene and other similar materials.
- **TROUBLE FREE GRIP**
  Permanent contact is maintained by pressure on the copper braid over a large contact area which holds the cable so that it cannot slip or place any strain on the centre conductor.
- **FULLY INSULATED**
  It is unnecessary to remove the neoprene insulating sleeve when fitting the plug.
- **HIGHLY COMPETITIVE PRICE**
  Both the Plug and the Socket are **8d.** each (retail) —THE PRICE OF AN EXPENDABLE ITEM.
  CO-AXIAL PLUG TVP/1 **8d.** each.
  CO-AXIAL SOCKET TVS/1 **8d.** each.

VISIT US AT THE RADIO SHOW, EARLS COURT
AUG. 22 — SEPT. 1, on STAND 69

YOU CAN RELY ON ANTIFERENCE EXPERIENCE

ANTIFERENCE LTD. AYLESBURY, BUCKS.
Telephone: Aylesbury 1467/8/9

AYLESBURY • TORONTO, CANADA
LONDON • SYDNEY, AUSTRALIA

TRUVOX

Tape Recorder
Model R1

(Release Mid-July)

It has taken a long time to produce a Recorder that is really worthy of the name TRUVOX and all that the name implies, but it has come—an instrument that does full justice to the world-famous Truvox Tape Recording products. A high-fidelity instrument in every sense of the word, giving not only endless hours of enjoyment recording and replaying one's own programmes but also providing perfect reproduction of the new, outstanding and ever-growing number of pre-recorded tapes of the world's finest music, with all those finer gradations of tone that are there *for those who can hear the difference.*

Frequency response 50–12,000 cps. 10″×6″ Loudspeaker.

Contemporary cabinet styling is in keeping with the high standard set by the equipment it contains.

Price complete with crystal microphone and 1,200 ft. reel of standard tape. **66 GNS.**

Fitted with precision 'place' locator, 3 gns. extra.

Additional optional equipment

Truvox Senior and Standard Radio Jack
Truvox Foot Control and Headphones for transcription of recorded material
Truvox telephone attachment for recording two-way telephone conversations
Credit and Hire Purchase facilities available through Selected Retailers.

A TRUVOX PRODUCT

Send for full details

TRUVOX LIMITED

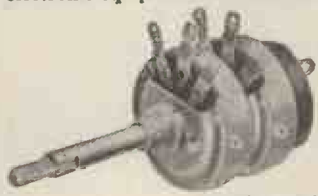
Sales Office : 15, Lyon Road, Harrow, Middlesex. Harrow 9282

Tech. & Service Dept.: 328, Station Road, Harrow, Middlesex. Harrow 4455.

YOU'RE ON THE RIGHT TRACK with

EGEN
components

In design, dependability, accuracy and freedom from wear these Egen components are quite outstanding. They are backed by unrivalled experience of the requirements of television and electronic equipment manufacturers.



DUAL POTENTIOMETERS

with concentric operating spindles. Incorporating many outstanding design features, including multiple contact rotors and thorough screening between sections. Control spindles can be supplied to suit customers' requirements. Type 136 less switch. Type 137 with SPST switch. Type 138 with DPST switch.

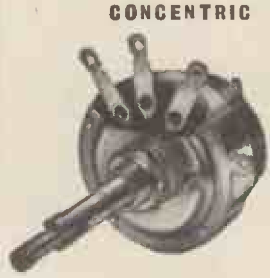
PRE-SET POTENTIOMETERS

Completely enclosed in high-grade phenolic mouldings. Solder tags heavily silver-plated for quick soldering. Fully insulated spindles with integral control knobs. Tapped for 2-hole 6 B.A. fixing on $\frac{3}{4}$″ centres. Type 126, wire-wound. Type 127, carbon.

MINIATURE POTENTIOMETERS

$\frac{7}{8}$″ diameter: utmost reliability within a very small compass. Positively located soldering tags, silver-plated for easy soldering. All steel parts rustproof. Standard values available, from 5000 ohms to 2 megohms. Type 115 less switch, Type 105 with specially designed 2-pole Q.M.B. switch.

CONCENTRIC SWITCH POTENTIOMETERS



Thorough screening between switch and potentiometer. Concentric operating spindles give independent operation of switch or potentiometer with 'one-control' simplicity. Quick make-and-break action mains switch. Knob location to suit specified requirements. Type 154 with SPST switch, Type 155 with DPST switch.

The wide range of EGEN controls includes also: Standard Carbon Potentiometers Type 102, Pre-set Resistors, Inductance Coil Assemblies, Sub-Miniature Potentiometers, (for use in miniature electronic apparatus) and TV Aerial Plug and Socket.

EGEN ELECTRIC LIMITED

CHARFLEET INDUSTRIAL ESTATE

CANVEY ISLAND · ESSEX · *Phone: Canvey Island 691/2*

The NEW Marconi

GENERAL PURPOSE RECEIVER Type NS. 702

Combines exceptional versatility with rugged reliability

—an integral part of an efficient communications system

- Continuous frequency coverage 15 Kc/s to 28 Mc/s in ten bands.
- Directly calibrated main tuning and band-spread scales with built-in crystal oscillator for precise band-setting. 80 : 1 flywheel action tuning drive, and electrical fine tuning control of ±3 Kc/s above 800 Kc/s.
- Magneto-striction filter providing the narrowest of four I.F. bandwidths of 8 Kc/s, 3 Kc/s, 1000 c/s and 100 c/s.
- Unwanted beats between interfering signals minimized by balanced demodulator for C.W. reception.
- Facilities for working with an associated transmitter include desensitizing, either electronically or by internal high-speed relays, and reproduction of transmitter sidetone on C.W., M.C.W., or telephony.
- Very low level of oscillator radiation and spurious whistles.
- Can operate direct on 110v. or 220v. D.C., or 115v. or 230v. A.C. supplies, without vibrator or rotating machine.
- Meets the latest international regulations and complies with the G.P.O. specification for General Purpose Receiver for ships.

Write for descriptive literature.

Lifeline of Communication

MARCONI

Complete Communication Systems

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX

LN2

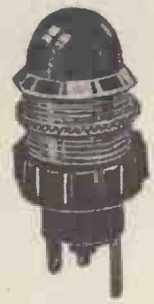
NEW ARCOLECTRIC SIGNAL LAMPS

For Low Voltage or Mains

Illustrated are a few signal lamps taken from our wide range. The insulation of every Arcolectric signal lamp will resist a flash test of 1,500 volts A.C. The S.L.90 illustrated here is a typical Arcolectric low voltage signal lampholder. It is designed to accept popular M.E.S. bulbs. The bulb is accessible from front or rear of panel. The domed plastic lens surrounded by a polished chrome bezel gives a most attractive panel appearance. This holder can be fixed in a single ¾in. hole. The mains voltage signal lamp S.L.88/N is supplied completewith an M.E.S. neon tube and a suitable series resistance.

Write for Catalogue No. 129


S.L.88/N


S.L.90


S.L.86


S.L.82


S.L.92

ARCOLECTRIC SWITCHES · LTD

CENTRAL AVENUE, WEST MOLESEY, SURREY. TELEPHONE: MOLESEY 4336 (3 LINES)

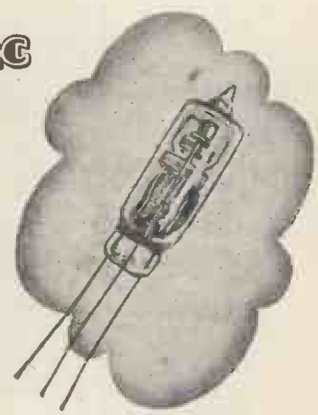
HIVAC THE SCIENTIFIC VALVE

YOU CAN COUNT ON Hivac COLD CATHODE TUBES

Continuing development in the field of cold cathode tubes has brought a new

COLD CATHODE TRIODE XC18

This electrically reliable and mechanically robust tube is contained in a 10mm round bulb, 34 mms in length Vsa $\nless$ 200V: Vma $\simeq$ 70V: Vst $\simeq$ 68V.


ACTUAL SIZE

DATA SHEET ON REQUEST

Perfection in *miniature*

Hivac Limited

Telephone: Ruislip 3366 *Cables: HIVAC, RUISLIP*

STONEFIELD WAY, VICTORIA ROAD, SOUTH RUISLIP, MIDDLESEX

MUTUAL & SELF INDUCTANCE BRIDGE

Designed for the accurate measurement of either mutual or self inductance and resistance in the range 0·001μH to 30mH and 100μΩ to 3000Ω respectively.

All measurements are made in the form of a four-terminal network and inductance and resistance of leads and clips are not included in the measurement.

Accuracy within ± 1% frequency 1592c/s (ω = 10 000)

Full technical information on this and other 'Cintel' Bridges is available on request.

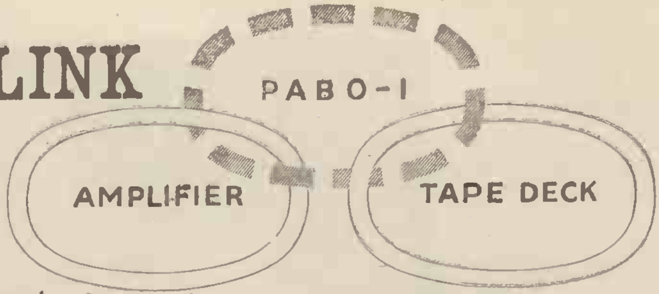
CINEMA TELEVISION LTD

A COMPANY WITHIN THE RANK ORGANISATION LIMITED

WORSLEY BRIDGE ROAD · LONDON · S.E.26
HITHER GREEN 4600

SALES AND SERVICING AGENTS:
Hawnt & Co. Ltd., 59 Moor St. Birmingham, 4
Atkins, Robertson & Whiteford Ltd., 100 Torrisdale Street, Glasgow, S.2
F. C. Robinson & Partners Ltd., 122 Seymour Grove, Old Trafford, Manchester 16

THE MISSING LINK



PABO-1 TAPE PRE-AMPLIFIER AND ERASE UNIT

PRICE : £12.10.0

This compact unit provides the necessary link between the Tape Deck and Amplifier Control Unit in a high fidelity system. The circuit has been critically designed to preserve faithfully the quality of the signal fed to it and to pass it on without distortion or alteration except in so far as the built-in equalising circuits apply. These enable the standard tape recording curve to be applied in recording and the corresponding equalisation on play back. PABO-1 can be used with almost all makes of High Fidelity Amplifier and Tape Deck.

PLAYBACK—One amplifying stage is utilised to increase the tape head signal to the amount required to load the main pre-amplifier to normal working level.

RECORD AND ERASE. The oscillator circuit energises the erase head to clear the tape of all previously recorded material, and supplies the bias voltage for the recording head. A two stage amplifying circuit operates on record.

RECORDING LEVEL. A "magic eye" type valve is used as a recording level indicator, providing an accurate means of setting the correct signal level. The quick rise time and delayed fall away enable transient peaks to be observed for the level to be adjusted accordingly.

SPECIFICATION

CONTROLS: 1. *Record/Replay switch.* 2. *Monitoring volume control.* 3. *Record level gain control.*

DIMENSIONS: *9in. × 9in. × 4½in. high.*

INPUT REQUIRED: *On Replay—2-3 mV for 100 mV output. On Record—100 mV for full modulation of the tape.*

POWER SUPPLIES: *300 volts at 40 mA; 6.3 volts at 1.2 amps.*

HUM/NOISE LEVEL: *Better than 40 dB down at max. volume.*

BIAS/ERASE FREQUENCY: *60 Kc/s—ensuring negligible intermodulation of Audio, and Erase and Bias frequencies.*

VALVES (Mullard): *EF 86, ECC 83, EL 84, EM 34.*

Armstrong

SPECIALISTS FOR OVER 20 YEARS IN HIGH QUALITY REPRODUCTION

Demonstrations at your local High Fidelity specialists or at our showrooms in Holloway. If you are unable to visit us please complete the coupon so that we may send you full descriptive literature.

Please send me descriptive literature of PABO-1 and.................................... and details of Hire Purchase, Home Trial facilities and Guarantee.

NAME ....
(BLOCK CAPITALS PLEASE.)

ADDRESS ....

....WW

ARMSTRONG WIRELESS AND TELEVISION CO. LTD., Warlters Rd., Holloway N.7. Phone North 3213

At Your Service

Even the best instruments sometimes fail. It is then that quick and ready service is appreciated. Our Service Department, operating from new and larger premises, is more than ever ready to "do its job."

★

THE LARGEST STOCKISTS OF ELECTRONIC INSTRUMENTS IN THE NORTH OF ENGLAND

★

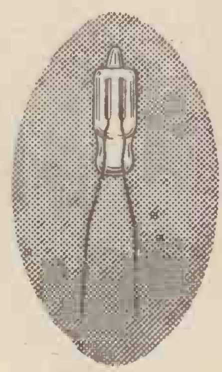
ADVANCE · AVO · CINTEL · COSSOR · DAWE ELECTRONIC INSTRUMENTS · HIVOLT KELVIN & HUGHES · MULLARD · SARGROVE J. LANGHAM THOMPSON · WAYNE KERR WAVEFORMS ETC.

★

F. C. Robinson & Partners Ltd.
122 SEYMOUR GROVE : OLD TRAFFORD
MANCHESTER 16 · Telephone CHOrlton 5366

Good ELECTRICAL EQUIPMENT

is Better



with **NEON**

Indicator LAMPS

For all A.C. or D.C. mains voltages—long life—negligible power consumption—extreme reliability.

HIVAC
INDICATOR LAMPS

MAY WE SEND YOU A DETAILED FOLDER ?

HIVAC LIMITED
STONEFIELD WAY, VICTORIA ROAD SOUTH RUISLIP, MIDDLESEX
Telephone : Ruislip 3366

TECHNICIANS AND ENTHUSIASTS WHO KNOW SPECIFY

Dulci

FM (VHF) TUNER CHASSIS COMPLETE

SELF POWERED

- Designed for use in conjunction with radiograms, receivers with pick-up sockets, tape recorders and Quality Amplifiers.
- Switching is incorporated for direct intercommunication. The tuner is connected to the PU terminals and the PU leads transferred to the tuner so that GRAM or FM may be selected without changing any connections.

CIRCUIT: Permeability tuned superheterodyne with R.F. stage and additive mixer. 3 stage I.F. amplifier, ratio detector and triode audio-amplifier. Magic eye tuning indicator. Latest type all glass miniature B.V.A. designed for FM application ECC85, two EF89, EABC80, EM80, 6X4. **FREQUENCY RANGE CONTROLS:** Two front panel controls, OFF-FM-GRAM and FM TUNING.

At rear: PRESET VOLUME CONTROL for adjusting output level. DIMENSIONS: front panel 10½in. x 5¾in., depth from front panel 6¾in., depth overall inc. knobs 7½in. CONSUMPTION 22.5 watts.

THIS F.M. UNIT OFFERS THE CUSTOMER HIGHEST VALUE

PRICE INC. TAX.

£17 · 10 · 0

RADIO & RADIOGRAM CHASSIS TYPE H.4

MAINS: A.C. 200-250 volts, 50 cycles. FOUR WAVEBANDS: Long-1,000-2,000 metres, 300-150 kc/s. MEDIUM: 187-540 metres, 1,600-540 kc/s. SHORT: 16-50 metres, 19-6 mc/s. V.H.F. (Frequency Modulated) 87-101 mc/s. Intermediate frequencies 10-7 mc/s and 471 kc/s. VALVES. B.V.A. Glass-seal miniature of latest type. Developed specifically for frequency modulation receivers. ECC85, ECH81, EF89, EABC80, EL84, EZ80, EM80. High "Q" inductances used throughout. Separate Ferrite rods are used for medium and long waves and all other coils have high performance adjustable iron dust cores. Signal and oscillator circuits of V.H.F. section are permeability tuned and ganged. The oscillator is temperature compensated for zero drift and enclosed in die-cast case for minimum radiation.

EXTRAS: ESCUTCHEON FOR DIAL. Plastic extrusion, available in brown or cream. Made to fit wood panels ¾in. thick.

MATCHED SPEAKERS. Goodmans 8in. or 10in. P.M.

RECORD CHANGERS. Fully auto. B.S.R. latest model "Monarch."

PRICE INC. TAX.

£27 · 16 · 0

Write for details of these Fully Guaranteed high quality units

Direct to the manufacturers

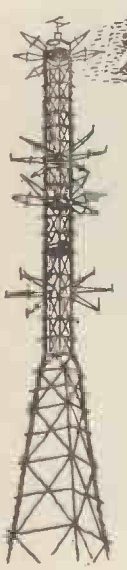
FULL TRADE TERMS AVAILABLE

Dulci COMPANY LTD.

97 VILLIERS RD., LONDON. N.W.2

TELEPHONE: WILLESDEN 6678

Write also for details of PRE-AMPLIFIER for the New COLLARO Tape Transcriptor



A SPARK OF GENIUS!

I.C.S. training supplies the spark you need to further your career. The Courses I.C.S. offer are practical and up to date, they recognise the present emphasis on Frequency Modulation, and they can help you attain one of the many well-paid posts that exist today in the radio world. Prepare yourself now, at home and in your own time, with the expert help of I.C.S. tutors.

The cost of an I.C.S. Course is moderate and includes all books.

Among the I.C.S. Courses available are:

- FREQUENCY MODULATION ENGINEERING
- T/V ENGINEERING
- RADIO SERVICING
- RADIO ENGINEERING
- RADAR ENGINEERING

Basic Electronics • Industrial Electronics
Electronic Engineering.

Complete the coupon below and post it to us today for further details of the Course which interests you. Write to: Dept. 223E, I.C.S., 71 Kingsway, W.C.2

INTERNATIONAL CORRESPONDENCE SCHOOLS
Dept. 223E, International Buildings, Kingsway, London, W.C.2.

Please send FREE book on .... *Age*..............

Name... *Occupation*..............................
(Block letters please)

Address ....

INTERNATIONAL CORRESPONDENCE SCHOOLS

M. R. SUPPLIES Ltd.

(Established 1935)

Special notice to **PRODUCTION** and **RESEARCH** managers:—We hold large stocks of **F.H.P. GEARED MOTORS** for immediate delivery. A copy of our list GM/355, giving details, sent on request. The following first-class **ELECTRICAL MATERIAL** is also for immediate delivery. Prices nett.

VOLTAGE STABILIZERS—FREQUENCY INDEPENDENT. Very limited offer of brand new Philips £80 units—exceptional opportunity. Input 180/250 volts. Frequency range 47-51.5 cycles. Rating 150 vA. Output voltage 220 v. Regulation:—negligible variation between 0 and 100% load. Rapid Response—time for complete recovery 1 cycle or 0.02 second. The stabilizer is temperature compensated over the range + 10 deg. C. to + 50 deg. C. Further details, if required, on request, but we have very few left. **£27/10/-** each nett (despatch 12/6).

B.T.H. SHADED POLE INDUCTION MOTORS. 200-250 v. A.C. 1,400 r.p.m. Size: 4in. by 3¼in. dia., with ¼in. screwed shaft, torque 500 grm./cms. The ideal silent running motor for many lab. and domestic uses. Very limited supply at **37/6** each (despatch 2/-).

TOTALLY ENCLOSED A.C. MOTORS (English Electric Co.). 230-250 v. 50 c. 1 ph., 1,425 r.p.m. split-phase induction, ball bearings. Conservatively rated at 1/10th H.P. for continuous duty—developing 1/6th H.P. Frame size approx. 7in. by 5¾in. dia. Brand new—**£3/15/-** (despatch 5/6). We can fill a large variety of small motor requirements from stock.

EXTRACTOR FANS. Very well made new units much below normal price. 200/250 v. A.C. (Induction motor, silent running, no interference). With mounting frame and back grille, ready for easy installation. With 8in. impeller (12,000 c. ft./hr.), **£5/5/-**. With 10in. impeller (15,000 c. ft./hr.), **£5/12/6** × des. either 3/-).

OPERATION COUNTERS. latest G.P.O. type, electromagnetic, brand new, 1in. square by 4in. long. Counting up to 9,999. Resistance 2,300 ohms, therefore suitable for electronic operation, **18/6** (des. 9d.). Also **MECHANICAL** type, counting to 999, forwards and backwards, with re-set and flexible drive, size approx. 1in. by 2¼in., flex. drive 3in. long, at right angles, **15/6** (des. 1/-). These count one digit per rev. and can be used for testing motor speeds.

COMPLETE SEWING MACHINE MOTOR OUTFITS—there is no better quality job at any price, 200/250 v. A.C./D.C., fitted suppressors, including motor with fixing bracket, foot control, needle light with switch, belt, etc., with instructions for fixing to any machine. **£6/15/-** (des. 2/9).

HIGH DUTY AIR BLOWERS (or extractors). We have in stock a large and useful range. Examples: powered with B.T.H. type CFS 2615 repulsion-induction motor. Estimated delivery 1,500 c. ft./min. at 6in. W.G. Overall length 24in., width 20in., height 18in. Inlet 7in. dia. Outlet 7in. by 3in. Weight approx. 1 cwt. Brand new, in original cases, **£22/10/-** (despatch mainland U.K. 20/-).

SYNCHRONOUS TIME SWITCHES 200-250 v. 50 c. Brand new Sangamo-Weston, in compact black plastic housing 4in. dia. by 3¼in. deep, providing up to three on-off operations per 24 hours, with day-omitting device (use optional), capacity 20 amps. A.C. (250 v.), **£5/8/6** (despatch 2/-).

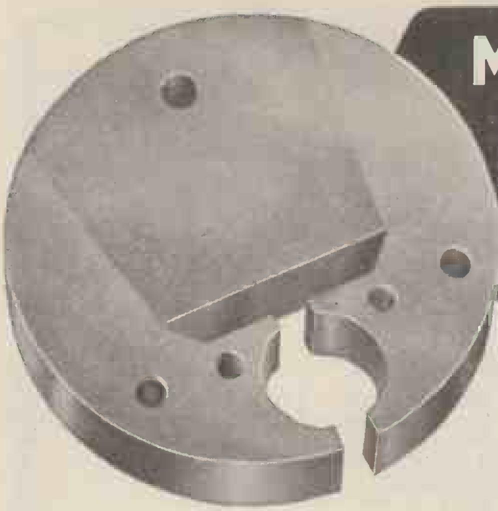
RELAYS, 12 v. 2 pole C.O., low capacity, suitable for R.F. switching, new, boxed, **7/6** (despatch 9d.). **THERMAL DELAY SWITCHES,** 6.3 volt, delay approx. ½ minute, **4/6**. **MINIATURE RELAYS,** approx. 1in. cube, 2 pole "make," 650 ohms coil, **5/6**. **CONDENSERS** (paper) 8 mfd. 500 v. D.C. wkg., best makes, **5/6** (despatch 1/6).

B.P.L. MEASURING INSTRUMENTS. Shelf-stock again available for immediate delivery: S.50 (5in. rectangular) 25, 50, 100 and 500 Microammeters, and 0/1 Milliamp. Also S.35 (3½in. round) 100 Microammeters and 0/1 Milliammeters. And others—please enquire.

M. R. SUPPLIES. Ltd., 68, New Oxford St., London, W.C.1

Telephone: MUSeum 2958

MUREX 'SINCOMAX' MAGNETS
are used in this EVERETT, EDGCUMBE MOVING COIL MILLIAMMETER



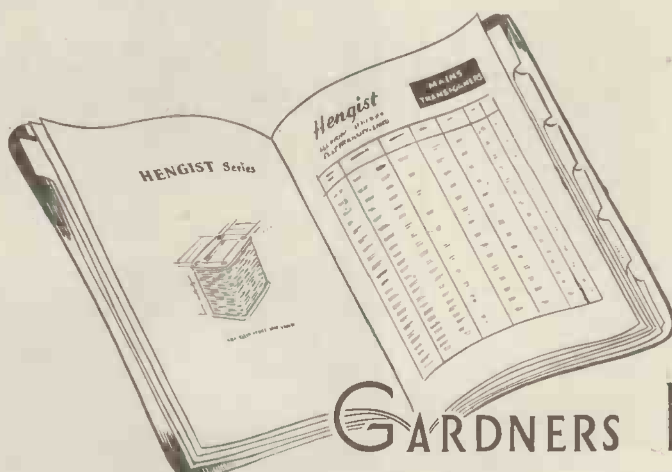
Photograph of
3½" Moving Coil Milliammeter
by courtesy of Everett, Edgcumbe & Co. Ltd.

A further example of the use of Murex 'Sincomax' Magnets where a high energy product with high magnetic stability is essential.

Murex 'Sincomax' Magnets, with an alloyed bond between magnet and soft iron, continue to give accurate and reliable service in this and many other applications.

MUREX LIMITED (Powder Metallurgy Division)
RAINHAM · ESSEX · Rainham, Essex 3322
Telex: 8632. Telegrams: Murex, Rainham — Dagenham Telex.
LONDON SALES OFFICE: CENTRAL HOUSE
UPPER WOBURN PLACE, W.C.1 EUSton 8265

An essential reference book for *ALL* users of TRANSFORMERS & CHOKES



GARDNERS RADIO
CATALOGUE

The full catalogue is available free to industrial concerns. An abridged edition is forwarded to private users.

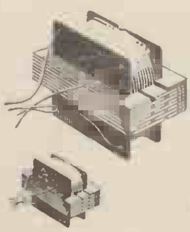
GR

GARDNERS RADIO LTD., Somerford, Christchurch, Hants. Tel. Christchurch 1024

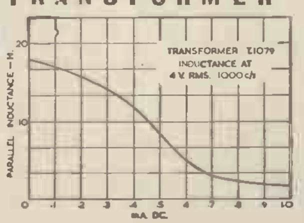
ARE YOU SEARCHING?

FOR HIGH QUALITY
ELECTRONIC MINIATURES

Make contact with Ardente Acoustic Laboratories Limited, for details of high-quality Miniature Earphones, Transformers, Switches, Volume Controls, Plugs and Sockets; also of the widely-known ARDENTE Hearing Aids.



SUB-MINIATURE TRANSFORMER



SIZE
·315" x ·425" x ·530"

Of robust construction; its unique design of laminations enables Transformer characteristics to be closely controlled, despite its small size. Weight: ·12 ozs. Lead-out wires are colour coded for phase sense of windings applications.

Specially designed apparatus, capable of detecting one short-circuited turn of 50 SWG in 5,000 turns, is used in manufacture to safeguard against premature failure caused by electrolytic action on the fine wire at short-circuited points.

A comprehensive range is available. A typical example is a Transformer with primary inductance of 100 Henries with no D.C. in the winding. The graph shows variation of primary inductance with D.C. in a similar unit.

Special designs of Transformers are produced to meet individual requirements.

THE MINIATURE EARPHONE
will be featured in a following advertisement; details will gladly be sent on request.

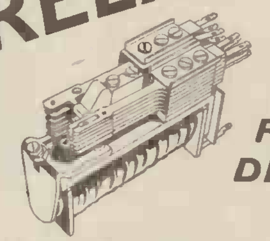
ARDENTE ELECTRONIC COMPONENTS

Details on request to

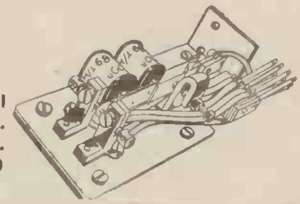
ARDENTE ACOUSTIC LABORATORIES LTD.
8-12 Minerva Road, North Acton, London, N.W.10
Telephone: ELGar 3923 (5 lines)

RELAYS

P.O. TYPES TO YOUR SPECIFICATION

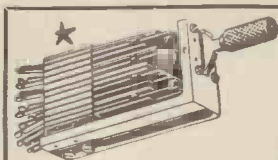


PROMPT DELIVERY



3000 TYPES

COILS standard or special up to 80,000Ω.
CONTACTS up to 8 c/o's.
600 and **HIGH-SPEED TYPES** also Supplied.



LARGE STOCKS OF KEYSWITCHES

THE KEYSWITCH CO.
ALL POST OFFICE EQUIPMENT
Enquiries to Sales Manager
126 KENSAL ROAD, LONDON, W.10
Telephone: LAD. 0666, 4640. Grams: "Fonequipt", London, W.10

VARIACS for S-M-O-O-T-H Voltage Control

The "VARIAC"† is the original, continuously adjustable auto-transformer ... the ideal control for varying the a-c voltage applied to any electrical, electronic, radar or communications equipment. Voltages from Zero to 17% above line are obtained by a 320-degree rotation of the shaft, which is equipped with a direct-reading dial, calibrated accurately. "VARIAC" offers many real advantages over any other type of a-c control: compared with the losses of resistive controls they save their initial cost within about one year. They are available in various sizes from 170 VA up to 25 Kilowatts. 3-gang assemblies are also available for 3-phase working. Prices vary from £7.10.0. upwards.

Write for our Catalogue—Technical Manual V-549, which gives all possible information, to:

CLAUDE LYONS LTD.

Head Office and Works: 76 Oldhall Street, Liverpool 3, Lancs.
Southern Factory: Valley Works, Ware Road, Hoddesdon, Herts.
†Registered Trade Mark.

Connoisseur 3 SPEED MOTOR

The turntable with a 4% variation on all three speeds.

The Connoisseur motor is made for the perfectionist. It is one of the finest turntables in the world.

The speed change is arranged mechanically and gives a 4 per cent variation on all speeds. A synchronous motor, which is virtually vibrationless with low noise level and hum induction, maintains a constant speed at all settings. There is no braking action to obtain speed change.

The 12-in. turntable is lathe turned in non-ferrous metal. The main spindle, which is precision ground and lapped to mirror finish, runs in phosphor bronze bearings.

A sound, precision engineering job, the Connoisseur motor provides the foundation for perfect reproduction.

Price £20, plus P. Tax £8/11/-.

Matching Connoisseur Pick-up Mark II with a frequency range from 20-20,000 cycles:

Pick-up complete with 1 head fitted with Diamond armature £8/19/- plus P. Tax £3/16/6.

A. R. SUGDEN & CO. (ENGINEERS) LTD.

WELL GREEN LANE, BRIGHOUSE, YORKSHIRE. Phone: Halifax 69169. Grams: Connoiseur Brighouse.

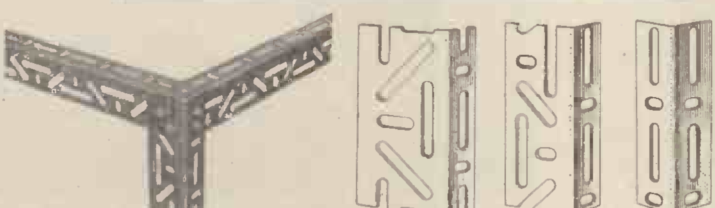
OVERSEAS AGENTS:
SOUTH AFRICA: W. L. Proctor (Pty.) Ltd., 63, Strand Street, Cape Town. CANADA: The Astral Electric Co. Ltd., 44, Danforth Road, Toronto 13, Ontario. NEW ZEALAND: Turnbull & Jones Ltd., Head Office, 12/14, Courtenay Place, Wellington. HONG KONG: The Radio People Ltd., 31, Nathan Road, Hong Kong.

MAIN DISTRIBUTORS:
AUSTRALIA: British Merchandising Pty. Ltd., 183, Pitt Street, Sydney, and J. H. Magrath (Pty.) Ltd., 208, Little Londsdale Street, Melbourne. EAST AFRICA: International Aeradio (East Africa) Ltd., P.O. Box 3133, Nairobi. MALAYA: Eastland Trading Co., 1, Prince Street, Singapore.

ABIX SLOTTED ANGLE

NOW IN A *NEW* RANGE OF 3 SIZES

DELIVERY FROM STOCK



SENIOR 3" x 1½"   UNIVERSAL 2¼" x 1½"   JUNIOR 1½" x 1½"

USE ABIX SLOTTED ANGLE FOR SHELVING, RACKS, BENCHES AND "ONE HUNDRED AND ONE" OTHER JOBS.

ABIX SLOTTED ANGLE manufactured from 14 G Steel. Phosphated and stove enamelled grey. In packets of 100 ft. with 72 sheradized nuts and bolts. The junior size contains 20 gusset plates and 60 nuts and bolts (minimum quantity 100 ft.).

ORDER A TRIAL 100 ft. PACK TODAY!

ABIX STEEL CLOTHES LOCKERS

ABIX Clothes Lockers are of All-Steel construction, with separate hat and coat compartments. Single units or banks of two, three or four. Stove enamelled olive green. With lock and die-cast handles.

SIZE OF SINGLE UNIT:
75" high
12" wide
15" deep

Write for illustrated catalogues to:

ABIX (METAL INDUSTRIES) LTD.

FACTORY EQUIPMENT SPECIALISTS

Also Manufacturers of: DOUBLE SKIN PARTITIONING

TAYBRIDGE HOUSE,
TAYBRIDGE ROAD,
BATTERSEA, LONDON, S.W.11
Phone: BATtersea 8666/7
Grams: ABIX., BATT., LONDON

only VENNER make Silver-Zinc accumulators

IN GREAT BRITAIN

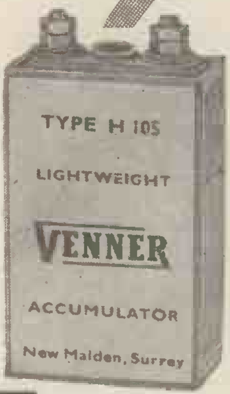
only Silver-Zinc accumulators have such—

small measurements

high rates of discharge

high power to weight ratio

constancy of output



actual size

This typical Venner Silver-Zinc cell with a capacity of 1.5 ampere hours weighs only $1\frac{1}{8}$ ounces.

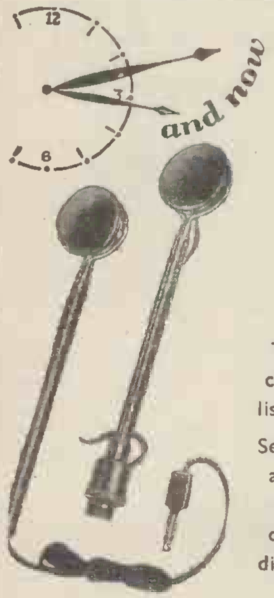
For full particulars please write to Dept. WW

VENNER ACCUMULATORS LTD.

Kingston By-Pass, New Malden, Surrey. *Tel: MALden 2442*

Member of the Venner Group of Companies, manufacturers of Time Switches • Park-O-Meters • Electronic & Electro-Mechanical Instruments

---



S.G. Brown

AUDIO AIDS

Handphones with individual volume control. Ideal for use with church and cinema deaf aid installations or for individuals with impaired hearing. They provide the essential clarity of reception when listening to Radio and T.V.

Send for Brochure "W" of all types available. If desired, advice is given on selection of type most suited to individual needs.

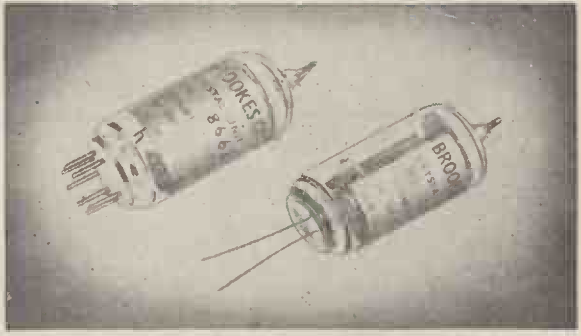
S. G. Brown provide Headphones and associated equipment for all known purposes.

S.G.Brown, Ltd.

SHAKESPEARE STREET, WATFORD, HERTS.

Telephone: Watford 7241

BROOKES Crystals



mean DEPENDABLE frequency control

● *Illustrated above are two Type G Crystal units from a range covering 111 kc/s to 500 kc/s, and 3 Mc/s to 20 Mc/s.*

ALL Brookes Crystals are made to exacting standards and close tolerances. They are available with a variety of bases and in a wide range of frequencies. There is a Brookes Crystal to suit your purpose—let us have your enquiry now.

BROOKES

Brookes Crystals Ltd.

Suppliers to Ministry of Supply, Home Office, B.B.C., etc

181/3 TRAFALGAR ROAD, LONDON, S.E.10.

Phone: GREenwich 1828 *Grams:* Xtals, Green, London

BASF magnetic recording tape

GIVES ALL FOR THAT LITTLE EXTRA

1,000 metre for professional use
1,200 ft. on plastic spool
600 ft. on plastic spool
300 ft. on plastic spool
150 ft. miniature tape for postal recordings.
Special tapes for GRUNDIG TK. 9. TK. 819 and STENORETTE.
Also
the New Thin Long Playing Tape giving 50% more tape on the same spool.
Please write for further details.

Wear doesn't tear; nor do scratches impair . . . TAPE for recording designed for witholding all halts and all faults from sonic events . . . What's more it prevents all defects on repeats . . . it's as tough as tape can be since it's based on PVC . . . for that little more initially you get precious durability.

In short:

You get so much more — For that little extra.

F. A. HUGHES & CO. LTD.
DEVONSHIRE HOUSE PICCADILLY LONDON W1
Telephone: Mayfair 8867

A new milestone in Hi-Fi Reproduction

The cradled interchangeable disks are a coarse counterbalance for all heads and cartridges.

The two slide weights give complete fine adjustment gradation within 8 grammes.

A finger-touch calibrated pedestal gives a new approach to rapid precision alignment of all heads and cartridges.

Closure of the feed lead gives freedom from interference both mechanically and electrically.

Friction-free spheres give the ultimate in tracking smoothness.

The plug-in shell will take ALL popular cartridges (two shells are included with each arm). The fitting is standard for direct plug-in heads.

We believe this to be the LAST WORD in Pickup arm refinement

ASK YOUR LOCAL DEALER FOR FULL DETAILS

ANOTHER MAGNUM PRODUCT manufactured by

BURNE-JONES SUNNINGDALE ROAD CHEAM SURREY ENGLAND

A book for every viewer, home-constructor and service engineer

Correcting

TELEVISION PICTURE FAULTS

By John Cura and Leonard Stanley

Uses about 150 remarkable photographs of actual faults appearing on the screen of a television receiver to enable quick diagnosis of trouble. The accompanying text explains what action can be taken to remedy the faults and is primarily written in everyday language for the ordinary viewer. Further details of a more technical nature are included in differently displayed text for the service engineer, the advanced amateur, and the home constructor.

7¼" x 4¾" 77 pp. Illus. 3/6 **net.** By post 3/10.

Over 150 pictures of actual picture faults

from all booksellers

Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1

THIS MAGNIFICENT RECORDER

TAKES EVERYTHING IN ITS STRIDE

The remarkable performance on standard or pre-recorded tapes of the Celsonic high-fidelity magnetic Tape Recorder is world famous. It also takes in its stride the superimposing of words over music and the conversion of silent films to sound.

Long playing times possible on reels up to 3,280ft. Full track and half track available.

CELSONIC

Send for details:

EXCEL SOUND SERVICES LTD., (Dept. W.D.O.)
Garfield Avenue, Bradford 8, Yorkshire. Tel.: 45027

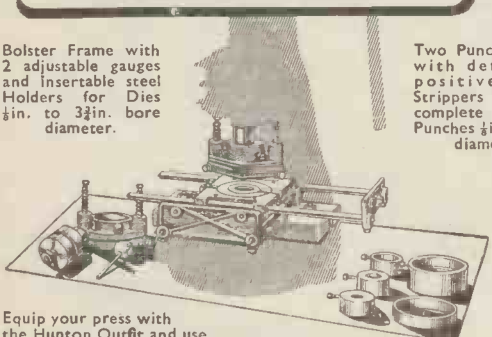
Please PRINT your name and address.

REDUCE YOUR PRESS TOOL COSTS

THE HUNTON UNIVERSAL BOLSTER OUTFIT FOR SHEET METAL PIERCING AND BLANKING ON FLY PRESSES

Bolster Frame with 2 adjustable gauges and insertable steel Holders for Dies ⅛in. to 3¾in. bore diameter.

Two Punch Holders with detachable positive-action Strippers take the complete range of Punches ⅛in. to 3¾in. diameter.



Equip your press with the Hunton Outfit and use **inexpensive standardised Punches and Dies ⅛in. to 3¾in. diameter obtainable from stock—in $\frac{1}{32}$in. sizes**—when required.

Standardised Tools also available at short notice for Square, Oblong and other shapes, Louvre Forming (up to 8in. long), Corner Notching, Corner Radiusing, Angle Iron Notching and Piercing, etc.

Get the Outfit now—Buy Punches, Dies and Tools as you need them

Descriptive brochure and price list W.B. on request.

HUNTON LIMITED

Phoenix Works, 114-116 Euston Road, London, N.W.1

Telephone: EUSton 1477-8-9. *Telegrams:* Untonexh, London

METERS

TO B.S. 89-1954 AVAILABLE FOR PROMPT DELIVERY

EXAMPLES OF TYPES AVAILABLE IN 2½in. FLUSH PATTERN MOVING COIL INSTRUMENTS

AMPERES D.C. 0-1, 2, 3, 5, 10, 15, 20, 25, 30, 50.
MILLIAMPS. 0-1, 1-0-1, 0-5, 10, 15, 20, 25, 30, 50, 100, 250, 500.
MICROAMPS. 0-25, 0-50, 100, 200, 250, 400, 500, 750, 50-0-50, 100-0-100, 250-0-250, 500-0-500.
AMPS. R.F. 0-1, 3, 5, 10, 15, 25, 50.
VOLTS D.C. 0-1, 5, 10, 15, 25, 50, 100, 250, 500, 750, 1,000, 1,500, 2,500.
VOLTS A.C. 0-5, 10, 15, 25, 50, 100, 250, 500, 750, 1,000.

We can supply meters with NON-STANDARD CURRENT and VOLTAGE RANGES to any specification. DELIVERY 7-14 days. MOVING IRON. THERMO AND ELECTROSTATIC INSTRUMENTS. 2in. SQUARE FLUSH, 3½in. ROUND FLUSH and INDUSTRIAL SWITCHBOARD INSTRUMENTS ALSO AVAILABLE FOR PROMPT DELIVERY.

ELECTRONIC TEST EQUIPMENT AND INSTRUMENTATION DEVELOPED AND MANUFACTURED FOR SPECIALISED APPLICATIONS.

ANDERS ELECTRONICS LTD.

91, HAMPSTEAD ROAD, LONDON, N.W.1.

Telephone: EUSton 1639

Suppliers to Govt. Depts., B.B.C., Tech. Colleges, Leading Manufacturers & Research Laboratories

PRESENTING

We are proud to represent the products of these internationally famous Makers chosen by our Experts at the recent **AUDIO FAIR** and now available to every Audiophile on the M.O.S. Personal Credit Plan.

LONDON'S NEWEST HI-FI SHOWROOM

RONETTE · CONNOISSEUR · ROGERS
WOOLLETT · LOWTHER · GOODMANS
LEAK · GARRARD · G.E.C.
COLLARO · ACOUSTICAL QUAD · W.B.
BURGOYNE · WHARFEDALE · E.A.R.

BRITISH MADE EQUIPMENT—

Amplifiers (complete)	CASH PRICE £ s. d.	CREDIT SALE 9 mthly. pmts. of	HIRE PURCHASE Deposit 50% £ s. d.	HIRE PURCHASE 12 mthly. pmts. of	EXPORT PRICE nett £ s. d.
Acoustical Quad Mk. II..	42 0 0	103/1	21 0 0	38/11	42 0 0
Leak TL 10 and Point One	28 7 0	70/4	14 3 6	26/3	28 7 0
Rogers RD Junior	26 0 0	63/7	13 0 0	24/2	26 0 0
W.B. 12 Hi-Fi..........	25 0 0	61/1	12 10 0	23/4	25 0 0
E.A.R. Mullard 510......	18 18 0	46/5	9 9 0	18/3	18 18 0
Loudspeakers					
Wharfedale W15CS......	17 10 0	42/9	8 15 0	17/1	17 10 0
,, Super 12CSA	17 10 0	42/9	8 15 0	17/1	17 10 0
,, W12CS......	10 5 0	26/1	5 2 6	11/-	10 5 0
,, Golden 10 ..	8 0 11	21/3	4 0 6	9/2	5 15 0
,, Super 8CSAL	7 6 11	19/8	3 13 6	8/7	5 5 0
G.E.C. Metal Cone......	9 5 0	23/11	4 12 6	10/2	6 13 7
Goodmans 150 Mk. II....	10 15 9	27/4	5 8 0	11/6	10 15 9
,, Axiom 80....	24 4 9	59/3	12 2 6	22/8	17 10 0
,, Audiom 60....	9 2 9	23/8	4 11	10/1	9 2 9
,, Axiom 22....	15 9 0	35/6	7 14 6	15/4	15 9 0
,, Axiom 102....	10 7 9	26/5	5 4 0	11/2	7 10 0

Tape Recorders and Decks	CASH PRICE	CREDIT SALE	DEPOSIT	12 mthly. pmts.	EXPORT PRICE
Editor 2-speed Standard L.P. Tape...........	50 8 0	123/3	25 4 0	46/8	50 8 0
Editor Super Hi-Fi......	65 2 0	159/1	32 11 0	60/4	65 2 0
Playtime (complete)	31 4 6	76/4	15 12 6	29/-	31 4 6
Playtime Plus	36 15 0	89/10	18 8 0	34/-	36 15 0
Vortexion 2A	84 0 0	205/4	42 0 0	77/10	84 0 0
,, 2B	99 0 0	242/-	49 10 0	91/9	99 0 0
Ferrograph 2A/N or 2A/NL	79 16 0	195/1	39 18 0	74/-	79 16 0
,, 2A/NH	90 6 0	218/6	45 3 0	83/8	90 6 0
Collaro Tape Transcriptor	20 0 0	48/11	10 0 0	19/2	20 0 0
Wearite 2A Tape Deck ..	35 0 0	85/7	17 10 0	32/5	35 0 0
Truvox Mk. IIIU Deck ..	23 2 0	56/5	11 11 0	21/9	23 2 0
Lane Mk. VI Deck	18 10 0	45/3	9 5 0	17/11	18 10 0

Gramophone Motor Units	CASH PRICE	CREDIT SALE	DEPOSIT	12 mthly. pmts.	EXPORT PRICE
Garrard RC110 Changer..	14 13 3	35/11	7 7 0	14/9	10 11 0
,, RC80M	18 6 8	44/9	9 3 4	17/9	13 3 9
Collaro RC54 Changer....	13 17 0	34/1	6 18 6	14/-	10 0 0
,, 2010 and Pickup(T)	19 10 0	47/8	9 15 0	18/11	14 1 6
,, 2010 less Pickup(T)	14 18 0	36/5	7 9 0	14/11	10 15 0
Connoisseur Variable (T)	28 11 4	71/-	14 5 8	26/6	20 0 0
Garrard 301 (T)........	26 8 2	66/7	13 4 1	24/6	19 0 0

We detail above selected Equipment available to you by Credit Sale (9 equal monthly payments) or Hire Purchase terms, and the latter can be extended up to 18 months for amounts over £50, the Equipment being despatched to you shortly after receipt of the initial deposit.

Export Prices are shown separately for easy import facilities.

9 DEPARTMENTS covering:

HI-FI · TAPE RECORDERS
TEST METERS · ELECTRIC TOOLS
REFRIGERATORS · ELECTRICAL APPLIANCES
RADIOGRAMS · TELEVISION
SERVICE DEPT.

Staffed by a team of qualified technicians offering a 24-Hour service.

E & G MAIL ORDER SUPPLY CO.

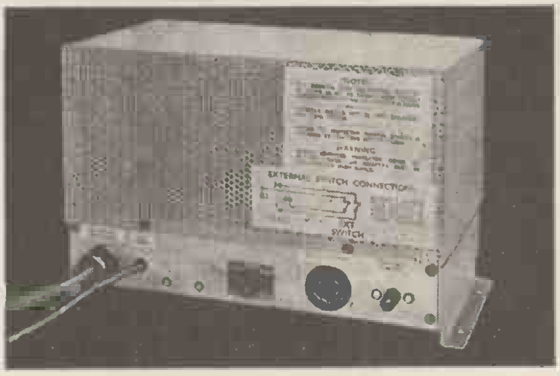
The Radio Centre

33 Tottenham Court Road, London, W.1

Tel: MUSeum 6667

M·O·S

have you a DC 'bug-bear'?



No longer need D.C. current be a 'bug-bear'. The Felgate ELECTRONIC INVERTER will transform 200/250 volt D.C. current to operate almost any A.C. apparatus needing a power of between 25 and 78 watts.

The instrument consists of a hard valve push-pull power amplifier driven by a separate oscillator; there are no moving parts. It is silent in operation and its frequency is very stable. Measuring 9¾" x 6¾" x 5½" it can be fixed inside a large instrument such as a radiogram, with control switch on the dial.

PRICE £12. (no P.T.)

FELGATE

electronic inverter

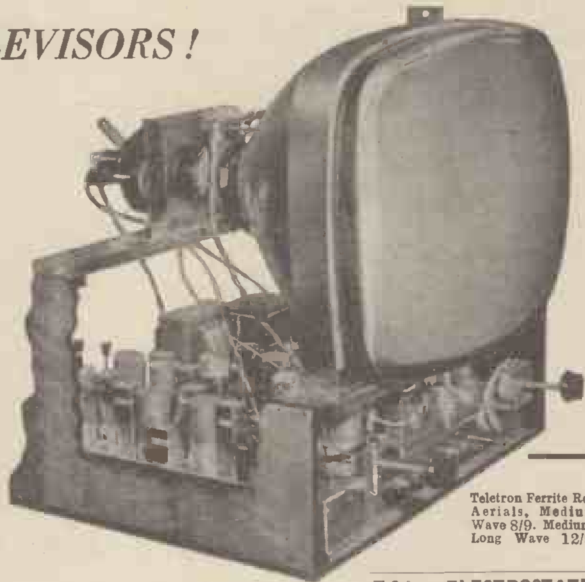
See your dealer today. If any difficulty write to:

FELGATE RADIO LTD. FELGATE HOUSE, STUDLAND STREET, HAMMERSMITH, W.6.

20

You'll do better

Build these New PREMIER TELEVISORS!



★ **13 CHANNEL DESIGN No. 1**
MAY BE BUILT FOR £32 - 7 - 11 PLUS COST OF C.R.T.

★ **5 CHANNEL DESIGN No. 2**
MAY BE BUILT FOR £27 - 9 - 4 PLUS COST OF C.R.T.

BUILD IN 5 EASY STAGES. FULL CONSTRUCTIONAL DETAILS AVAILABLE. INSTRUCTION BOOK 3/6 POST FREE INCLUDES BOTH DESIGNS

CONSOLE CABINETS with full length doors for 14in., 16in. and 17in. tubes PRICE £14/14/-. H.P. Terms: Deposit £7/7/6 and 9 monthly payments of 18/6

CONSOLE CABINETS previously advertised, still available at £12/12/-. H.P. Terms: Deposit £6/6/- and 8 monthly payments of 18/3

On above cabinets add 21/- for pkg. & carr.

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

ILLUSTRATED LIST AVAILABLE GIVING FULL DETAILS OF BUREAU TYPE CABINETS

BARGAIN OFFER

DARK SCREEN FILTER IN TRIPLEX GLASS 18in. × 14in. SUITABLE FOR ALL TUBES UP TO 17in., 10/-. PLUS PACKING AND POSTAGE 1/6. LATEST TYPE RUBBER ESCUTCHEON SUITABLE FOR 17in. RECTANGULAR TUBES AT A SPECIAL PRICE OF 10/-. PLUS PACKING AND POST 1/6.

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

The most efficient BAND III CONVERTER available

Includes 2 valves plus metal rectifier utilising the latest circuit technique. Midland, North and London Models A.C. Mains only 200/240 v., complete with power supply. Provision is made by means of a four position switch to cover all Band III channels. Size—Height 2½in., Width 5¼in.

PRICE COMPLETE £8 . 8 . 0 *Plus 2/6 pkg. & carr.*

Credit Terms: Deposit £1/1/4 and 8 monthly payments of £1/2/1.

SEND 2½d. STAMP FOR OUR 1956 CATALOGUE

COMMUNICATION RECEIVER P.C.R.2.

Send for leaflet.

6-Valve 3 wavebands 13-50, 190-570 and 900-2,000 metres, in black case with crackle front, illuminated calibrated dial, flywheel tuning, size 17½ x 10 x 8in. Cash £7/10/–, *plus packing and carriage 10/6.* Supplied complete with built-in A.C. Power Supply. Brand new and ready for use. Cash £9/19/6, or H.P. terms. *Plus packing and carriage 10/6.* Circuit diagram available, 9d. post free.

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

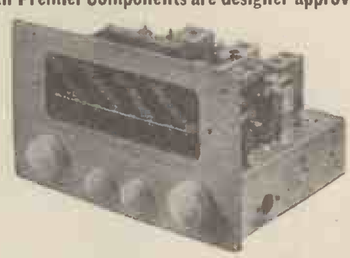
Air spaced co-axial wire, 1/9 per yard.

MAKE YOUR OWN ROD AERIAL

Ferrite rod 6in. × 5/16in., complete with descriptive constructional details. These aerial rods are suitable for medium and long wave reception. Price 5/3, post free.

THE JASON "ARGONAUT" MW/FM DESIGN

All Premier Components are designer approved



The very latest FM Receiver design PLUS a medium waveband, as described in "The Radio Constructor." ALL components to build the complete Receiver, including output stage, may be purchased for £15/5/–, or all components less output stage but including Power Supply, for £13/19/6, plus packing and postage 3/6 on each. The chassis, front plate, dial, flywheel drive assembly, special tuning condenser and wavechange switch (which includes main switch) supplied completely assembled. This is also available separately at £4/4/– plus packing and postage 2/6.

MULLARD AMPLIFIER KIT

WHY NOT MAKE THE BEST!

All the components for model 510, PLUS pre-amplifier on one chassis (total six valves) may be purchased for £12/12/- plus pkg. & post 7/6, or pre-amplifier and tone control in a separate unit £14/14/- plus pkg. and post 7/6.

T.S.L. ELECTROSTATIC SPEAKERS

Type LSH75 ....Price 12/6
Type LSH100 ....Price 21/–
Type LSH518 ....Price 17/6

SPECIAL OFFER

Limited Quantity

The well-known Band 3 Univerter in chassis form suitable for any home-built or commercial Televisior, will fit into existing Cabinet complete with own A.C. Power Supply, tested and ready for use, two models, London or Midland. Cash price £6/6/-, plus packing and postage 3/6.

LATEST B.S.R. MONARCH 4-SPEED AUTOCHANGER

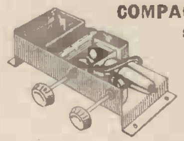
Designed to play 12in., 10in. and 7in. Records intermixed in any order at 16, 33⅓, 45 or 78 r.p.m. Capacity 10 Records. New reversible Dual Stylus Crystal Pick-up, for use on 100/150 v. 50 cycle A.C. mains. £9/15/0, plus packing and postage 5/-.

B.S.R. MONARCH 3-Speed Autochanger still available at £7/19/6. Plus pkg. & post 5/-.

LATEST TYPE 3-SPEED SINGLE PLAYER

By famous manufacturer, with crystal turnover head. For use on 100-250 v. 50 cycle A.C. mains. £6/19/6. Plus pkg. & carr. 5/-.

COMPACT GRAM AMPLIFIER



Suitable for any type of Pick-up. Volume and tone control fitted with knobs. Overall size 7½in. long × 3¾in. wide × 2½in. high. Complete and ready for use.

£2 . 19 . 6

Plus packing and postage 2/6

METER RECTIFIERS. Miniature type with leads 1—5 mA. 6/9, post paid.

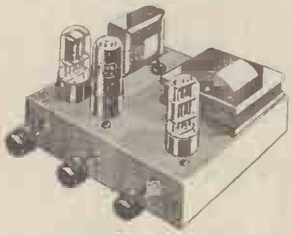
SEND FOR DETAILS OF OUR H.P. AND CREDIT TERMS

TERMS OF BUSINESS:

Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-, 1/6 under 40/-, unless otherwise stated.

PREMIER RADIO COMPANY,

with PREMIER



4 WATT AMPLIFIER

MAY BE BUILT FOR **£4 . 10 . 0** Plus 2/6 Pkg. & Postage

A steel case is now available, complete with engraved panel, for 21/- extra. The amplifier may be supplied complete for £5/5/- plus pkg. and post 3/6, or fitted in case at £6/6/- plus pkg. and post 3/6.

3 BAND SUPERHET RECEIVER

MAY BE BUILT FOR **£7 . 19 . 6** Plus 3/- Pkg. & Postage

2-BAND TRF RECEIVER MAY BE BUILT FOR £5.15.0 *plus pkg. & post 3/-.*

These two receivers use the latest type circuitry and are fitted into attractive cabinets 12in. × 6½in. × 5½in. in either walnut or ivory bakelite or wood. Individual instruction books 1/- each, post free.

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		

CAN WE HELP YOU!

IF THE EQUIPMENT OR COMPONENTS YOU REQUIRE ARE NOT IN OUR ADVERTISEMENT, DON'T HESITATE TO WRITE TO US—WE PROBABLY HAVE THEM IN STOCK.

THE NEW T.S.L. FM TUNER MARK 2

6 Valves including Magic Eye and Power Supply, using the latest type Gorler permeability Unit complete with first audio stage and preset output volume control. Maximum radiation less than 10 microvolts per metre. Sensitivity better than .5 microvolts. Cash price £17/10/- (inclusive), or on H.P. terms, deposit £8/15/- and 9 monthly payments of £1/1/8. Credit terms, deposit £2/3/9 and 8 monthly payments of £2/3/4. Postage and packing 5/- extra.

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

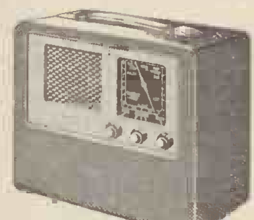
WILLIAMSON AMPLIFIER

MAY BE BUILT FOR **£15 . 15 . 0** Plus 7/6 Pkg. & Postage

Supplied completely wired and tested for £20, or available on H.P. or Credit terms, postage and packing 10/-.

PRE-AMPLIFIER & TONE CONTROL UNIT

Available completely constructed, £5/5/-, plus 2/6 packing and postage.



ALL DRY BATTERY PORTABLE RADIO RECEIVER

MAY BE BUILT FOR **£7 . 8 . 0** Plus 3/- Pkg. & Postage

4 Miniature valves in a superhet circuit covering medium and long waves, Rexine covered cabinets 11½in. × 10in. × 5¾in., in two contrasting colours, wine with grey panel or blue with grey panel. Please state choice when ordering. **Instruction book 1/6 post free, which includes full constructional details and list of priced components.**

AM/FM RADIOGRAM CHASSIS

9 Valves (including Magic Eye), output 2 × 6BW6 valves in push-pull, output suitable for 3 or 15 ohms speakers. Ferrite Rod Aerials on medium and long "Gorler" permeability Unit on FM. A.C. mains 200-250 volts, chassis 15in. long, 7½in. deep, 8in. high, dial 14¾in. × 8in. Cash price £27/6/-, or on H.P. Terms.

Plus packing and carriage 7/6 extra.

T.S.L. LORENZ SOUND SYSTEM

Type LP 312-2

Consists of a 12in. Unit and two LPH65 Treble Units. Co-axially placed to give the widest listening angle. Bass and treble Units have magnetic systems of the highest efficiency, each magnet having a flux density of 17,500 gauss. This Speaker system gives a level response from 20 to 20,000 cycles. No expensive cross-over Units are required.

Leaflet available giving full details. Price £14/19/6 H.P. terms available.

Postage and packing 7/6 extra

Single Treble Units available separately at 39/6 each plus packing and postage 1/- extra.

Improve your existing Speaker system with this Unit giving an output of 2 k/c to 20 k/c ±1db.

A range of High Fidelity Amplifiers, Speakers and Record Players, the following makes in stock: Leak, E.A.R., Rogers, Goodmans, Wharfedale, W.B. Stentorian, Lorenz, B.S.R., Collaro, Garrard, Lenco, Connoisseur. We shall be only too pleased to demonstrate any of the above equipment.

PORTABLE TAPE RECORDER CABINETS

All Rexine covered

Tape Deck	Amplifier	Type	Price
Lane Mk. VI	Premier	Mk. VI	£4/19/6
Lane Mk. VI	Premier	de Luxe	£4/19/6
Truvox Mk. III	Truvox C	T.D.3	£4/4/-

Plus Postage and Packing 5/-

The New "PREMIER"

TAPE RECORDER

£5 DEPOSIT & 8 MONTHLY PAYMENTS OF £4.18.6 or CASH PRICE £40 plus 21/- pkg. & carr.

★ Case finished in Brown and Antique Fawn. Size 15in. × 12½in. × 7¾in., with the very latest type continental gilt fittings. For A.C. mains 200-250 volts, 50 cycles.

207, EDGWARE RD., LONDON, W.2. Tel: Ambassador 4033 & Paddington 3271

Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: H. F. SMITH
Assistant Editor: F. L. DEVEREUX, B.Sc.

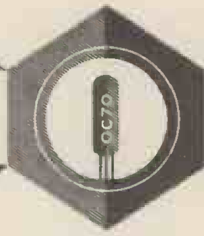
AUGUST 1956

In This Issue

VOLUME 62 NO. 8
PRICE: TWO SHILLINGS

FORTY-SIXTH YEAR
OF PUBLICATION

PUBLISHED MONTHLY (4th Tuesday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* "Ethaworld, Sedist, London." *Annual Subscription:* Home and Overseas £1 12s. 6d. U.S.A. and Canada $5.00. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *COVENTRY:* 8-10, Corporation Street. *Telephone:* Coventry 5210. *GLASGOW:* 26B, Renfield Street, C.2. *Telephone:* Central 1265. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. OVERSEAS OFFICES: *U.S.A.:* 111, Broadway, New York, 6, N.Y. *Telephone:* Digby 9-1197. *CANADA:* 74, College Street, Toronto, 2 Ontario. *Telephone:* Walnut 4-5631

Transistors 

at Small Signals (h-Parameters)

The most convenient way of describing the electrical characteristics of a transistor, like any other electronic device, is by means of a set of static characteristic curves. These graphs show how the voltage or current at the input electrode varies with the voltage or current at the output electrode.

The primary function of transistor static characteristic curves is to enable the circuit designer to choose the direct voltage and current for the working point. In the second place these graphs are used for designing circuits where large signals occur, for example in output stages or pulse amplifiers. However, for applications where the signal is small in comparison with the direct voltages and currents it is possible to calculate performance accurately from the slopes of the characteristic curves at the working point. Under small signal conditions the transistor never moves far away from this point and hence the characteristics in the immediate neighbourhood can be taken as linear. It is generally impracticable to read the slopes with sufficient accuracy from the graphs given, and so they are quoted in transistor data for some nominal working point such as collector voltage —2V and collector current —3mA. The h-parameters are the slopes of a particular set of characteristic curves but are in fact measured by small-signal a.c. methods.

In transistor data, this set of four characteristic curves consists of:—(1) the input characteristic giving the variation of input current I_1 with input voltage V_1, for constant output voltage: slope $= h_{11}$; (2) the output characteristic showing the relation between the output current I_2 and the output voltage V_2 for a series of fixed input currents: slope $= h_{22}$; (3) the transfer characteristic giving the variation of output current I_2 with input current I_1 for a fixed output voltage: slope $= h_{21}$; (4) the feedback characteristic showing the connection between the input voltage V_1 and the output voltage V_2 for a series of fixed input currents: slope $= h_{12}$.

By drawing the axes of the static characteristic curves and using the subscripts 1 and 2 to refer to the input and output electrodes, the notation h_{11} etc. can easily be explained and three of the h-parameters are seen to be related simply to parameters in the Mullard system. Thus h_{11} is the ratio of two quantities measured at the input electrode, hence it is the slope of the input characteristic, and is equal to r_{in}. V_1, I_1 represent the direct voltage and current at the input electrode and V_2, I_2 similarly apply to the output electrode. The a.c. quantities are v_1, i_1 and v_2, i_2. The formal definition of h-parameters is then as follows;—

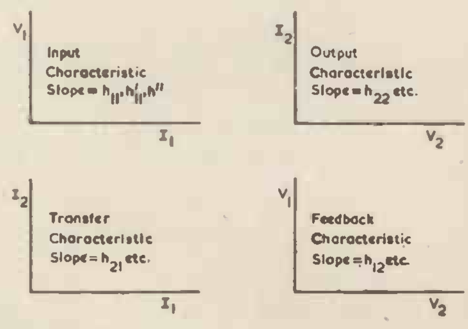
$h_{11} = v_1/i_1$ = slope of input characteristic
= input impedance for constant output voltage
= input impedance for output short-circuited to a.c.
= r_{in} (in ohms or kilohms)

$h_{22} = i_2/v_2$ = slope of output characteristic
= output admittance for constant input current (= reciprocal of output impedance)
= output admittance with input open-circuited to a.c.
= $1/r_{22}$ (usually in micro-mhos)

$h_{21} = i_2/i_1$ = slope of transfer characteristic
= current gain for constant output voltage
= current gain with output short-circuited to a.c.
= *a* (a ratio, that is, a pure number)

$h_{12} = v_1/v_2$ = slope of feedback characteristic
= voltage feedback ratio for constant input current
= voltage feedback ratio with input open-circuited to a.c.

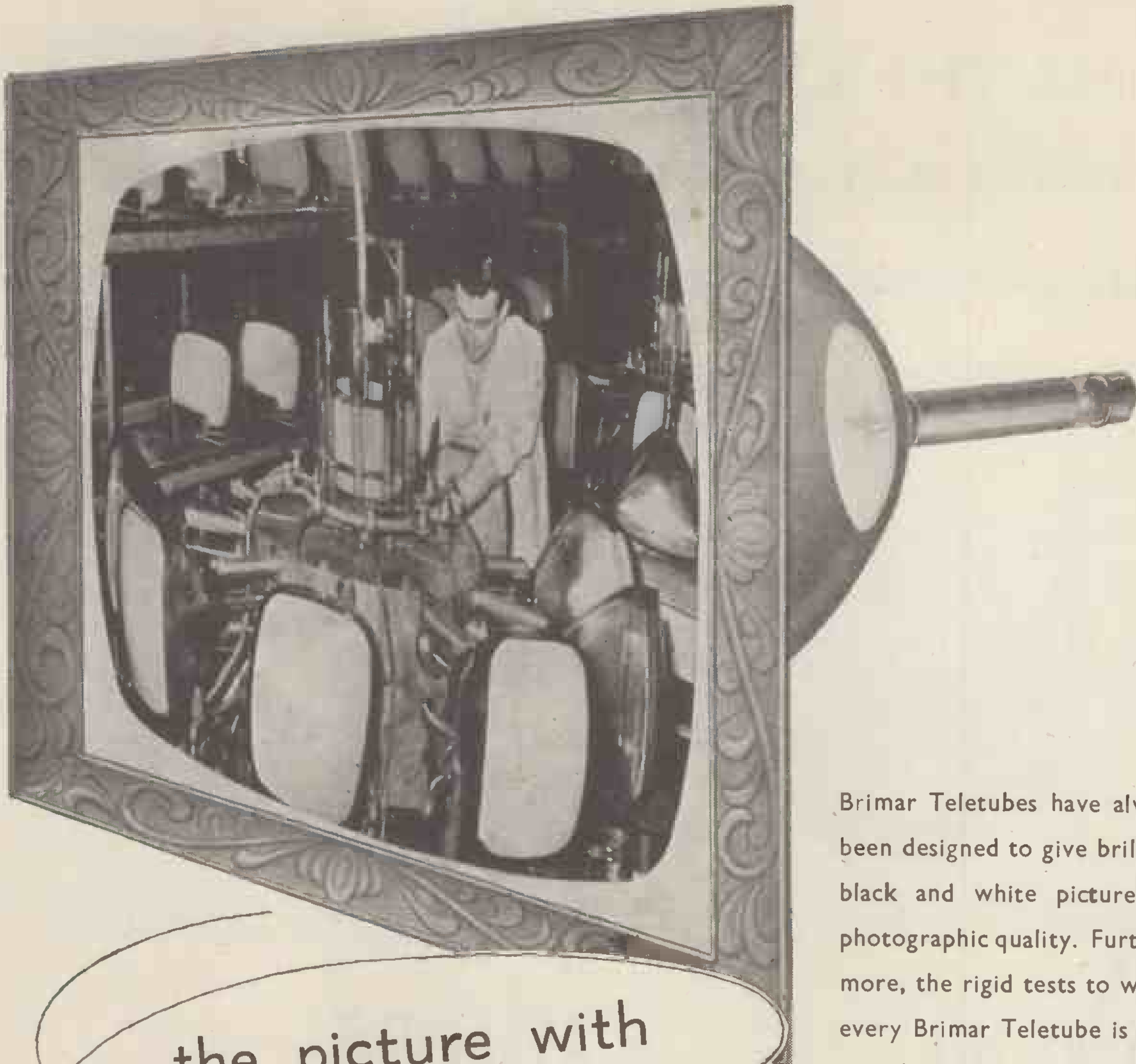
In defining the h-parameters the transistor is treated as a 'black box' with an input and output, paying no regard to whether the transistor is in a common base, common emitter or common collector configuration. In an actual circuit the values of these slopes will depend on which configuration is used. Thus the undashed terms such as the a.c. current gain h_{21} are reserved for grounded base applications, whereas a single prime as in h'_{21} shows the value required for calculations on grounded emitter circuits, and h''_{21} etc. apply to grounded collector circuits.



Grounded base: e = 1, c = 2.
Grounded emitter: b = 1, c = 2.

Grounded Base	*Grounded Emitter*	*Grounded Collector*
$h_{11}=r_e+(1-\alpha)r_b=r_e+\frac{r_b}{1+\alpha}$	$h_{11}'=(1+\alpha)h_{11}$	$h_{11}''=h_{11}'$
$-h_{21}=\alpha=\frac{\alpha}{1+\alpha}$	$h_{21}'=\alpha$	$-h_{21}''=1+h_{21}'$
$h_{22}=1/r_c$	$h_{22}'=(1+\alpha)h_{22}$	$h_{22}''=h_{22}'$
$h_{12}=r_b/r_c$	$h_{12}'=h_{22}'r_e$	$h_{12}''=\frac{1}{1+h_{12}'}$

2709



the picture with

real black and white

photo quality

Brimar Teletubes have always been designed to give brilliant black and white pictures of photographic quality. Furthermore, the rigid tests to which every Brimar Teletube is subjected ensures an unfailing high standard of excellence and reliability.

Always use Brimar Teletubes for photo-quality black and white pictures.

BRIMAR *Teletubes*

Standard Telephones and Cables Limited

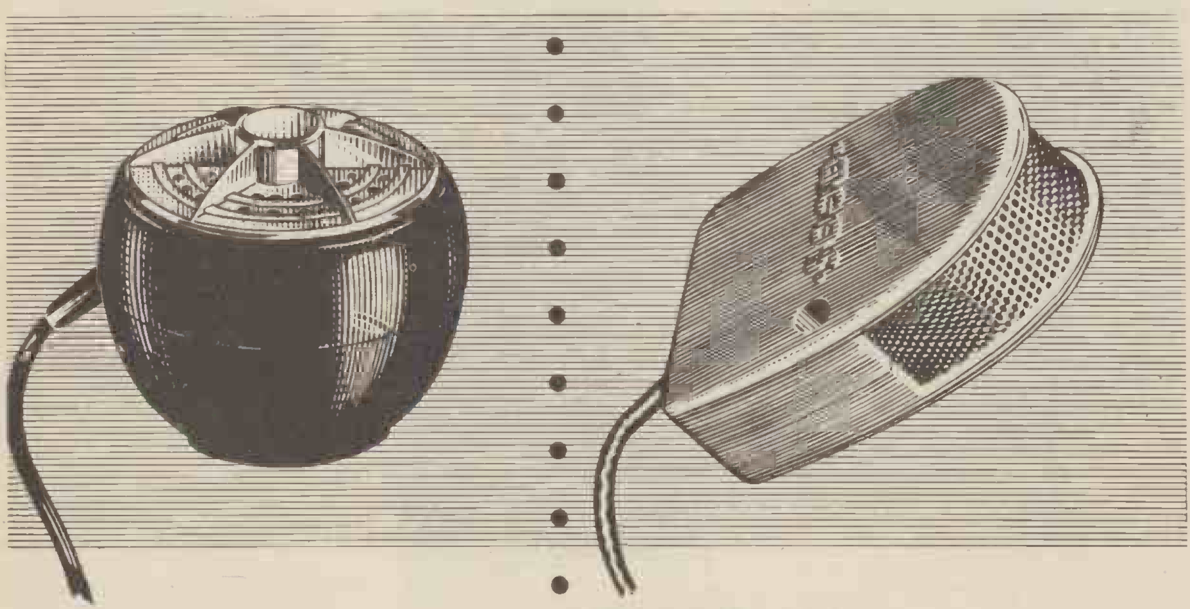
Regd. Office: Connaught House, 63, Aldwych, London, W.C.2

FOOTSCRAY · SIDCUP · KENT · FOOtscray 3333

IF YOU WANT A GOOD Microphone

WITHOUT HAVING TO PAY TOO MUCH FOR IT

What about one of these?



MIC 33

A crystal microphone that fits the hand perfectly. For the high quality public address and tape recording field, incorporating a specially designed acoustic filter giving a flat response from 30 to 7,000 c/s.

RETAIL PRICE £2.10.0

MIC 35

A general purpose hand microphone of robust construction and convenient "handling" qualities with substantially flat response from 50 to 5,000 c/s. Suitable for recording apparatus, Public Address equipment, etc.

RETAIL PRICE £1.5.0

acos *always well ahead*

COME TO THE **radio show** EARLS COURT AUG 22-SEPT 1

STAND NO. 202

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

COSMOCORD LIMITED · Eleanor Cross Road · Waltham Cross · Herts.

Telephone: Waltham Cross 5206

Wayne Kerr

INSTRUMENTS

ADMITTANCE BRIDGE TYPE B.801

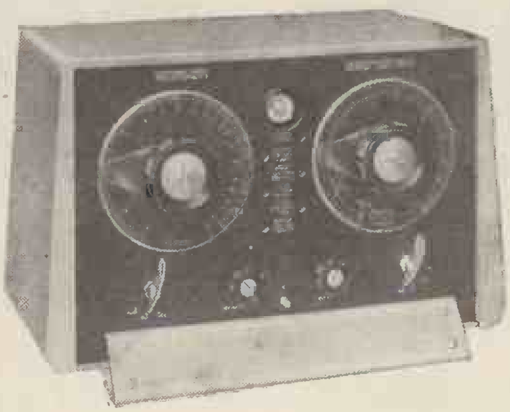
1 Mc/s – 100 Mc/s

For balanced and unbalanced measurement.

Susceptance: Equivalent to ±230 pF.	Conductance: 0-100 mmho.
Accuracy: ±2%, ±0·5 pF.	Accuracy: ±2%, ±0·1 mmho.

This is one of a range of bridges for use with external source and detector for the measurement of aerials, cables, feeders, and a variety of components and materials between 15 kc/s and 250 Mc/s. Bridge sources and detectors are available for use between 1-100 Mc/s and 50-250 Mc/s.

PRICE £150 NET EX WORKS



COMPONENT BRIDGE TYPE B.121

A general purpose 50 cps 3 terminal transformer ratio arm bridge for the measurement of Resistance, Capacitance and Inductance in the ranges 3-100 MΩ, 1 pF-100μF and 100 mH-10,000H, accuracy ±2%. Direct readings of the resistive and reactive components of impedance and facilities for "in situ" measurements are notable features.

PRICE £60 NET EX WORKS

AUDIO WAVEFORM ANALYSER TYPE A.321

A portable instrument to measure the relative levels of the components of a complex waveform over a range of 75 db between 50 c/s and 20 kc/s. Input impedance 100KΩ unbalanced or >25KΩ balanced. In transportable case as shown, or for standard 19″ mounting.

PRICE £250 NET EX WORKS

FOR FURTHER DETAILS WRITE OR TELEPHONE

THE WAYNE KERR LABORATORIES LTD · NEW MALDEN · SURREY MALDEN 2202

E·M·I for Oscilloscopes

MEASURING OSCILLOSCOPE W.M.I.

See what you measure.... ....measure what you see

Because of its handy size this Oscilloscope (9¼″×8¼″×11½″) can be used in a dozen different ways—ranging from industrial research and production testing to television and radio servicing. It is also eminently suitable for use in technical schools and colleges.

Measured Pulse amplitude 4 volts

£49.0.0

LIGHTWEIGHT OSCILLOSCOPE TYPE 2300

The latest addition to our range of instruments.

Designed and manufactured by Industrial Electronics

BRIEF SPECIFICATION

Dimensions:	4¾ in. × 7¼ in. × 7¼ in.
Weight:	6¼ lb.
Cathode Ray Tube:	2¾ in. diameter.
Sensitivity: Wide-band operation (-6dB at 3 Mc/s)	0.7 cm/V.
Narrow-band operation (-3dB at 100 Kc/s)	7 cm/V.
Time Base Range.	7 c/s to 50 Kc/s.

- Direct coupled amplifiers.
- Wide range of horizontal expansion.
- Input attenuator.
- Internal, external or 50 c/s synchronisation.
- Direct access to tube deflectors.

£39.10.0

E.M.I. ELECTRONICS LTD. INSTRUMENT DIVISION

HAYES · MIDDLESEX · ENGLAND · Telephone: SOUthall 2468, Ext. 655, 1013, 857

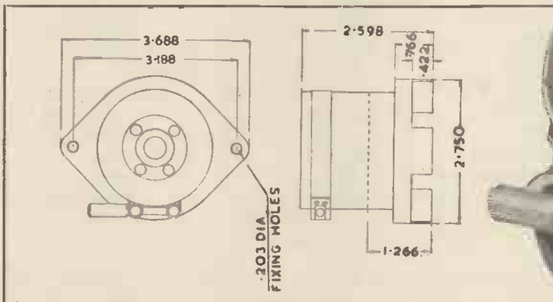
EE 26/32

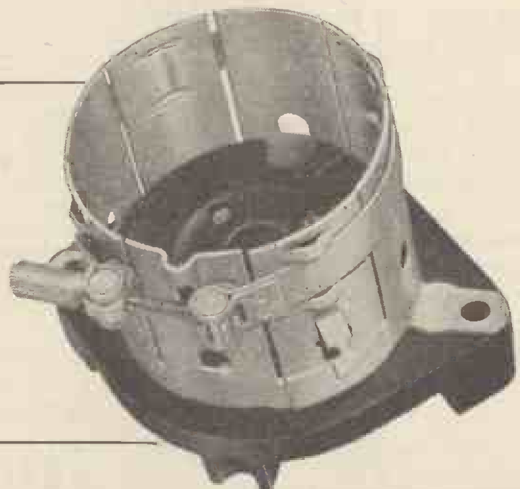
valveholders

for industry

Ediswan Clix Valveholders give continuous trouble-free operation under the most exacting conditions encountered by Industrial Electronic equipment.

The very wide range includes B7G, B8A, B9A, B9G and a number of larger types such as B4A, B4D and B4F all complying with the appropriate specifications for Government equipment. Insulation materials include P.T.F.E., Nylon-phenolic and Quartz-phenolic; contact material is silver-plated Beryllium copper. Catalogue of complete range of Radio, Television and Electronic components available on request.





This B4D Quartz-loaded moulded valveholder is a typical specimen from the Ediswan Clix range.

EDISWAN

CLIX

STAND 19
NATIONAL RADIO SHOW
EARLS COURT
AUG. 22 — SEPT. 1

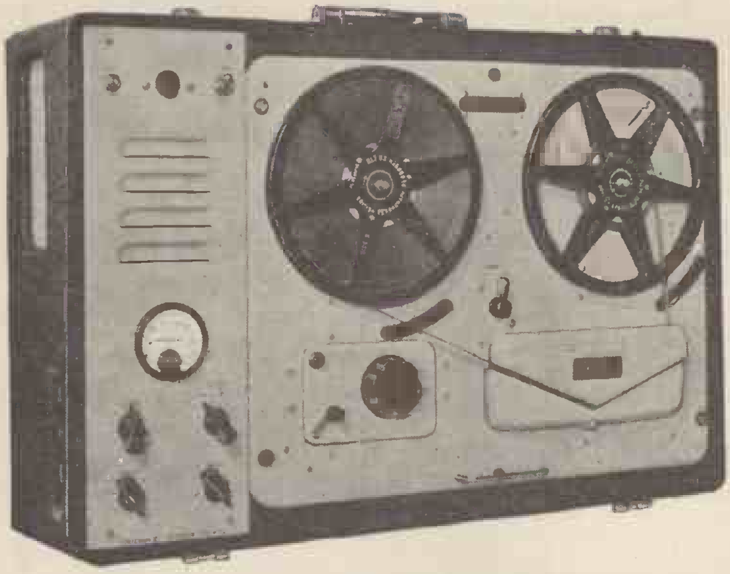
RADIO, TELEVISION & ELECTRONIC COMPONENTS

THE EDISON SWAN ELECTRIC COMPANY LIMITED

155 Charing Cross Road, London, W.C.2 and Branches

Telephone: Gerrard 8660 · *Member of the A.E.I. Group of Companies* · *Telegrams: Ediswan, Westcent, London*

VORTEXION TAPE RECORDER



★ The total hum and noise at $7\frac{1}{2}$ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 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 $8\frac{1}{4}$in. x $22\frac{1}{2}$in. x $15\frac{3}{4}$in. 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%. Supressed for use with Tape Recorder. **PRICE £18 0 0.**

3-WAY MIXER AND PEAK PROGRAMME METER

FOR RECORDING AND LARGE SOUND INSTALLATIONS, ETC.

One milliwatt output on 600 ohm line (.775V) for an input of 30 micro-volts on 7.5-30 ohm balanced input.
Output balanced or unbalanced by internal switch. The meter reading is obtained by a valve voltmeter with 1 second time constant, which reads programme level, and responds to transient packs.
Calibration in 2 db steps, to plus 12 db and minus 20 db referred to zero level. Special low field internal power pack supplies 8 valves including stabilising and selenium rectifier, consumption 23 watts.

Manufactured by

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

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

When you buy a tape recorder

your choice will be governed by two factors—

PRICE AND SPECIFICATION

The best tape recorder won't be cheap—but it will be good value for money.

The Grundig 'Specialist' TK.820/3-D is the best value for your money. Its presentation, its versatility, its performance, its push-button track changeover, makes it the only possible choice for so many people. Provided the machine has the facilities, appearance and ease of control you demand, it remains to check whether or not its specification will stand up to your requirements.

Here is the complete technical specification of the TK.820/3-D. Read it critically—and write to us if there is anything else you would like to know.

GRUNDIG Makers of the finest tape recorders in the world.

GRUNDIG (Great Britain) LTD., Dept. WW,
Advertising Dept. & Showroom:
39-41, NEW OXFORD STREET, LONDON, W.C.1
Sales Dept. & Works:
KIDBROOKE PARK ROAD, LONDON, S.E.3.
(Electronics Division, Gas Purification & Chemical Co. Ltd.)

GRUNDIG 'SPECIALIST'

Mains voltage: suitable for A.C. only, 105 – 115, 190 – 210, 210 – 230, 230 – 250 volts, 50 cycles. Power Consumption: approximately 90 watts maximum. Mains Fuses: 2 amps (for 105 – 115 volts), 1 amp (for 190 – 250 volts). H.T. fuses: 500 m/A Surge Resisting, 120 m/A Surge Resisting. Valve line-up: EF 86, ECC 81, EL 84, EL 42, EM 71 + 2 metal rectifiers. Mains tapping panel and fuses instantaneously available. Two tape speeds — 3¾ ins/sec and 7½ ins/sec: speed change instantaneous by electrical means – heavy duty dual speed split phase induction motor: recording time (with 1,200 feet recording tape) 2 × 30 minutes at 7½ ins/sec – 2 × 60 minutes at 3¾ ins/sec: half track recording, track change without spool reversal: track changeover by press button approximately 2 seconds. Trackbutton remains down to indicate which track was played last: frequency range 50 – 9,000 cycles at 3¾ ins/sec, 40 – 14,000 at 7½ ins/sec: noise is down at least 40 dBs and wow and flutter less than 0.3% at 7½ ins/sec, less than 0.5% at 3¾ ins/sec.

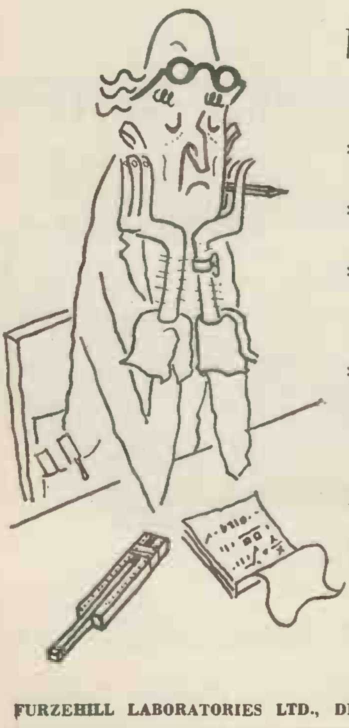
Automatic stop foil at end of spools: fast forward and fast rewind time approximately two minutes per full spool. Illuminated precision place indicator: recording level meter by 'magic eye', tone control for treble or bass emphasis.

Loudspeakers: elliptical high-flux permanent magnet moving coil + two 2½ inch tweeters. Special four-position speaker control. Connections for low impedance extension speaker and high impedance external amplifier remote controls, earphones. Microphone, diode and radio input sockets.

Overall dimensions: 17 inches × 17½ inches × 9¼ inches. Weight approximately 48 lb.

Retail Price **98 gns.**

Incremental Inductance Bridge?



What he needs is this

FURZEHILL B.800

- **50 mH to 500 H**
- **D.C. polarising up to 1.5 A**
- **Tunable selective amplifier null detector**
- **Excitation 25 c/s to 3000 c/s**

B.800 Bridge £192 • 10 • 0

B800P D.C. supply £82 • 10 • 0

Furzehill Laboratories Ltd.

FURZEHILL LABORATORIES LTD., DEPT. WW8, 57 CLARENDON ROAD, WATFORD, HERTS. TELEPHONE: GADEBROOK 4686

OLYMPIC HONOUR FOR BRITAIN

We are proud to announce that our TL/12 amplifiers have been chosen for use at the 1956 Olympic Games to be held in Australia.

It was in 1945 that H. J. Leak revolutionised the performance standards for audio amplifiers by designing the original "Point One" series, and we became *the first firm in the world to market amplifiers having a total distortion content of 0.1 per cent* This claim was received with incredulity, but it was subsequently confirmed by the National Physical Laboratory and since then hundreds of TL/12 amplifiers have been used by the B.B.C., and Commonwealth and foreign broadcasting authorities, and thousands have been used by recording studios, leading musicians and music-lovers throughout the world. We were the only British exhibitor at the world's first Audio Fair which was held in New York in 1949 and the volume of our exports to the United States of America has grown steadily since then.

Further development work resulted in our producing, at a much lower price but with the same high performance standards, the TL/10 amplifier. The TL/10 amplifier and "Point One" pre-amplifier received such an excellent reception when they were first exhibited at the Audio Fair in New York in October, 1953, that we received an initial order for 1,000 sets. Since then several thousand sets have been sold throughout the world. The output of the TL/10 is ample for high-fidelity home music systems, and the quality of reproduction obtained is equal in every respect to that of the TL/12. We always use the TL/10 amplifier and "Point One" pre-amplifier for our public demonstrations of high-fidelity reproduction of gramophone records and radio. The TL/10 amplifier, when used with the best available complementary equipment, gives to the music-lover a quality of reproduction unsurpassed by any equipment at any price. Even when the complementary equipment falls below that of the best obtainable, the use of these amplifiers will enable one to obtain very marked improvements in reproduction.

LEAK

HIGH FIDELITY EQUIPMENT

LEAK TL/10 AMPLIFIER, £17. 17. 0.
& 'POINT ONE' PRE-AMPLIFIER, £10. 10. 0.

Prices made possible only by world-wide sales

POWER AMPLIFIER

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.

OTHER LEAK PRODUCTS

Varislope II pre-amplifier	£16 16 0	
TL/12 power amplifier	£28 7 0	
TL/25A power amplifier	£34 7 0	
Leak dynamic pickup:—		
Arm	£2 15 0	p.t. £1 3 1
LP head with diamond stylus	£5 15 0	p.t. £2 8 4
78 head with diamond stylus	£5 15 0	p.t. £2 8 4
Mu-metal cased transformer	£1 15 0	
Trough-Line FM tuner unit with built-in power supply	£25 0 0	p.t. £10 10 0

Those seeking to obtain the highest quality of gramophone and radio reproduction are invited to ask their dealer for a demonstration of Leak products which, with their tradition o excellence, represent the best that can be obtained.

"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 amplifiers.

★ **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

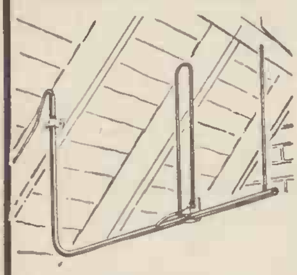
Reprints of "The Gramophone" article (May, 1955) by H. J. Leak, summarising his work and findings on Electrostatic and Dynamic Loudspeakers, are available on request, free of charge.

★ *Write for leaflet W* ★

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

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

BAND III AERIALS



THE 'READY'

This is a ½ wave-length, 3 element array. Of all alloy construction, the aerial is completely assembled and ready for instant mounting in loft, bedroom cupboard, window frame, etc. Price 12/6, plus 2/-.

3 element array with swan-neck mast with "U" bolt clamp for fitting to existing masts from ¾in. to 2in. dia.	41/6
3 element array with cranked mast and wall mounting bracket	42/6
3 element array with cranked mast and chimney lashing equipment	65/-
5 element array with swan-neck mast and "U" bolt clamp for fitting existing mast from ¾in. to 2in. dia.	52/6
5 element array with cranked mast and chimney lashing equipment	67/-
8 element array with swan-neck mast and "U" bolt clamp for fitting to ¾in. to 2in. dia. mast	69/-

THE "CRISPIAN" BATTERY PORTABLE

A 4-valve truly portable battery set with very many good features as follows:—Ferrite rod aerials.

- **Low consumption valves.**
- **Superhet circuit with A.V.C.**
- **Ready built and aligned chassis if required.**
- **Beautiful two-tone cabinet.**
- **Guaranteed results on long and medium waves anywhere.**

All parts, including speaker and cabinet, are available separately or if all ordered together the price is £7/15/- complete. Post & insurance 3/6d. Ready built chassis 30/- extra. Instruction booklet free with parts or available separately price 1/6.

CAR STARTER/CHARGER KIT

All parts to build 6- and 12-volt charger which can be connected to a "flat" battery and will enable the car to be started instantly. Kit comprising the following:—

Mains transformer	19/6
5-amp rectifier	17/6
Regulator Stud Switch	3/6
Resistance Wire	2/-
Resistance Forme	2/6
Mains on/off Switch	1/-
0-5 amp. Moving Coil Meter	9/6
Constructional Data	1/6

or if bought all together price is 52/6, plus 2/6 post and packing.

CONNECTING WIRE

P.V.C. covered in 100ft. coils—most colours—four coils, different colours, 10/-, post free.

MINI-RADIO

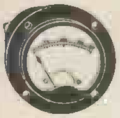
Uses high-efficiency coils—covers long and medium wavebands and fits into the neat white or brown bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, £4/10/-, plus 3/6 post. Constructional data free with the parts, or available separately, 1/6.

MAINLY FOR EXPERIMENTS AND INDUSTRIAL USERS

VACUUM RELAY

American made type No. C61610, this is a relay completely sealed in a glass envelope. It will close in a strong magnetic field or by a coil placed close to or round one of its arms. Price 49/6. Operating coils 25/- each.

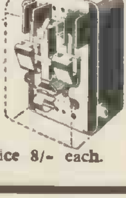
WESTINGHOUSE (U.S.A.) METERS



All flush mounting type, outside diameter of face 3½in.

0-500 v. D.C.	25/-
0-1.5 kV D.C. external multiplier	35/-
0-2.5 kV D.C. external multiplier	35/-
0-15 v. A.C. moving Iron	30/-
0-1 mA.	25/-
0-50 mA.	25/-
0-100 mA.	25/-
0-150 mA.	25/-
0-250mA	25/-
0-500 mA.	25/-

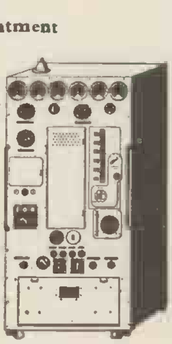
CONTACTOR



Solenoid operated—completely enclosed in cast-iron case, contacts rated at 7.5 amps D.C.—suitable for up to 30 amps. A.C. — coil volts 24 D.C. price 8/- each.

NAVY MODEL TCK-7

Seen at Eastbourne by appointment



We have a few only American transmitters still in original packing cases. Designed for the Navy, these are really beautifully made and most impressive, standing 5ft. high by 2ft. wide and finished in instrument crackle. All meters and controls are on the front penel. The transmitter tunes over the range of 2 megacycles to 18 megacycles and it is designed for high speed precision communication without preliminary calling. Frequency control and stability is particularly good being better than .005% under the worst conditions. Power output is 400 watts on C.W and 100 watts on phone. Tuning is very simple—a unit control mechanism—gives a direct reading in frequency.

Complete with valves and instruction manual. Price £95. ex works.

NOTE.—The transmitter will work off A.C. or D.C. with the appropriate power unit. Power units are not available at present.

UNITS FOR CONTROLLED AUTOMATIC ROTATION

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.

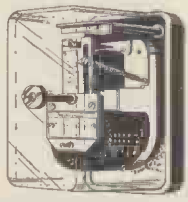
Item 1, known as Tower 24A, is in fact the geared driving motor which rotates the mast. This is quite a heavy construction and would rotate a heavy scanner, reflector. Beam array etc. etc.

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. TB24A £35 plus carriage.

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

OVERCURRENT RELAY

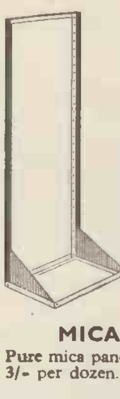


Beautifully made by the famous American Westinghouse Company. These are the surface through panel type with clear Pyrex glass covers. They have coils for remote push button resetting.

Type A—calibrated for currents between .1 and .4 amps.

Type B—calibrated for currents between .5 and 2 amps.

Price, unused and perfect, £3/17/6 each.



RACKING EQUIPMENT

STANDARD OPEN RACK

6ft. high and 19in. wide, heavy steel construction. Holes drilled and tapped at the standardized spacings. Price £3/15/-, plus carriage.

MICA PANELS

Pure mica panels size 2in. × 3in., 3/- per dozen.

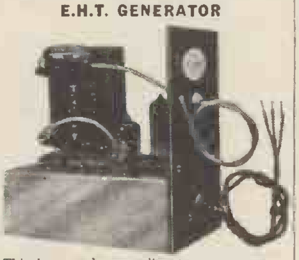
GRAMOPHONE AUTO-CHANGER

Latest types by all famous makers are invariably in stock at competitive prices. B.S.R., Monarch, Garrard, etc. Latest models from £7/15/0, plus 5/- carriage and insurance.

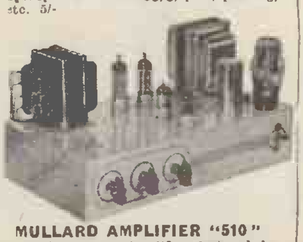
THIS IS ON OFFER AT APPROX. HALF COST TO MAKE

An impressive costly looking cabinet originally designed for T.V. but simple modification makes the cabinet suitable for radiogram, amplifier, tape recorder, or reflex speaker—size 23in. wide, 22in. deep and 37½in. high. Limited quantity at £8 15/- each, carriage 12/6.

E.H.T. GENERATOR



This is a made-up unit, power consumption (6.3 volt 8 amp. filament and approx. 59 mA. H.T.). Contains three BVA valves. Output from 6 kV to 9 kV rectified with normal H.T. rail input but somewhat higher outputs can be obtained with higher H.T. supply. Dimensions are 6½ × 4½ × 7in Price 69/6, post, packing, etc. 5/-



MULLARD AMPLIFIER "510"

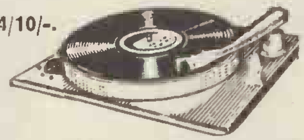
A High Quality Amplifier designed by Mullard engineers Robust high fidelity with a power output exceeding 10 watts and a harmonic distortion less than .4% at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 20,000 C.P.S.—three controls are provided and the whole unit is very suitable for 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/-, 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.

CABINETS FOR ALL

WE CARRY A VERY VARIED STOCK PLEASE CALL

The one illustrated is the "Empress," it is undoubtedly a beautiful piece of furniture. It is elegantly veneered externally in figured walnut, internally in white sycamore. The radio section is raised to convenient level but is not drilled or cut. The lower deck acts as the motor board, again is uncut, it measures 16 × 14 and has a clearance of 5in. from the lid. There is a compartment for the storage of recordings. Overall dimensions of this essentially modern cabinet are 3ft. wide, 2ft. 8in. high and 1ft. 4½in. deep. Price £14/14/–, carriage and insurance 20/–.

RECORD PLAYER FOR £4/10/-.



3-SPEED INDUCTION MOTOR

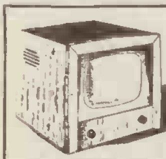
3-speed motor with metal turntable and rubber mat. Latest rim drive with speed selection by knob at the side.

HI-FI PICK-UP

Using famous Cosmocord Hi-G turnover crystal. Separate sapphire for each speed. Neat bakelite case with simple adjuster for weight compensation.

SPECIAL SNIP OFFER THIS MONTH

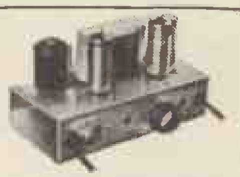
The two units for £4/10/-, or 30/- deposit and four payments of 18/-, post and insurance, 5/-. Or fitted upon base, as illustrated, £5/10/-, plus 7/6 post and insurance.



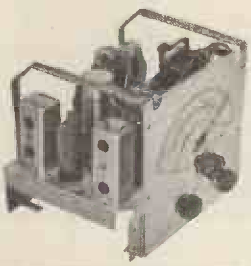
14" T.V. CABINET

14in. T.V. cabinet of the latest styling made for one of our most famous firms—beautifully veneered and polished—limited quantity—19/6 each. Carriage and packing 3/6 extra.

The "ESTRONIC" BAND III CONVERTER



To-day's best value in Band III converters suitable for your T.V. or money refunded. Complete ready to operate. 59/6 non mains or 85/- mains, post and insurance, 3/6.



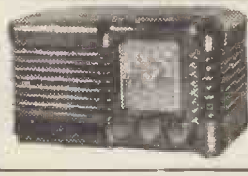
HALF-PRICE OFFER

BEETHOVEN CHASSIS

Extremely well built on chassis size approx. 9½ × 7½ × 8½, using only first-class components, fully aligned and tested. 110-240 volt A.C. mains operation. Three wave bands covering medium and two shorts. Complete with five valves. frequency changer. double diode triode. pentode output and full wave rectifier. Special cash-with-order price this month, £5/19/6, carriage and insurance 7/6 Polished cabinet, 49/6

NEW CIRCUIT

OCCASIONAL 56—we have evolved a new T.R.F. circuit and have had really good results, equal in fact to many superhets. You really should try this circuit. All parts including valves (6K7, 6J7, 6F6, and 6X5) and Bakelite case with back cost only £5/10/- plus 2/6 post and insurance. Data included with the parts is also available separately, price 2/-.



PLEASE INCLUDE POSTAGE WHEN ORDERING

R1155 YOURS FOR £2

The R1155 is considered to be one of the finest communication receivers available to-day. Its 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. Completely overhauled and guaranteed in perfect working order. Price £9/19/6 or 5 payments of £2 each. Carriage and Transit case 15/- extra. Mains Power Pack, with built-in speaker, £5/10/- or in polished cabinet, £6/15/-.

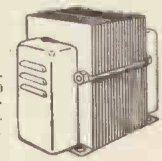
OFFICE TELEPHONES

New G.P.O. telephone sets with Internal bell and push button switch easily connected together to form office intercom. Price £2/10/- each. Post, etc., 2/6.

TRANSFORMER SNIP

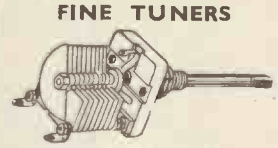
11/6

Post 2/-.



Fully shrouded—standard 200-250 v. primary 280-0-280 at 80 mA., 6.3 v. at 3 amp. 5 v. at 2 amp.

FINE TUNERS



Ceramic trimmers all with ¼in. spindle of fair length. 5, 10, 15 30, P.F. at 2/3 each or 24/- per dozen.

CIRCUIT DETAILS

Diagrams and other information extracted from official manuals. All 1/6 per copy. 12 for 15/-.

American Service Sheets	R.109
A.1134	78 receiver
BC.348	76 receiver
BC.312	R28/ARC5
R.103A	R1116/A
B.C.342	RA-1B
RA-1B	AR88D
R-208	AN/APA-1
R-1155	78
R-1124A	76
R-1132A/R-1481	R.T.18
R-1147	CAY-46-AAM RADAR
R-1224A	A.S.B.-3
R-1082	Indicator 62A
R-1355	Indicator A.F.B.3
B.C.1206-A/B	Indicator 62
B-455-A (or -B)	Indicator 6K
B-454-A (or -B)	R.F. unit 24
B-453-A (or -B)	R.F. unit 25
Transmitter T1154	R.F. unit 26
B.D.J.N.	R.F. unit 27
Fifty-eight walkie talkie	Wireless set No. 19
Frequency meter B.C. 221	Demobbed valves

ELECTRONIC PRECISION EQUIPMENT LTD.

249 Kilburn High Road Kilburn. Phone: MAI 4921 Half-day Thursday | 42-46, Windmill Hill. Ruislip Middlesex. Phone: RUISLIP 5780 Half-day Wednesday | 152-153 Fleet St., E.C.4. Phone: FLEET 2833 Half-day Saturday | 29 Stroud Green Road, Finsbury Park, N.4. Phone: ARCHWAY 1049 Half-day Thursday

Post orders should be addressed to E.P.E. LTD., M.O. Dept. 2, 123, TERMINUS ROAD, EASTBOURNE. All enquiries to Eastbourne address and please enclose S.A.E., terms are cash with order.

at the Radio Show

Aug. 22nd to Sept. 1st

Goodmans

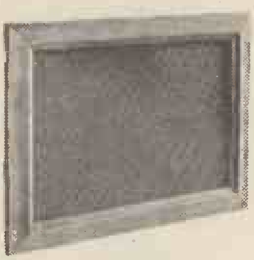
Axiom Full Range HIGH FIDELITY Loudspeakers

AXIOM 150 Mk.II
15 watts 12 in.
30-15,000 c.p.s.

AXIOM 22 Mk.II
20 watts 12 in.
30-15,000 c.p.s.

AXIOM 80
6 watts 9½ in.
20-20,000 c.p.s.

AXIETTE
6 watts 8 in.
40-15,000 c.p.s.



Acoustical Resistance Unit . . .

The Acoustical Resistance Unit *(illustrated)*, developed and manufactured exclusively by GOODMANS INDUSTRIES LTD., enables the cubic content of the Bass Reflex System to be reduced by one-third, while retaining full bass performance when used with Audiom or Axiom loudspeakers. *(Full dimensional drawings for enclosures supplied with all Audiom and Axiom loudspeakers).*

Axiom Enclosures . . .

Illustrated is a typical AXIOM Enclosure designed to incorporate GOODMANS LOUDSPEAKERS when used with an Acoustical Resistance Unit. Styling and shape of cabinet need only conform to the correct volume for any particular speaker system. Overall size is two-thirds that of an equivalent Bass Reflex Chamber. The bass response of the AXIOM or AUDIOM Loudspeaker, when used in these cabinets, is extended down to 20 c.p.s. No objectionable resonances occur above this frequency. Air loading of the loudspeaker cone is fully maintained to zero frequency, reducing harmonic and intermodulation distortion due to excessive cone displacement.

tickets?

See Goodmans Loudspeakers at Stand No. 105 . . . hear them in Demonstration Room D.7. Daily Demonstrations throughout the show every half-hour. Tickets available on the Stand. Avoid disappointment by posting the coupon, indicating preference of day and time. Tickets for SATURDAYS only available at the Stand on the day.

TO: GOODMANS INDUSTRIES, LTD., AXIOM WORKS, WEMBLEY, MIDDX.

Please send............*tickets for your demonstration*

at....................*a.m./p.m. on*....................*(date)*

OR at....................*a.m./p.m. on*....................*(date)*

Name ....

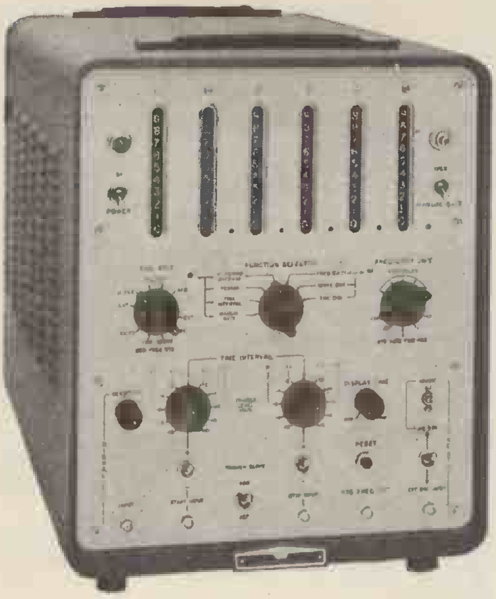
Address ....

....

WW856

Scottish Distributors: LAND SPEIGHT & COMPANY, LIMITED, 2 FITZROY PLACE, SAUCHIEHALL STREET, GLASGOW

Direct readings of



FREQUENCY
TIME
PERIOD

New -hp- 523B
ELECTRONIC COUNTER

10 cps to 1.1 MC!

- **Extreme dependability**
- **Etched, unitized circuits**
- **Permits viewing time-interval start and stop points on oscilloscope**
- **High accuracy crystal oscillator circuit**
- **Trouble-localizer lights**
- **Counts pulses of selected voltage level**

Construction of the new *-hp-* 523B is highest quality throughout. Etched circuits are rugged, ultra-dependable. Circuits are arranged for complete visibility. Trouble-localizer lights and plugs disconnecting circuit elements further simplify mainteance.

Exclusive features include a pulse output for oscilloscope Z-axis modulation permitting visual identification of the time-interval start and stop points on the input waveform measured. There is also a pulse count discriminator counting only pulses of voltage above a pre-determined level; and a high accuracy, high stability crystal controlled oscillator. Controls are color-coded, concentric, functionally arranged. Readings are direct in clear, bright numerals; decimal is automatic and illuminated.

The broad range and versatile usefulness of *-hp-* 523B is indicated by the Specifications at right. Model 523B is designed for utmost speed and simplicity in measuring production quantities, rpm, nuclear pulses, power line frequences, repetition rates, time intervals, pulse lengths, shutter speeds, velocities, relay times, frequency ratios, phase delay, etc.

With transducers, *-hp-* 523B also provides local or remote measurement of weight, pressure, temperature, acceleration, etc.

BRIEF SPECIFICATIONS

FREQUENCY MEASUREMENT:	
Range:	10 cps to 1.1 MC
Accuracy:	±1 count ±crystal stability
Input Minimum:	0.2 v RMS
Input Impedance:	Approx. 1 megohm, 30 μμf shunt
Gate Time:	0.001, 0.01, 0.1, 1, 10 seconds
Reads Directly In:	KC. Automatic decimal
PERIOD MEASUREMENT:	
Range:	0.00001 cps to 10 KC
Accuracy:	±0.3% (1 period); ±0.03% (10 periods)
Input Minimum:	1 v RMS
Input Impedance:	Approx. 1 megohm, 40 μμf shunt
Gate Time:	1 or 10 cycles of unknown
Standard Counting:	10 cps, 1 KC, 100KC, 1 MC, External
Reads Directly In:	Sec, msec, μsec; automatic decimal
TIME INTERVAL MEASUREMENT:	
Range:	3.0 μsec to 100,000 sec (27.8 hrs)
Accuracy:	±1/std. freq. counted ± stability
Input Minimum:	1 v peak. dc coupled
Input Impedance:	Approx. 1 megohm, 25 μμf shunt
Trigger Slope:	Pos. or neg. on start/stop independent or common channels
Trigger Amplitude:	−300 to +300 v adjustable
Standard Counting:	10 cps, 1 KC, 100 KC, 1 MC, External
Reads Directly In:	Sec, msec, μsec, automatic decimal
STABILITY:	2/1,000,000 per week. Also WWV
DISPLAY TIME:	Variable 0.1 to 5 sec, or indefinite
OUTPUTS:	Secondary standard: 10 cps, 1 KC rectangular, 100 KC, 1 MC sine wave.
PRICE:	$1,175.00

Data subject to change without notice. Price f.o.b. factory.

HEWLETT-PACKARD COMPANY

Represented by

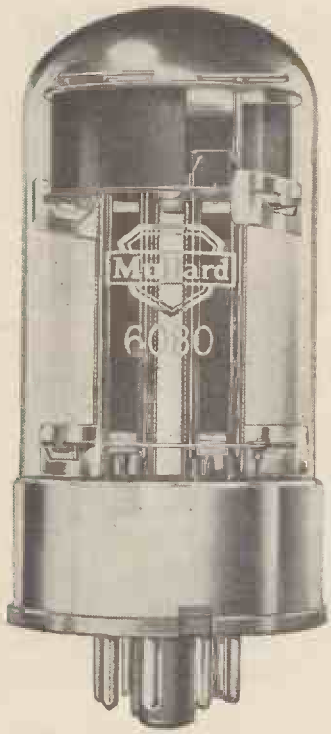
LITHGOW ELECTRONICS LTD.

1 GRANGE COURT, SUDBURY HILL • HARROW, MIDDLESEX

Telephone: Byron 8783

-hp- complete coverage in quality counters

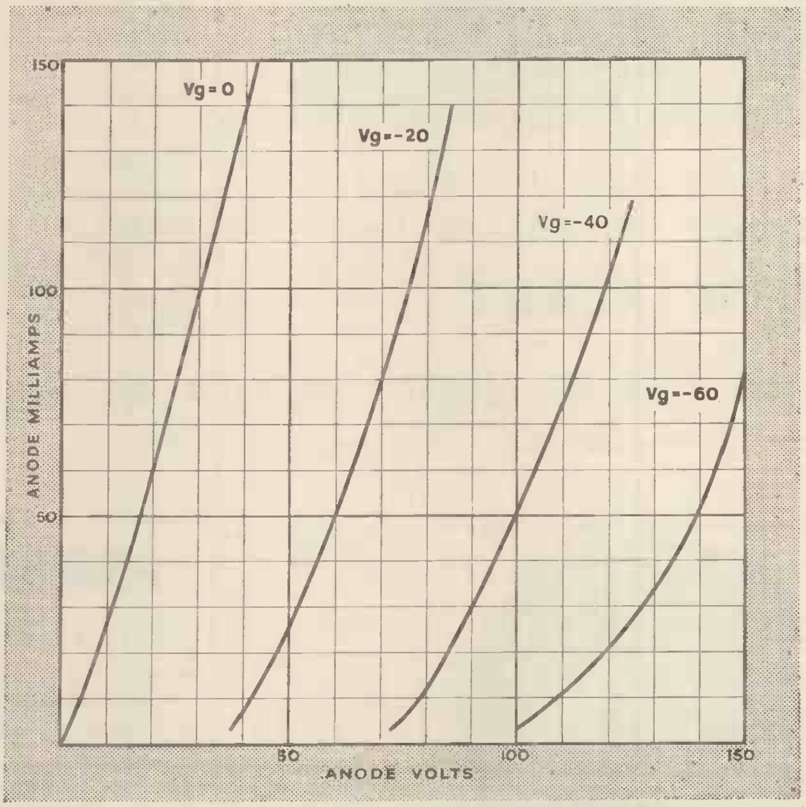
B174



SERIES REGULATOR VALVE 6080

a new double triode with REALLY low impedance

A quick reference to the anode characteristics of the 6080 reveals its unusually low impedance and the very small voltage drop produced across each of its triode sections. These are the factors that are making the 6080 indispensable in the design of more efficient series regulation and servo control systems.



Anode characteristics of each triode section of the 6080.

6080 (CV2984) Double triode with separate cathodes

V_h: 6.3 volts. I_h: 2.5 amps. Base: Octal.

Abridged data for each triode section

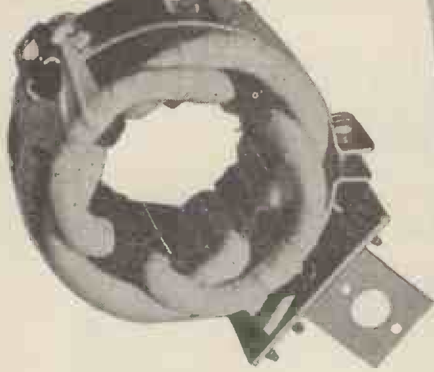
$V_a$max. 250 volts	g_m 7.0 mA/V	$I_a$max. 125 milliamps
μ 2.0	r_a 280 ohms	$p_a$max 13 watts

The 6080 is the modern version of the 6AS7-G and is available from Mullard to the American MIL-E-1 Specification.

Mullard

MULLARD LIMITED · COMMUNICATIONS & INDUSTRIAL VALVE DEPARTMENT · SHAFTESBURY AVENUE · LONDON · W.C.2

MVT 288a



Line Transformers Deflector Coils T.V. Coils

DEFLECTOR COILS
designed for 70° Deflection and employing Castallated Ferroxcube core.

LINE TRANSFORMER
employing a Ferroxcube core and incorporating Width and Linearity Controls. E.H.T. 13.5 KV.

TELEVISION COILS
wound to specification.

also 13 CHANNEL T.V. TURRET TUNERS

All enquiries to:

Gillone Electric LIMITED

ROCKSTONE WORKS . DOMAN ROAD
CAMBERLEY . SURREY
TELEPONE: CAMBERLEY 2360

FREQUENCY METERS

2½-8" up to 10,000 cycles

DIFFERENTIAL A.C. CURRENT METERS

COMPARING THE MAGNITUDE OF TWO CURRENTS.

PHASE SEQUENCE INDICATORS AND SYNCHROSCOPES UP TO 5 Kc

A Full Range of Switchboard and Portable Instruments

THE ELECTRICAL INSTRUMENT CO. (HILLINGTON), LTD.

Boswell Square Industrial Estate, Hillington, Glasgow, S.W.2. Halfway 1166 and 2194

WALMORE ELECTRONICS LIMITED

PHOENIX HOUSE, 19/23 OXFORD STREET, LONDON, W.I.

Telephone : GERrard 0522 *Cables : Valvexpor*

For immediate response Telex London 8752.

EXPORTERS OF RADIO, TELEVISION AND INDUSTRIAL TUBES, HAVE PLEASURE IN INTRODUCING THEIR BRAND

RADIO WALRAD TUBE

AND INVITE ENQUIRIES FROM BUYING AND CONFIRMING HOUSES EXCLUSIVELY FOR EXPORT

SUPPLIERS OF RADIO COMPONENTS ELECTROLYTICS, AND CATHODE RAY TUBES.

"YOU CAN RELY ON US"

Stockists of all Radio and Electronic components for manufacturers, laboratories, Educational authorities, and the amateur.

MULLARD 510 AMPLIFIER AND G.E.C. 912 AMPLIFIER—ALL PARTS STOCKED AND AVAILABLE ON H.P.

★

INCLUDING ELCOM, BULGIN, TCC, HUNTS, DENCO, ETC.
DETAILED LISTS ON ABOVE AVAILABLE
ALL AVO, TAYLOR, INSTRUMENTS FROM STOCK
NEW CATALOGUE AVAILABLE 2½d. STAMP.

RADIO SERVICING COMPANY

82, SOUTH EALING ROAD, LONDON, W.5. *Telephone : EAL. 5737*

Next to South Ealing Tube (TURN LEFT) 9 to p.m., Wed. 1 o'clock.

LEEVERS RICH

STUDIO CONSOLE MAGNETIC RECORDER

A recently developed magnetic recorder for A.C. operation in studios and laboratories.

The audio performance and reliability of this machine are of a very high order, and comply with the most advanced requirements of film, T V and sound broadcasting. Special versions are available for recording and transcription, using the

FEATURES

Rugged all-steel construction.

Free-running castors with foot-operated brakes.

Two tape speeds, and universal spool adaptors.

Entirely self-contained.

Heavy-duty Model E mechanism.

Immediate access to all parts for routine maintenance.

Syncropulse *patent interlock system*

LEEVERS-RICH EQUIPMENT LTD., 78b, Hampstead Road, London, N.W.1. Eus. 1481

AMBASSADOR *presents*

The 7856

POWERFUL LONG RANGE 8 WAVEBAND SUPER-HET

in continental styling

This Is Britain's finest Export Radio Receiver—far away ahead in appearance, technical design and performance. Long range with R.F. stage. Electrical Bandspreading Twelve and a half inches of scale length to each band. Tuning indicator, separate bass and treble controls. A.C. operation only.

High Fidelity sound system with Twin frontal angular mounted wide frequency range loudspeakers.

Send today for new Export leaflet describing this and other new models.

The choice of quality minded people

Ambassador Radio & Television Ltd., Brighouse, England.

"Don't forget

your Televet"

The COMPLETE TELEVISION SERVICING INSTRUMENT

Write now for full details to

AIRMEC LTD
HIGH WYCOMBE
BUCKINGHAMSHIRE

WANTED

VERY HIGH PRICES PAID FOR THE FOLLOWING:—

APN3	BC342	I-152
ARCI	BC6II	TS13
ARC3	BC713A	TS35
ARN7	BC714A	TS45
ARTI3	BC721	TS148
BC221	BC788C	TS174
BC312	CPN2	TS175

Also Modulation Transformers Thermador No. CS2160. and Scanner (antenna) RC94 or parts.

ALTHAM RADIO CO.
JERSEY HOUSE, JERSEY STREET
MANCHESTER 4

Telephone: Central 7834/5/6

Largest stocks in Europe of Government surplus material.

OSMOR

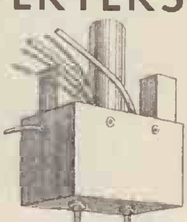
Free! Send 7½d. in stamps for circuits, practical drawings, of F.M. Tuner, Band III Converter, various T.R.F. and Superhet circuits, Miniature circuits, Switching circuit, Price Lists, etc. Components and information supplied concerning most published circuits in **WIRELESS WORLD, PRACTICAL WIRELESS, RADIO CONSTRUCTOR**

BAND III CONVERTERS

I.T.A. Converters: London, Lichfield, Manchester. A very efficient Band III Converter for all T.V. sets (including TRF). Approximately one hour to build! Guaranteed no breakthrough of Band I. Will convert any Band III Channel to any Band I Channel A.C. or A.C./D.C. Size 4⅜ x 2¼ x 3in. Circuits, Wiring Diagrams and Full constructional information.

Complete Kit **65/-**

Completely Wired **80/-**



Band I Filter—Rejects B.B.C. from I.T.A. aerial and Improves picture. Suitable for all makes inc. instructions. Fitted in 2 minutes. **10/-**

A masterpiece of technical achievement!

418 BRIGHTON ROAD, SOUTH CROYDON, SURREY *Telephone: CROydon 5148/9*

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

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. All our equipment is on demonstration at our showroom in conjunction with a variety of pick-ups, speakers, etc. If you can possibly call we shall be pleased to see and help you.

The New No. 1 "SYMPHONY" AMPLIFIER MARK III 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 even more important than the 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, and there is full provision for Radio Tuner, Tape take-off and Playback. It is available to match 2/3 or 15 ohms speakers. Price 12 gns. (carriage 5/-). Fitted in portable Steel Cabinet, 2 gns. extra.

The New No. 2 "SYMPHONY" AMPLIFIER MARK III, as No. 1 but with 10-watt Push-pull triode output and triodes throughout. Woden mains and output transformers and choke. Output tapped 3, 7.5 and 15 ohms. Full provision for Tuner and Tape. 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.

No. 1 "SYMPHONY" FM TUNER. High grade instrument with extremely silent background **£15/8/-.** Power Pack **£3/7/6.**

No. 2 "SYMPHONY" AM/FM TUNER. Combining all the specifications of the Long, Medium and Short wave Superhet AM Tuner and our No. 1 FM Tuner. Separate Coil Assemblies and I.F.s. Fully self-powered on one chassis. **26 gns.**

N.R.S. EMPRESS FM/VHF TUNER/ADAPTOR. Fine little job, will plug into any radio and add F.M. **£13/15/-.** Magic eye assembly **£1** extra if required. Ditto mounted in beautiful dark walnut cabinet complete with magic eye **16½ gns.** Carriage 7/6.

"SYMPHONY" AM/FM RADIOGRAM CHASSIS. Very high grade radiogram chassis combining Long, Medium and Short and V.H.F. bands. Large engraved dial. Push/pull output for high quality. Complete with 10in. Goodmans speaker **26 gns.** Carriage and packing 7/6.

GRAMOPHONE UNITS

COLLARO AC3/554 *£9/6/0*

Special Bargain. **COLLARO RC54 AUTOCHANGER.** Price reduced to £9/10/0 (List Price, £13/17/6). Both complete with Studio 'O', 'P', or 'PX' head.

GARRARD TA and TB **£9/0/0**

New model RC88 AUTOCHANGER **£15/11/4**

RC98 **£17/10/3**

Variety of Pickup cartridges available in Garrard shell to fit. Leaflets on Collaro and Garrard Gram. Units on request.

COLLARO 2010, less pickup, **£14/15/-,** with Studio pickup and transcription cartridge **£19/10/-.**

LENCO GL50, 4-speed continuously variable from above 78 r.p.m. to below 16 r.p.m. Special Autostop. Price with Studio "O" or "P" head or Goldring variable reluctance head **£21/17/10.**

LENCO GL55, as above but without pickup and autostop but fitted with Special Device for Groove Location and knob which completely disengages drive-wheel. Suitable for use with any pickup, especially transcription types and B.J. Arm. Price **£17/10/4.** Immediate delivery guaranteed.

NORTHERN RADIO SERVICES

11 KINGS COLLEGE ROAD, ADELAIDE ROAD, LONDON, N.W.3. *Phone: PRImrose 8314*

Tubes: Swiss Cottage and Chalk Farm. Buses: 2, 13, 31, 113 and 187

LENCO GL56, as GL55 but with pickup, **£23/7/-.**

CONNOISSEUR 3 variable speeds, **£28/8/-.**

GARRARD 301, 3 variable speeds, **£26/8/-.**

"SYMPHONY" RJ ENCLOSURE. In polished walnut 24 in.×11 in.×10 in., **£9.** Super 8CSAL Speaker to suit, **7 gns.** Real hi-fi in small space.

"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.** Carriage 7/6. Ready built, **15/-** extra.

As above but fully finished in figured walnut veneer with beautiful moulding and speaker grille, 10in., **£11,** 12in., **£11/10/-.** Other veneers to order.

CONSOLE AMPLIFIER CABINETS, 33in. high, lift-up lid with piano hinge, take Tape Deck, Gram Unit or Autochanger, Amplifier, Pre-Amplifier, and Radio Feeder Unit, finished medium walnut veneer. De luxe version, price **12 gns.** Oak or mahogany veneers and special finishes to order. Carriage according to area. We will quote by return.

BK

PARTNERS LTD.

introduce

The new Goodsell MA5/UL/C Ultra Linear Amplifier and UL/TC Control Unit - £23.5.6 *complete*

Details of this high quality 10-12 watt Amplifier and the B K range of splendid loudspeakers enclosures gladly sent on request.

Demonstrations at our showrooms
Daily 10.30 a.m.—5.30 p.m.
Saturdays 10.30 a.m.—12.30 p.m.

Available from us:— "High Fidelity" — the Why and How for amateurs. By G. A. Briggs, 12/6. Published by Wharfedale.

H.P. TERMS ARRANGED

B. K. PARTNERS LTD.

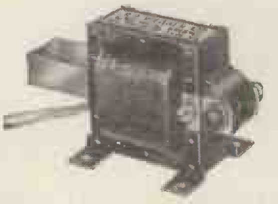
229 REGENT ST., LONDON, W.1 (*Entrance Hanover St.*) *'Phone: REG 7363*

Si vous lisez le français technique, demandez un spécimen gratuit de

ELECTRONIQUE INDUSTRIELLE

revue tèchnique publiée par les
EDITIONS RADIO, 9, rue Jacob
Paris 6°—France

A.C. SOLENOID TYPE SA/T



Continuous ¾ lb. at ¾"
Instantaneous to 6 lbs.

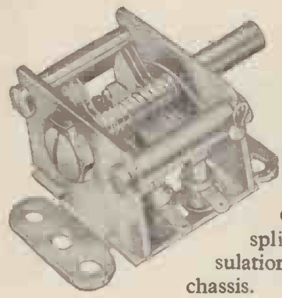
100% PRODUCTION INSPECTION

Larger and Smaller Sizes Available. Also Transformers to 6 KVA 3 Phase

R. A. WEBBER LTD.

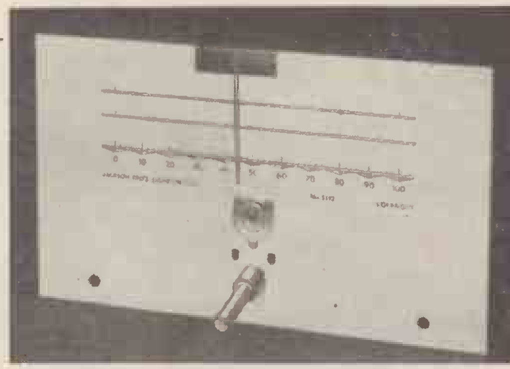
18 FOREST ROAD, KINGSWOOD, BRISTOL. PHONE 74065

JACKSON



TYPE U.101/S.S.
Cat. No. 5095.

Chassis Mounting Gang Condenser with split-stators, ceramic insulation. Cadmium plated chassis. Silver plated brass rotor and stator. Rotor earthed to frame. Capacities available each half: 3-10 pf., 3.8-27 pf., 4-35 pf. or 4.43 pf. PRICE **10/9**



S.L.16 DRIVE RETAIL PRICE **11/6**

A general purpose slide rule drive for F.M./V.H.F. units, short-wave converters, etc. Printed in three colours on aluminium, with a 0-100 scale and provision is made for individual calibrations. Travel of pointer 4$\frac{3}{8}$in. Scale plate 7in. × 4$\frac{1}{2}$in. Scale aperture 5$\frac{1}{2}$in. × 1$\frac{1}{2}$in.

S.L.15 DRIVE RETAIL PRICE **25/6**

A complete kit of parts for the construction of the Jackson S.L.15 drive, scale calibrated for the F.M./V.H.F. band.

IT'S RELIABLE— IF IT'S MADE BY JACKSON'S!

Write for further details :—

JACKSON BROS. (LONDON) LTD. · KINGSWAY · WADDON · SURREY.
Telephone : CROydon 2754/5. Telegrams : Walfico, Souphone, London.

TRANSFORMERS COILS CHOKES

LARGE OR SMALL QUANTITIES
TRADE ENQUIRIES WELCOMED

SPECIALISTS IN
FINE WIRE WINDINGS
MINIATURE TRANSFORMERS, PICK-UP, CLOCK AND INSTRUMENT COILS, ETC.
VACUUM IMPREGNATION TO APPROVED STANDARDS

ELECTRO-WINDS LTD.

CONTRACTORS TO G.P.O., M.O.S., L.E.B., ETC.
123-5-7 PARCHMORE ROAD, THORNTON HEATH, SURREY
LIVINGSTONE 2261 EST. 1933

THE WORLD'S GREATEST BOOKSHOP

FOYLES

★ ★ FOR BOOKS ★ ★

NEW AND SECONDHAND
Technical Books

Foyles have Departments for Gramophone Records, Stationery, Handicraft Tools and Materials, Music, Magazine Subscriptions, Lending Library.

119-125 CHARING CROSS ROAD, LONDON, W.C.2
Gerrard 5660 (20 lines) ★ Open 9-6 (Thurs. 9-7)
Nearest Station: Tottenham Court Road

WESTWOOD'S for the Best goods

GET ALL YOUR
COMPONENTS
(made by The leading mfgs only)
From

WESTWOOD'S

46 George Street

Phone **OXFORD** 47783

Spectone
STEREOPHONIC

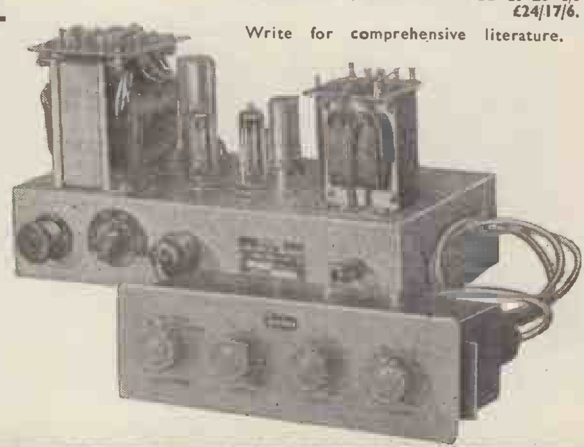
TAPE REPRODUCERS
bring
DIMENSIONAL SOUND REPRODUCTION
into the home

Type 123 200 gns.
A Twin-track Tape Reproducer designed to reproduce the new "Stereosonic" recordings and single track tapes. An instrument calculated to give the connoisseur "high fidelity" of a quality hitherto unattainable.
Other models at 100 gns and £165.

The Spectone WINDSOR Five-Fifteen

POWER AMPLIFIER with pre-amplifier. This remarkable equipment based on the famous Mullard 5-10 circuit will meet the most exacting requirements of "high fidelity" at an extremely low price. Treble Control continuously variable from +16 db to -15 db at 10 Kc/s. Bass Control continuously variable from +18 db to -12 db at 20 c/s
£24/17/6.

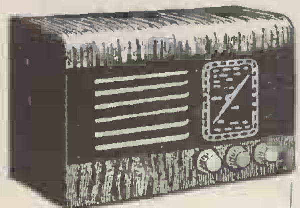
Write for comprehensive literature.

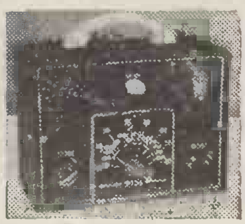


Spectone *The Living Truth in Sound*

SPECTO LTD. Vale Rd Windsor

BUILD ONE OF THESE RADIOS NOW





£5.7.6

Total building cost £5/7/6 including choice of beautiful walnut veneered cabinet or ivory or brown bakelite.

This is the lowest possible price consistent with high quality. No radio knowledge whatever needed . . . can be built by anyone in 2-3 hours, using our very simple, easy-to-follow diagrams. This terrific new circuit covers all Medium and Long Waves with optional negative feedback, has razor-edge selectivity, and exceptionally good tone. Price also includes ready drilled and punched chassis, set of simple, easy-to-follow plans—in fact, everything! All parts sparkling brand-new—no junk! Every single part tested before despatching. Uses standard octal-base valves: 6K7G high-frequency pentode feeding into 6J5G anode-bend detector triode, coupled to 6V6G powerful output beam-power tetrode, fed by robust rectifier. For A.C. Mains, 200-250 Volts (low running costs—approximately 18 Watts). Size 12in. × 6in. × 5in. Cost of all parts and set of plans £5/7/6 (plus 3/6 for packing and post). C.O.D. 1/6 extra. Priced Parts list 2/-.

49/6

Build this exceptionally sensitive twin-triode radio. Uses unique assembly system and can be built by anyone without any radio knowledge whatever in 45 minutes. Handsome black-crackle steel case with specially made black and gold dial with stations printed. Size of radio only 6½in. × 5in. × 3in. Covers all Medium and Long waves works off throwout aerial (from 6ft. long)—uses one only "Ever-Ready" all-dry battery which lasts many months, as H.T. consumption is only 1 to 1.5 mA. Ideal for Bedroom, Garden, Holidays, etc. Many unsolicited testimonials. Mr. Woods of Boston, writes: "I am quite pleased with the little set I purchased from you. I can get the "Home," "Regionals," "A.F.N." and lots of Foreign Stations. I am very satisfied—it is worth every penny of the price." Cost of all parts, plans—everything down to last nut and bolt, 49/6, including post, packing, etc. (for headphone reception), or send 2/- for priced parts list. Optional extra stage with speaker and button base valve. All fit inside case—costs only 38/6. Post free. Note: We stock complete range of components and valves.

Orders despatched by return.

Limited Quantity — **SEND TODAY!**

CONCORD ELECTRONICS (Dept. W.W.9.)
39, Queens Road, BRIGHTON, 1

POLYTHENE
INSULATORS, END CAPS, PLUGS, ETC.
for
T.V. AERIALS
Standard Articles or Special Mouldings

AMPLEX APPLIANCES (KENT) LTD.
19 DARTMOUTH ROAD, HAYES, BROMLEY, KENT
(RAVensbourne 5531)
All export enquiries to
ANTEX LTD., 3 TOWER HILL, LONDON, E.C.3

THE BEAU-BUREAU MARK III

This magnificent bureau type cabinet is in specially selected walnut veneer exterior, with a light sycamore lining. It gives you two large-sized storage compartments
Overall dimensions:
Length 32″ Height 34″
maximum depth 16″
minimum depth 11″
Motor board size: 15½″ x 13″
Scale aperture size: 10½″ x 14½″
NET TRADE PRICE £13.13s.0d.
Plus 15s. 0d. carr.

Send for Cabinet List for more details.
Send for our current monthly bulletin of Replacement Radio/Radiogram chassis, Tape recording Equipment, etc.
Trade only supplied
V.E.S. WHOLESALE SERVICES Ltd.
Dept. (W.W.), 11, Gunnersbury Lane, Acton, W.3 *Tel.: ACOrn 5027*

CLYNE RADIO LTD.

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

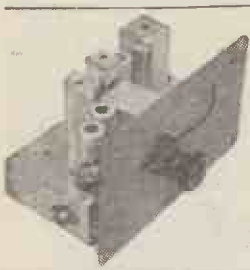
MUSeum 5929/0095.

(50 yards only from Tottenham Court Road Tube !)

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

EUSton 5533/4/5

TELETRON BAND III CONVERTOR! Still available, this very popular convertor kit as illustrated and fully described in previous issues of the "W.W." For use with most T.R.F. or Superhet Band I .T.V. Receivers. Construction details only, with separate individually priced parts list 6d. post free. Kit complete as specified 48/6, plus 2/- P. & P.
Mk. II Fringe area version kit complete 59/6, plus 2/- P. and P. Power pack kit for either of above 25/-.
We carry comprehensive stocks of all Band III Convertors by leading manufacturers. Also aerials, cross-over boxes, air-spaced low-loss co-axial cable at 10d. per yard. Let us have your enquiries. Any branded convertor supplied on H.P. terms!

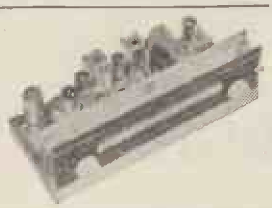


THE JASON F.M. TUNER

Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in mc/s., and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 8in. × 5in., chassis 7in. × 4½in. × 1½in. Complete standard kit £6/15/- plus 2/6 p. and p. Fringe area kit £7/15/-, plus p. and p.

THE T.S.L. F.M. TUNER!

We can now supply this FM/VHF adaptor either in kit form, or fully assembled, wired and tested. Our price for the ready-built unit which incorporates its own power supply, is £13/15/- only tax paid, plus 5/- P. & P. or H.P. terms. Magic eye tuning indicator, just plug in, 19/- extra. Or the kit complete as specified £10/19/6 plus 3/6 P. & P. The booklet "F.M. TUNER CONSTRUCTION" (32 pages) with full technical data and point-to-point wiring diagrams, together with our separately priced parts list, is available at 2/6 post free.



THE T.S.L. AM/FM CHASSIS! Exceptional value. Covers L.M. and S.W. plus F.M.! 8-valve push-pull output. Ferrite rod aerial. Valve line-up: ECC85, ECH81, EF89, EABC80, ECC82, two 6BW6s plus 5y3. Large full-vision dial, size 14¾ × 6in. Chassis size, overall: 15 × 7¾ × 8in. high. Tax paid 26 guineas, plus 5/- packing and carriage. A supplementary extra is magic eye EM34, complete with escutcheon and fixing cable at 26/-. H.P. terms available. Demonstrations at 18 Tottenham Court Road!

THE DULCI F.M. TUNER. Incorporates own power supply, suitable for use with any amplifier. Valve line-up: ECC85, two EF89, EABC80, 6 x 4, and EM80 indicator! Overall size: 9 × 6 × 5½in. high. Pre-Budget price £16/16/- plus 5/-. P.P. Illustrated leaflet available, also H.P. terms.

SPECIAL OFFER!! Champion Model 835 FM/VHF Adaptor! Designed for the instant conversion of A.C. radiograms, table A.M. receivers and Hi-Fi audio amplifiers, to enable owners through their existing equipment to obtain the best results from the new F.M. transmission. Two connections only. One to the A.C. mains supply, the other to the pick-up sockets. Valve line-up: EF85, two EF80s, EB91, and EZ80. In attractive red and cream bakelite cabinet. Illustrated leaflet available on request. Price whilst stocks last only £13/19/6 tax paid, plus 3/6 P. & P. H.P. terms available.

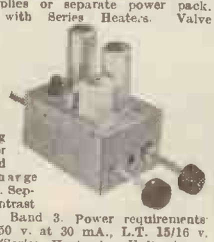
DENCO F.M. TUNER. This highly successful kit is still available at inclusive price of £6/7/6 plus 2/6 P. & P. This kit includes all components and the five valves required for the extra I.F. Stage for fringe area reception. If required, "Denco" dial and drive assembly is available for the above at 9/- extra. Full constructional details 1/6 post free.

F.M. POWER PACK KIT. We can now supply complete kit for power pack suitable for the above F.M. tuners or any other similar type. Price for the complete kit is 37/6 only, or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X4 and built on chassis size only 6 × 4 × 1½in. Optional extra for power pack. Bulgin Octal Plug 2/3.

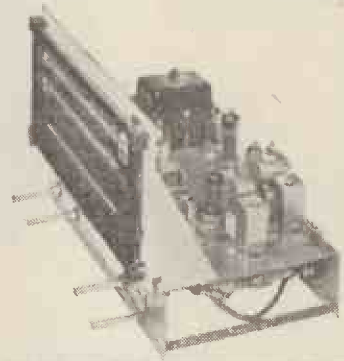
THE R.E.P. 1-VALVE RECEIVER. All dry battery operation, for use with headphones. The complete kit is available at 42/-, less batteries, plus 2/- P. & P., or full instructions at 9d. post free.

COMPETITIVE!! BAND III. CONVERTORS!

THE FAMOUS UNIVERTER—COMPARE THE PRICE! Handsome walnut cabinet. Suitable all areas. Contains own power supply. Simply connect to aerial. Four-valve circuit. Complete with all instructions £6/19/6 plus 3/6 P. & P.



Type "M.L." for running from existing power supplies or separate power pack. Available with Series Heaters. Valve line-up: PCC84 and PCF80. Size: 4 × 2¾ × 4½in. Fitted with external fine tuning control for Band 3 and Band 1/3 change over switch. Separate contrast control for Band 3. Power requirements H.T. 150/250 v. at 30 mA., L.T. 15/16 v. .3 amp. (Series Heaters). Unit simply fitted inside cabinet. Complete with handsome escutcheon. Available for A.C. operation with parallel heaters, ECC84 and ECF80 as above. Price £4/12/6. P. & P. 2/6. Full instructions supplied with each unit. Please specify whether for London, or Birmingham, or Manchester.



AM/FM RADIOGRAM CHASSIS! BARGAIN!

A special purchase of strictly limited quantity enables us to offer the following! For Medium, Long and F.M. Wavebands, plus gram position . . . Chassis size overall 13½in. long, 9in. high, 7½in. deep. Dial which is attractive red, green and gold lettering, on black background, measures 12in. × 5¼in. horizontal. For A.C. mains, 200/250 v. Valve line-up EL84, EABC80, EF85, ECH81, ECC85, EZ80, plus EM80 Magic Eye!! Limited quantity at bargain price of £18/19/6 only, plus 5/- P. & P. H.P. terms.

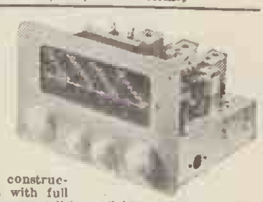
DULCI AM/FM CHASSIS H4

Illustrated leaflet available. L.M. and Short Waves plus F.M. This is a quality chassis 6 latest B.V.A. Mullard Valves, including magic eye. High Q. inductances throughout, also Ferrite rods. Price is £27/16/- cash—or H.P. terms.

DULCI AM/FM TUNER

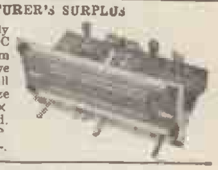
Just released. Details available. Price £24 including tax, or H.P. terms.

AM/FM KIT! FIRST AGAIN!



Introducing the JASON AM/FM KIT for medium waves and F.M.! As illustrated this is a very high quality chassis incorporating 8 of the latest miniature valves, plus DM70 magic eye. Kits are available for chassis complete with output stage at £15/5/-. Also less output stage but with own built-in power pack at £13/19/6 only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Fully illustrated Data Booklet with full construction details, plus individually priced component list, available per return of post at 2/- post free. Both plus 3/6 P. & P.

SPECIAL PURCHASE! MANUFACTURER'S SURPLUS



Owing to favourable purchase, we can offer strictly limited quantity of these handsome chassis. AC/DC 200/250 v. for Medium and Long Waves, plus gram position. Incorporates own frame aerial. Valve line-up: U107, N108, DH107, W107 and X109. Overall chassis size 12 × 5¾ × 7½in. high. Attractive bronze dial with gold and cream lettering. Dial size 11¼ × 4½in. Scale length 7½in. Logging scale provided. Price £7/19/6 only, tax paid, plus 3/6 P. & P. H.P. terms. £4 deposit plus four monthly payments of 22/-.

THE R.C. GRAM REPLACEMENT CHASSIS KIT.

Still available Our very popular Gram Chassis replacement kit. For long, medium and short waves, and provision for gram. Valves 6K8, 6K7, 6Q7, 6V6 and 6X5.

For A.C. Mains 200/250 v. Chassis size: 13½in. × 5½in. × 2¾in. Dial size 10in. × 4½in. Assembly is simplified by use of ready assembled coil pack Illustrated booklet with full assembly instructions, with itemised price list, is 1/6 post free—or the kit complete to last nut and bolt at £8/8/- plus 2/6 P. & P.

THE R.C.3/4 WATT AMPLIFIER KIT.

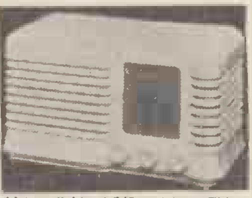
Just released! Compare the advantages! Treble bass, AND middle controls! For crystal or magnetic pickup! A.C. Mains 200/250 v. Valve line-up, 6V6GT, 6SG7, metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 4in. × 1½in. Four engraved cream knobs are included 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. and p. Hearing is believing.

ACOS TYPE 7 Crystal Microphone Inserts Brand new. 7/6 each, post free.

Our advantageous H.P. terms are available on any single item over £5. Let us have your enquiries.

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

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. Plus 2/6 packing and carriage for complete kit.



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 6SG7, 6 X5GT and 6 V6GT. Chassis ready drilled. Cabinet size, 10½in. × 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 wave-change 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.

SURPLUS BARGAINS

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamps	D.C. 2in.	M.C.	R.P.	50/-
50 microamp	D.C. 3½in.	M.C.	F.R. (Tropicalised)	85/-
50 microamp	D.C. 5in.	M.C.	Rectangular	120/-
50 microamp	D.C. 4in.	M.C.	Rectangular	110/-
50 microamp	D.C. 3½in.	M.C.	F.R.	95/-
100 microamp	D.C. 2½in.	M.C.	F.R	45/-
200 microamp	D.C. 2in.	M.C.	F.R. (Tropicalised)	30/-
200 microamp	D.C. 3½in.	M.C.	F.R.	65/-
500 microamp	D.C. 2in.	M.C.	F.R.	18/6
1 mA.	D.C. 2in.	M.C.	F.R.	17/6
1 mA.	D.C. 2in.	M.C.	F.Sq.	22/6
1 mA.	D.C. 2in.	M.C.	F. Sq. (1954 manufacture by Elliott)	25/-
1 mA.	D.C. 2½in.	M.C.	Desk Type	30/-
5 mA.	D.C. 2in.	M.C.	F. Sq.	10/-
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
500 mA.	D.C. 2½in.	M.C.	F.R.	10/6
.5 amp.	R.F. 2in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2½in.	M.C.	F.R.	10/-
120-0-120 amp.	D.C. 2in.	M.C.	F. Sq. (shunt required)	15/-
150 amp.	A.C. 4in.	M.I.	R.P.	45/-
1 amp.	R.F. 2½in.	Thermo	R.P.	7/6
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
25 amp.	D.C. 2½in.	M.I.	F.R.	6/6
30 amp.	D.C. 2½in.	M.I.	F.R.	12/6
15 volt	A.C. 2½in.	M.I.	F.R.	10/-
20 volt (5 mA.)	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
300 volt	A.C. 2½in.	M.C.	F.R.	35/-
300 volt	A.C. 3½in.	M.I.	F.R.	30/-

2½in. ROUND FLUSH MOUNTING METER by WESTON, blank scale ready for re-engraving, FSD 650 microamps, brand new, 27/6 only.

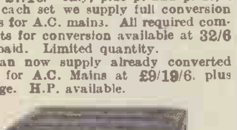
SPECIAL. U.S. 0-1 mA. 2½in. taken from equipment but perfect, 22/6 each. R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.

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

COMMUNICATION RECEIVER PCR.2 3-wave band, 13-50, 190-570, 900-2,000 metres. Valve line-up 6V6, EBC33, X61 and 3-EF.39. Illuminated calibrated dial, fly-wheel tuning, aerial trimmer. In black crackle case size 17½in. × 10in. × 8in. Output socket for 3 ohm speaker, or headphones. Absolutely brand new in original cartons, manufactured for Govt. by PYE LTD.

Price £7/10/- only, plus p. and p. 10/-. With each set we supply full conversion details for A.C. mains. All required components for conversion available at 32/6 post paid. Limited quantity.

We can now supply already converted ready for A.C. Mains at £9/19/6. plus carriage. H.P. available.



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, 17/6.

COIL PACKS. Manufacturers' Surplus. Miniature size, only 2½in. × 2½in. × 1½in. deep. Iron-cored. For L.M. and S.W. with gram. position. Switch has 2-inch spindle. Absolutely brand new, complete with circuit. Price only 27/6. plus 1/6 P. & P. A snip!

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., transformer, and a host of small components. The whole unit which measures only 8½ in. × 8½in. × 13½in. is brand new, enclosed in black crackle box, and can be supplied at 45/-, plus 5/- p. & p.

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. × 7in. × 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. and p. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at 10/-. Also LT. 1.5 v. A.D. 35 at 1/6.

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. × 2½in. × 1½in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 v. L.T.

B.S.R. MONARCH. The very latest cream 3-speed mixer Auto-changer. Complete with turn-over crystal pick-up. Complete in original manufacturer's cartons, fully guaranteed. Price only £7/19/6 Carriage Paid. Buy now! Quantity at this price strictly limited.

JUST ARRIVED! Replacement pick-up cartridge for B.S.R. Monarch, etc., type HGP 37. Complete with sapphire stylii. fitted in few seconds. Limited quantity at 18/6 only! Tax paid, post free!

RC.54. Special Purchase! Latest type 3-speed, incorporating "T" type turnover head. Cream finish. Original manufacturer's cartons. £9/19/6 only, plus 3/6 p. and p. H.P. terms available.

RECORD PLAYER CABINETS. Specially made to house any type of single record unit. Finished in dove-grey leatherette. Baseboard measures 14½in. × 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 leaflets.

R.F. UNITS. All new condition and complete. Case size 9½in. × 7½in. × 5in. Type 24, 20-30 Mc/s. 8/6. Switched Tuning. Type 25. 40-50 Mc/s. 10/6. Switched Tuning. Type 26, 50-65 Mc/s. Variable Tuning, 22/6. ALL these units Post Free.

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.

MU-METAL SCREEN for VCR97. Price 10/- post free.

MAINS TRANSFORMER BARGAINS. Limited quantities. 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. 230 v. Input, 300-0-300 80 mA., 6.3 v., 3 a., 4 v. 2 a. Tropicalised drop-through type, 9/6 only, plus 1/6 P. & P. Input 110/230 v. Auto load 230 v. 750 mA., 350-0-350 130 mA. Tapped 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. 270-0-270, 100 mA. 6.3 v. 3 a., 5 v. 2 a., 200/250 v. Input universal mounting 16/6, 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/- P. & P. New condition.

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 stadard 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.

HEADPHONES. Low resistance. Brand new Ex.-W.D. type CLR. 7/6 per pair, plus 1/6 p. & p. High resistance, 4000 ohms, brand new lightweight 15/- per pair, plus 1/6 p. & p.

VALVES

We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list but the following is a selection only of brand new imported valve types, fully guaranteed. Purcahse Tax Paid.

EABC80	10/-	DAF96	10/6	PL83	11/6
EAF42	10/-	DF96	10/6	PY80	10/6
EB41	7/6	DK92	10/6	PY81	10/-
EB91	7/6	DK96	10/6	PY82	9/6
EBC41	10/-	DL96	10/6	PY83	11/6
EBF80	11/6	or 39/6 per set		UBC41	10/6
ECC81	9/-	of four.		UCH42	11/6
ECC82	9/-	DM70	9/-	UF41	10/6
ECC83	9/-	EL41	10/6	UL41	10/6
ECC84	15/-	EL84	11/6	UY41	9/-
ECC85	10/-	EM80	9/-	6AQ5	8/6
ECF82	15/-	EY51	12/-	6AT6	8/-
ECH42	11/6	EY86	14/6	6AU6	9/6
ECH81	11/6	EZ40	8/6	6BA6	8/6
ECL80	11/6	EZ80	8/6	6BE6	9/-
EF41	10/6	PCF80	12/6	6BW6	8/6
EF80	10/6	PCF82	12/6	6X4	7/6
EF85	10/6	PCC84	12/6	35W4	7/6
EF86	12/6	PL81	13/6	50B5	10/-
EF89	10/-	PL82	10/6	50C5	10/-

In addition we naturally have all usual surplus types available such as 6V6GT, etc. All in our valve price list!

BRAND NEW C.R. TUBES.—By leading manufacturer, 12in. equivalent to MW 31/74 £11/19/6. MW36/24 Tinted. Latest type 14in. rectangular 6.3 v. heater. 12-14 Kv. in original sealed cartons. Limited quantity only at £12/19/6. Ditto 17in. type 17ASP4. Price £18/19/6. All H.P. available. Plus 15/- packing, carriage and insurance

TRANSISTORS! MULLARD TYPE OC.71. Available ex stock at new list price of 24/- each, post free.

Another Cabinet Bargain. Special purchase of walnut veneered trolley-type cabinets originally intended for use in projection T.V. Easily recognised as being of leading High Quality manufacturer's stock, heavy dark solid walnut. Can be easily adapted to house tape recorder, amplifier, radiogram. etc., etc. Measurements external 24½in. × 16in. × 29in. The whole is mounted on castors. Unrepeatable bargain at £5/19/6. plus 10/- packing and carriage. We have a large selection of all type cabinets. A stamp will bring list.

No. 38 TRANSMITTER/RECEIVER WALKIE-TALKIE. Range approx. 5 miles. Coverage 7.4-9 Mc/s. The set only complete with valves at 25/-, in very good condition.

We also have available "38" sets, absolutely complete with junction box, aerial, headphones, microphone, spare set of valves, with full operating instructions, absolutely brand new in original sealed packing cases, at 99/6 each complete station, plus 5/- carriage. Export enquiries invited.

POWER PACK. By leading manufacturer. Input 200/250 v. Output 350-0-350 280 mA., 6.3 v., 8 a., 6.3 v. 2 a., 4 v. 7 a., 5 v. 2 a. Fully smoothed. Incorporates valve rectifier GZ32. Chassis measures 13½in. × 7in. × 5½in. Wt. 22lb. Few only at £4/19/6, plus 3/6 p. and p.

CLYNE RADIO LTD.

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

R.S.C. BATTERY CHARGING EQUIPMENT

All for A.C. MAINS 200-250v., 50 c/cs. Guaranteed 12 months.

ASSEMBLED CHARGER 6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads, Double Fused. Only **46/9** carr. 3/6.

ASSEMBLED CHARGERS

6 v. 1 amp	19/9
6 v. or 12 v. 1 amp.	25/9
6 v. 2 amps.	29/9
6 v. or 12 v. 2 amps.	38/9
6 v. or 12 v. 4 amps.	56/9

Above ready for use. Carr. 2/9

HEAVY DUTY KIT
12 v. 30 amp. Suitable for garage or firm with a number of vehicles. Mains input 200/250 v. 50 c/s. Outputs 12 v. 15 amp. twice. Consists of Mains Trans. 2 Metal Rectifiers. 2 Meters. 4 Fuses. 4 Terminals. 2 Rheostats and circuit. Only 9 gns., carr. 15/-.

BATTERY CHARGER KITS
Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case, Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.

6 v. or 12 v. 1 amp.	22/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 4 amps.	49/9

BATTERY CHARGER KIT
Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trains., 0–9–15 v. 6 a. output, and variable charge rheostat with knob. Only 45/9. Post 3/-.

Assembled 6 v. or 12 v. 4 amps.
Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 3/6. **69/6**

SELENIUM RECTIFIERS

L.T. Types			
2/6 v. ½ a.h.w.	1/9	6/12 v. 6 a.	19/9
6/12 v. ½ a.h.w.	2/9	6/12 v. 10 a.	25/9
F.W. Bridge Types		**H.T. Type H.W.**	
6/12 v. 1 a.	5/9	120 v. 40 mA.	3/9
6/12 v. 2 a.	8/9	250 v. 50 mA.	5/9
6/12 v. 3 a.	12/9	250 v. 80 mA.	7/9
6/12 v. 4 a.	16/9	250 v. 150 mA.	9/9
		300 v. 275 mA.	12/11

CO-AXIAL CABLE. 75 ohms, ¼in., 8d. yard. Twin screened feeder, 11d. yard.

5 CORE FLEX. Henleys circular rubber 14/36. Each lead colour coded. 1/6 yd.

T.V. CABINETS. For 15, 16 or 17in. tube. Table model with doors, 79/6, carr. 7/6. Table type for 12in. tube, 27/6, carr. 5/6. All leading manufacturers surplus.

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 6d. each, 3/9 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.2 a., 6/9 doz. 6.5 v. 0.3 a., 6/9 doz.

ELECTROLYTICS (current production). NOT Ex Govt.

Tubular Types		Can Types	
8µF 450v.	1/9	8 mfd. 350 v.	1/3
8 mfd. 500 v.	2/6	8 mfd. 600 v.	2/11
16µF 350 v.	2/3	16 mfd. 350 v.	1/11
16µF 450 v.	2/9	16µF 450 v.	2/9
16µF 500 v.	3/9	16 mfd. 500 v.	3/9
32µF 350 v.	3/9	32µF 350 v.	2/11
32 mfd. 500 v.	5/9	32 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.	2/9
50µF 12 v.	1/3	8-16µF 450 v.	2/11
50 mfd. 25 v.	1/9	16-16µF 450 v.	3/11
50µF 50 v.	1/9	16-32µF 350 v.	4/9
100 mfd. 12 v.	1/9	32-32µF 350 v.	4/9
100 mfd. 25 v.	2/3	32-32µF 450 v.	5/9
		64-120 mfd. 350v.	7/6
		100-200 mfd. 275 v.	6/11

Many others in stock.

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

VIBRATORS. Oak 2 v. 7 pin, synchronous, 7/9.

EX GOVT. E.H.T. CONDENSERS

.5 mfd., 2,500 v. Blocks	3/9
.1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated)	9/6

EX GOVT. METAL BLOCK PAPER CONDENSERS

2 mfd. 500 v.	1/9	10 mfd. 600 v.	6/9
4 mfd. 500 v.	2/8	8-8 mfd. 500 v.	5/11
8 mfd. 500 v.	5/9	15 mfd. 500 v.	7/9
4 mfd. 400 v. plus 2 mfd. 250 v.			1/11

EX GOVT. VALVES. VR137, EA50, EB34, 11d.; SP61 2/3; 4SHA 1/3; EL32 3/9; 6X5 4/9.

EX GOVT. UNITS, type RDF1 in original sealed cartons with 14 valves including 5Z4G, etc., trans., L.F. choke, Rectifier, etc., etc. We cannot enter into correspondence regarding these units which represent a really exceptional bargain at 29/9. Carr. 7/6.

CONTROL PANEL with 1 six-position 3-wafer Yaxley switch, 1 pointer knob. 2 S.P.S.T. switches, various plugs and sockets. Only 1/6.

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

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

8.8 v. 4 a., 9/9. 120-0-120 v. 40 mA.	5/9
300-0-300 v. 150 mA. 4 v. 3 a.	9/9
250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a. Potted 4¾-3¾-3in.	11/9
460 v. 200 mA., 6.3 v. 5 a.	22/9

0-16-18-20 v. 35 a., 79/6. Carriage 5/- extra.

MANUFACTURERS SURPLUS TRANSFORMERS
Fully shrouded upright. Primary 200-230-250 v. Sec. 425-0-425 v. 150 mA. 6.3 v. 3 a., 5 v. 3 a., 33/9. Clamped type 325-0-325 v. 100 mA. 6.3 v. 3.5 a., 5 v. 2 a. Wearite 19/9. Post 2/9.

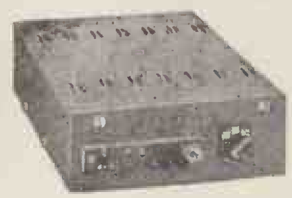
EX GOVT. SMOOTHING CHOKES

250 mA., 10 H., 50 ohms	14/9
250 mA., 3 H., 50 ohms	8/9
150 mA., 10 H., 50 ohms	10/11
150 mA., 6-10 H., 150 ohms, Tropicalised	6/9
100 mA., 10 H., 100 ohms, Parmeko	6/9
100 mA., 10 H., 200 ohms, Tropicalised	3/11
50 mA., 50 H., 1,000 ohms	6/9
L.T. type 1 amp., 2 ohms	2/9

SPECIAL OFFERS. Small 2 gang variables .005 mfd., 4/9. 8-8 mfd., 450 v. Electrolytics (midget) in lots of six, 1/6 ea.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1 An all dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagrams 39/9, or ready for use, 46/9.



Type BM2. Size 8 × 5½ × 2½in. Supplies 120 v., 90 v. and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed. **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2v. ACCUMULATORS.** When connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions 49/9 or ready for use 59/6.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS. (15 ohms), consisting of a high quality 12in. speaker, of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A8 or any similar amplifier. Rating is 10 watts. Price only £5/17/6.

MAINS ENERGISED SPEAKERS R.A. 2-3 ohms. 8in. Field 600 ohms., 10/9. 10in. Field 1,500 ohms., 23/9.

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., 5 v. 2 a.	19/9
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	25/9
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
300-0-300 v. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a., suitable for Mullard 510 Amplifier	33/9
350-0-350 v. 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. 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 ... 36/6

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

6.3 v. 1.5 a.	5/9	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
6.3 v. 3 a.	8/11	12 v. 3 a. or 24 v. 1.5 a.	17/6
12 v. 1 a.	7/9		

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; 0-3.5-9-17 v. 3 a., 17/9; 0-3.5-9-17 v. 4 a., 18/9; 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9; 0-9-15 v. 7.5 a., 28/9.

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

120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 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, 8,000Ω to 3Ω	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 or 15Ω	15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms	21/9
Push-Pull 10-15 Watts, Ultra Linear, designed for Mullard Amplifier 510	39/6
Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9
Williamson type exact to spec.	85/–

SMOOTHING CHOKES

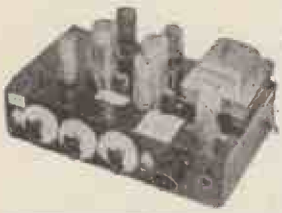
250 mA., 5 H., 100 ohms.	11/9
150 mA., 7-10 H., 250 ohms.	11/9
100 mA., 10 H., 200 ohms.	8/9
80 mA., 10 H., 350 ohms.	5/6
60 mA., 10 H., 400 ohms.	4/11

R.S.C. A6 ULTRA LINEAR 30 WATT AMPLIFIER

NEW 1956 DESIGN. HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. Tone Control Pre-amp stages are ncorporated. Sensitivity is extremely high Only 30 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams. Only **9 GNS.** Carr. 10/-. Or Factory built with 12 months' guarantee. 50/- extra. **TERMS ON ASSEMBLED UNITS: DEPOSIT 28/9** and 9 monthly payments of 28/9. If required an extra input with associated vol. control can be provided so that two separate inputs such as "mike" and gram., etc., etc., can be simultaneously applied for mixing purposes. Extra cost of this 13/-. Cover as illustrated 17/6 extra.

Type 807 output valves are used wth High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 17 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B., 30-20,000 c/cs., 12 D.B. "lift" at 50 c/cs., 12 D.B. "lift" at 12,000 c/cs., Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue crackle. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc.** We can supply Microphones, Speakers, Rotary Converters, etc., at keen cash prices or on H.P. terms with amplifiers.

EXPORT ENQUIRIES INVITED



R.S.C. TA1 HIGH QUALITY TAPE DECK AMPLIFIER

FOR ALL DECKS WITH HIGH IMPEDANCE RECORD/PLAYBACK AND ERASE HEADS. Such as Lane, Truvox, etc. Chassis size 12-7-3in. Overall size 12-7-6½in. For 230-250 v. 50 c/cs. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum input required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Can be used as gram. amplifier with input of 0.75 v. R.M.S. Negative feedback equalisation. Linear frequency response ± 3 D.B. 50-11,000 c/cs.

11 GNS. Ready for use Carr. 7/6

Facilities for recordings at 15in., 7½in. or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. **PERFORMANCE IS COMPARABLE WITH UNITS AT OVER TWICE THE COST. LEAFLET 6d.**

R.S.C. ULTRA LINEAR 12-WATT AMPLIFIER

NEW 1956 MODEL A8 HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL, PRE-AMP. STAGES.

High sensitivity. Includes 5 valves (807 outputs), High Quality sectionally wound output transformer, specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut."** Frequency response ± 3 db. 30-30,000 c/cs. Six negative feedback loops. Hum level 71 db. down. **ONLY 70 millivolts INPUT required for FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and practically all microphones. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS,** etc. **OUTPUT SOCKET** with plug provides 300 v. 20 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT. H.P. TERMS ON ASSEMBLED UNITS. DEPOSIT 25/6** and nine monthly payments of 22/4. Size approx. 12-9-7in. For A.C. mains 200-230-250 v. 50 c/cs. Output for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied.

Unapproachable value at **£7/15/-** or factory built 45/- extra. Carriage 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 17/6.

Where an extra input socket with associated volume control is required for mixing purposes this can be provided for 13/- extra.

GARRARD 3-SPEED AUTOMATIC RECORD CHANGERS. Latest Model. Type RC110. Fitted high fidelity turnover crystal pick-up head. For 200-250 v. A.C. mains. Limited number. Brand new cartoned. Only £8/17/6, plus 5/6 carriage.

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).

MICROPHONES. High fidelity crystal types. Acos 33-1 hand or desk type. 50/-. Piezzo with heavy floor base and telescopic stem. £6/18/6.

BRAND NEW B.S.R. MONARCH 3-SPEED MIXER AUTO-CHANGERS. With crystal. pick-up and dual point sapphire stylii for standard or long playing records. Plays ten 7in., 10in. or 12in. intermixed. For A.C. mains 200-250 v. 50 c/cs. Supplied in sealed cartons with template and operating instructions, £7/15/- plus 3/6 carr.

WALNUT VENEERED CABINETS. Designed for above record changers with provision for housing amplifier and speaker. Attractive design. Limited number. Brand new cartoned £3/19/6, carr. 7/6.

QUALITY AMPLIFIERS. 3-4 watt, specially designed for use with BSR changer and above cabinet. Latest miniature type valves used. Separate Bass and Treble Controls and Vol. Control with mains switch. For A.C. 200-250 v. mains. Ready for use, only £3/19/6, carr. 3/6.

P.M. SPEAKERS. Suitable for use with above equipment. Elliptical 7 × 4ins. with 2-3 ohms speech coil, 19/9 ea.

COLLARO HIGH FIDELITY MAGNETIC PICK-UPS. High Impedance, brand new, boxed at fraction of normal price. Only 31/-.

P.M. SPEAKERS. 2-3 ohm., 5in. Goodmans, 17/9, 6½in. R.A., 15/9, 8in. Rola, 19/9, 10in. R.A., 26/9, 12in. Plessey, 29/11.

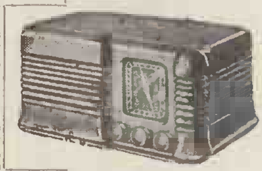
R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

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. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v., 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carriage.

R.S.C.A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only £3/15/-, carr. 3/6 or factory built 22/6 extra.

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, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, veneered walnut.

ROTARY CONVERTERS. 200 watts. Input 12 v. D.C. Output 230 v. 50 c/cs. A.C. Only 7 gns. Carr. 7/6.

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. Illustrations full set or 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.

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, £5/17/6. carr. 7/6.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance £4/10/9. Please state whether 3 ohm. or 15 ohm. required.

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 1/9 extra on *all* orders under £2, 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5d. Open to Callers: 9 a.m. to 5.30 p.m. Saturday until 1 p.m.

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

LASKY'S RADIO

Special Bargain

3-WATT AC/DC MIDGET AMPLIFIER

Push pull, very high gain. 4 valves: two UL41 (p.p.) UCH42, UAF42. Input voltage 100/110 A.C./D.C. Easily converted to 230 v. Ideal for record players, tape recorders, baby alarms, etc. Supplied fully assembled with valves, circuit diagram and details.
REDUCED TO 50/-
Carr. 5/-.

LASKY'S RADIO CONSTRUCTOR PARCELS

No. 1. Contains everything to build a 4-valve, 3-wave superhet for 200-250 A.C. mains. Wood or plastic cabinet as preferred. Can be built for **£7.19.6**
Carr. 2/6.

No. 2. Contains everything to build a T.F.R. 3-valve, 3-wave set for 200-250 A.C. mains. Wood or plastic cabinet as preferred. Can be built for **£5.10**
Carr. 2/6.

INSTRUCTION BOOKS for above, 1/- each, post free. All components available separately.

LARGE RANGE OF TAPE DECKS

Collaro "Tape Transcripter", £20
Truvox, 22 Gns.
Lane, £18/10/-.
Brenell, 18 Gns.
And all other makes.

TAPE DECK MOTORS

Anti-clockwise, shaded pole. Special offer, COLLARO, 25/-. GARRARD, 26/6. B.T.H., 29/6.
Post extra.

FAMOUS AMPLIFIERS BUILT ON T.C.C. PRINTED CIRCUITS

All specified components used, with your choice of transformers and chokes. Fully assembled and ready for use.
The **MULLARD 510.** Price, according to transformers used, from 14 gns. The Book, 3/6.
OSRAM 912. From 18 GNS. The Book, 4/-, post free.
All components available separately, also printed Circuits.

R1155 RECEIVERS

In original wood transit cases.

Brand New	£11	19	6
Second-hand, Grade 1	£9	19	6
Ditto, Grade 2	£7	19	6

Carr. 12/6.

Power Pack and Output Stage with 6½in. Speaker..	£5	5	0

FILAMENT TRANSFORMERS

6.3 v. 1.5 amp.	5	11
6.3 v. 3 amp.	7	6
6.3. v 1 amp.	4	6
0-30 volts	19	6

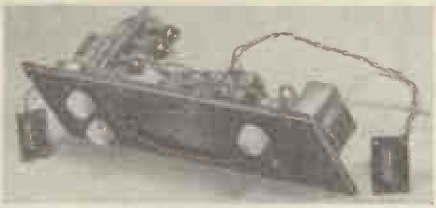
METER BARGAINS

2½in. moving coil. Brand new micro-ammeters F.S.D. 0-750 micro/amps., 15 ohms resist. 15/-.
0-1.5 amps., 12/6. 0-200 v. A.C., rect. incorporated, 12/6.
Dozens of other types.

TRANSISTORS

Lowest prices. Fully guaranteed. By Mullard, S.T.C., etc.
SUB-MINIATURE TRANSISTOR TRANSFORMERS, 4 to 1 ratio. Each 4/6.

SPECIAL OFFER OF PORTABLE GRAM AMPLIFIERS

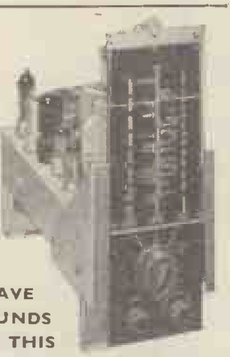


Uses 3 latest miniature valves, U78, N78, DH77. Volume, bass and treble controls; extension L.S socket and internal L.S. switch, indicator lamp. Mounted on wood baffle, overall size 14 × 4½in. with speaker centralised. All top quality new components. For A.C. mains 200-250 v. Ideal for portable record players, input will match Monarch, RC54, RC3/554, etc.
Price, complete with 3 new Osram valves, 7 × 4in. Goodmans elliptical speaker, metal speaker grille mains lead, and knobs.
Post and Pkg. 5/-. **£5.9.6**

LARGE STOCK OF HI-FI EQUIPMENT

Amplifiers, Speakers, etc. Wharfedale, W.B., Goodmans, G.E.C., Leak, Rogers, RCA., Quad, etc.

20,000 VALVES IN STOCK
Send for our latest price list.



SAVE POUNDS ON THIS

6-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES

Famous Manufacturer's Surplus. 6-valve, 3-wave Superhet. 13-50 m. short. 200-550 m. medium, 1,000-2,000 m. long. Brand new Mullard valves: ECH42, EF41, L63, EB41, 6V6 g.t., EZ40 and finest quality components. Gram., switch, 465 Kc/s I.F. tone control, three-colour dial. Overall size 13¾ × 5in., height 12¼in. Aperture required for dial and controls 11 × 3½in. Complete with valves, output trans., knobs., etc.

LASKY'S PRICE £10.19.6
Carriage and packing 7/6 extra.

5-VALVE RADIOGRAM CHASSIS

A.C. mains, 3-wave superhet. Large full vision dial, 11½ × 4½in. Overall dimensions 14 × 6 × 7in. Valve line-up: 12AN8, 6BA6, 6AT6, 6BW6, 6X4.
LASKY'S PRICE, complete with valves, Carr. 7/6. **£9.19.6**
Table Cabinet for above, complete with 6½in. P.M. speaker, 49/9

LASKY'S FIRST AGAIN !

We proudly announce a

NEW BATTERY PORTABLE FOR HOME CONSTRUCTION ON PRINTED CIRCUIT

Utilises all latest innovations, giving simplicity of construction with fine quality. 11 STAR FEATURES make this superb new design undoubtedly the finest Portable Radio ever offered to the home constructor.

PEAK VALUE FOR MONEY has been obtained without any sacrifice of quality or design. Use of the printed circuit completely eliminates wiring errors.

- ★ PRINTED CIRCUIT, size 7½in. × 2½in.
- ★ 4-valve Superhet, med. and long waves.
- ★ Low consumption Valves. Double Battery Life.
- ★ Ferrite Rod Internal Aerial.
- ★ 3 or 5in. P.M. Moving Coil Speaker (your choice).
- ★ Brand New T.C.C. Capacitors.
- ★ Automatic Volume Control.
- ★ New Style Contemporary Cases.
- ★ Alternative Styles of Cases.
- ★ Lightweight and Handsome Appearance.
- ★ Every Component available separately.

CAN BE BUILT FOR £7.7.0 approx.

The most up-to-date Portable available. We regret that at time of going to press illustrations could not be included.

SEND FOR ILLUSTRATIONS with circuit diagram, assembly data, all instructions and full shopping list. Price 1/6 post free.

DEMONSTRATION MODELS AT BOTH OUR ADDRESSES

MAKERS' SURPLUS TV COMPONENT BARGAINS

WIDE ANGLE 38 mm.

Line E.H.T. trans., ferrox-cube core, 9-16 kV.	25/-
Scanning Coils, low imp. line and frame	25/-
Ferrox-cube cored Scanning Coils and Line Output Trans., 10-15 kV, EY51, winding Line Trans. incorporates width and linearity control. Complete with circuit diagram, the pair.	50/-
Frame Output Transformer	6/6
Scanning Coils low imp. line and frame	17/6
Frame or line block osc. transformer	4/6
Focus Magnets Ferrox-dure	19/6
P.M. Focus Magnets, Iron Cored	19/6
Duomag Focalisers	22/6
300 m/a. Smoothing chokes	15/-
Electromagnetic focus coil, with combined scan coils	25/-

STANDARD 35 mm.

Line Output Transformers. No. E.H.T.	12/6
Line Output Transformers 6.9 kV. E.H.T. and 6.3 v. winding. Ferrox-cube	19/6
Scanning coils. Low imp. line and frame	12/6
Ditto by Igranic	14/6
Frame or line blocking oscillator transformer	4/6
Frame output transformer	7/6
Focus Magnets:	
Without Vernier	12/6
With Vernier	17/6
Focus Coils, Electromagnetic	12/6
200 m/a. Smoothing Chokes	10/6

LATEST BRENELL TAPE EQUIPMENT

DECK. 3-speed, 3 motors, record and play back, 18 Gns.
AMPLIFIER Mk. II, 5 watts, for use with 3 ohms speaker. Magic eye. 18½ Gns.
Suitable Carrying Case, £5.18.0
Write for full details.

RECORDING TAPE

SPECIAL OFFER. Magnetic Recording Tape, kraft base. On Cyldon metal spools: 1,200ft., 11/6; 600ft., 7/6.
On plastic spools: 1,200ft., 12/6; 600ft., 9/6.
PURETONE TAPE on plastic spool: 1,200ft. 14/11.
Post 1/- extra.
All makes of Tape stocked including the new thin long-playing. Also Spools.

LASKY'S (HARROW RD.) LTD.

LASKY'S RADIO

42 TOTTENHAM COURT ROAD, W.1.
(Between T.C.R. and Goodge St. Stns.)
MUSeum 2605

370 HARROW ROAD, PADDINGTON, W.9.
(Opposite Paddington Hospital)
CUNningham 1979

Open all day Saturday. Early closing Thursday (both addresses)

ALL MAIL ORDERS TO HARROW ROAD PLEASE

Phone: LAD 4075

FULLY GUARANTEED

RADIO & RADIOGRAM CHASSIS

Superhet. Chassis of Latest Design and Technique

General Specifications applicable to all models

Mains: A.C. 200/250 volts 50 cycles only.
Dial: Suitably lit multi-coloured glass dial of the horizontal type.
Tuning Drive: Slow motion by means of glass-cored Nylon cord.
A.V.C.: Full provision of Automatic Volume Control. Negative feed-back from output transformer secondary.
Sockets: Sockets provided for Aerial, Earth, Gram. Pick-up and Extension Speaker. Connections provided to Gram. Motor controlled by Chassis On/Off switch.
Inductances: All inductances have an exceptionally high Q value.
Audio Section: The Audio Section is designed for first rate reproduction on Radio and Gramophone. The tone controls have been given an extra wide range to embrace all types of recordings.

CAT. NO. CR/A: 5-valve Superhet, 3 wavebands. **12 Gns.**

CAT. NO. CR/B: 7-valve Superhet with push-pull output, 3 wavebands. **16 Gns.**

Packing and Carriage on Models CR/A and CR/B, 12/6.

CAT. NO. CR/AFM47: 7-valve Superhet with F.M/VHF Band (4 wavebands). **23½ Gns.**

CAT. NO. CR/AFM49/PP: 9-valve Superhet with F.M./VHF Band (4 wavebands). Push-pull output including 2 loudspeakers. **26 Gns.**

Packing and Carriage on Models CR/AFM47 and CR/AFM49/PP, 15/

★ built to the highest standard!

ALL FULLY GUARANTEED. GENEROUS EXTENDED CREDIT TERMS ON ORDERS EXCEEDING £15

RADIOGRAM DROP-IN UNITS

These are fully guaranteed Radiograms consisting of Receiver Chassis, Auto Record Changer and matching loudspeaker mounted on a light-weight frame with polished top panel. Needs only fixing inside suitable cabinet to become high quality Radiogram. Offered in two different models.

CAT. NO. UNIT/A35
Chassis as type CR/A described elsewhere. 5-valve Superhet. 3 wavebands. **29½ Gns.**

CAT. NO. UNIT/AFM47
Chassis as type CR/AFM47 described elsewhere. 7-valve Superhet with F.M./VHF Band. **37½ Gns.**

Both units are fitted with latest BSR FOUR-speed Auto Changer.

Packing and carriage 20/-.

HIGH QUALITY BUREAU-TYPE CABINET TO SUIT EITHER UNIT, 15 GNS.

★ CABINET

CAT. NO. CAB/02
A well-designed Bureau-type cabinet in a medium size. Veneered in a highly figured Walnut. Outside dimensions, length 29¾in., depth 16in., height 32in. Sloping control panel on right hand side approx. 13in. × 10½in. Removable baseboard on right hand side approx. 13½in. × 13in. Large record compartment located inside the cabinet, above gram motor.
CASH ONLY **12 Gns.**
Packing and carriage 20/-.

★ PORTABLE TAPE RECORDER

CAT. NO. TR/A
A superb High-Fidelity instrument incorporating the latest TRUVOX Tape Deck. In a beautifully fitted moroccan grained carrying case, this Tape Recorder is the very finest of its class, regardless of price.
TAPE DECK: TRUVOX model TR7U. Twin track with B.S.S. sense of recording. Two speeds, 7½in. (one hour for 1,200ft. reel), and 3¾in. (2 hours for 1,200ft. reel). Full press-button control. Fast forward and rewind. Electro-magnetic braking. **44 Gns.**
PACKING AND CARR.: Payable in advance with order —25/-.

★ PORTABLE TAPE RECORDER (KIT FORM)

CAT. NO. TR/A/KIT.
A complete kit consisting of:—
FULLY FITTED CARRYING CASE
TAPE DECK—TRUVOX TR7U
TAPE RECORDER AMPLIFIER
MICROPHONE—ACOS 33-1
SPEAKER—7in. × 4in. Elliptical
MAGNETIC TAPE REEL
To the same specifications and similar to those used in the Portable Tape Recorder (Cat. No. TR/A), this complete kit offers the home builder all that is required to construct a portable Tape Recorder of the finest quality. **42 Gns.**
PACKING AND CARRIAGE: Payable in advance with order—25/-.

★ F.M./V.H.F. TUNERS

CAT. NO. FMT/A
An F.M./V.H.F. Tuner Unit with automatic Magic Eye Tuning, fitted in a high grade dark Walnut cabinet. Adaptor is self-powered and completely self-contained.
CIRCUIT DETAILS: SIX Valves and 10 Tuned Circuits for maximum sensitivity and best signal to noise ratio.
Packing and Carriage 12/6. **16½ Gns.**

CAT. NO. FMT/B
An F.M./V.H.F. Tuner Unit in chassis form, suitable for building into existing Radiograms or Radio Receivers. Adaptor is self-powered. Socket for additional Magic Eye fitment is provided in the Chassis.
Packing and Carriage, 12/6. **£13-15-0**

★ LOUDSPEAKERS

Permanent Magnet Type (Voice Coil Impedance 3 ohms).
CAT. NO. LS/10/PM: 10in. diameter, Flux density 8,500 lines.
PRICE: CASH ONLY £1/10/-.
PACKING AND CARR.: 3/-.
CAT. NO. LS/8/PM: 8in. diameter, Flux density 8,500 lines
PRICE: CASH ONLY £1/10/-.
PACKING AND CARR: 3/-.
CAT. NO. LS/74/PM: Elliptical 7in. × 4in. Flux density 7,500 lines.
PRICE: CASH ONLY £1/1/-.
PACKING AND CARR.: 3/-.
Electrostatic "Treble" type, imported (suitable for accentuating treble response, particularly on F.M./V.H.F. reception)
CAT. NO. ELEC/LSH 75: PRICE, CASH ONLY 12/6.
Packing and carriage free.
CAT. NO. ELEC/LSH518: PRICE, CASH ONLY 17/6.
Packing and carriage free.
CAT. NO. ELEC/LSH100: PRICE, CASH ONLY £1/1/-.
Packing and carriage free.

★ BUREAU CABINET

CAT. NO. CAB/C3

A magnificent Bureau-type Cabinet of the very highest quality in specially selected Walnut veneered exterior. Light Sycamore interior with Rexine lining to match. Outside dimensions, length 34in., depth 17¾in., height 33in. Sloping control panel on right-hand side approx. 16in. × 10½in. Removable baseboard on right side approx. 15¼in. × 15in. Two full-sized felt lined compartments in the lower half.
Packing and Carriage payable in advance with order—25/-. **16½ Gns.**

★ MULTI-SPEED AUTOMATIC RECORD CHANGERS

All automatic Record Changers are of the latest type and unused.
CAT. NO. RC/A: This is the latest. Multi-speed changer incorporating 16 r.p.m. for "talking-books," and arrangement for manual control. Fitted with high fidelity Crystal Turnover Pick-up Head. A.C. mains 200/250 volts, 50 cycles only.
PRICE: CASH ONLY
PACKING AND CARR.:—12/6. **£9-15-0**
CAT. NO. RC/B: Latest GARRARD RC88 model, fitted with GC-2 Crystal Turnover Pick-up Head. A.C. 200/250 volts, 50 cycles.
PRICE: CASH ONLY
PACKING AND CARR.:—12/6. **£13-0-0**

Dealers supplied at full discounts. Send for Complete Catalogue.

All enquiries (excluding Northern Area) to:-

DOMESTIC
DIRECT SALES LTD.
90 JUDD ST., LONDON, W.C.1. TER 9876

Northern enquiries only (not Scotland and N. Ireland) to :-

MAYLIT LTD
3 MARLBOROUGH ROAD, ALTRINCHAM, CHESHIRE
Telephone enquiries: ALTRINCHAM 4045

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 mounting or drop-thro'. Pri. 110-150 v. Sec. 350-0-350, 250 mA., 6.3 v. 7 amp., 6.3 v. 0.5 amp., 5 v. C.T., 0.5 amp. 4 v. amp. P. & P. 3/6. **32/6.**

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

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.**

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/-.

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/-.

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., **39/6.**

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

R. & T.V. Energised 6½in. Speaker with O.P. trans. field coil. 175 ohm **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.

Volume Controls. Long spindle and switch. ¼, ½, 1 and 2 meg., **4/-** each. 10K and 50K, **3/6** each. ½ 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 4¾ × 3 × 1½in., **7/6.**

T.V. Coils, moulded former, iron-cored wound for re-winding purposes only. Ali-can 1⅜ × 1⅞in., **1/-** each. 2 iron-core All-can 2⅜ × ⅞in., **1/6** each. The above coil formers are suitable for the "Wireless World" F.M. tuner.

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

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

OUTPUT TRANSFORMERS

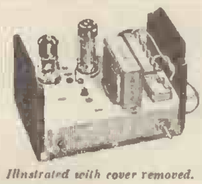
Standard type 5,000 ohms imp., **4/9.** 42-1 with extra feed-back windings, **4/3.** Miniature 4-2, **13/3.** Multi-ratio 3,500, 7,000 and 14,000, **5/6.** 10-watt push-pull, 6V6 matching, **7/-.** 90-1 ohm speech coil, **6/6.**

COMMERCIAL TELEVISION CONVERTER

SUITABLE ANY T.V.

using lower side band

NO ALTERATIONS TO SET



Complete with built-in power supply, 230-250 v. A.C. mains. Crackle finish case 5¾in. long, 3¼in. wide, 4¼in. high. Incorporating gain control and band switch.

£3 - 19 - 6 Plus Post & Packing 2/6.

Illustrated with cover removed.

Less power supply **£2/19/6.** P. & P. 2/6.

BAND III CONVERTER KIT

comprising 5 channel tuner, mains transformer, metal rectifier, electrolytic, 2 valves 12AT7 and EF80 and all necessary components for A.C. mains operation. Complete with conversion data, **£2/5/-.** P. & P. 2/6.

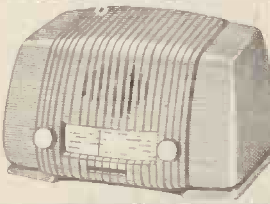
P.M. SPEAKER. 6½in. closed field, **18/6.** 8in. closed field, **20/6.** 10in. closed field, **25/-.** 3½in., **16/6.** 12in. closed field, **25/-.** P. & P. on each, 2/-.

EXTENSION SPEAKER in polished walnut, complete with 8in. P.M. P. & P. 3/-. **24/6.**

B.S.R. MONARCH three speed automatic changer, current model. Brand new. Will take 7in., 10in., or 12in. records mixed. Turnover crystal head. A.C. mains 200-250. Pre-Budget Price while stocks last. **£7/15/-.** P. & P. 3/-.

T.R.F. KIT

IN PLASTIC CABINET



3 valve plus metal rectifier, A.C. mains 200-250 v. Medium and long waves. In pastel blue or brown. Valve line-up: 2 VR658 and VT52. Size 15½in. long by 9in. high by 7in. deep. **£3/19/6.** P. & P. 4/6.

3-speed TRANSCRIPTION MOTOR

BY FAMOUS MANUFACTURER

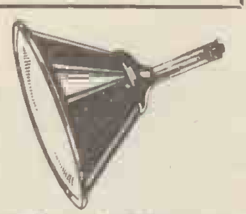
Complete kit of parts comprising accurately balanced precision made heavy turntable with rubber mat, large constant speed condenser starting motor, base plate. Can be assembled in half an hour. A.C. Mains 200/250 v. Fully guaranteed. Parts sold separately.

£6 - 19 - 6 Post Paid

16 in. TUBE

METAL CONE

BY FAMOUS MANUFACTURER



Brand new E.H.T. 14 Kv. Heater. 6.3 volts 0.6 amp., guaranteed 3 months. £9/19/6. Post, packing and insurance 22/6. H.P. terms available. E.H.T. and scanning components available.

4 VALVE ALL-DRY SUPERHET PORTABLE KIT

Medium and long waves. In grey leatherette. Size 9" x 7" x 6". Valve line up IT4, IR5, IS5, 3V4. Complete kit of parts (less batteries).

£6 - 6 - 0 Plus 2/6 Post and Packing.

Germanium Crystal Diode, **1/6,** post paid.

Line O.P. Transformer in aluminium can mounted in rubber, **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 ali-chassis. Overall size 4¾ × 1⅞in. 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, **35/-.** P. & P. 3/-.

As above, but complete with line and frame blocking transformers, 5 Henry 25 mA. choke, 100 mfd. and 150 mfd. 250 wkg. 380 mA. A.C. ripple. **£2/9/6.** 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.

GARRARD RC/110

3 speed automatic changer. 10 Records, turnover crystal head, brand new, current model. A.C. mains 200/250 v. (list price £14/10/-). **£8-19-6**

P. & P. 5/-.

Hire purchase available.

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.

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

Standard 465 Kc. iron-cored I.F.s, 3in. × 1½in. × 1½in., per pr., **7/6.**

1,200ft. High Impedance Recording Tape on aluminium spool, **12/6,** post paid.

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.**

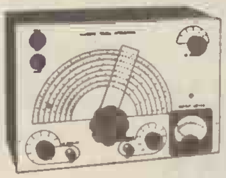
CHOKES.

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/-. 250 mA., 10 henry, **10/6;** 5 henry 250 mA. 60 ohms, **8/6.**

Wide Angle P.M. Focus Units. Vernier adj. state tube, **15/-.**

P.M. Focus Unit for Mullard tubes with vernier adjustment. P. & P. 2/-. **15/-.**

SIGNAL GENERATOR



Coverage 120 Kc/s-84 Mc/s.

A.2 Mains 200/250 v. **£4 - 19 - 6**

Or 34/- deposit, 3 payments of 25/-. P. & P. 4/6 extra.

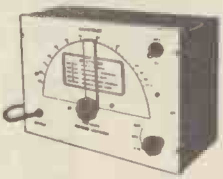
SIGNAL & PATTERN GENERATOR

Coverage 7.6 Mc/s.-210 Mc/s. in five bands, all on fundamentals, slow-motion tuning, audio output, 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy + − 1%.

A.C. mains 200-250 v., **£6 - 19 - 6** P. & P. 5/6.

Or £3 deposit, P. & P. 5/6 and 3 payments of 30/-.

PATTERN GENERATOR



Coverage 40 Mc/s.-70 Mc/s.

A.C. Mains 200/250 v. **£3 - 19 - 6**

Or 29/- deposit, 3 payments of £1. P. & P. 4/6 extra.

R. AND T.V. COMPONENTS (ACTON) LTD.

23 HIGH STREET, ACTON, LONDON, W.3

GOODS NOT DESPATCHED 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.

". . . this is a good book . . . no, on second thoughts it is an excellent one"

SCOTTISH RADIO TRADE DIGEST

A book for students and engineers

Cathode Ray of "Wireless World."

Forty-four articles reprinted from popular *Wireless World* series, in which the author examines various aspects of elementary radio science, explains them clearly and shows that there may be more behind them than is apparent from the usual text-book. This volume deals with basic ideas; circuit elements and techniques; circuit calculations; and some matters in lighter mood. An entertaining and helpful text-book for the student, refresher course for the engineer, and reference book for all, combined.

8¾″ × 5½″. 410pp. 266 illustrations.

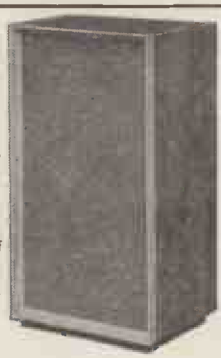
25s. 0d. net. (By post **26s. 2d.**)

SECOND THOUGHTS ON RADIO THEORY

Published for "Wireless World"
Obtainable from all booksellers.
Iliffe & Sons Limited, Dorset House, Stamford St., London, S.E.1.

THE NEW AXIOM ENCLOSURES as demonstrated at the RADIO SHOW by Messrs. GOODMANS INDUSTRIES

Completely Fitted comprising 12in. Axiom No. 150 Mk. II Speaker. The Acoustic Resistance Unit and Cabinet to Messrs. Goodmans specification. Lined and Quilted with 1in. cotton felt and constructed of ¾in. Weyrock.
Cash Price £27/18/6 or £4/7/6 deposit and 9 payments of 57/3 monthly. Cabinet only £14/7/6 or £2/5/- deposit and 9 payments of 29/- monthly. Delivery 12/6 cash or terms.
Also in Corner Cabinets 27/6 extra.
Write for catalogue of cabinets for Records—Equipment—Speakers.



S.4

A. L. STAMFORD
(Dept. D4), 20 College Parade, Salusbury Road, London, N.W.6.

WANTED URGENTLY

Exceptional Prices Paid for

BC221
FREQUENCY METERS
or CASES

Kindly advise price required.
NO REASONABLE FIGURE REFUSED
As we DO require these urgently.

UNIVERSAL ELECTRONICS
22 Lisle Street, Leicester Square, London, W.C.2

METAL SPINNING OUR SPECIALITY

PARABOLIC REFLECTORS up to 9ft. dia. LOUDSPEAKER HORNS, Etc., Etc.
POWER PRESSWORK to 250 ton capacity, including Hydraulic
GENERAL SHEET METAL WORK . ARGON . ARC & OXY-ACETYLENE WELDING

SHAWE METAL SPINNING WORKS

SWINTON STREET, KING'S CROSS, LONDON, W.C.1.

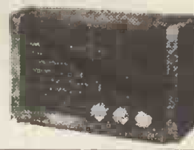
'Phone: TERminus 7422/3 *Grams:* Alipryde Phone London

FOR VALVES—GUARANTEED NEW AND BOXED

				9003	5/6	ECL80	10/6	PL82	11/6
				9004	5/6	EF22	8/6	PL83	13/-
				9006	6/-				
0Z4	6/-	6F11	13/-	954	2/-	EF40	11/6	PP225	5/-
1A3	6/-	6F13	14/-	955	4/9	EF41	11/6	PY80	10/-
1A5GT	6/6	6F14	12/6	956	3/6	EF42	13/6	PY81	11/6
1A7	11/6	6F15	14/-	10C1	12/6	EF80	10/-	PY82	10/6
1C5GT	9/6	6F6G	7/6	10C2	12/6	EF86	13/6	PX25	13/6
1H5GT	10/6	6F6M	8/6	10F1	12/6	EF89	13/6	QP21	7/6
1L4	6/6	6G6G	4/-	10F9	12/6	EL2	12/6	R19	13/6
1LD5	6/9	6H6	3/6	10P13	11/6	EL35	7/6	SP220	6/9
1N5	10/6	6J5G/GT	5/-	12A6	6/9	EL41	11/6	SP22	6/-
10P14	13/6	6J5M	6/6	12AH7	6/9	EL84	12/-	U10	9/-
1R5	8/-	6J6	7/6	12AT7	9/6	EL91	5/-	U22	8/-
1S5	7/6	6J7G	6/6	12AU7	9/6	EM34	11/6	U25	13/6
1T4	7/6	6K6GT	7/-	12AX7	10/-	EM80	11/-	U403	10/-
1U5	8/-	6K7G	5/9	12BE6	10/-	EY51	12/6	U404	11/6
2X2	4/-	6K7GT	6/9	12H6	5/-	EY86	14/6	UAF42	12/6
3A4	7/-	6K7	6/9	12J5	6/-	EY91	7/-	UB41	8/-
3Q4	9/6	6K8G	8/9	12J7	9/6	EZ40	10/-	UBC41	11/-
3Q5	10/-	6K8GT	9/6	12K7	9/6	EZ41	11/-	UCH42	11/-
3S4	8/6	6L6G	9/-	12K8	11/-	EZ80	10/6	UF41	11/6
3V4	8/6	6L7M	7/6	12Q7	9/6	E1148	2/-	UL41	11/6
4D1	3/-	6N7	7/-	12SC7	2/6	FW4/500	10/-	UY41	10/6
42	8/-	6Q7G/GT	9/-	12SG7	7/6	GZ32	12/6	VR21	3/-
5R4Gy	9/6	6SA7GT	8/-	12SH7	5/6	H30	5/-	VR53	6/6
5U4G	8/6	6SG7	7/6	12SJ7	8/6	HL2	5/6	VR54	2/-
5Y3GT	8/6	6SH7	6/-	12SK7	6/6	HLI320	4/-	VR55	7/6
5Z4G	8/9	6SJ7GT	8/-	12SQ7	9/6	HL23DD	8/-	VR56	6/-
6A7	11/6	6SK7	5/6	15D2	5/-	HP211C	6/9	VR57	8/-
6A8GT	10/6	6SL7	8/-	20LI	12/6	HP4101	7/-	VR65	3/6
6AC7	6/6	6SN7	8/-	25L6GT	9/6	IC2	9/6	VR65A	3/3
6AG5	6/6	6SQ7	9/3	25U4GT	10/-	IN5	10/6	VR66	3/9
6AK5	6/6	6SS7	8/-	25Y5G	9/9	LK35	8/6	VR91	5/6
6AL5	7/-	6U4GT	15/-	25Z4G	9/6	KT2	5/-	VR91SYL	7/6
6AM5	5/-	6U5G	8/6	25Z6GT	9/6	KT33C	10/6	VR92	2/-
6AM6	7/6	6U7G	9/-	35L6GT	9/-	KT61	13/-	VR105/30	7/6
6AQ5	9/-	6V6G/GT	7/6	35W4	9/-	KT66	12/-	VR116	4/-
6AT6	8/9	6X4	8/-	35Z4GT	9/-	KTW61	7/9	VR119	4/-
6B4	5/-	6X5G/GT	7/9	50L6GT	9/-	KTW63	8/6	VR136	7/-
6B8	4/-	7B6	9/6	AC6/PEN	7/-	KTZ41	6/-	VR137	5/6
6BA6	8/-	7B7	9/-	ATP4	6/6	LP220	6/9	VR150/30	8/-
6BE6	8/-	7C5	8/6	DH73M	10/-	MS/PEN	5/-	VP23	8/-
6BW6	8/6	7C6	9/-	DM70	10/6	N709	12/-	VS70	3/-
6BW7	12/6	7Q7	8/-	EAF42	12/6	P41	9/-	VT52	8/-
6C4	7/6	7R7	8/6	EB41	9/-	P61	6/9	VT501	6/-
6C5GT	7/6	7S7	9/-	EBC41	11/-	P215	5/-	VU39	8/9
6C6	6/6	7Y4	8/6	EBF80	15/-	PEN25	6/-	VU64	9/-
6C8	5/-	75	10/6	EC91	9/6	PEN46	8/6	VU111	3/6
6C9	10/6	77	8/-	ECC31	8/6	PEN220A	4/-	VU120A	3/-
6CH6	9/-	80	8/6	ECC84	14/6	PCC84	13/6	W77	8/6
		807	6/6	ECC85	12/6	PCF80	13/6	W61	8/-
6D3	7/6	8D2	2/9	ECF82	15/-	PCF82	12/6	X65	10/-
6D6	7/3	9D2	3/9	ECH35	13/6	PCL83	12/6	X66	11/6
6F1	13/6	9001	5/6	ECH42	11/-	PL81	12/6	Y63	9/-

Packing and postage 6d. per valve.

ALPHA 3-VALVE T.R.F. KIT



★ Easy to build. ★ Valves 6J7, 6K7, 6V6GT plus metal rectifier. Full instructions, point to point wiring diagram. Price £5/10/- each. Post and Packing 3/-. Circuit diagram and full shopping list 1/-. All components may be purchased separately.

★ Walnut finished cabinet.

MAINS TRANSFORMERS
3-way mounting type

MT1
Primary: 200-220-240v.
Secondarys: 250-0-250 v., 80 M/A 0-6.3 v. 4 amp. 0-4 v. 2 amp. Both tapped at 4 v., each 18/6

MT2
Primary: 200-220-240 v.
Secondarys: 350-0-350 v. 80 M/A 0-6.3 v. 4 amp. 0-5 v. 2 amp. Both tapped at 4 v., each 18/6

MT3
Primary: 200-220-240 v.
Secondary: 30 v. 2 amps.
Taps at 3 v., 4 v., 6 v., 8 v., 9 v., 10 v., 15 v., 18 v., 20 v., 24 v., each 18/6

2/- packing & post on above transformers.

CRT ISOLATION TRANSFORMERS

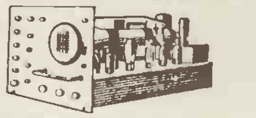
NR9A 2 volt: NR9B 4 Volt: NR9C 6.3 v.: NR9D 10.8 v.: NR9E 13.3 v. Price 10/6 each, all for use on receivers with own transformer.

NR14 Input 230/240 v., output 2-2¼-2½-2¾-3 volts at 2 amps. 17/6 each.

NR12 Input 220/240 v. Multi output 0-2-4-6.3-7.3-10-13 volts, 25% and 50% BOOST. 21/- each.

NR15 Input 220/240 v. Output 6.3 v., with 25% and 50% BOOST. Price 17/6 each.

AMERICAN INDICATOR UNIT TYPE BC929A



Brand new, incorporating 3in. tube 3BP1, with mu-metal shield, two 6SN7GT, two 6H6GT, 6X5G, 2X2, 6G6G, nine potentiometers, 24 v. aerial switch motor, transformer, and a host of small components. The whole unit, which measures only 8½in. x 8½in. x 13½in., is brand new, enclosed in black crackle box, and can be supplied at price 65/-, plus 5/- postage and packing.

TRANSFORMERS, ETC.

HEATER TRANSFORMERS

230 v. Input 2 volt .5 amp., each	5/-
230 v. Input 2 volt 3.0 amp., each	8/3
230 v. Input 4 volt 1.5 amp., each	5/6
230 v. Input 4 volt 3.0 amp., each	10/6
230 v. Input 5 volt 2.0 amp., each	10/6
230 v. Input 6.3 volt, .5 amp., each	5/6
230 v. Input 6.3 volt 1.5 amp., each	6/6
230 v. Input 6.3 volt 3.0 amp., each	9/6
230 v. Input 12 volt, .75 amp., each	5/6

CHOKES
20H, 250 ohms, 60 M/A. Clamp construction, each 6/-
10H, 200 ohms, 90 M/A. Clamp construction, each 9/3
10H, 200 ohms, 150 M/A. Clamp construction, each 13/-
10H, 300 ohms, 40 M/A. Midget Clamp construction, each 5/3

TRANSFORMERS FOR BATTERY CHARGERS
230 v. Input Tapped 6-12 v. 1 amp., ea. 13/6
230 v. Input Tapped 6-12 v. 3 amp. (Both with tap on Primary for 2.5 v. Pilot light), each 18/-

HEATER AUTO TRANSFORMERS
Designed to adapt common low tension voltages 4 v., 5 v., 6.3 v. at 3 amps., centre tapped and interchangeable, each 7/9

Aerialite Band III Aerials, 5 element, 702 x U. An array with universal 1in.-2in. masthead bracket, suitable channels 8, 9 and 10. Price 41/-, carriage 4/6.
Aerialite Coaxial outlet boxes at 4/6 each.
Aerialite Coaxial plugs and sockets at 1/1 each.

Transformers T1154N, 25/- each.
Transformers T1154H, 37/- each.
Transformers T1154 in rough condition, 15/- each.
Carriage and postage on above transformers is 12/6.
Meters 0-100 m/a. panel mounting, 7/6 each.
Meters 0-5 amp. R.F. panel mounting, 7/6 ea.

If you are not in possession of our 1956 24-page illustrated catalogue, please forward 6d. for your copy.

TYANA SOLDERING IRON

Lightweight 40 watt iron, with easily replaceable elements and bits. 200/250 v., price 16/9 each.

TRANSFORMER MT6

Small mains transformer suitable for TV convertors, etc. Primary 230 v. Secondary 250 v. 40 M/A and 6.3 v., 1.5A. Price 15/6 each. Postage 1/6.

PURETONE TAPE

1,200ft. Reels, Plastic Spool. 17/6 each.

LOUDSPEAKER UNITS—all 2/4 ohms
3½ in. types ..... 17/6 each
5in. types by Goodmans, Elac, Lectrona, Bafflette, etc., all ..... 17/6 each
6½in. types by Goodmans, R. & A., Plessey, etc., all ..... 18/6 each
8in. types by Goodmans, Plessey, R. & A., etc., all ..... 19/6 each
10in. types by Celestion, R. & A., Plessey, etc., all ..... 25/6 each
12in. types by Plessey, lightweight unit ..... 35/- each
Goodmans 4in. x 7in. elliptical speaker ..... 19/6 each
8in. units with output transformer by Goodmans and Lectrona.. 22/6 each

MAINS ENERGISED TYPES
8in. 600 ohm field, 21/-. 6½in. 600 ohm field, 17/6.
Postage on all above 1/6 extra.

WIRE WOUND CONTROLS
By Colvern, etc., all with ¼in. spindle. 5 ohms, 100 ohms, 200 ohms, 250 ohms, 500 ohms, 1K ohms, 5K ohms, 10K ohms, 20K ohms, 25K ohms and 50K ohms. All 2/6 each.

A NEW ALPHA KIT FOR YOU TO BUILD

Suitcase Portable. AC/DC Mains/Battery Receiver, 4 valves (latest types), 2 wave-band Superhet in an attractive lizard grey case size 8½" x 8½" x 4½". Full kit of parts down to last nut and bolt. **£9.9.0**

Or if you prefer you can build the battery version first for £7.17.6 and add the mains components later. Post extra on kit 2/6.

Full circuit diagram, shopping list and point-to-point wiring diagram 3/-.

G.E.C. CABINET LOUDSPEAKERS, Cat. No. BC1955
8in. P.M. moving coil loudspeaker unit, 2/4 ohms with volume control in very attractive cabinet. Price 52/6 each, post 2/6.

CONDENSERS

BEC 100 MFD 25 v.	1/9
BEC 500 MFD 12 v.	1/9
TCC 25 MFD 25 v.	1/3
DUBILIER 100 MFD 12 v.	1/9
BEC 50 MFD 50 v.	2/-
TCC 25 MFD 50 v.	1/9
TCC 50 MFD 25 v.	1/9
TCC 250 MFD 12 v.	1/6
BEC 250 MFD 25 v.	1/6
BEC 12 MFD 50 v.	1/-
TCC 50 MFD 12 v.	1/9
BEC 250—250 MFD 6 v.	1/6
DUBILIER 50—12 MFD 12 v.	1/9

OUTPUT TRANSFORMERS

Multi Ratio Type, each	6/6
Midget for 384 Output, each	4/6
Standard 5,000 ohms, each	4/6
Standard 10,000 ohms, each	4/6
Igranic Jack Plugs, each	2/3
Bell Lee 7-pin Plug and Socket, each	1/6

CHARGER RECTIFIERS—All Full Wave

12 volt 1 amp., each	5/3
12 volt, 2 amp., each	8/6
12 volt, 3 amp., each	13/6

VOLUME CONTROLS
Type with Single Pole Switch.
5K ohms; 10K ohms; 20K ohms; 50K ohms; 100K ohms; ¼ meg.; ½ meg.; 1 meg.; 2 meg. All 3/6 each.

DUAL VOLUME CONTROL
With Double Pole Switch 500K ohms and 500K ohms. Price 6/9 each.

WHEN ORDERING PLEASE QUOTE DEPT W.W.

ALPHA RADIO SUPPLY CO.
5/6 VINCES CHAMBERS
VICTORIA SQUARE
LEEDS I.

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 9d.; 20/- add 1/6; 40/- add 2/-; £5 add 3/-; unless otherwise stated. Minimum C.O.D. fee and postage 2/3.

MAIL ORDER ONLY

Henry's (RADIO) LTD.

RADIO COMPONENTS ELECTRONIC & TELEPHONE EQUIPMENT

5, Harrow Road, Paddington, W.2

PADdington 1008/9 and 0401

OPEN MONDAY to SAT 9-6. THURS. 1 o'clock

SEND STAMPS FOR NEW 1956 28-PAGE CATALOGUE

U.S.A. TEST METER

25 ranges. 1,000Ωp. volt. A.C. and D.C. Readings 10–6,000 volt. Milliamps 1 mA–600 mA. Ohms 0–5 megs. Decibels —10 to +70 DB. Complete with internal batteries, leads and instruction book

£6/19/6

PIRANI HIGH VACUUM TEST EQUIPMENT

Manufactured by "Pye" Cambridge Ltd., for Atomic Research Station.

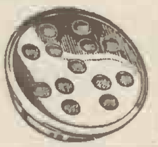
Comprising: Pirani Control Unit, Pirani Bridge Unit, Gauge head with calibrator, and Pye scale lamp galvonometer, all items brand new, in original packing. Offered at less than half original cost.

£33-10-0

complete

Spare Pirani Heads (Edwards M6) 15/-.

CRYSTAL MICROPHONE INSERTS



Ideal for Tape Recording, Gramophone Amplifier, etc. Very sensitive. Guaranteed and Tested, 5/- (ex-units), or 8/6 Brand new and boxed.

SPECIAL REDUCTION FOR SETS OF VALVES

1A7GT, 1N5GT, 1H5GT, 1A5GT (or 1Q5GT or 3Q5GT)	37/6 Set
10 EF50 (ex-Brand New Units) 5/- each	45/- „
10 EF50 (Red Sylvania, ex-new units) 6/- each	55/- „
6K8G, 6K7G, 6Q7G, 5Z4G, 6V6G	35/- „
1R5, 1S5, 1T4, 1S4 or (3S4 or 3V4)	27/6 „
DK96, DF96, DAF96, DL96	32/6 „
6K8G, 6K7G, 6Q7G, 25A6G, 25Z5 (or 25Z6G)	37/6 „
12K8GT, 12K7GT, 12Q7GT, 35Z4GT, 35L6GT (or 50L6GT)	37/6 „
12SA7GT, 12SK7GT, 12SQ7GT, 35Z4GT, 35L6GT or 50L6GT	35/- „

WE HAVE OVER 50,000 BRITISH AND AMERICAN VALVES AVAILABLE AT VERY LOW PRICES—SEND FOR LISTS.

FERRANTI TESTVAC

High Speed Vacuum tester, 200-250 A.C. £10 10 0

GARRARD 3-SPEED MIXER AUTO-CHANGER Model RC110

A.C. 200/250. List price £14/13/-. Brand New. **£8/18/6** P. & P. 5/-.

TRANSISTORS

OFFERED AT LESS THAN HALF-PRICE

This **Junction Transistor Type P.N.P.** is designed for A.F. application up to 800 Kc/s, and is suitable for use in Radio Control, Signal Tracers, Local Station Receivers, Oscillators, Transistor Voltmeters and Experimental work, etc.

10/- EACH

(complete with Technical Data and Circuits)

ELECTRICAL DATA

Maximum collector voltage	—5 volts
Peak collector voltage	—5 volts
Maximum collector current	—10 mA
Maximum emitter current	—10 mA
Maximum power dissipation	—25 mW

MINIATURE TRANSMITTING STRIP "TYPE 81"

Size 7½in. x 6in. x 3in. Complete with Valves Type CV415, CV309, 2-6AM6, 2-7D9 and Quartz Crystal, 4,860 kc/s. Fully wired with circuit.

£4/10/- complete.

B.S.R. RECORD CHANGERS

Very latest type "Monarch" in hammered gold finish. 3-speed with HGP37 crystal turnover pick-up. Plays mixed records. Brand new and guaranteed. Listed at £16/10.

£7/19/6. carr. paid.

MINIATURE I.F. STRIP TYPE "373" 9-72 MEG.

Brand new miniature I.F. Strip size 10¾in. x 2½in. x 3in. high. Valve line-up: 2-EF92; 3-EF91 and EB91. With circuit.

Price (less valves) 7/6. P. & P. 1/6.

This I.F. Strip is part of above equipment.

T/R 1196 RECEIVER

Complete with 6 valves: 2 EF36, 2 EF39, 1 EK32, 1 EBC33, 465 I.F.T., ideal for conversion. In absolute new condition. 27/6, P.P. 2/6, with circuit.

TR 1196 TRANSMITTER

Transmitter section comprising EL32, EF50, VT501, Relay, etc. 12/6. P.P. 2/6

COMPLETE TRANSMITTER RECEIVER with 24 v. power-pack in original transit case. 57/6, P.P. 5/-

U.S.A. INDICATOR UNIT BC929A

Complete with 3BP1 C/R tube and screen, 7 valves—2-6SN7GT, 2-6H6GT, 6G6, 2X2, 6X5G, volume controls, condensers, etc. Ideal for portable 'scope. In black crackle case size 15½in. x 9in. x 9in. BRAND NEW. 65/-, carr. FREE.

MEGGERS

Record Junior, 500 v., 20 meg. (Leather case 7/6 extra.)	£8 0 0
Bowthorpe Continuity Meter with Internal Battery Reading, 0-500 Ω and 100/200,000 Ω	£3 5 0

TRANSMITTER RECEIVER "38" WALKIE TALKIE SETS

Special offer of above set, complete with 5 valves, 4-ARP12 and ATP4, with circuit. Range 7.4 to 9 Mc/s. These sets are not guaranteed but are serviceable.

25/-

Junction box, 2/6 extra.

QUARTZ CRYSTALS

TYPE FT243 fundamental Frequencies. 2 pin ½in. spacing.

120 TYPES. 5675 Kc/s. to 8650 (in steps of 25 Kc/s.).

80 TYPES. 5706 Kc/s. to 8340 Kc/s. (in steps of 33.333 Kc/s.).

ALL BRAND NEW **10/-** each

Special price for complete sets of 80 or 120

Above are suitable for regrinding

TYPE FT241A 54th harmonic Crystals. 2 pin ½in. spacing.

80 TYPES AVAILABLE 20 Mc/s.—27.9 M/Mc/s. (in steps of 100 Kc/s.). COMPLETE SETS AVAILABLE.

ALL BRAND NEW **7/6** each

FT241A 200 Kc/s. 10/- each.

Crystal Holders for both Types 1/3 *each.*

CATHODE RAY TUBES

VCR138A WITH SCREEN ..	£1 15 0
VCR139A. 2½in. C/R Tube. Brand new in original cartons (carr. free)	£1 15 0
VCR97. Guaranteed full T/V picture (carr 2/-)	£2 0 0
VCR517C. Guaranteed full T/V picture	£1 15 0
MU-METAL SCREENS for VCR97 or 517. P.P. 1/6 ..	10 0
6in. ENLARGER for VCR97 or 517. P.P. 1/6	17 6
VCR97. Slight cut-off. Carr. 2/-	15 0
3BP1. Brand new	£1 10 0

62A INDICATOR UNIT

Containing VCR97 with Mu-Metal Screen. 21 Valves: 12-EF50, 4-SP61, 3-EA50, 2-EB34. Plus Pots., Switches, H.V. Cond., Resistors, Muirhead S/M Dial. Double Deck Chassis and Crystal. BRAND NEW ORIGINAL CASES. 67/6. Carr. 7/6.

PYE 45 Mc/s STRIP TYPE 3583 UNITS

Size 15in. x 8in. x 2in. Complete with 45 Mc/s. Pye Strip, 12 valves, 10-EF50, EB34 and EA50, volume controls, and hosts of Resistors and Condensers. New condition. Modification data supplied.

Price 69/6. Carriage paid.

LATEST TYPES NOW IN STOCK

EBC41	10/-	EABC80	10/-	12AT6	8/-	PABC80	15/-
EY51	12/-	ECC85	10/-	12AT7	9/-	6AU6	9/6
EF41	11/-	EF80	10/-	12AU6	9/-	117Z3	8/6
EL41	11/-	ECL80	12/6	12BA6	9/-	12AX7	10/-
EZ40	10/-	PL81	12/6	12BE6	10/-	DK96	9/-
EM34	10/-	PL82	10/-	12AH8	12/6	DL96	9/-
UL41	11/-	PY81	10/-	35W4	8/6	DAF96	9/-
UY41	11/-	EM80	10/-	PCF80	15/-	DF96	9/-
UF41	11/-	6X4	8/-	EBF80	11/6	ECC84	12/6
UCH42	12/6	PY82	10/-	EF85	10/6	6AQ5	10/-
UBC41	10/-	PCC84	12/6	EF89	10/6	PCL82	12/6
DK40	10/-	PCF82	12/6	ECF82	15/-	ECH42	12/6
EF80	10/-	12AU7	9/-	EF86	12/6	3A5	12/6

TRANSMITTER/RECEIVER SCR 522

Comprising the well-known BC625 and BC624A Units complete with 17 valves types: 2-832, 3-12A6, 3-12SG7, 3-9003 9002, 6G6G, 12J5GT, 12AHGT, 12C8, 6SS7. The Complete unit is in very good condition having very useful parts including Relays, Transformers, Condensers, etc.

Less valves, £3/10/-, carr. paid

With valves, £7/10/-, carr. paid.

INDICATOR UNIT TYPE 182A

Unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-Metal screen, 3 EF50, 4SP61 and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Offered BRAND NEW (less relay) at 67/6. Plus 7/6 carr. "Radio-Constructor" scope circuit included.

MODERN ELECTRICS LTD.

164 Charing Cross Road, London, W.C.2.

Tel.: TEMple Bar 7587.
Covent Gdn. 1703.
Cables: Modcharex, London.

Export enquiries welcomed. *Immediate delivery from stock.* *Prompt attention to post orders.*

TAPE RECORDERS

GRUNDIG TK5	46 gns.
GRUNDIG TK820/3D	98 gns.
SIMON	75 gns.
FERROGRAPH 2A/N	76 gns.
FERROGRAPH 2AN/H	86 gns.
VORTEXION 2A	80 gns.
VORTEXION 2B	£99
BRENELL 3-SPEED	48 gns.

The following Recording Tapes are available from stock.

	1,750ft.	1,200ft.	600ft.
FERROGRAPH	£3/3/-		
FERROGRAPH		45/-	26/9
GRUNDIG BASF		40/-	25/-
SCOTCH BOY		35/-	21/-
EMI 77		48/-	—
EMI 88		35/-	21/-
AGFA		37/6	22/6
GEVAERT		35/-	21/-
PURETONE		20/-	—
FERROVOICE		32/6	—
SOUNDMIRROR		30/-	—

Long Playing Tapes now in stock

RECORD REPRODUCING EQUIPMENT

COLLARO TRANSCRIPTION

Model 2010 PX	£19 9 0
RC54	£13 17 0
554 Unit	£9 7 0

GARRARD GRAM UNITS

RC98	£19 17 7
RC88	£17 18 8
RC121D	£13 13 10
301 Transcription	£26 8 3
TA/AC	£11 6 7
TA/B for Decca	£8 19 3

CONNOISSEUR

Variable 3 speed	£28 11 0

SPEAKERS

W.B. STENTORIAN

HS.610	£2 13 6
HS.812	£4 3 6
HS.912	£4 8 6
HS.1012 tapped coil, 3 7.5 or 15 ohms	£4 19 9

GOODMANS

Axiom 150 Mk. II	£10 15 9
Axiom 102	£10 7 9
Axiom 101	£6 18 6
Axiom 22	£15 9 0

WHARFEDALE

W15 CS	£17 10 0
Super 12CS/AL	£17 10 0
W12CS	£10 5 0
Golden 10 CSB	£8 14 11
Super 8CS/AL	£7 6 11
Super 3	£7 0 11
Bronze 10in.	£4 17 3
Bronze 8in.	£3 10 0
W.B. Crossover Unit	£1 10 0
W.B. Tweeter Unit	£4 4 0
Kelly Ribbon Tweeter	£12 12 0

TEST EQUIPMENT

AVO

Model 8	£23 10 0
Model 7 (latest)	£19 10 0
Uniminor Mk. II	£10 10 0
Electronic Meter	£40 0 0
Wide Band Sig/Gen.	£30 0 0
Valve Characteristic Meter Mk. III	£75 0 0
D.C. Minor	£5 5 0
10kV Multiplier for Model 8	£3 5 0
Carrying Cases for Models 7, 8 and 40	£3 0 0

ADVANCE

H.1. (Sig./Gen.)	£28 0 0
E.2 (Sig./Gen.)	£32 10 0
P.1	£22 5 0

COSSOR

Oscilloscope 1035	£120 0 0
Oscilloscope 1052	£104 0 0
Volt: Calibrator 1433	£18 5 0

TAYLOR

All new Taylor Test Gear in stock.

PICKUPS AND PLAYERS

ACOS, DECCA, COLLARO, CONNOISSEUR, LEAK, FERRANTI, B.J., GARRARD, PHILIPS.

MICROPHONES

ACOS

Mic 22 (Crystal)	£4 4 0
Mic inserts for above	£1 0 0
Mic 33-1	£2 10 0
Mic 35-1 (Crystal)	£1 5 0

LUSTRAPHONE

M/C High Imp.	£5 15 6
LFV59 Dynamic	£8 18 6

RESLO

VMC (low imp.)	£6 0 0
RBL/T	£8 15 0

FILM INDUSTRIES

Ribbon	£8 15 0

MICROPHONE STANDS

Floor, 3 extensions	£3 12 6
Table Stand	£1 5 0

LEAK AMPLIFIERS

TL.10 complete	£28 7 0
Point 1, TL.12	£28 7 0
Point 2, TL.25	£34 7 0
QUAD, Mk. II	£42 0 0
MULLARD	£18 18 0
E.A.R. 4 watt	£9 9 0
TRIX 4 watt	£16 10 0

ALL GARRARD, CONNOISSEUR, DECCA and COLLARO HEADS. SAPPHIRE and DIAMOND STYLI for the above HEADS NOW AVAILABLE.

KAYE

ELECTRICAL MANUFACTURING CO.

Manufacturers of Magnetic Relays. B.P.O.3,000 and 600 types. to A.I.D.—I.E.M.E. or G.P.O. Standards.

CONTACTS

Twin silver ½ amp.
Twin platinum 1 amp.
Heavy duty 5-8 amp.

COILS

Up to 100,000Ω Guaranteed.
± 3% on Turns.
± 5% on ohms.

Fully Tropicalised—Jungle or Services finish to Specification.

New descriptive leaflet and price list on request.

Enquiries are invited regarding our newly developed time delay relay unit for giving up to approx. 10 secs. delay with immediate reset.

Early Deliveries. **Competitive Prices.**

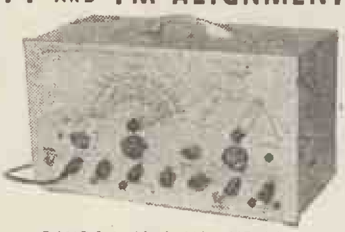
Spring Contacts, Coils, Buffer Blocks and components parts for relays supplied separately.

HAVELOCK WORKS, HAVELOCK PLACE, HARROW, Middx.

HARrow 1432.

NEW

TV AND FM ALIGNMENT GENERATOR



BANDS I, II & III AND I.F.s

ABSORPTION MARKER FOR IF.s 10-40 M/CS.

SINGLE OR DOUBLE TRACE OPERATION. 0-20 M/CS SWEEP WIDTH.

BANDS IV AND V ON HARMONICS.

Price and Further details on application

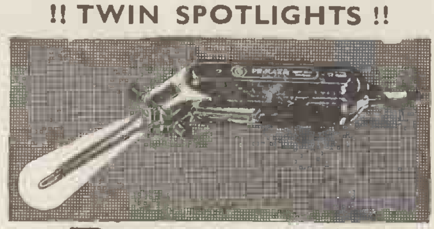
Trade and export Enquiries invited

WHARTON INSTRUMENT COMPANY

1081, FINCHLEY RD., LONDON, N.W.11. Tel.: Meadway 3407

!! TWIN SPOTLIGHTS !!

HEAVY DUTY



PRIMAXA

SOLDERER

Model 100W. 96/6 *post free.* Available 110, 200/220, 220/250v. INSTANT HEATING. You only consume current when actually soldering. One Year Guarantee except on soldering bits and lamps.

S. KEMPNER Ltd., 29 Paddington St., LONDON, W.1.
Phone: HUNTER 0755.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

TRADE ENQUIRIES INVITED

FOR ALL RADIO BARGAINS

WE PURCHASE ALL TYPES OF RECEIVERS AND TEST GEAR

CHOKE BARGAINS

G.B. 20 henry 175 ma.	10/6
Parmeko 8 henry 250 ma.	10/6
Parmeko 9 henry 100 ma.	7/6
Parmeko C core 4 h. 22.5 ma.	4/6
Collins 8 henry 100 ma.	8/6
Parmeko swinging choke 3.6-4.2 henry 250 ma.	10/6

All supplied new and unused.

BUZZERS. Brand new and boxed. Operate from 3 volt D.C., 2/6 each.

JACK PLUG LEADS. Brand new 6ft. screened leads fitted with two standard P.O. jack plugs, 3/- each.

COPPER AERIAL WIRE. Brand new reels of bare copper aerial wire, approx. 300ft. Only 3/6 reel

R.C.A. ET4336 PLATE TRANSFORMERS. Brand new and boxed, in original transit cases. Input 200/250 volt 50/60 cycles. Output 2,000-0-2,000 volts 500 ma. tapped 1,500-0-1,500 volts. Price £7/10/- each.

POST OFFICE RACKS. Standard 19in U channel type, 5ft., 59/6 each.

TRANSFORMER BARGAIN. Admiralty pattern. Primary 230 volt 50 cycle. Two separate secondary windings each 14 volt CT. 12 amps. This will give either 7, 14, 21 or 28 volts 12 amps. Brand new and boxed, 42/6 each

YAXLEY METER SWITCHES. Single pole 12 way, 8 bank. Brand new, 7/6 each.

FIELD TELEPHONES. Type DON Mk. 5. Buzzer calling. These are ideal for inter office, house communication. Supplied complete with buzzer, bell, handset etc., and two 1.5 volt cells, ready to operate. Price 39/6 each.

EDDYSTONE 12 VOLT ROTARY POWER UNITS. Input 12 volt D.C. Output 180 volts 65 ma. Housed in grey metal case complete with all smoothing, 19/6 each.

HEADPHONE ADAPTORS. High to Low impedence matching. American type. brand new, 1/3 each.

AMERICAN PANORAMIC ADAPTORS. Brand new and boxed. Sweep frequency 200 kc/s For use with receivers having an I.F. frequency between 455 and 475 kc/s. Operates from 110/230 volt A.C. 50-60 cycles. Price £30 each.

HEAVY DUTY CHARGING TRANSFORMER. Input 230 volt 50 cycles. Output 17.5 volts 35 amps. Brand new and boxed, 72/6 each.

18 PIN UNITERS. Brand new 3/6 pair.

ADMIRALTY POWER UNIT 234. Input 200/250 volt A.C. 50 cycles. Output 240 volts 150 ma. and 6.3 volts 6 amps. Double choke and paper condenser smoothed. Fitted with 2½in. moving iron meter reading, input A.C. volts and D.C. output volts. Mounted in grey metal case for 19in. rack mounting. Supplied in perfect order, 69/6 each.

CRYSTAL MICROPHONE INSERTS. Ideal for tape recorders, amplifiers etc., extra sensitive. Supplied in good condition and tested, only 4/6 each. Size only ¾in square.

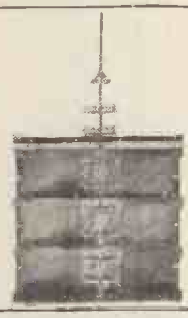
DEAF AID UNITS. Due to another huge purchase we are again able to offer these units at a fantastically cheap price. Made by famous manufacturer. Complete less only outer case Battery space provided on chassis. Requires 22½ and 1.5 v.

Feature includes: 1. 3 Mullard valves. 2 DF64 and 1 DL66 output. 2. Output transformer matched to 30 ohms. 3. Extra sensitive crystal microphone. 4. Built in volume control. 5. Size only 3¼ × 1⅞in. ONLY 19/6 each.

Earpieces to match, 3/6 each. Leads, 1/-. Few only chassis available using 2 DF66 valves and 1 OC71 transistor as an output stage. This chassis requires only a 1.5 v. battery to operate, price 40/- each. Deaf aid spares. CK505 valves, 2/6 each. 1 meg. pots w/switch, 1/-. Miniature output transformers, 2/6.

TRANSFORMER SNIP. Admiralty pattern. 230 volt 50 cycle input. Three separate secondary windings, each 10 volt C.T. 5 amps. This will give either 5, 10, 15, 20, 25 or 30 volts 5 amps. Supplied brand new, ONLY 29/6.

COSSOR DOUBLE BEAM OSCILLOSCOPES. Type 3339. These laboratory test instruments are offered in perfect condition, fully reconditioned and tested. Operation 200/250 volt A.C. Main features are: Frequency 6 cps.-2 mc/s. 10 time base positions, sweep 10 cps.-250,000 cps., Y1, Y2 sensitivity 3.6 volts D.C. 1.1 volt RMS, X sensitivity 2.25 volts D.C. Size of tube approx. 4½in. Price only £21 each.



AR.88 RECEIVER SWITCH ASSEMBLIES. 8 wafer 6 position screened assembly supplied brand new in original boxes. A must have spare for this receiver. Price only 17/6 each

Few only geared drive assemblies for this receiver, brand new 10/6 each.

MARCONI CRYSTAL CALIBRATORS. Frequency coverage 170/240 mc/s. Directly calibrated, accuracy .001%. Supplied brand new and boxed in original transit cases, complete with 5 mc/s. crystal and spare set of 5 valves. Price £5/19/6 each.

MODULATION TRANSFORMERS. Collins type. Push-pull 807-807. 20 watts audio. Brand new 12/6 each. Bendix type for TA-12, brand new, 15/- each.

SUB-STANDARD VOLTMETERS. Six ranges. 0-7.5, 15, 30, 60, 150 and 300 volts D.C. 6in. mirror scale calibrated 0-150 volts with knife edged pointer. Each instrument calibrated to an accuracy of 0.3%. Supplied in perfect condition in polished wood case size 7¾ × 7¼ × 4in. Price £4/19/6 each.

METER BARGAINS

50 microamp 2¼in. F.M. M.C.	59/6
50 m/amp. 2in. F.M. M.C.	7/6
150 m/amp. 2in. F.M. M.C.	6/9
200 m/amp. 2½in. F.M. M.C.	9/6
1 amp R.F. 2½in. F.M T.C.	6/9
1 amp. R.F. 2½in. Pj. T.C.	5/-
4 amp. R.F. 2in. F.M. T.C.	5/-
300 volt D.C. 2in. F.M. M.C.	10/6
300 volt A.C. 2½in. F.M. M.I.	25/-
500-0-500 microamp. 2½in. F.M. M.C	25/-
2 kV. Electro Static 2½in. PJ	22/6

SPECIAL OFFER GRAM. MOTORS. Garrard 200/250 volt A.C. gram motors, complete with turntables. Adjustable speed from 0 to 45 r.p.m. Can be used for latest type records 33 or 45 r.p.m. A real snip at only 22/6 each

AMERICAN EXTENSION SPEAKERS. Brand new and boxed 8in. speakers housed in attractive black crackel case, 3 ohm coil, ideal for all applications, 39/6 each.

SUB-STANDARD MILLIAMETERS. Basic movement 1 ma. Seven ranges 0-1, 5, 20, 50, 100, 200 and 500 ma. 6in. mirror scale with knife edged pointer calibrated 0-100 ma. Calibrated to an accuracy of 0.1%. Supplied brand new in polished wood case size 7¼ × 7¼ × 6in. and complete with leather carrying case. Price £12/10/- each.

ROTARY CONVERTORS. Input 24 volt D.C. Output 230 volt 50 cycles 100 watts. Supplied brand new, 92/6 each.

MULLARD CAPACITY RESISTANCE BRIDGES. Ranges 10pF to 10 mfd. and 1 ohm to 10 megohms operation 110/230 volts A.C. Supplied checked and working, £5/19/6 each.

50 MICROAMP METERS. A grand offer of brand new test sets containing a flush mounting 50 microamp meter, 2½in. scale, housed in grey instrument case complete with chromium plated handle. Price 59/6 each.

AMERICAN PRECISION POTS. 10,000 ohms. 5½in. dia. Built in correction plate. Brand new and boxed, 22/6 each. Colvern type, 3½in. dia. 100,000 or 50,000 ohms. Brand new and boxed, 10/6 each.

FREQUENCY METERS. For 230 volt A.C. 50 cycles. 5in. scale calibrated 45-55 cycles. Perfect condition, £5/10/- each.

MARCONI SIGNAL GENERATORS. Laboratory instruments supplied brand new, boxed and tested. 200/250 volt A.C. operation. Model TF390g, 4-100 mc/s., £25 each. Model TF517g, 16-58 and 130-260 mc/s., £35 each.

AMERICAN POWER RHEOSTATS Brand new and boxed. 8 ohm 3.3 amp., 8/6; 8 ohm 2.5 amp., 7/6; 90 ohm. 0.74 amp., 7/6; 200 ohm. 0.35 amp. 5/6.

R.1294 RECEIVERS. Superhetrodyne receiver covering 500-3,000 mc/s. (10-60 cm.). Input impedance 70 ohms. 2 detector stages, 2 L.F. amplifier stages. I.F frequency 13.5 mc/s. Bandwidth 3.5 mc/s. Price £35 each

BRAND NEW BENDIX COMMAND RECEIVERS. Supplied in original carton complete with all valves: 2-12SK7, 2-12SR7, 1-12K8 and 1-12A6, BC453, Q Finer, 190/500 kc/s 69/6. BC XXX, top band, 1.5/3 Mc/s. 85/-, with circuit.

MINIATURE H.T. TRANSFORMER. Input 220/240 volts. Output 200 volt 25 ma. and 6.3 volt 1 amp. 10/6 each. Miniature metal rectifier to match, 7/6 each.

HOURS OF BUSINESS:—9 a.m.—6 p.m. Thursday 1 p.m. Open all day Saturday.

PLEASE PRINT NAME AND ADDRESS CLEARLY, ALSO INCLUDE POSTAGE OR CARRIAGE ON ALL ITEMS

Best Buy at Britain's

METER BARGAINS

RANGE	TYPE	SIZE		PRICE
50 Microamp.	D.C. M/C	2½in.	Flush circular, scaled 0-100	59/6
100 Microamp.	D.C. M/C	2½in.	Flush circular, scaled 0·1,500	39/6
500 Microamp.	D.C. M/C	2in.	Flush square, Weston	27/6
500-0-500 Micro-amp.	D.C. M/C	2½in.	Flush circular, scaled 100-0-100 V.	25/-
1 Milliamp.	D.C. M/C	2in.	Flush square, Fe/NFe	22/6
1 Milliamp.	D.C. M/C	2½in.	Desk Mounted type	32/6
10 Milliamp.	D.C. M/C	2½in.	Flush circular, blank scale	10/6
100 Milliamp.	D.C. M/C	2½in.	Flush circular	10/6
150 Milliamp.	D.C. M/C	2in.	Flush square	7/6
200 Milliamp.	D.C. M/C	2½in.	Flush circular	10/6
1 Amp.	Thermo-couple	2½in.	Projecting circular	6/9
4 Amp.	Thermo-couple	2in.	Flush square	6/9
20 Amp.	D.C. M/C	2in.	Projecting circular	7/6
30-0-30 Amp.	D.C. M/I	2in.	Proj. circ., metal cased, car type	5/-
15 Volts	A.C. M/I	2½in.	Flush circular	8/6
300 Volts	A.C. M/I	3½in.	Flush circular	30/-
300 Volts	D.C. M/C	2in.	Flush square	10/6

METER RECTIFIERS. 1 mA. Salford Instruments, 8/6; and 5 mA., 6/9; 2 mA., S.T.C., as used in E.M.I. Output Meter, 5/6.
All are full wave bridge and brand new.

ADMIRALTY COMMUNICATIONS RECEIVER TYPE B.28 (MARCONI CR.100). Frequency range, 60 Kc/s to 30 Mc/s. Self-contained power pack 200/250 volts A.C. 50 cps. Variable Selectivity Crystal Filter. Complete with valves and Air Tested. SUPERB CONDITION. PRICE ONLY £21.
Plus £2 carriage and packing (£1 refunded on return of packing case). Send S.A.E. for full details and illustration.

PANORAMIC ADAPTORS. Visual display of signals on 3in. CR Tube 3BP1. Band width 200 Kc/s. Suitable for receivers with I.F. of 450–475 Kc/s. Operates from 110–230 V. A.C. mains. BRAND NEW, as shipped ex-U.S.A. With instruction manual, £30. Suit CR100.

RCA SPEAKER—An 8in. P.M. unit contained in beautiful black crackle cabinet, suitable for AR88, etc. BRAND NEW. Price only 45/-.

COMMAND RECEIVERS. Complete with 6 metal valves, 3 12SK7, 1 12K8, 1 12SR7 and 1 12A6. Size 5in. x 5½in. x 11½in. deep. In very good condition. Less dynamotor. FREE CIRCUIT WITH EACH SET. BC455, 6-9 Mc/s., 25/-. BC453 (the famous Q5'er), 190–550 Kc/s., 59/6. BC454, 3–6 Mc/s., 27/6. BCXXX ("Trawler" band), 1.5–3 Mc/s., 65/-.

U.S.A. POWER UNITS. 115 v. A.C. input. 1,000 v. 250 mA. output. Complete with two 1616 and 1 spare. Double smoothing. BRAND NEW, £5/5/-.

AM POWER UNITS 247. 230 v. A.C. input. 600 v. 200 mA., 6.3 v. 3 amp. output. BRAND NEW, 49/6.

EDDYSTONE ROTARY POWER UNITS. 12 v. D.C. input, 180 v. 60 mA. output, smoothed and filtered. In grey metal case, 12 x 6 x 5in. Weight 16 lb. BRAND NEW, 19/6.

HEAVY DUTY LT TRANSFORMERS. 230 v. A.C. mains input. Secondary 5-0-5 v. 5-0-5 v., and 5-0-5 v., all at 5 amps., each winding. 5, 10, 15, 20, 25, 30 v. at 5 amps. or other possible combinations. Size 4¾in. x 4½in. x 6in. high. Weight 12 lb. BRAND NEW, 29/6.
Primary 230 volt 50 cycle. Two separate secondary windings each 14 volt C.T. 12 amps. 7, 14, 21 or 28 volts 12 amps. or other possible combinations. Weight 24 lb. Admiralty pattern. BRAND NEW, 42/6.

G.E.C. 200–250 v. A.C. input. 30 v. tapped at 10 v. 36 amps. output, 5½in. x 6in. x 7in. high, weight 24 lbs., 55/-.

SELENIUM BRIDGE RECTIFIERS. Funnel cooled. 45 v. RMS input. 30 v. 10 amp. D.C. output. BRAND NEW, 47/6.

METAL RECTIFIERS. 250 volts 100 mA., 6/9. 230 volts, 60 mA., 5/-.

INSTRUMENT TRANSFORMERS, Parmeko. 230 v. A.C. in 0–65–130–195 v. 85 mA. 6.3 v. 5 amp. 6.3 v. .3 amp. output. Shrouded, 3¼in. x 3¾in. x 3¾in. high, 15/-.

MINIATURE MODEL MOTORS. 2in. long x 1¾in. diam., 3/16in. diam. spindle, weight 5 ozs. Will work from 6-volt dry battery and are reversible. Ball bearings. Price 8/6.

5ft. P.O. TYPE 19in. RACKS. "U" channel, heavy angle base, 59/6.

RESISTORS. Latest miniature insulated Dubilier ½ watt type BTS. Wire ends. Useful values. ONLY 10/- for 100 assorted!

FIELD TELEPHONES. Army type D. Mk.5. Buzzer calling. Ideal for building sites, farms, workshops, etc. Complete with handset and batteries. Tested before despatch. 39/6 each.

PLEASE ADD POSTAGE OR CARRIAGE ON ALL ITEMS

CHARLES BRITAIN (Radio) Ltd.

11 UPPER SAINT MARTIN'S LANE
LONDON, W.C.2 *TEMple Bar 0545*
One Minute from Leicester Sq. Station (up Cranbourn St.)
Shop hours: 9-6 p.m. (9-1 p.m. Thursday) *Open all day Saturday*

MAGNETIC RELAYS

TYPES 3000 and 600

Supplied to specification for the following uses:—

- METER PROTECTION
- TIME DELAY
- OVERLOAD TRIPS
- ALARM SYSTEMS
- FLASHING & PULSING
- PROCESS CONTROL
- TIMING DEVICES
- AERIAL CHANGE-OVER
- MAINS FAILURE PROTECTION
- COMPLEX OR SEQUENCE SWITCHING
- SELECTION & COUNTING SYSTEMS
- HIGH VOLTAGE SWITCHING

(CONTACT INSULATION UP TO 2KV)

Consult us with your problems

POLARISED, HIGH SPEED, A.C. & TELEGRAPH RELAYS IN STOCK

ELECTRO MAGNETIC COUNTERS
UNI-SELECTORS
KEY SWITCHES, P. O. and LOW LOSS

JACK DAVIS (RELAYS) LTD.

TUDOR PLACE, LONDON, W.1
MUSEUM 7960 LANGHAM 4821

Electronic Engineers are required for development and technical liaison duties related to the development of highly interesting projects. A knowledge of aircraft electrical systems would be an advantage but not essential. Apply in writing, stating age and experience, to the Staff Manager, G.E.C. Stanmore Laboratories, Stanmore, Middx., quoting Ref. AMV/FH.

Senior and Junior Electronic Engineers are required with a good general background of electronic design and development for the study and development of complex electronic systems related to aircraft. Preference will be given to candidates with a general rather than specialised knowledge of electronics. Apply in writing, stating age and experience, to the Staff Manager, G.E.C. Stanmore Laboratories, Stanmore, Middx., quoting Ref. AMV/FH.

There is always a fine selection of equipment at The Walk-around Shop

AN/APN1 UNITS

MOVING COIL TRANSDUCERS *as illustrated on page 252 June "Wireless World."*

RECEIVER

A sub-chassis 3½ × 6½ × 2¼in. houses a Receiver tuned to the transmitting frequency. Contains TWO 9004 valves. For use in 70 cm. band.

PRICE, post paid **12/6**

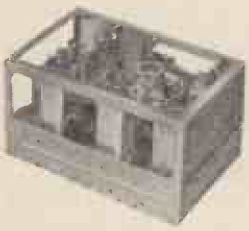
A.F. AMPLIFIER

An Audio Frequency Amplifier in a sub-chassis 5 × 3 × 3¼in. R/C coupled, using TWO 12SH7 and ONE 12SJ7 valves; and can be used for Telephone Intercom., Pre-Amplifiers, etc.

PRICE, post paid **15/-**

BENDIX I.F. Transformers 1.63 Mc/s complete in cans, set of two new and boxed. Size 2 × 1½ × 3¾in., 5/-, p.p. 1/6.

BENDIX Potted Audio Output Transformer complete with integral smoothing choke. Ratings 4½ watt 9,000 ohm Primary. 600 and 4,000 ohm Secondary. Size: 4 × 1¾ × 2in. New and boxed, 4/6, p.p. 1/6.

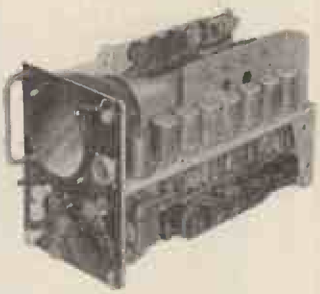


RECEIVER UNIT Ex 1143A
Suitable for conversion to 2 metres or F.M. Wrotham transmissions.

Valve line-up: (4) EF50. (1) EL32. (2) EF39. (1) EBC33. (1) EA50. Supplied with circuit diagrams.
Fully valved 35/- each, plus 3/- p.p.

TYPE 62A INDICATORS

Ideal for conversion to oscilloscopes, T.V. units, etc. Containing V.C.R.97, 12 VR91 (EF50), 2 VR54 (EB34), 3 VR92 (EA50), 4 CV118 (SP61). Slow-motion dial, 13 Pots and scores of useful components. Size: 8½ × 11½ × 18in. In wooden packing case, £3, carriage 7/6.

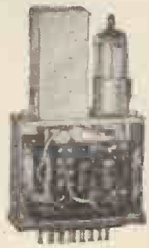


PAPER BLOCK CONDENSERS

8 µF 600 V wkg., 5/6 p.p. 4 µF 400 V wkg., 4/- p.p.

I.F. AMPLIFIER UNIT

460 kc/s with IT4. Brand New and Boxed. Fully Screened in plug-In Box. Size 2½" × 1" × 4½". Price with circuit, 10/- each. Plus 1/- p.p.



MINIATURE TRANSMITTER STRIP TYPE 81 Complete with valves CV415 (TT15), CV309 (QV04-7), 2-6AM6, 2-EL91 and Crystal. Circuit supplied Free with unit. Price £4/10/- post paid.

MINIATURE I.F. STRIPS

Size 10¾ × 10½ × 3in. Frequency 9.72 Mc/s. 2 EF92s and 1 EF91. I.F. amps. EB91. DET/AGC. EF91 AGC. Amp. and EF. 91. Limiter. Circuit supplied.

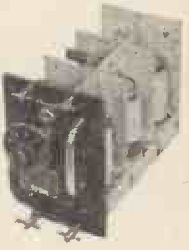
Price : 8/- less valves.
Post paid.

R.F. UNITS

R.P.25 40-50 Mc/s. Switched Tuning. Valved. 9/6 each.

R.F.26 50-65 Mc/s, Variable Tuning. Valved (new and boxed) 25/- each.

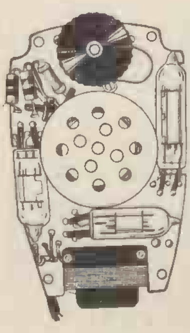
Packing and postage 2/- each.



2-3mA MEASUREMENT METER

2-3 mA movements in metal case measuring 4¾in. high, 3¼in. wide and 5in. deep. 7/6 plus 2/- p.p.

Make a miniature POCKET RADIO



Incorporating high "Q" technique using the New Ferrite rod. Made possible by simple conversion of an ex-Govt. Hearing Aid.

Technical Details. A Germanium Diode Detector circuit followed by the existing 3 valve Amplifier, giving adequate amplification throughout the medium wave band.

This conversion can be carried out in approximately 30 minutes.

SEE and HEAR this Miniature POCKET RADIO demonstrated.

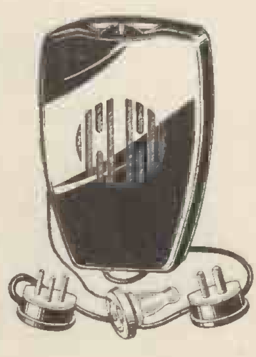
THE COMPLETE KIT OF PARTS includes a Type OL10 Hearing Aid (with Crystal microphone) in perfect working order with miniature earphone and moulded ear insert attached; ferrite rod, germanium diode, components, circuit diagram and full instructions.

Price **£2 6s. 0d.** post paid.

ALL COMPONENTS SOLD SEPARATELY

	£	s.	d.
Deaf Aid Unit with earpiece ..	£1	15	0
Plastic Ear mould		2	0
Ferrite Rod		5	0
Conversion Components		4	0
Batteries 1.5 v. L.T. (Type D.18)			8
30 v. H.T. (Type B.119)		4	3

NOTE: As the crystal microphone is not used in the Pocket Radio, it can, if desired, be used as a general microphone and it does not require a matching transformer.

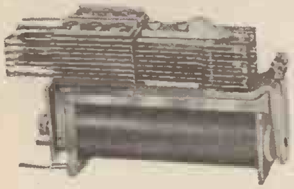


NOTE: Carriage prices quoted apply only to England and Wales.

PROOPS BROS. LTD.

NOTE: Orders and Enquiries to Dept. "W" Shop hours 9 a.m. to 6 p.m.—Thurs.: 9 a.m. to 1 p.m.
OPEN ALL DAY SATURDAY *Telephone : LANgham 0141*
52 TOTTENHAM COURT ROAD, LONDON, W.1

RELAYS P.O. TYPE 3000



BUILT TO YOUR SPECIFICATION

QUICK DELIVERY

KEEN PRICES

CONTACTS UP TO 8 CHANGE OVER

METERS GUARANTEED

F.S.D.	Size	Type	Price
250 Microamp. (multirange scale)	3½in.	MC/FR	5 /-
500 „	2in.	MC/FS	27/6
500 „ (scaled 0/15 KV)	2in. plug type	MC/FR	18/6
1 Milliamp	2in.	MC/FR	17/6
1 „	2in. 5Q/87	MC/FSElliott	27/6
5 „	2in.	MC/FS	10/6
30 „	2½in.	MC/FR	12/6
100 „	2½in.	MC/FR	12/6
200 „	2½in.	MC/FR	12/6
500 „	2½in.	MC/FR	12/6
20 Amp.	2½in.	MI/FR	25/-
50 „	5in.	MI/PR	60/-
50-0-50 Amp	2in.	MC/FS	12/6
15 Volt	2½in.	MI/FR	15/6
20 „	2in.	MC/FS	10/6
40 „	2in.	MC/FS	10/6
300 „	2in.	MC/FS	10/6
300 „	2½in.	MI/FR	25/-
200 „	5in.	MI/PR	60/-
2,000 „	2½in.	ES/FR	40/-

PHOTOMULTIPLIER No. 931A. Ideal for film scanning, spectography, Alpha counting, colorimetric measurement, etc., supplied complete in lightproof chamber with lamp, wired with the resistor network, 70/-. 9 stage multiplier only, 50/-.

SIGNAL AND NOISE GENERATOR. Television frequencies 20/88 Mc/s. in 4 bands. Crystal controlled. Operating on 115 v. or 80 v. suitable for conversion to 230 v. The few we have left we offer at the very special price of £8/17/6.

TEST SET 205. Wavemeter range, 3.05 to 3.35 centimetres, built-in oscillator with 9 valves including Klystron type CV.129, etc., in good condition, £17/10/-.

AMPLIFIERS. A high fidelity unit with separate Bass and Treble controls, constant impedance attenuator for setting volume level. 15 watt output, for 200/250 v. A.C. mains operation. Ideal for P.A. work, dances, etc. LESS VALVES, £12/10/-. Complete with valves, £15/12/6. Cge. 12/6.

RECEIVER R1155. Brand new. Aerial tested. In maker's original transit case. £11/19/6. Carr. 10/6. Publication giving circuit diagrams, etc., 1/3.

45 Mc/s PYE I.F. STRIP. These vision units are brand new and complete with 6 EF50 valves and EA50. Our price only 65/-. Post 3/-.

TELEPHONE SETS. For perfect communication between 2 or more positions. Wall Type, one, pair of units, £5. Batteries 5/6. Twin wire 5d. yard. Desk Type now available, latest modern style. Two complete units ready for use, £8/17/6. Wire 5d. per yard. Post 3/-.

RADIATION MONITORS. Various types, 1092C, 1092B, Airmec Rate meter No. 1011B in case with Gamma probe, spare Geiger tubes, etc. The 64 Scaler. Further details on request.

WAFER SWITCHES. Miniature, 2 Pole 6 Way, 3 Pole 2 Way, Both 2/6 ea. Standard, 1 Pole 3 Way, 1 Pole 4 Way. Both 2/6; 2 Pole 4 Way 3/-; 1 Pole 11 Way, 2 Pole 6 Way, 4 Pole 3 Way, 6 Pole 2 Way, 6 Pole 3 Way, 3/6; 2 Pole 11 Way, 3 Pole 6 Way, 6 Pole 4 Way, 4/6; 8 Pole 6 Way, 10/-. Ceramic Types, 1 Pole 3 Way 4/-; 2 Pole 12 Way, 10/6; 4 Pole 4 Way, 6/-; 12 Pole 3 Way, 15/-. Post 9d.

CONDENSERS, METALMITE. 350 vt. wkg., .001, .002, miniature 1/4 ea., 12/- doz.; .005, .01, .02, 1/2 ea., 10/- doz.; .05, 1/4 ea., 12/- doz.; .1, 1/6 ea., 13/6 doz.; .25 Metalpack, 1/10 ea., 16/- doz.; 1.0 Metalpack 2/8 ea., 24/- doz. Post 1/-. Full list available including BLOCK TYPES 8 mfd. 750 v., 7/6 ea.

ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Far. 250 v. 10 amp. A.C. Ideal for greenhouses, etc., 35/-. Post 2/-.

GEARED MOTORS. 4 R.P.M. at 12 v., 8 R.P.M. at 24 v. Very powerful, supplied with a suppressor which can easily be removed. 35/-, post 2/-.

P.M. SPEAKERS. 10in. In portable case with flex and plug in own compartment, 50/-. Cge. 5/-.

VENTAXIA FANS. 230/250 volts A.C., 6in. diam. blades, 130/-. 12 volt D.C., 90/-, post 2/9.

GENALEX EXTRACTION FANS. 230/250 volt, 50 cv. Induction motor 1,350 r.pm., 85 watts, 9in. blades, silent running, £6/15/-. Cge. 7/6.

RATIO ARM UNITS. H. W. Sullivan. 600 ohms to 600 ohms, 50/-. Post 2/-.

WHEATSTONE RESISTANCE BRIDGE. 1 to 10,000 ohms. Plug type. £5.

ELECTRO MAGNETIC COUNTERS

Post Office type 11A, counting up to 9,999, 2 to 6 volts D.C. 3 ohm coil, 12/6 each. Post 1/-. Many other types in stock.

ROTARY CONVERTERS. Input 24 volt D.C. Output 100 watts at 230 volt A.C., 150 watts at 200 volt A.C., 92/6. Also available in a metal case with switch, 105/-. Cge. 7/6.

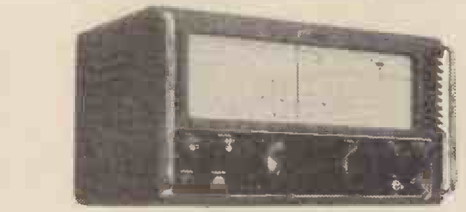
ROTARY CONVERTERS. Input 24 volt D.C. Output 150 watts at 230 v. A.C., 200 watts at 220 volts A.C., complete in wood case with 0/300 voltmeter, 4 position switch and voltage regulating resistance. 150/-. Also available with 12 volt input, 170/-. Cge. 10/-.

L. WILKINSON (CROYDON) LTD.

19 LANSDOWNE ROAD, CROYDON

Phone : CRO. 0839. Telegrams : " WILCO," CROYDON

EDDYSTONE COMMUNICATION RECEIVERS



Model 840A illustrated

Cash Prices and Special Credit Terms

Model	Cash Price	Deposit	8 monthly payments of
820	£38 0 0	£4 8 8	£4 8 8
840A	£55 0 0	£6 8 4	£6 8 4
750	£78 0 0	£9 2 0	£9 2 0
680X	£120 0 0	£14 0 0	£14 0 0

Carriage paid per passenger train

Model 840A, is for A.C. or D.C. 110/250 v. making it especially suitable for universal use. 750 and 680X 110/240 v. A.C. The very large tuning dials are clearly marked with band spread logging. Silky gear driven flywheel loaded tuning mechanism. These sets are the choice of the discerning professional and amateur users. Descriptive literature gladly forwarded.

Latest EDDYSTONE Component Catalogue 1/-.

HP RADIO

The Eddystone Specialists

SERVICES LTD.,

55 COUNTY ROAD, LIVERPOOL, 4

Telephone: AINTREE 1445 *ESTAB. 1935*

Branch Address: MARKET CROSS, ORMSKIRK

G.E.C.

Applications are invited from young men (preferably ex-National Servicemen) under 25 years of age who possess Inter B.Sc. or 3 "A" Level G.C.E. Science Passes (preferably Physics, Pure and Applied Maths.) for admission to a newly instituted INDUSTRY-BASED SANDWICH SCHEME.

This is a four year course and involves alternating periods of 6 months full time studying and interesting varied practical work at these Laboratories. It is designed primarily for Physicists and Electrical Engineers and will lead to the London B.Sc. (Special Physics) or B.Sc. (Eng.). A small number of potential Chemists will also be considered. Apart from a generous salary all College and examination fees will be paid.

★ *Applications should be made within 3 weeks of the appearance of this advertisement and should be addressed to :—*

THE EDUCATION AND TRAINING OFFICER, RESEARCH LABORATORIES, G.E.C. LTD., EAST LANE, N. WEMBLEY, MIDDX. QUOTING REFERENCE RLL/103.

Technical Publications

TECHNICAL WRITERS and **ILLUSTRATORS** are required with experience of electronic equipment for radar and similar projects.

An experienced **TECHNICAL CLERK** is also required.

Write giving full details etc. to Personnel Manager, Ref. RG, The General Electric Co. Ltd., Brown's Lane, Allesley, Coventry.

GEE BROS RADIO LTD

R.C.A. BRAND NEW 15in. 15 ohms 30 watt P.M. SPEAKERS. Snip price £9/19/6. Carriage 12/6.

R.C.A. PRESSURE UNITS. 15 ohms. P.M. 20 watts. Complete with Exponential Horn, length 14in. dia. 17in. £5/19/6. Carriage 10/-.

COMMUNICATION RECEIVERS P.C.R.2. Waveband 13-49, 200-600, 800-2,100 metres. Also P.C.R.3. 13-41, 41-120, 200-550 metres. Both types in brand new condition. Fully tested before despatch. Price £7/10/- each. Carriage 7/6.

POWER PACKS for the above Models available, complete with Speaker, built into very attractive Polished 8in. Extension Cabinet, ready for use on 200-250 v. A.C. Mains. £5/10/-. Carriage 7/6.

B.C. 614A SPEECH AMPLIFIER (Part of B.C.610 Equip.). As new, £22. Carr. extra.

MARCONI CRYSTAL CALIBRATORS for Band III Ex. Gov. Freq. range 170-240 Mc/s. Directly Calibrated Dial, 5 Mc/s Crystal Oscillator, Self-contained Power Pack for A.C. Mains operation. Complete with crystal and all valves, also spare set of valves with Instruction Manual. Brand new in original Transit Case, £5/10/6. Carr. extra.

C.M.G.-25 PHOTO CELLS (Osram). Brand New 17/6 each.

B.S.R. MONARCH. 3 speed automatic record-changer. Brand New in sealed makers cartons, £7/15/-. Carr. 7/6.

B.S.R. 3 speed motor and turntable only. Brand New. £3. Carr. Pd.

50 WATT EX GOVT. AMPLIFIER with 4-KT66's in paralleled push-pull. Standard 200-250 v. A.C. input. Output imped. 600 ohms. Line. High imp. gram and mike input. Bass boost control fitted. Quality amplifier housed in strong metal case ready for use. Terrific performance. Bargain price £25. Carriage extra.

R.C.A. 20 WATT MIKE AND GRAM AMPLIFIER, complete, ready to use. Tested before despatch. Housed in attractive all-metal case. Limited quantity available, only £18/10/-. Carr. 10/-.

E.H.T. TRANSFORMERS: 4.5kv. at 10m/a. Pri. 230v. Bargain price, 32/6. Carr. 3/-.

3A5 VALVES, Brand new (DCC90), 15/-.

METERS
- 0-1 mA. 2½in. round flush mounting. 21/-.
- 0-10 mA. 2½in. round flush mounting. 12/6.
- 0-30 mA. 2½in. round flush mounting. 15/-.
- 0-5 amp. 2in. square flush mounting. 15/-.
- 0-300 v. A.C. flush mounting 2½in. scale. 25/-.
- 0-25 amp. D.C. flush mounting 2½in. scale. 12/6.
- 0-15 v. and 0-250 v. D.C. pocket volt-meter 2½in. 15/-.
- AR-77 "S" meters 2in. F.S.D. 5 mA. 30/-.
- 0-200 v. A.C. meters flush mounting 3½in. Grade I. 40/-.

WAVEMETER CLASS D. Freq. band 1,900 kc/s-8,000 kc/s. (158-37.5 m.) in two ranges, 1,900 kc/s-4,000 kc/s. Also 4,000 kc/s-8,000 kc/s. in perfect working order. Supply 6 v. D.C. input. £8/5/-. Carr. paid.

CONDENSERS. 2 mfd. 7.5 kv. wkg. at 15 kv. test (Dubilier). Brand new in original crates. £2/10/-. Carriage 5/-.

VARIABLE VOLTAGE REGULATOR TRANS. Input 230 v. A.C. at 21 amps. Output 57.5 volts in 16 equal steps to 230 v. at 21 amps. Ex. Govt. in perfect condition. £12/10/-. Carr. extra.

H-DUTY TRANSFORMERS L.T. 230 v. PRI, 11-12.5 v. SEC. at 70 amps. £5/10/-. Carriage 7/6.

DON "8" TWIN TELEPHONE CABLE on 1 mile and ½ mile drums. £5 per mile, 25/- per ½ mile. Carriage extra.

WESTON BATTERY OSCILLATORS. Model E 692 Type 2. In perfect condition. Coverage 100 kc/s-20 Mc/s. Audio output approx. 400 c/s. Complete with instruction books and charts. £5/19/6. P.P. 4/6.

COLLINS RADIO RECEIVERS TYPE 46159A. Freq. range 1,500 - 12,000 kc/s. Input 12 v. or 220 v. D.C. Less crystal and power pack. This unit is part of TCS-12-Trans. Receiver equipment. In clean and good condition. Limited quantity. £15. Carriage 7/6.

VALVE TESTER (by Radio City Products, U.S.A.). Model No. 314. Brand new, unused with instruction manual. 110-220 v. A.C. 50 c/s. Will test most American valves from 1.1 v. to 200 v. £10. Carr. 5/-.

EX-PHILCO 6 v. and 12 v. Car Radio Vibrator Transformers. H-T 280 v. @ 80 mA. New in perfect condition. 12/6. Postage 1/8.

R.C.A. PRE-AMPLIFIERS. Comprising 2 6J7 valves and connections. Available for photo cell input 250 v. H.T. 6.3 v. L.T. supply required. Output control. Complete unit. New and unused. £5. Carriage paid.

ROTARY CONVERTERS. Ex. Govt. 12 v. D.C. Input 230 v. A.C. Output 50 cycles at 125 watts output. Complete in carrying case containing voltage control, sliding resistance, mains switch and 0-300 v. A.C. Flush Meter, in perfect working order. £8/10/-. Carr. extra.

RACKS. G.P.O. STANDARD. For 19in. panels. Steel channel sides, correctly drilled, heavy angle base, height 6ft. £3/10/-. Carr. extra.

CARRIAGE CHARGES APPLY TO ENGLAND ONLY.

QUOTATIONS TO THE TRADE FOR BULK SUPPLIES. ALSO ACTUAL ENQUIRIES WELCOMED. MANY OTHER LINES IN STOCK.

15, LITTLE NEWPORT ST., LONDON, W.C.2.
(ADJOINING LEICESTER SQUARE TUBE STATION)
GERrard 6794/1453

SAMSON'S SURPLUS STORES

E.D.C. Rotary Convertors. Input 230 v. D.C. Output 230 v. 6.6. amps. A.C. 50 cycles. £20. Ex warehouse.

S.T.C. 24 v. 4 amp. Selenium Rectifiers 27/6. P.P. 2/6.

Special Offer of Block Condensers. T.C.C. 10 mfd. 500 v. wkg. at 140 deg. F. Sub chassis. 6/6. 8 mfd. 500 v. wkg. at 140 deg. F. 4/9. 4 mfd. 1,000 v. wkg. at 140 deg. F. sub chassis. 4/6. 0.5 mfd. 2,000 v. wkg. at 60 deg. C. 3/6. 2 mfd. 2,500 v. wkg. at 60 deg. C. 7/6. Postage on all condensers 2/-.

Just arrived—Parmeko Heavy Duty Transformers. Input 230 v. Output 4 v CT 20 amps. Tropically rated. 27/6. Carr. 3/6.

American Smoothing Chokes. 13 henries 160 ma. 160 ohms. 10/6. P.P. 2/6.

A.C. 200-240 v. 40 Amp. Contactor. Double pole. New, in maker's cartons. 32/6. Carr. 4/-.

Advance Components. Constant Voltage Transformers Input 190-260 v. Output 230 v. 150 watts. £6/10/-. Carr. 7/6.

Brooks Capacitor. Start 0.4 h.p. A.C. 230 v. motors, 2,860 r.p.m. As used in the Brooks heavy duty air blowers. £5/10/-. Carr. 10/-.

Frost Electric. 1/6 h.p. A.C. 230 v. cap. **Start Motor £3/17/6.** Carr. 7/6.

Field Telephones. Mark DV. Complete with batteries. 49/6 ea. Carr. 5/-.

Telephone Cable. Type D3. Twin ½ mile. 65/-. Carr. 7/6. Type D8. Twin 1-mile drums. £7/10/-. Carr. 12/6.

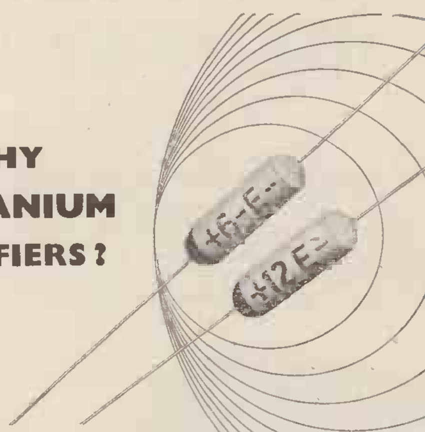
P.V.C. Commando Assault Telephone Cable. 1,000-yard drums. 10/6. P.P. 2/6.

Sliding Resistors. 60 ohms 1.5 amp. Geared drive. 15/-. P.P. 2/-. 50 ohm 1 amp. S.M. drive. 8/6. P.P. 2/-. 1 ohm 12 amp. slide control 12/6. P.P. 2/-. 0.4 ohm 25 amp. geared drive 17/6. P.P. 2/6. 17.5 ohm 8 amp. **Fixed Resistor** with adjustable tapping. 17/6. P.P. 3/-. Many other types available from stock.

169/171 Edgware Road, London, W.2. Tel.: PAD 7851
125 Tottenham Court Road, W.1. Tel.: EUS 4982

All orders and enquiries to our Edgware Road branch, please. This is open all day Saturday.

WHY GERMANIUM RECTIFIERS?



In the high frequency field and in cases where the maximum efficiency must be packed into the minimum space, Ediswan Germanium Rectifiers are greatly in demand. Both Point Contact and Junction types are available. They are remarkably robust and have an unusually long operating life.

Literature giving performance curves, ratings and dimensions is available on request, and of course, our technical experts are always at your service.

EDISWAN
RADIO DIVISION

THE EDISON SWAN ELECTRIC COMPANY LIMITED
155 Charing Cross Road, London, W.C.2 and Branches
Member of the A.E.I. Group of Companies
Telephone: Gerrard 8660 *Telegrams: Ediswan, Westcent, London*

CITY SALE & EXCHANGE LTD

The High Fidelity Specialists

WHARFEDALE

SUPER 12/CS/AL SPEAKER

A high flux density (17,000 lines) gives excellent transient response and sensitivity with wide frequency range.

Tax free **£17 . 10 . 0**

PART EXCHANGE & EASY PAYMENTS ARRANGED

HIGH FIDELITY *plus* HIGH VERSATILITY

The RCA New ORTHOPHONIC HIGH FIDELITY AMPLIFIER & PRE-AMPLIFIER

PRICE £48 Complete

ALSO FROM STOCK

RD Junior Amplifier and Control Unit	£26 0 0
Pye HF5/8 Amplifier with Controls on same Chassis	£26 5 0
Leak TL10 Amplifier with Point One Control Unit	£28 5 0
Armstrong A10 Amplifier and Control Unit	£29 10 0
Vortexion Tape Recorder with Wearite Tape Deck	£84 0 0
Connoisseur 3-speed Transcription Motor	£28 11 0

93-94 FLEET STREET, LONDON, E.C.4 *Phone: FLEet St. 9391/2*

LP 312-2

EXPAND AND

LABORATORY BALANCED. The TSL LORENZ LP312-2 is a main bass, 12in. diaxial speaker combined with two LPH65 electro-magnetic high frequency TREBLE units permanently mounted coaxially across the front of the main bass speaker at such an angle to give full spherical binaural response. All are laboratory balanced and matched for perfect tone with a frequency range of 20 cycles to 22,500 cycles essentially level output. To ensure level frequency response the voice coils of the two treble speakers are fed through a specially designed crossover network which balances the frequency response of the three speakers as a combined unit.

IMPROVE ANY

LPH65

The TSL LORENZ LPH 65 is the basic treble speaker used in the TSL LORENZ Sound System. Round in shape to ensure smooth, melodious sound the plastic cone is fully tropicalised. Special features are the super high flux density magnet of 17,500 gauss and non-perforated back plate.

SOUND SYSTEM

SUPER HIGH FIDELITY THIS YEAR

Let your ears be your judge . . . crisp clear, natural reproduction without coloration with TSL LORENZ speaker units. Ten years ahead in engineering and design, this speaker unit will enable you to design and build up a sound system in your own home which will truly add the miracle of LIFE to the magic of music . . .

No Extra Cost. You get these extra features at no extra cost with every TSL LORENZ Sound system . . . Greater output and more sensitivity . . . heavy duty oversize speech coil . . . Super high flux magnet . . . Permanently flexible self-damped cone . . . Multi-parameter cone fully tropicalised . . . Sealed in air gaps . . . built-in centralizing device for perfect gap alignment.

Improve your own H.F. Sound System. *For those devotees of high quality who possess bass speakers fitting one or more LPH65 treble units will greatly extend your range of super fidelity reproduction. They are, without a doubt, the most sensitive and efficient treble reproducers research has revealed to date. The non-perforated back plate ensures that the LPH65 can be used with any other speaker irrespective of make or type without interaction taking place.*

SPECIFICATION LP312-2

IMPEDANCE 15 ohms; **FREQUENCY RANGE** 20-22,500 c/s; **POWER RATING** 25 w.; **PEAK POWER RATING** 40 w.; **DIAMETER** Bass 12¼ inches. Treble 2½ inches; **DEPTH** Bass 7⅛ inches Treble 2 inches; **BAFFLE OPENING** 10⅞ inches; **SPEECH COIL DIAMETER** Bass 1.5 inches. Treble ½ inch; **FUNDAMENTAL RESONANCE** Bass 20 c/s., Treble 1,600 c/s.; **FLUX DENSITY** Bass 17,500 gauss, Treble 17,500 gauss; **INTERMODULATION PRODUCTS** under 0.5%; **CROSSOVER FREQUENCY** 2,000 c/s. **FINISH:** Grey and blue vitreous anti-corrosion stove enamel.

RETAIL PRICE £14.19.6 (not subject to Purchase Tax).

SPECIFICATION LPH65

HIGH FREQUENCY CONE-HORN TYPE TREBLE UNIT. IMPEDANCE 5.5 ohms; **FREQUENCY RANGE WITH SUITABLE HIGH PASS FILTER CONDENSER** 2,000 22,500 c/s; **POWER RATING AS A SINGLE UNIT** 3 w.; **PEAK POWER RATING AS A SINGLE UNIT** 5 w.; **DIAMETER** 2½ inches; **DEPTH** 2 inches; **BAFFLE OPENING** 2¼ inches.

PRICE 39/6. (including Purchase Tax).

TSL LORENZ

Exclusively distributed to the Radio Trade & Industry throughout Great Britain and the Commonwealth by:— ● *Ask your local retailer for full details, including Bass Reflex enclosures.*

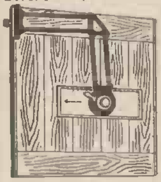
TECHNICAL SUPPLIERS LTD., HUDSON HOUSE, 63 GOLDHAWK RD., LONDON, W.12. SHEpherds Bush 2581/4794

MIDLAND INSTRUMENT CO.

ELBOW TELESCOPES by Cooke, Sims & Troughton, 8 × 30, in gunmetal housing, size 9in. long, 4½in. high, base 5½in. dia., unused and perfect, value £20, our price **50/-**, post 2/6; otherwise we can supply the complete optical system for above—consists of the variable eyepiece, right-angle erector prism and objective, all mounted, **20/-**, post 1/-.

HUGHES 12-VOLT D.C. SHUNT MOTORS, taking 1.25 amps., up to 2-amps. on load, speed 5,000 r.p.m., external reversing terminations, size 3⅜in. long, 1⅞in. dia., ¼in. dia. shaft, weight 20 oz., oil impregnated bearings, balanced armature, a very superior powerful motor, original cost over £7, our price new unused **10/-**, post 1/3, 2 for **20/-**, post paid. Ditto, fitted reduction gears, giving a final drive of either 320 or 160 r.p.m. (state which required), **12/6**, post 1/6, 2 for **25/-**, post paid.

HAND GENERATORS, fitted gearbox and detachable handle, generates 28 v. L.T. and 300 v. H.T., with data to convert in a few minutes to an efficient 200/250 v. A.C./D.C. motor with final drives of approx. 60, 12 and 2 r.p.m. unused and perfect. **17/6**, post 2/6



NAVIGATORS CHART BOARDS, selected 7-piece polished wood 17in. × 17in. by ⅜in. thick, fitted brass parallel motion drawing arm, hinged to board edge slide with lock screw, free arm end fitted protractor scale marked in degrees, also ruled Perspex transparent straight edge 10in. × 3in. by ⅛in. thick, each with locking device, board back has felt lined feet with pencil holder, these are brand new and boxed, value 70/-, our price **25/-**, post 2/6, 2 for **50/-**, post paid.

BENDIX SELSYNS (Magslips). 3in. synchro transmitters, 50-v. 50-cycle single phase A.C., we have supplied over a thousand of these to large firms and Govt. Depts. for automation, etc., research, these are brand new, elaborately protected and packed, each with angular accuracy, etc., test report, our price per pair (2 units), with wiring diagram, **60/-**, post paid.

VIBRATOR PACKS, input 6 v. provides all L.T. and H.T. outputs for the 18 and 38 sets, in metal cases size 9in. × 6½in. × 3¾in. complete with Mallory Type 650 non-sync. vibrator, also leads, new unused, **17/6**, post 2/6; vibrators only, **5/-**, post 7d.

TRANSISTORS, germanium junction P.N.P., by the leading manufacturers in this country, complete with data, **10/-**, post 3d.

SLYDLOK FUSES, 5-amp. back terminations, brand new, **1/6**, post 4d., **15/-** doz, post 1/1, ditto 15-amp. end terminations, brand new, **1/6**, post 4d., **15/-** doz., post 1/3.

BURGESS MICRO SWITCHES, 2 types, red spot, normally closed, or green spot, normally open, new unused, **1/9**, post 4d., **18/-** doz., post 1/3, reduction for quantity.

ROTARY TRANSFORMERS, input 12-v., output 500-v. at 50-m.A., new and boxed, **15/-**, post 2/9.

ACHROMATS by Ross or Taylor Hobson, new and perfect, 3 types all 40-mm. dia. f.1.7, 2¾in. focal length, f.2, 3in. focal length, f.2.3, 3¼in. focal length, **10/-** each, post 4d., the 3 for **30/-**, post paid.

Many other bargains; send stamped addressed envelope for lists.

MIDLAND INSTRUMENT CO., MOORPOOL CIRCLE, BIRMINGHAM, 17

Tel.: HAR 1308

NEW G.E.C. MOBILE RX/TX complete with 12 v. rotary power unit, 80.9, 81.1, 81.3 Mc/s, 7 watt output. Special price **£25.**

1294 RECEIVERS in good order, £20 each.

MULTI-RANGE TEST METERS by Weston, Radio City Products and other well-known makers.

SPECIAL OFFER of Constructor's parcel of 100 assorted resistors comprising ¼, ½, 1 and 2 watt from 10 meg.-22 ohms, 12/6.

MEGGER SAFETY OHMMETERS. Perfect, £3.

H.R.O. SENIOR RECEIVERS. With A.C. P.P., 5 coils, **£28.**

D.S.T. 100 RECEIVERS, as new. Coverage is 7 bands from 30 Mc/s. to 50 Kc/s., £20 each.

HALLICRAFTERS SX28, S27, S41, S38, etc. Perfect cond. **AR88LF, AR88D, CR100,** from stock.

CANADIAN R.103 RECEIVERS, as new, modified, for A.C. working, **£14.**

A.C./D.C. MOTORS suitable for sewing machines, 47/6 each.

A.C./D.C. 12 v.-15 v. MOTORS, long spindle for models, 15/- each.

NEW M/C MICROPHONES, hand type, with 12 yds. heavy duty screened cable, **£3** each.

TEST EQUIPMENT. We hold a comprehensive stock. Multi-range meters at 1,000 and 20,000 o.p.v., valve testers, signal genes.

RECTIFIERS, 12 v., bridged, 8 amps, **18/6** each.

MAINS TRANSFORMERS. 350-0-350 v. Ellison at 120 mA. 6.3 v. 5 a., C.T. 5 v. 3 a., **37/6.** Full range of all types of Ellison products in stock.

F.M. DEVIATION METER, in perfect working order, **£20.**

PARTRIDGE TRANSFORMERS, 100 m/a. 250-0-250 v., 6.3 v., 110-230 v. input. **£1** each.

H.R.O. COIL, 0.48-0.96 Mc/s., etc., at **£2/5/-** per coil.

Your post enquiries welcomed. S.A.E. for reply, please. Orders, C.W.O. or pro-forma invoice, no C.O.D. Prices quoted do not include carriage and packing.

Callers welcomed—all stock must be sold within six months. Great Bargains.

SERVICE RADIO SPARES

4, LISLE STREET, LONDON, W.C.2

Telephone : GERrard 1734

RADIO TRADERS LTD.

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

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

SPECIAL OFFER OF CURRENT MANUFACTURE ELECTROLYTIC CONDENSERS
8 mfd. 450 v., 2/6 each; 16 mfd. 450 v., 3/-; 32 mfd. 450 v., 4/-; 8 x 8 mfd. 450 v., 3/9; 8 x 16 mfd. 450 v., 4/-; 16 x 16 mfd. 450 v., 4/6; 32 x 32 mfd. 350 v., 5/-. Bias Condensers: 25 mfd. 25 v., 1/6; 50 mfd. 50 v., 1/9. Please note we can offer special discounts for quantities.

ELECTROLYTIC CONDENSERS. Manufacturers' Surplus, in perfect condition.
16 mfd. 375 v., 2/-; 24 mfd. 350 v., 1/6; 24 mfd. 450 v., 2/3.

BIAS CONDENSERS: 1,000 mfd. 12 v., 1/6; 25 mfd. 25 v., 1/3; 50 mfd. 12 v., 1/-.

BLOCK PAPER CONDENSERS. 12 mfd. 250 v., 7/6; 8 mfd. 600 v., 7/6; 4 mfd. 400 v., 3/6. We carry a large stock of block paper type condensers. We invite your enquiries.

MIDGET MICA CONDENSERS. .0001, .0002, .0003, .0004, .0005, 5/- per dozen.
200 Assorted Moulded Mica Condensers, popular values........ £2 10 0
200 Assorted Silver Mica Condensers, popular values.............. £2 10 0
200 Assorted Carbon Resistors, ¼, ½ and 1 watt. Good selection. £1 10 0

PAXOLIN SHEET. 18 x 4½ x 1/16in., 1/6; 10 x 10 x 1/32in, 1/6; 20 x 10 x 1/32in. 3/-; 10 x 10 x 1/16in., 2/-; 20 x 10 x 1/16in., 4/-. Minimum P. & Pkg. 1/6.

BARGAIN OFFER OF METERS
"S" Meters as used in S.27 receivers, £2/10/-; 0-200 m/a., 2½in., 10/6; 0-300 m/a., 2½in., 10/6; 0-500 m/a., 2½in., 12/6; 0-40 m/a. (scaled 0-3 kV.), 10/6; 0-100 m/a., 2in. (scaled 0-300 "mag feed"), 7/6; 0-2 m/a., 2½in., 12/6.

B.T.H. CRYSTAL DIODES, 1/3. Very special price for large quantities.

RESISTORS. ¼ watt, 2/6 doz.; ½ watt, 3/- doz.; 1 watt, 4/- doz.; 2 watt, 6/- doz.

W.W. RESISTORS. 5 watt, 1/6; 10 watt, 2/6; 15 watt, 3/-; 20 watt, 3/6. We carry stocks of resistors from 2 watt to 150 watt W.W. Your enquiries invited.

HIGH STABILITY RESISTORS. ½ watt 5%, 6d; ½ watt 5%, 9d; 1 watt 5%, 1/-. 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 types, 2/6; Spindle types, 3/-; Carbon type, less switch spindle and pre-set, 2/-. With switch, 3/6 each.

SEMI-MIDGET 2-GANG. .0005 Condenser, size 2⅞ x 2 x 1⅞in., 6/9 each.

PUSH-BUTTON UNITS. 10-way, complete with escutcheon and knobs, 10/6 each; 4-way, 2/6 each; knobs 3/- doz. extra.

JONES PLUGS AND SOCKETS. 4-way, 3/-; 6-pin, 3/6; 8-pin, 4/-; 10-pin, 4/6; 12-pin, 6/- per pair.

BARGAIN OFFER OF BATTERIES

4½ v. Heavy Duty Bell Battery. Size 6½ x 4½ x 2½in.	2/6
72 v. H.T. 1.5 v. L.T. Size 6 x 5 x 1⅞in.	2/6
150 v. H.T. Size 2¾ x 5½ x 1⅜in.	5/6
67½ v. Size 2¾ x 3⅞ x 2¾in.	6/6
60 v. H.T. 1.5 v. L.T. 3¼ x 3¾ x 1½in	4/6

All batteries sealed and unused. All plus 1/6 post and pkg. Special reduction for quantities.

WEARITE COILS. PA4, PO4, PA5, PO5, 1/3 each............doz.	12/-
VALVE HOLDERS. Moulded B9A. 7/6; B7G, 6/-; Int. Oct., 9/-; Eng. Oct. ....doz.	4/6
VALVE HOLDER FITTED WITH LOWER CAN, 1/6 per doz. extra. Screening Cans for B7G and B9A.......doz.	6/-
Paxolin V/H Int. Oct. B9A, B7G, 5/- per doz.; Eng. Oct., 5-pin, 7-pin .... doz.	3/-
BELLING-LEE PLUGS AND SOCKETS, 5-pin, 1/9; 7-pin, 2/-; 10-pin .... each	2/6
AIR-SPACED TRIMMERS, 5, 10, 15, 20, 25, 50 and 75 of pre-set and spindle types, 2/- each........doz.	21/-
PYE PLUGS AND SOCKETS, 1/6 per pair, "Tee" pieced...each	1/9
GROMMETS, 1 grs. assorted grommets, ¼in. to 1in..........gross	8/6
POST OFFICE LAMP JACKS No. 10, 1/- each..............doz.	9/-
Lamp Covers for same .... doz.	3/-

P74 2-pin plugs and sockets are now available, 3/6 each.

OUTPUT TRANSFORMERS. Multi-ratio, 5/- each; Pentode or power .... each	4/-
WESTECTORS. WX6, WX12, W12, W4, 1/- each...........doz.	9/-
SIGNAL LAMP HOLDERS. Panel mounting, complete with adjusting lampholder, 2/- each........doz.	21/-
TAG STRIPS. 3-way, 2/-; 4-way, 2/6; 5-way, 3/-; 7-way, 4/-; 28-way .... doz.	12/-
POINTER KNOBS. Small black with white line, standard ¼in. spindle .... doz.	7/6
WANDER PLUGS. Red and black........ doz.	2/-
PHILIPS TRIMMER TOOLS. 1/- each........ doz.	10/6

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.

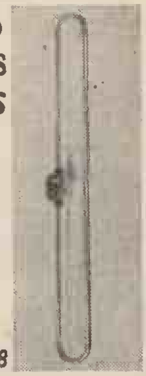
Trade Counter open 9 to 6 Monday to Friday
Also 9 to 1 Saturdays. Callers Welcomed.

WHOLESALE MANUFACTURERS' AND EXPORT ENQUIRIES INVITED

TELEVISION AERIAL COMPONENTS

DESIGNED FOR CONSTRUCTING BAND I & BAND III T.V. AERIALS

ELEMENT DIMENSIONS SUPPLIED FOR ALL CHANNELS



Selecting at random from our new multi-page catalogue :

- ★ Band III Folded Dipoles (*As illustrated*)
- ★ Reflector and director rod holders
- ★ Masthead Fittings for ¾", 1", 1½" and 2" Masts
- ★ Mast Coupling units for 2" Masts
- ★ Insulators, both Rubber and Plastic (*As illustrated*)
- ★ Alloy Tubing for Elements, Cross-boom and Masting

Send 1/- P.O. for the revised, fully illustrated catalogue to :

FRINGEVISION LTD., Marlborough, Wilts. Phone 657/8

Senior Radio Engineers

SENIOR RADIO ENGINEERS REQUIRED FOR THE LABORATORY OF A LARGE RADIO ENGINEERING COMPANY SITUATED IN THE LONDON AREA. APPLICANTS SHOULD HAVE H.N.C. OR EQUIVALENT QUALIFICATIONS AND EXPERIENCE OF MODERN DOMESTIC RADIO DEVELOPMENT AND ENGINEERING PRODUCTION. THE SELECTED CANDIDATE WILL BE CAPABLE OF WORKING WITHOUT SUPERVISION AND ABLE TO CONTROL A SMALL TEAM OF ENGINEERS. SALARY UP TO £1,100 PER ANNUM ACCORDING TO QUALIFICATIONS AND EXPERIENCE. PLEASE REPLY, GIVING FULL DETAILS TO BOX NO. 2541.

PRODUCT DESIGNER WITH AN INTIMATE KNOWLEDGE OF MODERN PRODUCTION TECHNIQUE IS REQUIRED FOR A LARGE COMMERCIAL RADIO AND TELEVISION LABORATORY. THE SELECTED APPLICANT WILL BE REQUIRED TO TAKE CHARGE OF THE MECHANICAL SIDE OF NEW PROJECTS AND WILL HAVE A WIDE EXPERIENCE OF THE RADIO INDUSTRY. THE COMMENCING SALARY WILL BE IN THE REGION OF £1,000 PER ANNUM WITH GOOD PROSPECTS OF ADVANCEMENT. LONDON AREA. APPLICATIONS, WHICH WILL BE TREATED IN CONFIDENCE, SHOULD GIVE FULL DETAILS OF QUALIFICATIONS AND EXPERIENCE AND BE ADDRESSED TO BOX NO. 2542.

BENSONS BETTER BARGAINS

COMMAND RECEIVERS 1·5-3mcs **BRAND NEW**, less Dynamotor, o .d 38/- delivered U.K. **RXS.112/114** (TR1987), with 3/EF91, 2/EL91, 5 gang tuner, new, 37/6, less valves, 7/6. Circuit 1/3. 129 Rxs. 1-560 kc/s., new; with valves, mains driven £7/10/- (carr. 10/-). **MOTORS:** Gram., 230 v. Induction, 78 r.p.m. with governor (Garrard), 30/- (post 2/9); **SYNCH.** 230 v. geared to 1 r.p.m. final, new, 22/6; Synch. 100 v. 3.000 r.p.m. 10 VA., 10/-. **SPEAKERS** 12in. Goodmans, new, £6/10/-. **INDICATORS**, type 6L, new 45/- (carr. 7/6). **TRANSFORMERS**, new, Primary 230 v. 50 c. Sec. 66, 69, 72, 155, 165, 175 v. HW 0.5 A; (additive to 221-247 v.), 15/- (carr. 2/9). **U.S.A. BOXES**, diecast alum., black crackle, with relay 5 mA. 10 v. 1920 Ω, switches, etc. 10 x 6 x 5in., 12/6 (post 2/9). **SUPPRESSOR**, radio interference, ex-A.M., 5/6 (post 2/-). **VIBRAPACKS**, U.S.A. Jefferson-Travers, 12 v., 15/6, Mallory, 18/6 (post 2/9 each). **RESISTORS**, Hi-stab., close tol., pref. values, 10/- doz. **VITREOUS**, 12 Ω to 100 K, 3-20 w., 10/- doz.; 15 Ω 100 w., 150 Ω 25 w., 10 k., 120 w., 15 k., 56 w., 1/6 each. **BRAND NEW UNITS, TYPES** R.F. 26 or 27, 27/6 (postage 2/6); RF24, RF25, soiled 10/6. **AERIAL RELAYS** (co-axial) c/o 12/24 v., 7/6, **TYPE 78A**, 24 v., or manual 15/- (post 2/9). **DYNAMOTORS**, D.C., 6 v. Input, 250 v. 80 mA. output, 11/6. Filters for these, 2/6. **EDDYSTONE** 12 v. to 190 v. 75 mA., cased, 15/- (post 3/-). 11 v. to 300 v. 200 mA., cased, 13/6 (carr. 8/6). **CLOCKWORK** Contactors, 2 impulses per sec., 8/6. U.S.A. type, small, 9/6. **R1355**, new improved type, 37/6 (carr. 7/6). **R1392A**, 100/150 Mc/s., 13 valves, used, good condition (damaged meters), £4 (carr. 10/-). **THROAT MICS.**, U.S.A., new, 2/6. **METAL RECTIFIERS**: 600 v. 30 mA., 6/-. 500 v. 500 mA., 10/6. 1,000 v. 30 mA., 7/6. **R1355 IF Strips** only, complete, new, with valves, 25/-; less valves, 12/6 (post 2/6). **POWER UNIT 301.** Input 200/260 v. A.C. Outputs, 250 v. 80 mA., D.C., 6.3 v., 3 a. A.C. and 24 v. 1 a. D.C., New, 40/- (post 2/6). Auto-transformers, 110/220 v., 450 w., brand new, 80/-. **WAFER SWITCHES**, 1 pole 11-way, 2 Bank, 3/6. 4 P 3 W, 4 P 2 W, 1 P 5 W 6 B, 2/6. **METERS**, list available. **SPLITTERS**, 15 a., G.E.C., D.P. switch, 4 fuses, new, 15/6. **RX159**, 160/220 mc/s, with 1/VR91, 1/CV66, 1/VR65, 1/VR92, 12/6. **I.F. AMPLIFIER 178** (for this), 13.0 mc/s, with valves, 15/6 (postage 2/6 each). **BENDIX RA-10**, 4 Wavebands, 8 valves, New, £3/10/- (carr. 10/-). **RELAYS**, 6 v. 2 break, 1/6. **I.F.T.'S** 10/13 mc/s., canned, new, 1/3. **R1155** Coilpacks, new, 12/6. Used, 9/6. **CHOKES**, L.F. Ferranti, 10H, 150 mA., Screened, 7/6. 10H, 200 mA., 8/6; 5H, 200 mA., 5/6. **TRANSCEIVERS**, W/T 67, super-regen., with 4 1C5GT valves and handset 45/-.

308 Closed 29th July/6 August.

List and enquiries. S.A.E. please! Terms: C.W.O. Postage extra. Immediate despatch.

Callers and Post, W. A. BENSON (WW), 308 Rathbone Road, Liverpool, 13. STO 1604. Callers, SUPERADIO (W'chapel) LTD., 116 Whitechapel, Liverpool 1. ROY 1130

DUODE

NATURAL SOUND

IS AVAILABLE IN MANY LANDS INCLUDING

Australia
Barbados
Canada
Hong Kong
New Zealand
South Africa
Trinidad
Venezuela

If you live in these parts we can tell you where to buy your **Duode** easily. But of course **Duodes** also go by post to homes in many other lands, bringing delight of **NATURAL SOUND** to hundreds of music lovers who rely on radio and records. The 12B and 12B/C are most widely used because they pack for post almost anywhere and even for air freight over moderate spans.

So do not hesitate to give yourself the joy of hearing your favourite music, your best loved artists, even your most hated politician, more clearly and naturally than ever before. Send an air letter or card for details.

DUODE SOUND REPRODUCERS

3, Newman Yard, London, W.1

COMMUNICATIONS EQUIPMENT

WIRELESS SET 19 Mk. III. Frequency 2-8 Mc/s., and 235 Mc/s. Antenna output 8 watt. Systems A.1, A.2, A.3. Power source 12 v. battery with operating equipment for mobile or ground use.

AMPLIFIER R.F. No. 2. For use with Wireless Set No. 19 Mk. III. Boosts antenna output to 30 watts.

WIRELESS SET X32D. Frequency 2-8 Mc/s. in two switched bands. C.W. and frequency modulated and amplitude modulated R.T. Remote control facilities. Mobile or fixed station use. Power source 12 v. D.C.

WIRELESS SET 62 Mk. II. Frequency range 1.6-10 Mc/s in two switched bands. Crystal controlled. For mobile use. Systems A.1, A.2, A.3—with operating equipment. Power source 12 v. D.C.

CRYSTAL CALIBRATOR No. 10 for use with Wireless Set 62.

WALKIE-TALKIE TYPE 58 (CANADIAN). Frequency range 6-9 Mc/s. Complete with accessories.

HANDY TALKIE SCR536. Frequency range 3.5-6 Mc/s. Complete with spare coils, etc.

TCS TRANSMITTER/RECEIVER STATIONS complete. Frequency range 1,500 kc/s.-12,000 kc/s. Output 10 watts phone, 25 watts C.W. All operating equipment including Remote Control with loud-speaker and choice of Dynamotor Supply (12 v., 24 v., or 115 v.).

AIRCRAFT RADIO COMPASSES. Installation Type SCR269G. Frequency coverage 200 Kc/s.-1,750 Kc/s. in three switched bands. Superhet communications receiver with compass circuit elements. Remote control facilities and motor driven aerial loop complete with all operating accessories.

AIRBORNE VHF EQUIPMENT. ARC-1 multi-channel transmitter/receiver complete. 100-156 Mc/s. ARC-3 10 channel transmitter/receiver complete 100-156 Mc/s.

TELEGRAPH AND TELEPHONE EQUIPMENT. Filter, line and directional.

High Speed Morse Telegraph Transmitters.
Telegraph Tape Printers.
Terminal Units Apparatus VF Speech + Duplex.
Apparatus VF Speech + Simplex.
Apparatus two-tone Telegraph.
Carrier Terminals 1 + 1.
Field Telephone Sets types D, F, H and L.
Switchboards, universal call, 6-line and 10-line.

Prices and further details on request.

3Ch Dx Relay Unit Group 1/2.

Transmitting valves types 803, 805, 832.
Magslips Hunter 3in. used at 6/6 each.
Morse Keys, totally enclosed Air Ministry type, at 1/6 each.
Aerial winches, Air Ministry type 5, at 2/6 each.
Flexible Drives, 7ft. 6in. long.
F.T. 243 Crystals, frequencies between 3,000 Kc/s. and 6,000 Kc/s., at 10/- each.

R. GILFILLAN & CO. LTD.,
7, HIGH ST., WORTHING, SUSSEX
Tel. Worthing 8719 and 30181
Cables 'GIL WORTHING' Codes BENTLEY'S 2nd

SENIOR ENGINEER

wanted by

Felgate Radio Ltd.

Degree or similar qualification necessary. Candidates who have been associated with production will receive preference.

Duties include the design of domestic radio and television, high fidelity audio equipment and miniature transmitter receivers.

Apply Managing Director:

FELGATE RADIO LTD.
Felgate House, Studland Street,
Hammersmith, W.6

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED, WEYBRIDGE, SURREY

require

(Z) RADIO ENGINEERS for the installation and testing of V.H.F., H.F.I.L.S. and A.D.F. equipments as used in civil aircraft. Applicants should preferably have served an appropriate apprenticeship, have had at least five years' experience on civil aircraft and hold academic qualifications not lower than an intermediate City and Guilds Certificate in Telecommunications.

Applications, quoting date and prefix letter of advertisement to: Employment Manager, Vickers-Armstrongs (Aircraft) Limited, Weybridge, Surrey.

Holidays already arranged by applicants for this year taken into account.

TWO SENIOR GRADUATE ENGINEERS

are wanted for a

FORWARD THINKING GROUP

under the direction of

Dr. E. K. Sandeman

at the

ENGLISH ELECTRIC COMPANY'S

GUIDED WEAPONS DIVISION,

LUTON, BEDS.

Each should have experience in one or more of the following:

BALLISTICS or CELESTIAL MECHANICS

RADAR or ELECTRONICS

SERVO THEORY

ANALOGUE or DIGITAL COMPUTORS

Dr. Sandeman would be pleased to receive applications for these permanent and progressive research posts, and will be glad to talk over the prospects of employment with suitable candidates.

Applications in the first instance should be addressed to Dept. C.P.S., 336-7, Strand, W.C.2, quoting Ref. 613B.

FERRANTI LIMITED, Edinburgh

invite applications for staff appointments as Field Trials Engineers to join teams engaged in the field trials of experimental radar and navigational systems. Although primarily based at Edinburgh, much of the work necessitates travel within the U.K. while one or two of the posts will require overseas travel. Applicants should possess a Degree, H.N.C. or equivalent in electronics or electrical engineering and have had at least three years' experience in centimetric radar techniques. Salary according to age, qualifications and experience. Please apply to the Personnel Officer, Ferranti Limited, Ferry Road, Edinburgh, 5, quoting Ref. FTE/TID/59.

ELECTRICAL ENGINEERS

You can train to service the

BRITANNIA

★

BRISTOL AIRCRAFT LIMITED are looking for experienced electrical engineers to service the Britannia. The men they need would be between 25-40, have at least their ONC and they would preferably have served an electrical engineering apprenticeship. Experience on modern aircraft would naturally be a great advantage.

The job would take about six months to learn and after that work will often take you outside the United Kingdom.

If you're interested write, with all the usual details, to:

MR P A TOBIN
Room 50/JW, Bristol Aircraft Limited, Filton House, Bristol

BRISTOL

—WHY WASTE TIME—

Give that set its best chance

FIT QUALITY COMPONENTS

Catalogue 1/-.

ALL POPULAR CIRCUITS

COVENTRY RADIO

EST. 1925

189, DUNSTABLE ROAD, LUTON BEDS.

Phone : Luton 2677

SIGNALS OFFICE STAFF REQUIRED

A number of vacancies, offering good conditions and prospects, exist for :—

CYPHER OPERATORS (Male and Female).

RADIO OPERATORS (Male).

TELEPRINTER OPERATORS (Male and Female).

Apply, giving details of qualifications and experience, to :—

Personnel Officer,
G.C.H.Q. (FOREIGN OFFICE),
53 Clarence Street, Cheltenham.

FERRANTI LIMITED, Edinburgh

require an engineer with diesel/petrol/electric and electronics experience to join a team of Field Trials Engineers engaged in the field trials of experimental radar and navigational systems. The work involved is mainly connected with the running and maintenance of diesel generating plant and petrol-driven cooling plant but assistance in maintaining the mechanical and electrical aspects of the radar equipment will be expected. Qualifications up to H.N.C. standard preferable but not essential, with at least three years' experience in dealing with such plant. Although primarily based at Edinburgh, much of the work necessitates travel within the U.K. Salary according to age, qualifications and experience. Please apply to the Personnel officer, Ferranti Limited, Ferry Road, Edinburgh, 5, quoting Ref. E/TID/59.

ENGINEERS!

Whatever your age or experience, you *must* read "ENGINEERING OPPORTUNITIES." Full details of the easiest way to pass A.M.I.Mech.E., A.M.I.C.E., C. & G. (Electrical, etc.), General Cert., etc., on "NO PASS—NO FEE" terms and details of Courses in all branches of Engineering—Mechanical, Electrical, Civil, Auto, Aero., Radio, etc., Building, etc. If you're earning less than £15 a week, tell us what interests you and write for your copy of "ENGINEERING OPPORTUNITIES" today—FREE.

144 PAGES *Free!*

B.I.E.T.

387 College House, 29-31, Wright's Lane, London, W.8.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY

LOUDSPEAKER CABINETS

For

GOODMANS W.B. G.E.C. KELLY and JENSEN

STANDARD BASS REFLEX CABINETS

Demonstrations without Appointment

You can see your cabinet being made in our cabinet-making workshop.

Cabinets made to order.

ARMSTRONG CHASSIS AND AMPLIFIERS LOUDSPEAKERS.

Open till 5.30 Saturdays.

A. DAVIES & CO. (Cabinet Makers)

3 Parkhill Place, off Parkhill Road, London, N.W.3. GULLIVER 5775.

Solder with LITESOLD

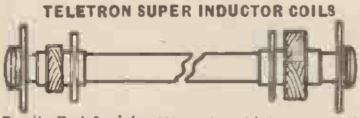
REGD. TRADE MARK

"PERMATIP"
AND
"PERMABIT"
INSTRUMENTS
FOR
GREATER SOLDERING EFFICIENCY

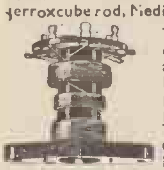
The soldering bit which maintains its face indefinitely without attention. 25 models available for mains or low voltage supply. Bit sizes 3/32 to 3/8 inch. Full details in booklet S.P.5 from sole manufacturers:—

LIGHT SOLDERING DEVELOPMENTS LTD.
106, GEORGE ST., CROYDON, SURREY.
Tel CROydon 8589

TELETRON SUPER INDUCTOR COILS



Ferrite Rod Aerials. Wound on high permeability ferroxcube rod, Medium wave 8/9, Dual wave 12/9.



Type HAX. Selective crystal diode coil for tape and quality amplifiers, MW 3/-, LW 3/6. Dual wave TRF Coils, matched pairs (as illustrated) 7/- pair. Type S.S.O. Supersonic Tape Osc. coil, provides 6.3 v. 3 a. RF for pre-amp heater. Eliminates induced 50 c/s hum, 40/100 kc. 15/- ea. Transistor coils, etc. Available from leading stockists. Stamp for complete data and circuits

THE TELETRON CO. LTD.,
266, Nightingale Rd., London, N.9. How. 2527

This Month's Offers

MOTOR ALTERNATORS. 400 cycles new surplus, 28 volts D.C. input, dual output 115 volts 3 ph. 750 V.A. and 24 volts 1 ph. 250 V.A. 24 volts D.C. input, 115 volts, 115 V.A. output, 400 cycles 3 ph. Other sizes in stock. Write for list.

CABLE INSULATION TEST SET. By Advance Components. 180–250 volts, 50–500 cycles, new condition tested and ready for use.

RECEIVERS. AR88, SX28, B29, CR100, CR300, all completely rebuilt, laboratory tested and guaranteed.

WAVEMETERS T.E.149 by R.C.A. 200 Kc/s to 20 Mc/s. accuracy 0.005% with crystal, spares and instruction, new surplus in transit case, lab. tested.

WAVEMETERS. Type 1191. New surplus in original transit case. 100 Kc/s. to 20 Mc/s. with valves, crystal, and charts.

WESTINGHOUSE METAL RECTIFIER UNITS. 230 volts 50 cycles input, 50 volts, ¾ amp. output, £5/10/–. 1½ amps. output, £6/10/–, crg. extra. 110/250 volts, 50 cycles, input 16/96 cells, 10 amps. output, 11/48 cells, 20 amps. output, 8/48 volts, 20 amps. output., all with Selenium Rectifiers. New surplus, tested and guaranteed. Write for list.

Leslie Dixon & Co.
Dept. A. 214 Queenstown Road, London, S.W.8
Telephone: MACaulay 2159

BRASS, COPPER, DURAL, ALUMINIUM, BRONZE
ROD, BAR, SHEET, TUBE, STRIP, WIRE
3,000 STANDARD STOCK SIZES
No Quantity too Small. List on Application.
H. ROLLET & Co. Ltd.
6 Chesham Place, S.W.1. *SLOane* 3463
ALSO AT LIVERPOOL, BIRMINGHAM MANCHESTER, LEEDS

LOCKWOOD
makers of
Fine Cabinets
and woodwork of every description for the Radio and allied trades
LOCKWOOD & COMPANY (WOODWORKERS) LTD.
Lowland Rd., Harrow, Middlesex. Byron 3740

MALVYN ENGINEERING WORKS

Manufacturers of: Chassis, Small Pressings, Machined Components, Wiring and Mechanical Assemblies to specification.
Single and Production Quantities.
100 PARK ROAD, WARE, HERTS.
Telephone: Ware 465

RADIO & TELEVISION COMPONENTS
WE OPERATE A PROMPT & EFFICIENT MAIL ORDER SERVICE
"VIEWMASTER" & "TELE-KING" specialists
Easy terms available. Stamp (only) for lists
JAMES H. MARTIN & CO.,
FINSTHWAITE, NEWBY BRIDGE, ULVERSTON, LANCS.

SIFAM ELECTRICAL INSTRUMENT CO. LTD.
LEIGH COURT – TORQUAY – Telephone 4547/8

TANNOY
SOUND EQUIPMENT
Tells you what's going on clearly
WEST NORWOOD · S.E.27
Telephone: GIPsy Hill 1131 (7 lines)

PROVED **The finest method for cleaning records**
Already over 20,000 enthusiastic users

THE **"Dust Bug"**
AUTOMATIC GRAMOPHONE RECORD CLEANER
PATENT APPLIED FOR

Price reduced to 17/6 (plus 7/- purchase tax)
From your local dealer or
CECIL E. WATTS
Consultant and Engineer (Sound Recording and Reproduction)
Oakleigh Grange, High Cross, nr. Uckfield, Sussex

BELCLERE TRANSFORMERS
offer—

★ High Quality Driver and Output transformers for use with Transistor Amplifiers.
★ Output transformers for F.M. receivers — types suitable for Push-pull or single-ended output stages.
★ Transformers to customer's own specification.

Illustrated leaflet and fullest details upon request. Excellent Delivery — Competitive prices.

BELCLERE TRANSFORMERS
P.O Box No. 22
117 High Street, Oxford
Tel. 48362. Cables: Belclere Oxford.

UNIVERSITY OF SOUTHAMPTON
Technical Department
FULL-TIME COURSE IN TELECOMMUNICATIONS ENGINEERING

A two year full-time day course in Telecommunications Engineering is now available. The course prepares candidates for the Intermediate, Final, and Full Technological Certificate Examinations of the City and Guilds of London Institute. It includes Physics for candidates who wish in addition to obtain full exemption from the Graduateship Examination of the British Institute of Radio Engineers.

The next course commences in September, 1956, and early application for entry is desirable. Application forms and further particulars may be obtained from the Technical Officer, the University, Southampton.

NEW BOOKS ON RADIO & TELEVISION

Fundamentals of Transistors, by L. M. Krugman. Postage 1/-	21/-
Radio Amateur's Handbook A.R.R.L. for 1956. Postage 1/6	30/-
Magnetic Recording Handbook, by Hickman. Postage 1/-	21/-
High Fidelity the Why and How for Amateurs, by G. A. Briggs. Post. 1/-	12/6
M.K. Valve Data Handbook, most up-to-date, published in Holland. Postage 9d.	15/-
Radio Servicing Manual, by W. T. Cocking. Complete new edition. Postage 1/-	17/6
T.V. Engineering. Vol. 2. Vision Frequency Amplifiers, by Amos and Birkinshaw. B.B.C. Training Manual. Postage 1/3	35/-
3rd Audio Anthology, by Radio Magazines Inc. of America. Postage 1/-	20/-
Germanium Diodes, by Dr. S. D. Boon. Phillips Technical Series. Postage 6d.	9/6
Loudspeakers, by G. A. Briggs. Post. 6d.	7/6
Beginners Guide to Radio, by F. J. Camm Postage 6d.	7/6

Write or call for lists of English and American publications.

UNIVERSAL BOOK CO.
12 LITTLE NEWPORT STREET, LONDON, W.C.2. (adjoining Lisle Street).

Wireless World Classified Advertisements

Rate 7/- for 2 lines or less and 3/6 for every additional line or part thereof, average lines 6 words. Box Number: 2 words plus 1/-. (Address replies: Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, S.E.1.) Trade discount details available on application. Press Day September 1956 issue, Wednesday, July 25th. No responsbility accepted for errors.

WARNING

Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee: Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

SHIRLEY LABORATORIES, Ltd., 125, Tarring Rd., Worthing, Sussex. Tel. Worthing 513, 3571.

THE JTR/S1 stereosonic tape recording and replay amplifier, separate meter monitoring on record and playback on both channels, 13watts C/P each channel, 96gns; TWA/15 tape recording and reproducing amplifier, 13watts O/P, as described in the March "Wireless World," for Wearite and Collaro decks, 45gns; TW/PA recording and replay pre-amplifier, 30gns; both with valve voltmeter monitoring; type SB/1-15E high-fidelity amplifier, exceptionally wide tone-control system, 40mv sensitivity, 20gns; with two inputs and 3-position gram filter, 22gns; specialized amplifiers for the musical and scientific industries including the Mullard 20watt. [0095

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

RECEIVER CR100/7 £14; another with S. meter £18; TF517 £15; exchanges for wide-angle C.R.T.—Box 2828. [6151

PHILIPS projection TV optical unit complete and in working order; £10.—Cosmic Radio, 6 & 8, Clifton Crescent, Birkenhead. [6117

AR.88.D, excellent condition, speaker £50 or offer.—Westlake, Leith Cottage, Sudbrook Gardens, Ham, Surrey. Kingston 7336. [6116

EDDYSTONE 750, 11 valve communication receiver with matching speaker, mint condition, cost over £80; offers over £40.—Box 2495. [6108

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

HIGH fidelity reproducer comprising Leak amplifier, Leak pick-up, Chapman F.M. and Leak M.W. receivers, 3-speed turntable in walnut console, Mordaunt corner speaker, cost nearly £200; complete £75.—Byron 7056. South Hill Lodge, South Hill Avenue, Harrow. [6152

"WIRELESS WORLD" 7-valve F.M. tuner unused with cathode follower, magic eye and power supply, fitted with latest type F.M. components including specified temperature compensating capacitors; price £14/15, including 7 valves, approx. half original price, exceptionally good reproduction, ideal for use with all high fidelity amplifiers and recorders; as above, but including high-grade cabinet 14½in×9½in×9in with slow motion tuning indicator, £18/10, limited number; bargain.—Box 1919. [6154

NEW TEST EQUIPMENT

S.I.M. TV signal intensity meter, directly calibrated in microvolts, indispensible for TV aerial and feeder installations, and finding that "elusive fault."—Send for full details to Radio-Aids, Ltd., 29, Market St., Watford. Tel. 5988. [0170

TEST EQUIPMENT—SURPLUS AND SECONDHAND

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

TRANSMITTING EQUIPMENT

QUICK sale ex G3DT transmitting and receiving equipment, power packs, speakers, components, etc.—Rozel, Harrietsham, Kent. Harrietsham 281. [6122

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

2,000c/s motor-alternator sets, input 220v d.c., output 80v, 1ph, 2,000c/s, 6.25amps, 500VA, complete with starter, fuses, control panel and voltmeter, all mounted in ventilated steel cabinet 14in×26in×49in high, new in original cases; £16, carr. extra.
P. B. CRAWSHAY, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0096

Send to Partridge for your copy

A free brochure is available giving full details of Partridge Transformers and chokes as specified for the Mullard High Quality Amplifiers. The brochure lists full technical and physical data and prices for the Partridge Components related to the Amplifiers shown below.

MULLARD 10 WATT AMPLIFIER
Mains Transformer H300/10
Output Transformer

MULLARD 10 WATT AMPLIFIER
(Distributed Load Version)
Mains Transformer P4013
Output Transformer P4014

MULLARD 20 WATT AMPLIFIER
Mains Transformer P3877
Smoothing Choke P3879
Output Transformer P3878

Post the coupon now for your copy of this informative publication.

PARTRIDGE TRANSFORMERS LTD.
TOLWORTH SURREY
PLEASE SEND MULLARD BROCHURE
Name ....
Address ....
.... WW/8/56

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

BRIDGE rectifier units, quantity of new, unused, ex-Ministry of Supply, by S.T. & C., Ltd., 200-250/1/50 in 70-90, 100v 16amp d.c. out or will charge 54, 2 V cells, at tropical rating up to 125°F, at normal temp. rect. output 32amp, rotary switches, fuses, V meter, steel case, 4ft 6in×3ft 6in×1ft 6in, approx. wt. 3cwt, suit home or tropics; £25 each, carr. free England.
NEW R.A.F. charging cut-outs, 12 and 24v 40amp, 12/6, p. 1/-; 60amp, 19/6, p. free; landing lamps 24v 240 watt, 1/6, 15/- per doz, post extra.
T. W. PEARCE, 66, Great Percy St., W.C.1. [0012

NEW COMPONENTS

CRYSTAL microphone inserts (Cosmocord Mic 6/4), in popular demand by Hams and sound engineers; guaranteed newly made and boxed; 15/6 post free.—Radio-Aids, Ltd., 29, Market St., Watford, Herts. [0169

CONSTRUCTORS.—Every type of component part supplied for constructors, brand new and all guaranteed, at below list price; all types of condensers, resistors, valves and transformers; stamp for lists; very quick M.O.S.—D. R. Smith, 47, Stannary St., Halifax. Tel. 66865. [0004

COMPONENTS—SURPLUS AND SECONDHAND

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188.
ELECTROLYTICS: Capacity, voltage, size, type of mounting, price post paid, 25, 25v, ⅝×1¾, W/E, 1/3; 500, 12v, ¾×¾, W/E, 2/1; 1,000+1,000, 6v, 1×3, clip, 3/3; 1,000, 6v, 1×2, clip, 2/3; 1,000+2,000 6v 1×3 clip, 3/9; 100, 12v, ⅝×1¾, clip, 1/9; 2,000, 12v, 1⅜×2, clip, 3/6; 50, 25v, ⅝×1¾, clip, 1/9; 100, 25s, ¾×1¾ 2/-; 1,000, 25v, 1×3, clip, 4/-; 3,000, 25v, 1⅜×4⅛, 5/-; 5,000, 25v, 1¾×4½, 6/6; 2,500, 50v, 1¾×4½, 6/6; 5, 150v, ⅝×1¼, W/E, 1/3; 8, 150v, ⅝×1¼, clip, 1/3; 40+40, 150v, 1×2, clip, 2/9; 100, 275v, 1⅛×3, clip, 3/-; 60+250, 275/350v, 1¾×4½, clip, 6/-; 8, 450, ¾×2, clip, 1/9; 16+16+8, 350/425v, 1⅜×2, lug, 4/3; 20+10, 450v, 1×3, clip, 4/-; 8, 500v, 1⅜×2¾, clip, 2/3; 32+32+8, 350/425v, 1⅜×3, clip, 5/-; 32+32, 350/425v, 1⅜×2, clip, 4/-; 100, 350/425v, 1⅜×3, clip, 4/-; 2, 350v, ⅝×2, 1/3; 16+16, 350v, 1×2, clip, 3/6; 16+16, 275v, 1×2, clip, 3/-; 32+32+8, 275v, 1⅜×2, clip, 4/3; 100+200, 350v, 1¾×4½, clip, 7/-; 50+50, 350v, 1⅜×3, lug, 4/6; 200, 250v, 1⅜×3, clip, 3/6; 16+8+4, 275v, lug, 3/-; 200+250+250, 275v, 2×4½, clip, 8/6; photoflash types, 1,000mf, 200v, 1¾×4½, 12/6; all ALI cans, some with sleeves, all voltages WKG, surve V where marked, all new stock, guaranteed.
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 strip 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, 9/11, post paid.
SCANNING coils, wide angle, with mounting lugs, 19/6, post paid.
MAINS trans.; 340-220-0-220-340v, 220mA, 4v, 6.5A, 4v, 3A, 4v, 1.5A, 2v, 1.5A, 4v, 6.5A Pri. 0-205-225-245v, 30/- post paid.
MAINS trans., 250-0-250v, 120mA, 6.3v, 2.5A, 6.3v, 0.6A, Pri. 0-110-125-150-205-225-245, 16/6 post paid.
C.T.V.IF's 34Mc/s, 2nd, 3rd, 4th, vision, cans 13/16×13/16×2½, slug tuned, set of three 5/6 post paid.
RADIO CLEARANCE, LTD., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport St., London, W.C.2. See our displayed advertisement, page 146.

TUBES, Mazda 12in and 15in, perfect condition, seen working, guaranteed; £6 and £8/10 each; callers only.—King's Tele-Service, 253, High Rd., Leytonstone. [6099

GOVERNMENT Surplus Illustrated Catalogue No. 12, containing over 400 items of electrical, mechanical and radio equipment for experiments, etc.; price 1/6, post free.—Arthur Sallis, 93, North Rd, Brighton, Sussex [0093

MAGSLIPS at low prices, fully guaranteed, 3 in Resolver No. 5 (AP 10861), 50v, 50c/s, unused, each in tin, 35/-, post 2/1; large stocks of these and other types.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0087

NEW GRAMOPHONE AND SOUND EQUIPMENT

TRANSISTOR pre-amps for tape playback; £9/ 5
RECORDING units osc erase and bias, with meter level 17gns, R/P amps, 6 watts U/L, 25gns.
REFLECTOGRAPH tape-decks, now £36; Stereosonic, £53/6/8.
COLLARO, Wearite and all decks and amps available
HARDING ELECTRONICS, 120a, Mora Rd., Cricklewood, London, N.W.2. Tel. Gladstone 1770. [0032

NEW GRAMOPHONE AND SOUND EQUIPMENT

AN unbeatable bargain (as many repeat orders testify), recording tape, plastic, sensitive, 1,200ft 22/6 inc. p.p. (£1 each 6 and above. 1/6 p.p.); also Mastertape. Tape recorders, Ferrograph, Leevers Rich, Brenell (excellent value at 48gns); disk recorders; blank disks; microphones.
TAPE to disk, 78 and LP, complete service backed by years of practical experience.
EROICA RECORDING SERVICES (1949), Recorder House, Peel St., Eccles, Manchester. Eccles 1624. Director, Thurlow Smith, A.R.M.C.M. [0122

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. [0210

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECONDHAND

C.J.R. tape recorder type D5, replay facilities during record; £75.—Parker, 3, Moran Rd., Macclesfield, Cheshire. Tel. 5301. [6110

GOODSELL Williamson G.W. 18 amp. P.F.A. pre-amp and two tun. units, Std and F.M., £55; Connoisseur 3-spd. gram. motor, lt.w. P.U., 2 heads, £25; Wharfedale 3-speaker corner system, £35.—Box 2804. [6145

WANTED, EXCHANGE, ETC.

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

WANTED, valves, TV tubes, televisions, radios, radiograms, tape recorders.—Stan Willetts, 43, Spon Lane, West Bromwich, Staffs. Tel. 2392. [5847

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

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Gerrard 2504. [5877

AMMETER and Voltmeter Selector Switches, 4- 5- or 6-way Rotary Switches, 5amp, 230V; quantities of the above required by electrical manufacturer; reply stating price and full details.—Box 2046. [6045

RADAR transmitter, any surplus 10cm Army types 3Mk2, 4Mk6, 3Mk7 or similar, complete with magnetron, magnet pulsing arrangements, associated transformers and alternator, in working order.—Box 2733. [6134

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estb. 16 years.—Call, send or 'phone Ger. 4638 Miller's Radio, 38a, Newport Court, Leicester Sq., W.C.2. [6059

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, S27CA, 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 British or American, transmitting and receiving; keenest cash prices paid. What have you to offer?—Write or call Lowe Bros., 9a, Diana Place, Euston Rd., N.W.1. [4485

CABINETS

LEWIS RADIO have the best selection and finest finish.—See page 133. [0224

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. [0113

LOUDSPEAKERS repaired promptly.—Model Loudspeaker Service, Bullingdon Rd., Oxford. [5963

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

REPAIRS AND SERVICE

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

REWINDS and conversions to mains and output trans., pick-ups, fields, clock coils, etc., from 4/6, PP equipment a speciality; all work guaranteed.—N.L. Rewinds, 173, High Rd., Willesden Green, N.W.10. Tel. Wordsworth 7791. [5944

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

PAINTS, CELLULOSE, ETC.

PAINT spraying handbook, 3/6 post free, cellulose and synthetic paints and all spraying requisites supplied; catalogues free.—Leonard Brooks, Ltd., 53, Harold Wood, Romford. [0207

WORK WANTED

ELECTRONICS manufacturer, Watford district, has facilities available for light assembly work.—Write Box 1798. [6002

CAPACITY AVAILABLE

FACTORY Capacity available for the following categories:
PLASTICS Injection Moulding (3 oz).
ALUMINIUM Die-Casting.
LIGHT Engineering.
ELECTRONIC & Electrical Assembly. Location Wiltshire.—Box 0077. [0114

MISCELLANEOUS

TAPE to disc, LP 22/-, 78 11/-; s.a.e. leaflet. —Marsh, Little Place, Moss Delph Lane, Aughton, Ormskirk, Lancs. [5705

ROTARY Convertor, 230 d.c. to 230 a.c., 50c, 100w, filtered input and output, TV suppressed, little used, in steel case; £8.—78, Reigate Rd., Worthing. [6141

YOUR own tape recording transferred to disc 78s or L.P.s. Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio Recordings. [6023

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

130A.—M.E.A. pattern radiometal nickel alloy laminations for sale under list price, 750lb at 12/6 per lb.—The Electroproducts Co., 230-254, Brand St., Glasgow, S.W.1. [6053

TAPE/DISC for connoisseurs, use Britain's oldest full-time transfer service; 40 min. L.P. 3gns; special prof. qual. tape, 25/- and 21/-.—Sound News Productions, 59, Bryanston St., W.1. Amb. 0091. [6123

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. WW58, London, W.4. (Associated with H.M.V.) [0180

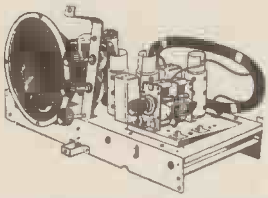
COIL Winding Machine. Neville's. Type Montreal. Only had very little use. Perfect condition including electrical equipment and reel stand. Open to reasonable offer.—The Medical Supply Association, Ltd., 53, Park Royal Rd., N.W.10. Elgar 4011. [0197

SWITCH Units, Type 207B. These beautiful electronic devices measure 14×7×6 approx. and contain a host of useful equipment, the main items being a precision double wound pot 4½in dia., 6 standard tropical pots, 4 Yaxley type switches, 3 P.O. lamp holders with bulbs, 2 toggle switches, 3 push switches, an assortment of knobs, multiway sockets, precision resistors, gear wheels, etc., etc. Have cost pounds to manufacture; our special price 7/6 + 2/6 P. & P. Wonderful value.
WALTON'S WIRELESS STORES, 48, Stafford St., Wolverhampton, Staffs. [0145

NOTICES

COVENTRY TECHNICAL COLLEGE.
SESSION 1956-57.
ELECTRONIC Engineering.
APPLICATIONS invited for entry to next 3-year full-time course commencing September, 1956, 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 C. and G., Brit.I.R.E., and I.E.E. examinations; entry age 16 or over.
APPLICATION forms and further information from Principal, Coventry Technical College.
W. L. CHINN,
DIRECTOR of Education. [6127

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



SITUATIONS VACANT

LABORATORY staff REQUIRED
FOR research and development work on special electronic valves for use in microwave equipment.
TECHNICAL assistant (male 20-25); applicants should be of educational standard approximating to Inter B.Sc. or O.N.C. level; experience in vacuum physics or valve design, while not essential, would be an advantage.
LABORATORY assistant (male 17-30); applicants should have had technical or grammar school education and be willing to learn laboratory techniques in valve design; any experience in glass working would be an advantage.
ABOVE appointments are permanent and offer good prospects in an expanding field; hours, 8.50/5.30 five days; canteen; pension scheme.—Apply Personnel Dept., Elliott Brothers (London), Ltd., Elstree Way, Borehamwood, Herts. [6111

FERRY AIRPORTS, Ltd.
APPLICATIONS are invited, Radio Mechanics and Licensed Radio Engineers, permanent vacancies, hangar and flight duties, Bristol freighter and Dakota aircraft.
EXPERIENCE STR12D, STR9X, MR80, AD7092, BC433G and Ultra I/C preferred, not essential. Modern heated hangar, canteen and assisted travel facilities.—Write partics., Engineer Superintendent, Ferryfield Airport, Lydd, Kent. [6130

CAMBRIDGESHIRE Education Committee.
CAMBRIDGESHIRE Technical College and School of Art (Principal: D. E. Mumford, M.A.).
APPLICATIONS are invited for the following full-time teaching posts:—
1. ELECTRICAL Installations Engineer required as soon as possible to develop new day-release and evening courses for electrician apprentices. At first the courses will be based on City and Guilds Course B in Electrical Installation Work, but later could develop to meet the requirements of Course C and of Electrical Engineering Practice. Applicants should have qualifications appropriate to the post, together with a wide range of practical experience. Salary Scale—Grade A Assistants: £450×£18—£725.
2. RADIO and Television Service Engineer required to develop Servicing Courses for day-release and evening students in new premises. Salary Scale—Grade A Assistants: £450×£18—£725, but an exceptionally well-qualified applicant may be appointed to the Grade B scale: £525×£25—£820.
THERE are additional allowances to the above scales for degrees and training, and starting position on each scale will depend on previous teaching, industrial experience and war service. The scales are under review and are likely to be improved in the near future.
FURTHER particulars and forms of application can be obtained from the Principal, Cambridgeshire Technical College and School of Art, Collier Rd., Cambridge. [6121

FULHAM & KENSINGTON HOSPITAL MANAGEMENT COMMITTEE.
TECHNICIAN required to assist in maintenance of electro-medical apparatus. Qualification at least to Ordinary National Certificate. Knowledge of mechanical engineering an advantage.
SALARY (at age 26+) £520 rising to £630.
APPLICATIONS with full particulars to Superintendent Engineer (W.W.76), 5, Collingham Gardens, S.W.5 immediately. [6103

A LABORATORY Assistant is required by progressive firm engaged in the manufacture of transformer cores.
APPLICANTS should be familiar with the use of electrical measuring instruments, and should have a good grounding in electromagnetics. Salary in accordance with qualifications and experience.
APPLY to the Chief Electrical Engineer, Telcon-Magnetic Cores, Ltd., The Industrial Estate, Chapelhall, Lanarkshire, Scotland. [6004

INSPECTOR required for electronic instrument company. Camberley area. Excellent prospects for rapid advancement in expanding organisation.—Box 2709. [6131

DRAUGHTSMEN required for light engineering concern in Boreham Wood area. Salary £750 to £900. Five-day week, five weeks holiday, generous sick leave, good canteen.—Box 2710. [6132

SENIOR and Junior Electrical and Mechanical Draughtsmen required for the Electronics drawing office at the Rugby Works of the B.T.H. Co., Ltd. Please apply in writing to:—CHIEF Draughtsman, Electronics Drawing Office, British Thomson-Houston Co., Ltd., Rugby, giving details of age, experience, etc. [5811

ELECTRONICS Technician required for prototype and research equipment used with million volt electron accelerator.—Apply to Director, Research Unit in Radiobiology, Mount Vernon Hospital, Northwood, Middlesex. [6128

INTERESTING and congenial position in London retail business of good standing; good English, typing and figure work essential; applicant must have high standards of service; state age and full details of career.—Box 2763. [6139

OLD-ESTABLISHED London retail radio business requires Television Service Engineer; also trainee; driving experience essential; good prospects for capable men; state age and details of experience.—Box 2762. [6138

BAKERS 'Selhurst' RADIO

THE CONNOISSEUR'S CHOICE

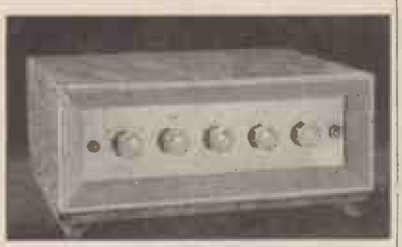
The "Selhurst" Enclosures

A new range of single speaker and multi-speaker phase inverter systems for a natural reproduction of the original sound.

Write for full details of our High Fidelity Equipment, which includes GOODSELL "Golden Range," with the ORTOFON Pick-Ups with Diamond Stylii, and the WOOLLETT Transcription Gramophone Turntable.

WE NOW FIT DIAMOND STYLUS TO ALL ORTOFON PICK-UP HEADS IN ACCORDANCE WITH THE MANUFACTURERS' SPECIFICATIONS.

THE CONNOISSEUR'S CHOICE



The PRESIDENT Audio Consolette

A High Fidelity Tone Control Pre-Amplifier and Power Amplifier encased in a compact attractive cabinet. (11¼in. wide x 6½in. high x 14in. deep.)

Mail orders only pending the opening of our new showrooms.

Trade and Export enquiries invited.

JOHN LIONNET & CO.

DEPT. W, 62-63 Queen Street, London, E.C.4

Tel: CITy 7167

SITUATIONS VACANT

ENGINEER required for development work on polystyrene film capacitors; position offers considerable scope for man with general experience in the capacitor industry particularly on the production side; own staff advised.—Write Box 2382. [6093

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

TRAINEE Television Service Engineer required by London retail radio business of good standing; good opportunity for keen man with aptitude for this work; driving experience essential; state age and details of career.—Box 2761. [6137

ADVERTISERS (estab. '46) and well known, extending into the amplifier market, have profit-sharing and active proposition to put to man with knowledge in this branch and small capital; district S.W. London; reply in strictest confidence.—Box 1943. [6144

ERICSSON TELEPHONES, Ltd., Beeston, Nottingham, are planning a considerable expansion in the fields of acoustics and acoustic transducers, relays, hearing aids, electro-mechanical devices, etc., and invite applications from:
PHYSICISTS.
ELECTRICAL Engineers.
MECHANICAL Engineers.
THESE posts, which offer considerable interest, are progressive and pensionable. In certain cases assistance with housing problems is available. Holiday commitments for this year will be honoured
APPLY by letter to the Personnel Officer, quoting reference No. IG/4 and giving details of previous experience and salary required. [6143

THE MITCHAM WORKS, Ltd., have a number of vacancies for young draughtsmen to be trained as mechanical designers, these opportunities provide for interesting work, leading to recognition as qualified designers in the radio and television field.
STARTING salaries would be in accordance with age and experience. Applicants are invited to write to the Personnel Officer, The Mitcham Works, Ltd., New Rd., Mitcham Junction, Surrey, quoting reference MD/1. [6120

RADIO/TELEVISION service engineer for established Murphy dealer; seaside town; equipped modern test gear; only first-class engineer considered; good wages; permanent post, but no accommodation provided.—Gerry, Bank St., Newquay. [6146

CONSULTING Geophysicists have vacancies in seismic oil exploration field parties for young men, preferably single, with electronic or radar engineering experience, with Higher National or C & G. Certificates in Electrical Engineering or Telecommunications; £600×£72.
WE offer a permanent career to men of initiative prepared to accept responsibility and work in camp conditions in all parts of the world; liberal home leave and allowances.—Box 2760. [6136

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 television development engineer with administrative experience required, capable of carrying out development projects with minimum supervision up to production stage; Kingston area.—Write, giving full personal details, stating salary required, Chief Engineer, Box 5942. [0123

ELECTRICAL measuring instrument repairers required for moving-coil, moving-iron and multi-range meters; expanding organization with high rates, bonus scheme and excellent conditions in light modern factory.—Apply L. Glaser & Co., Ltd., 96-100, Aldersgate St., E.C.1. Mon. 6822. [6008

ELECTRONIC INSTRUMENTS, Ltd., Richmond, have a vacancy on their testing staff which offers the prospect of an interesting job in this rapidly expanding company.—Please write to Electronic Instruments, Ltd., Lower Mortlake Rd., Richmond, Surrey, or Tel. Ric. 5656. [6153

VACANCIES occur, through promotion to managerial posts of our present staff, for television field engineers in the following areas —Luton, Aylesbury and Bedford; existing holiday arrangements will be honoured.—Forward full particulars to P. J. R. Robinson Rentals, Ltd., 47, St. Peter's St., Bedford. [6149

SENIOR Engineer required by electronic component manufacturers to take charge of test gear development, factory standards and maintenance of electrical special purpose plant. Permanent position requiring man with initiative and sound theoretical background. State salary required. Box 2364. [6101

CHIEF Inspector (Electrical) required by electronic component manufacturers. A.I.D. experience essential, preferably on R.C.S.C. specifications. Position suitable for applicant at present senior inspector who wishes wider scope and better remuneration within a small organisation. Location London, E.11.—Write Box 2365. [6102

EVERYTHING FOR THE SERIOUS CONSTRUCTOR

●

TRANSFORMERS OF EVERY DESCRIPTION. CHASSIS. SWITCHES TO SPECIFICATIONS

MAINS TRANSFORMER OFFER
Universal mounting. Standard Primary. Output: 250-0-250 volts at 60 m/A. 6·3 volts at ·6 amps. 6·3 volts at 2 amps.
Offered at the special price of **15/-**
(Add 2/- p/p.).

BATTERY CHARGING TRANSFORMER
6, 9 and 12 volts at 6 amps. **22/6**
(Packing & Postage 2/6).

STEEL METER CASES WITH ALUMINIUM PANEL, SLOPING FRONT

4in. × 4in. × 4in.	8/6
5in. × 5in. × 8in.	13/6
6in. × 6in. × 12in.	22/6

SMALL STEEL TEST METER CASES WITH ALUMINIUM PANEL

4in. × 4in. × 2½in.	6/-
6in. × 4in. × 3in.	8/-
8in. × 6in. × 3in.	10/-
10in. × 6in. × 2½in.	12/-

STANDARD STEEL CASES WITH ALUMINIUM PANEL

10in. × 7in. × 7in.	22/6	16in. × 9in. × 8in.	45/-
12in. × 7in. × 7in.	28/-	16in. × 11in. × 8in.	51/6
14in. × 7in. × 7in	32/6	19in. × 11in. × 10in.	58/-
14in. × 9in. × 8in.	41/6		

18 S.W.G. ALUMINIUM CHASSIS

8in. × 6in. × 2½in.	7/6	14in. × 5in. × 2½in.	9/6
10in. × 6in. × 2½in.	8/3	14in. × 8in. × 2½in.	10/6
12in. × 6in. × 2½in.	8/6	14in. × 10in. × 2½in.	11/-
12in. × 8in. × 2½in.	9/6	17in. × 10in. × 2½in.	12/6

18 S.W.G. STEEL CHASSIS

14in. × 8in. × 2½in.	9/8	17in. × 10in. × 2in.	11/3
14in. × 10in. × 2½in.	10/3	17in. × 10in. × 3in.	12/6

FULLY DRILLED CHASSIS FOR WILLIAMSON AMPLIFIER	27/6
G.E.C. OSRAM 912 AMPLIFIER DRILLED CHASSIS	21/-
G.E.C. OSRAM 912 FRONT PANEL	14/6
"PANL" CRACKLE PAINT, BLACK, per tin	3/-

CROSS-OVER INDUCTANCES
Special offer—4 m/H Pot Core, Litz wound Cross-Over Inductances. Made by well-known manufacturer. **15/-** Per pair
(Add 1/- p/p.).

0-30 M.A. METER	6/6
813 VALVE BASES (New)	10/-
40 H. 50 mA. WODEN CHOKES	12/6
2K COLVERN 15-WATT PRECISION POTENTIOMETERS	8/6
PEN46. New and Boxed	8/6
HVR2A. New and Boxed	6/6

LORENZ TWEETERS
Amazingly efficient moving-coil unit which is extremely easy to add to existing speaker systems. **39/6**

STOCKISTS FOR LEADING MAKES OF
Recording Tape · Microphones · Valves · Components of all types · Gramo Motors, Hi-Fi and Test Equipment, etc

Well-organised mail-order and export service available to all parts of the world.

- *Packing & Postage extra.*
- *Shop Hours—9 a.m. to 6 p.m. (1 p.m. Thursdays).*
- *Few minutes from Marble Arch.*

TELE-RADIO (1943) LTD.,

189, EDGWARE RD. W.2

(Our only Address)

Phone: PADdington 4455-6

SITUATIONS VACANT

ELECTRONIC Test Engineers are required by the General Electric Co., Ltd., Radio and Television Works, Spon St., Coventry; ex-Service radio and radar technicians and men with similar experience are particularly suitable for these posts; applicants should have an interest in one of the fields outlined below:—
(a) Testing of electronic equipment for Government contracts.
(b) Alignment, Test and Fault-finding on domestic T.V. receivers.
(c) Development, manufacture and maintenance of test equipment.
THESE positions offer good prospects of advancement. Those interested should write, quoting Ref. E.T. and giving details of career and experience, to the Personnel Manager at the above address. [6105

SENIOR and Junior Electrical and Mechanical Draughtsmen required for the Electronics Drawing Office of the British Thomson-Houston Co., Ltd., Blackbird Rd., Leicester.—Please apply in writing to Chief Draughtsman, Electronics Drawing Office, British Thomson-Houston Co., Ltd., Rugby, giving details of age, experience, etc. [5643

DESIGNER draughtsmen required by firm engaged in radio and electronic instrument work; experience in this field highly desirable; these are senior staff, pensionable appointments. Apply with details of experience and salary required to Personnel Officer, British Communications Corporation, Ltd., Exhibition Grounds, Wembley. [6114

AUSTRALIA (Sydney).—Television engineer with production experience required. Also experienced service engineer. Good salaries, bonuses, excellent prospects for right men. First class fares paid, accommodation guaranteed. Interview London. Replies, stating full particulars, treated with strictest confidence.—Box 2803. [6141

GOOD class radio and television dealers have opening for another experienced engineer who would help to retain their high reputation for service, top salary plus bonus, commencing date with respect holiday arrangements, permanency; excellent opportunity in expanding concern for loyal, qualified man.—Sievers, Marsh Road, Pinner 9283. [6135

RADIO engineers required to install and maintain two high power radio transmitting stations abroad; sites will be isolated and climatic conditions rigorous with no local amenities; excellent salaries paid to men with necessary experience and right temperament.—Quote Ref. D/NF. Box WD.381, c/o 191, Gresham House, E.C.2. [6115

DEVELOPMENT Engineer required to work on tape recording applications; the successful applicant must have experience in developing tape recording machines from the mechanical, electrical and electronic points of view; this is a senior position and an appropriate salary will be paid.—Apply to Box A45/12, Strand House, London, W.C.2. [6055

ELECTRONIC engineers.—Large organization has a few vacancies for electronic engineers to train as project leaders taking charge of all aspects of contracts abroad; qualifications H.N.C. or equivalent; age group 26-32; must be single and willing to work anywhere abroad for periods up to two years; excellent salary.—Write Box WD.438, c/o 191, Gresham House, E.C.2 [6147

TECHNICIAN or senior technician required for psychological laboratory; must have workshop experience and be familiar with electronic apparatus; salary scale: Technician, £520—£630; senior technician, £620—£755.—Apply, giving details of age, qualfications and experience to Hon. Director, Medical Research Council Unit, Institute of Psychiatry, Maudsley Hospital, S.E.5. [6113

BRISTOL Mental Hospital Management Committee requires an Electronic Engineer to service maintain and construct electro-encephalographic and electro-physiological equipment at Barrow Hospital, near Bristol. Salary £625 × £25—£800. Applications giving age, details of qualifications and experience, and names of two referees should be sent to Secretary, Bristol Mental Hospital, Fishponds, Bristol. [6129

GRADUATE electrical engineer.—Urgently required by international company at Oxford; unusual opportunity for man 27-35 with first-class qualifications for development work connected with TV circuitry; successful applicant must be able to spend month in United States this summer.—Applications with full details education, qualifications, experience, marital status and salary required to Box 2538. [6112

RADIO engineer required for Broadcasting Division, Social Development Department, Tanganyika, on contract for tour of 30-36 months in first instance. Salary scale (including inducement pay and present temporary allowance of 10% of salary) £1,003 rising to £1,498 a year. Gratuity at rate of 13½% of total substantive salary drawn. Outfit allowance £45. Free passages. Liberal leave on full salary. Candidates, preferably under 35, should have experience of high-power transmitting equipment and be able take charge of 20kW, 1.25kW and 250 watt R.C.A. transmitters at Broadcasting Station.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41312/WF. [6119

SITUATIONS VACANT

CIVILIAN instructors (male) Grade III in the trades of air radar fitter, air wireless fitter, ground radar fitter, ground wireless fitter and instrument fitter required by Air Ministry in provinces, appointments temporary but good prospects of becoming pensionable; trade training, practical experience and ability to teach are essential; pay £676 at age 26, rising to £833.—Apply to Air Ministry, S.5(g), (CIV 45), London, S.E.1. [6133

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

RESIDENT Radio Station Engineer and Resident Assistant Engineer required for isolated site near Stirling; good theoretical knowledge and practical background of transmitting station operation required; specialised training will be given to selected applicants; salary £450-£750 p.a. depending on qualifications and experience plus free house and heat.—Reply, giving details of present position, experience and qualifications to Box WW.365, c/o 191, Gresham House, E.C.2. [6107

ENGINEER for printed circuits required for development of printed circuit processes, including electro-plating of various metals, also development of printed resistors; qualifications B.Sc., or equivalent and experience of electro-plating and/or carbon resistors is desirable; superannuation scheme.—Write, giving full details of qualifications, experience, age and salary required to Personnel Manager, The Telegraph Condenser Co., Ltd., Wales Farm Rd., North Acton, W.3. [6094

TEST and Commissioning Engineer required by Elliott Bros. (London), Ltd., for interesting work on electronic instruments and systems. Applicants possessing O.N.C. or City and Guilds Intermediate preferred, but engineers with testing experience in this field are also invited to apply. The work is based on Lewisham, but occasional travelling is also involved.—Please write stating age, experience and qualifications to Personnel Officer, Century Works Conington Rd., Lewisham, S.E.13. [6142

SKILLED radio mechanics and servicemen.—A large organization has vacancies for men who are prepared to travel and work anywhere in the world; periods abroad from 6 to 24 months; salary £75 per month plus all found; candidates must be single, medically fit and have a good knowledge of radio theory and practice; initial engagements one to three years with excellent opportunities for men with ability and right temperament to obtain permanencies. —Write Box WD.439, c/o 191, Gresham House, E.C.2. [6148

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

AN outstanding opportunity in a rapidly expanding company located near Aylesbury is offered to a development engineer with a wide experience of electronic design; applicants must have a sound knowledge of communications techniques, be qualified by degree or equivalent, and experience of filter design would be an advantage; the post offers excellent scope for future advancement to a man with a good background of industrial or establishment experience.—Full details of age, experience, qualifications and salary expected, to Airtech, Ltd., Haddenham, Bucks. [6125

PHILIPS ELECTRICAL, Ltd., require a young man (25-30) to join the musical equipment department as a representative to operate in the Southern counties; musical equipment embraces record players and changers, loose and in cabinets with or without amplifiers, domestic tape recorders and high fidelity equipment; an interest in high fidelity and music generally is most important; it would be an additional advantage if candidates had some technical background; the post is pensionable and a car will be provided.—Reply in full to Personnel Officer, Century House, Shaftesbury Avenue, London, W.C.2, quoting reference No. 838. [6124

INSPECTOR of Workshops required for Broadcasting Department, Gold Coast Local Civil Service, for one tour of 18-24 months in first instance; consolidated salary scale £990 rising to £1,230 a year with gratuity at rate £100/£150 a year; outfit allowance £60, free passages, liberal leave on full salary; candidates must have up-to-date knowledge broadcasting equipment, should have at least ten years' experience workshops practice in radio, including five years in large broadcasting organisation, preferably B.B.C., or five years in large manufacturing firm in radio industry. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41020/WF. [6106

SOUTHERN RADIO'S WIRELESS BARGAINS

TRANSRECEIVERS. Type "38" (Walkie-Talkie). Complete with 5 valves. In metal carrying case. Ready for use. Less external attachments, 30/- per set. ATTACHMENTS for use with "38" TRANSRECEIVER HEADPHONES, 15/6; THROAT MICROPHONE with Lead and Plug, 4/6; JUNCTION BOX, 2/6; AERIAL, 2/6.
TRANSRECEIVERS. Type "18" Mark III. TWO UNITS (Receiver and Sender) contained in Metal Case. Complete with Six Valves, Microammeter, etc. LESS EXTERNAL ATTACHMENTS, £4/10/-.
TRANSMITTERS. T1154. Complete all valves, etc., etc. Perfect order. 3 frequencies. £2/7/6, in transit case. Delivered U.K.
BOMBSIGHT COMPUTERS. Ex-R.A.F. BRAND NEW. A wealth of Components. GYRO MOTORS, REV. COUNTERS, GEAR WHEELS, etc., etc. Ideal for Model Makers, Experimenters, etc., £3.
LUFBRA HOLE CUTTERS. Adjustable ⅞in. to 3½in. For Metal, Wood, Plastic, etc., 7/-.
RESISTANCES. 100 ASSORTED USEFUL VALUES. Wire Ended, 12/6 per 100.
CONDENSERS. 100 ASSORTED. Mica, Metal Tubular, etc., 15/- per 100.
PLASTIC CASES. 14in. x 10¾in. Transparent. Ideal for Maps, Display, etc., 5/6.
STAR IDENTIFIERS. Type I A-N. Covers both Hemispheres. In case, 5/6.
CONTACTOR TIME SWITCHES. In soundproof case. Clockwork movement. 2 impulses per sec. Thermostatic Control, 11/6.
REMOTE CONTACTORS. use with above, 7/6.
MORSE PRACTICE SET with Buzzer on Base, 6/9. Complete with Battery, 9/6.
MORSE TAPPERS, Std., 3/6; Midget, 2/9.
CRYSTAL MONITORS. Type 2. New in Transit Case. Less Valves, 8/-.
METERS AND AIRCRAFT INSTRUMENTS. Only need Adjustment or with broken Glass. TWELVE INSTRUMENTS, including 3 brand new Aircraft Instruments, 35/- for 12.
Postage or carr. extra. Full list of Radio Books, 2½d.

SOUTHERN RADIO SUPPLY LTD.
11 LITTLE NEWPORT STREET
LONDON, W.C.2. Gerrard 6653

ENGRAVING

Electronic Equipment, Scales, Indicators, etc. *Send or phone your requirements.*

A.G. ENGRAVING
292 EARLSFIELD ROAD, S.W.18
Phone: BATtersea 9897

Build your own Tape Recorder with the

'ASPDEN' TAPE DECK KITS

Compact model
7¼in. x 11in., 5in. reels......kit £7 10 0
Standard model
10¾in. x 15in., 7in. reels...kit £8 10 0

Easy to assemble, with full working drawings and instructions. First class motor, latest design High-Fidelity heads.

and the recorder
AMPLIFIER .... kit £5 18 0
Power Pack .... kit £2 18 6
(without valves)
Carr. extra.

"... very pleased with its performance—must congratulate you for supplying such an excellent kit." *W.P., Portsmouth.*

Send stamp for full particulars to:—

W. S. ASPDEN,
10, MARKET STREET, WESHAM, KIRKHAM, LANCS.

SITUATIONS VACANT

ROYAL NAVAL COLLEGE, Greenwich.
VACANCIES exist for highly qualified Instrument Makers and Toolmakers for employment as Laboratory Mechanics, a grade in which a high level of versatility and ability is required.
CANDIDATES should be fully indentured or have had at least five years' training and subsequent experience in the trade on various high-class machine tools, producing precision prototype instruments and assemblies. For some vacancies experience with electronic assemblies and equipment would be advantageous.
THE present pay range for five-day week of 44 hours is 211s 10d to 253s 10d, all appointments being subject to three months' probation.
NEW entrants commence at 211s 10d per week and during probation their skill, versatility, accuracy, speed on precision work and general adaptability will be assessed in relation to the performance of experienced Laboratory Mechanics.
ON completion of probation, re-assessment for pay, strictly on merit, will be made and appropriate rate in the pay range awarded, retrospective to date of entry.
FURTHER pay increases by stages up to maximum of pay range may be awarded on merit at annual reviews.
ALL appointments may lead to eventual establishment in Admiralty Service and promotion prospects exist.
APPLY by letter, giving age and full details of industrial experience, to the Secretary, Royal Naval College, Greenwich. [6155

ELECTRONIC Engineers.—Vacancies in new laboratory established by large manufacturers in North London to investigate unique uses of their products in connection with electronics and kindred apparatus. Applications considered from Graduate Engineers, holders of H.N.C. or equivalent, students who have thorough knowledge of basic theory. Quote reference SBE/W2, Box 2845. [6156

ELECTRONIC Engineers are required by the Equipment Engineering Department of Westinghouse Brake & Signal Co., Ltd., at Chippenham, Wiltshire, to take part in the development and subsequent engineering design for production, of new control systems, employing electronic techniques, for traffic control on British & Overseas Railways. The scope of the work will range from practical experimental work to the issue of design instructions on which will be based manufacturing drawings, together with the compilation of manufacturing specifications and descriptive pamphlets. In addition co-operation will be required with Production Engineers during manufacture of first-off equipments in the Company's Chippenham Works
POSITIONS are available for University graduates with a good telecommunication Degree in Electrical Engineering. Some experience with transistor techniques is required, together with experience of line communication systems employing audio and carrier frequencies. A knowledge of computing techniques would also be an advantage but is not essential.
THE salaries will be determined by age, qualifications and experience; the Company operates a pension scheme and a 5-day week.
FOR further information write, giving age and full particulars, to Personnel Superintendent, Westinghouse Brake & Signal Co., Ltd., Chippenham, Wilts, quoting ref EQUIP/N/Q. [5975

WIRELESS operator mechanics required by Falkland Islands Dependencies Survey for service at isolated British Bases in Antarctic. Must be able to transmit and receive morse at 20 words a minute (plain language or code) and be capable elementary maintenance wireless transmitting and receiving equipment. Salary according to age in scale £330 rising to £420 a year with all found, including clothing and canteen stores. Keen young men, between 20 and 30 years required preferably single, of good education and high physical standard with genuine interest in polar research and travel willing to spend 30 months under conditions testing character and resource.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41540/WF. [6150

SITUATIONS WANTED

CHIEF engineer, T.V. broadcast, requires change, wide industrial and broadcast experience, top engineering level, highest engineering and management qualifications.—Box 1918. [0265

GERMAN Radio Engineer, 6 years industrial experience in A.F. and V.H.F., seeks good position in British factory, married, accommodation required; only permanent position.—H. Kusior, Hildesheim, Hermannstr, 44, Germany. [6140

FULLY qualified radio engineer aged 45, specialist v.h.f. communications equipment, requires responsible position with manufacturer or large user, at home, or overseas, on design, maintenance or project development; all enquiries treated in strict confidence stating position and salary offered.—Box 2562. [6109

TECHNICAL TRAINING

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

TELEVISION ENGINEERING VOL. 2

(Video-Frequency Amplification)

S. W. AMOS & D. C. BIRKINSHAW
35/- Postage 1/-

TRANSITORS I by RCA Laboratories 38/6 Postage 1/6

AUTOMATIC DIGITAL CALCULATORS by A. D. Booth & K. H. V. Booth. 32/- Postage 1/-

TELEVISION TIMEBASE CIRCUITS Principles & Practice by C. H. Banthorpe 5/- Postage 4d.

THE V.T.V.M. by R. Samuel 20/- Postage 1/-

HIGH FIDELITY CIRCUIT DESIGN by N. H. Crowhurst & G. F. Cooper 48/- Postage 1/-

FIXED RESISTORS by G. W. A. Dummer 28/- Postage 9d.

INTERNATIONAL TUBE HANDBOOK (M. K. Buizen). 15/- Postage 9d.

SWEEP & MARKER GENERATORS FOR TELEVISION & RADIO by R. G. Middleton. 20/- Postage 1/-

THE MODERN BOOK CO.,

19-23 PRAED STREET, LONDON, W.2

Britain's Largest Stockists of British and American Technical Books

Please write or call for our catalogue.
'Phone: PADdington 4185.
Open 6 days 9–6 p.m.

FM and HI-FI COMPONENTS

in stock for the

WIRELESS WORLD FM TUNER UNIT

DENCO FM TUNER	circuits	1s. 6d.
RADIO CONSTRUCTOR FM	"	2s. 0d.
MULLARD AMPLIFIERS	"	3s. 6d.
OSRAM 912 PLUS AMPLIFIER	"	4s. 0d.

Separate price lists on request to

J. T. FILMER MAYPOLE ESTATE BEXLEY, KENT
Tel: Bexleyheath 7267

QUARTZ CRYSTAL UNITS

Q.C.C.

Type **B7**

The type B7 unit is mounted in the standard B7G valve envelope and is hermetically sealed and fully evacuated.

Available for the frequency ranges from 100 kc/s to 500 kc/s. and from 3 Mc/s. to 16 Mc/s. Gold electrodes applied by cathodic sputtering give permanence of calibration. Normal adjustment accuracy 0.01% Max. adjustment accuracy 0.003%.

Early delivery can be given of some frequencies, and we will be pleased to quote for your specific requirements.

THE QUARTZ CRYSTAL Co. Ltd.
63-71, Kingston Road, NEW MALDEN, SURREY
Telephone: MALden 0334 *Cables, etc., QUARTZCO NEW MALDEN*

GALPIN'S

ELECTRICAL STORES

408, HIGH STREET, LEWISHAM, S.E.13

Tel.: Lee Green 0309. Nr. Lewisham Hospital.

TERMS: CASH WITH ORDER (No C.O.D.).

All Goods sent on 7 days' approval against cash

MAINS TRANSFORMERS. Input 200/230 Volts. OUTPUT 0/9/18 Volts at 3/4 amps., 25/- each; another output 12½/0/12½ volts 2 amps., 25/- each; another suitable for soil heating, garage lighting, etc., 0/4/7½ volts, 20/25 amps., 52/6 each; another 4 volts 20 amps. twice, 35/- each.

EX-GOVT. ROTARY CONVERTORS 24 volts D.C. Input 50 volts 50 cycles, 1 phase at 450 watts. OUTPUT (complete with Step Up Transformer) from 50 volts to 230 volts, £13/10/- each or **CONVERTOR** only £9/10/- each.

EX-NAVAL ROTARY CONVERTORS 110 volts D.C. Input. Output 230 volts 50 cycles 1 phase 250 watts capable of 50 per cent. overload, in good condition, guaranteed weight approx. 110 lb. £13/10/- each.

SPARK COILS, fat spark on 4 to 6 volts, complete with trembler, 17/6, p/p 1/6 each.

TOTE SWITCHES with operating gear, large 25/-, small, 15/- each.

¼ H.P. D.C. MOTORS, 110 volts, 3,000 r.p.m., new, 35/-; starters to suit N.V.R. 25/-.

MAGSLIP MOTORS, 50 volts, A.C., large size, as new, 8/6, p/p 1/6. each.

A.C. MOTORS, 230 volts, sewing machine size, 35/- each.

IRON CLAD Safety Switches, 2 pole, D.P., D.T., 250 volts, 60 amp., new, 18/6, p/p 1/6 each.
D.C. MOTORS, 24 volts, large size 8/6, p/p 1/- each.

ROTARY CONVERTORS, new, with all smoothing and control, input 28 volts D.C. Output 300 volts, 260 M/amps, 150 volts, 10 M/amps and 14.5 volts 5 amps. All outputs are D.C. 45/-, p/p 2/6 each.
LARGE METER Movements, fairly low F.S.D., average 6 inch deflection, very high quality, 7/6, p/p 1/6 each.

MOVING COIL Meters, all 2 to 3 inches dia., damaged cases or glasses, 3 for 10/-, guaranteed one sound meter; 6 for 18/-, two sound meters, no junk, all are or suitable for M/amp. meters.

MAINS TRANSFORMERS all 200/250 volts primaries (New) Heavy duty Output combination of 0/6/12/18/24/30/36 volts 4/5 amps., 38/6 each. Ditto 6/8 amps., 51/6 each. Ditto 15 amps. Output 75/- each. Another combination of 0/6/12/18/24 volts 6/8 amps., 51/6 each. Ditto 10/12 amps., 58/6 each. Ditto 25/30 amps. Output, 85/- each.

MEDIUM SPOT WELDER TRANSFORMERS. Input 200/250 volts, OUTPUT combination of 0/2/4/6/8/10/12 volts at 50/70 amps., £5/7/6 each. Ditto 120/150 amps. Output, £7/10/- each.

PRE-PAYMENT 1/- SLOT METERS 200/250 volts A.C. 10 amp. size only, 100 per cent. overload set at 2d. per unit (guaranteed 12 months), £3/17/6 each. Ditto credit type 10 amps. only, 25/- each.

RECTIFIERS FOR CHARGERS 6 or 12 volts Output 2 amps. 9/6 each, 4 amps., 22/6 each, 6 amps., 36/- each. **MAINS TRANSFORMERS** to suit, 25/-, 30/- and 46/6 each respectively.

EX-CANADIAN EX-GOVT. ROTARY TRANSFORMERS for No. 19 receiver. Input 12 volts D.C. OUTPUTS 275 volts 110 M/amps.; also another output of 500 volts 50 M/amps. completely smoothed, 30/- each.

AUTO WOUND Voltage changer **TRANSFORMERS.** Tapped 0/110/200/230/250 volts 200 watts, 48/6 each; 350 watts, 57/6 each; 500 watts, 76/6 each; 1,000 watts, £6/5/- each; 1,500 watts, £8/5/- each; 3,000 watts, £17/10/- each.

EX-R.A.F. ROTARY TRANSFORMERS. Input 24/28 volts D.C. OUTPUT, 1,200 volts 70 M/amps. ¼ hour rating, 10/- each. Ditto 18/24 volts D.C. Input 450 volts 50 M/amps., Output constant, 25/- each. These latter ones can be used as motors off A.C. mains with a little alteration.

EX-R.A.F. MORSE TAPPING KEYS, 5/- each.
SINGLE EARPHONE with carbon microphone 40 ohms, 8/6 each.

Any **TRANSFORMERS** made to order within 7 days from date of order. Please ask for quote. Numerous other items in stock. Please ask for quotation.

MAINS TRANSFORMERS. 110/250 volt input, 300/0/300 volt 70/80 M/amps, 12 volt 1A, 4 volt 2A. Useful for Wireless, Model Trains, Chargers, etc., or as an 80-watt Auto Transformer 110/250 volts. 10/9 each. Guaranteed.

Clients In Eire and Northern Ireland, please ask for quotation as to carriage charges. The above charges only apply to England.

SPLENDID ODD BARGAINS FOR VISITORS

OPEN ALL DAY SATURDAY

PLEASE PRINT YOUR NAME AND ADDRESS

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. WW47, London, W.4. [0006

TUITION

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 128. [0172

WIRELESS operating: attendance and postal courses.—Stamp for reply to Manager, The Wireless School, Manor Gdns., London, N.7. [0104

FULL-TIME courses for P.M.G. Certs., C.G.L.I., Telecommunications, Radar Maintenance Cert. and B.Sc.(Eng.); prospectus free. —Technical College, Hull. [0111

WIRELESS.—See the world as a radio officer in the Merchant Navy; short training period; low fees; scholarships, etc., available; boarding and day students; stamp for prospectus.—Wireless College, Colwyn Bay [0018

A.M.I.Mech.E., A.M.Brit.I.R.E., City and Guilds, etc., on "No Pass—No Fee" terms; over 95% successes—or details of Exams and courses in all branches of Engineering, Building, etc., write for 144-page Handbook—Free: B.I.E.T. (Dept. 387B), 29, Wright's Lane, London, W.8. [0118

T/V & Radio.—A.M.Brit.I.R.E., City & Guilds, R.T.E.B. Cert., etc., on "No-Pass—No Fee" terms; over 95% successes—Details of Exams. and Home Training Courses in all branches of Radio and T/V, write for 144-page Handbook—Free, B.I.E.T. (Dept. 397A), 29, Wright's Lane, London, W.8. [0116

THE Institute of Practical Radio Engineers have available home study courses in every phase of radio and television engineering, specialising in the practical training of apprentices in the retail trade, enrolments limited, fees moderate.—The Syllabus of Instructional Text may be obtained post free from the Secretary, I.P.R.E., Fairfield House, 20, Fairfield Rd., Crouch End, London, N.8. [0088

FREE! Brochure giving details of home study training in radio, television, and all branches of electronics; courses for the hobby enthusiast, or for those aiming at the A.M.Brit.I.R.E., City and Guilds, R.T.E.B., and other professional examinations; train with the college operated by Britain's largest electronics organization; moderate fees.—Write to E.M.I. Institutes, Dept. WW28, London, W.4. [0179

WIRELESS telegraphy.—Merchant Navy offers to youths 16 upwards after qualification, lucrative positions as radio officers.—Apply British School of Telegraphy, 179, Clapham Rd., S.W.9. (Est. 1906.) Recognised by Ministry of Education, moderate fees, modern equipment, day and evening tuition; also postal courses in theory of wireless telegraphy for P.M.G. Certs. and Amateur Transmitting Licence. [0124

BOOKS, INSTRUCTIONS, ETC.

SALE "Wireless Worlds," 1946-1955, 4 missing; "Electronic Engineering," 1947-1955, 4 missing: first £10 secures.—Harrow 7851 or Box 2650. [6126

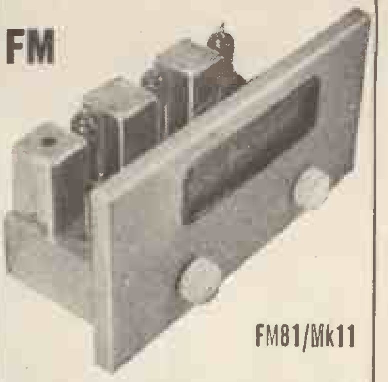
I.P.R.E. technical publications, 5,500 Alignment Peaks for Superheterodynes, 5/9, post free, data for constructing TV aerial strength meter 7/6, sample copy "The Practical Radio Engineer," quarterly publication of the Institute 2/-; membership and examination data, 1/-.—Sec., I.P.R.E. 20, Fairfield Rd., London, N.8. [0089

"DEVELOPMENT of the Guided Missile." 2nd Ed. By Kenneth W. Gatland, F.R.A.S. Presents all the main information now available on the development of guided weapons in Britain, U.S.A., Germany, U.S.S.R., and elsewhere. Other chapters discuss guided missiles as instruments of research into the upper atmosphere and outer space, and as vehicles of interplanetary travel. An appendix shows the characteristics of 130 powered missiles known to have been designed or constructed, 15/- net from all booksellers. By post 16/1 from Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1.

"TELEVISION Engineering: Principles and Practice." Volume I: Fundamentals. Camera Tubes, Television Optics, Electron Optics. A B.B.C. Engineering Training Manual, by S. W. Amos, B.Sc. (Hons.), A.M.I.E.E., and D. C. Birkinshaw, M.B.E., M.A., M.I.E.E., in collaboration with J. L. Bliss, A.M.I.E.E. This is the first volume of a comprehensive work on the fundamentals of television theory and practice written primarily for the instruction of B.B.C. engineering staff. Covers basic theory of the signal, all types of modern camera tubes, theory of light, mirrors and lenses as applied to television, and electron lenses. 30/- net from all booksellers. By post 31/2. Volume II: Video-Frequency Amplification. This volume describes the fundamental principles of video-frequency amplifiers and examines the factors which limit their performance at the extremes of the passband. A wide variety of circuits is described and particular attention is paid to the use of feedback. There is a section dealing with the special problems of camera-head amplifiers. 35/- net from all booksellers By post 36/2 from Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1.

—TUNERS—

FM



FM81/Mk11

F.M. V.H.F. TUNER completely stable drift free tuning. Volume control. Tuning indicator. A.V.C. Sensitivity better than 4 μV for 20 db quieting. 21 gns. Tax paid.

AM

S6BS

A.M. 9 band all wave tuner. 13 m.-570 m. Band spread, variable selectivity. Tuning indicator. Logging scale, delayed amplified A.V.C. Tropicalised. Sensitivity better than 2 μV for 250 m/v output £46/4/- tax paid.

FM/AM

S5/FM

FM/AM World Wide A.M. in 2 ranges. S5E/FM: 12.5 m.-37 m.; 35 m.-100 m.; 90 m.-250 m.; 190 m.-250.
S5/FM: 16 m.-50 m.; 195 m.-550 m.; 800-2,000 m. Sensitivity better than 10 μV on all ranges. PLUS completely stable drift free VHF.FM. Sensitivity better than 8 μV for 20 db quieting. Tuning indicator on all bands AM and FM. £34/2/6 tax paid.

All tuners suitable for modern high quality amplifiers. Most tuners available with Escutcheons in Gold, Silver or Bronze.

C. T. CHAPMAN (Reproducers) LTD

RILEY WORKS, RILEY STREET, CHELSEA, S.W.10

FLAxman 4577/8

Export Enquiries Invited

L/P THE RECORD LIBRARY

Because of Staff Holidays we shall not be open for changing records from August 25th until Sept. 1st.

OFFERS A UNIQUE LIBRARY SERVICE TO THE CLASSICAL L/P ENTHUSIAST

REMEMBER !

- Subscription includes postage and packing this end.
- Return of Post Changing Service.
- Special arrangements for members interested in new issues.
- Our completely comprehensive catalogue is currently extended to include virtually every recommended L/P issued.

For full details send S.A.E. to :—

IT COSTS AS LITTLE AS 1/- PER WEEK EACH L/P BORROWED

AND . . .

- We can supply a brand-new (guaranteed unplayed) factory fresh copy of any available L/P to order N.B. (except H.M.V.). With each purchase goes a POST FREE change of Library records.
- Many of the LIBRARY COPIES are themselves marked down for sale at most reasonable second-hand prices. (Surely the ideal way to buy a "used" record is to hear it first!)

The L/P Record Library, Squires Gate, Station Approach, Blackpool, Lancs.

L/P THE RECORD LIBRARY

L/P THE RECORD LIBRARY

BOOKS, INSTRUCTIONS, ETC.

"RADIO Interference Suppression: As Applied to Radio and Television Reception." By G. L. Stephens, A.M.I.E.E. 2nd Ed. An up-to-date guide to the various methods of suppressing electrical interference with radio and television reception. Many practical applications are given, particular attention being paid to the problem of interference at television frequencies. Other chapters deal with the design and choice of suppressor components, methods of locating the source of interference, and suppression at the receiver itself. 10/6 net from all booksellers. By post 11/1 from Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1.

High Fidelity Amplifiers and Pre-amplifier tone compensation units

Write for details to:

GOODSELL LTD.

40 Gardner Street Brighton I Sussex
Tel.: Brighton 26735

MORSE CODE Training

COURSES for BEGINNERS and OPERATORS, also a SPECIAL COURSE for passing the G.P.O. Morse Test for securing an AMATEUR'S TRANSMITTING LICENCE

Send for the Candler BOOK OF FACTS

It gives details of all courses.

Fees are reasonable.

Terms: Cash or Monthly Payments

THE CANDLER SYSTEM CO.
(55W) 52b ABINGDON ROAD, LONDON, W.8
Candler System Co., Denver, Colorado, U.S.A.

WANTED

B.C. 312
B.C. 342

Receivers. We will pay

£28

each for sets in good condition.

P.C.A. Radio,
Beavor Lane, Hammersmith, W.6
RIVerside 8006

METER REPAIRS

All types - Any make

Single and Multi-range repaired and recalibrated

Meters converted and re-scaled
PHONE FOR IMMEDIATE SERVICE
E.I.R. INSTRUMENTS LTD
329 Kilburn Lane, London, W.9
Tel.: LADbroke 4168

Brenell TAPE RECORDER

Has every worthwhile feature at a price you can afford

Literature free from:—

BRENELL ENGINEERING CO. LTD.
2 Northington Street, London, W.C.1

Engineer-mechanic (electrical) required at South-East London Technical College, Lewisham Way, S.E.4. Experience in the Telecommunications industry an advantage. Facilities for further education. Rate of pay £10.10.10 for 44hr. week. Further particulars and application forms (returnable within 14 days) from the Secretary. (1174)

An important Company engaged in the design and development of major guided weapon projects require an Executive Assistant for Administrative duties. The successful candidate must be trained in electronic or electrical engineering and the qualifications should include a University Degree or similar standard of attainment in the Services, and in addition workshop experience would be an advantage.

Applicants should be proficient in administration and be familiar with committee and associated office procedure. Their age should not be less than 30, although consideration would be given to an applicant below this limit in exceptional circumstances.

This is a responsible position and will carry an attractive salary and excellent prospects.

Pleasant working conditions and amenities are provided and a generous pension scheme is in operation.

Replies will be treated in the strictest confidence and should be addressed to:—

T.A.O. Box No. 2765.

Quoting reference: Comp/3.

THE POLYTECHNIC
309 REGENT STREET, W.1.

Electrical Engineering Department

Head of Department: D. O. Bishop, Ph.D., M.I.E.E.

FULL-TIME DAY COURSES are held for a Diploma in Electrical Engineering (Power and Telecommunications) extending over a period of three to four years. Courses are also held for the B.Sc. (Eng.) Degree of the University of London (External).

Session 1956-1957 begins on September 18th, 1956.

EVENING COURSES in the above subjects and also in Radio and Television Service Work commence on Monday September 24th. The courses prepare for the Ordinary and Higher National Certificates and for the City and Guilds of London Institute examinations. New students will be enrolled on September 19th, 5-8 p.m.

Prospectuses may be obtained on application to the DIRECTOR OF EDUCATION.

Philips Balham Works Ltd.
45 Nightingale Lane,
Balham, S.W.12.

require

TEST ENGINEERS

for nucleonic monitors and electronic apparatus; H.N.C. or equivalent qualification is desirable, but a good history in radio, television or allied work would be considered.

Prospects of advancement are good.

Write giving full details to the

Personnel Officer,
or telephone Battersea 8521 for appointment.

A. V. ROE & CO. LTD.

WEAPONS RESEARCH DIVISION
WOODFORD, CHESHIRE

have vacancies in their Trials Department for the following:—

1. Senior Electronic Engineers to lead groups on design and development of telemetry and monitoring equipment.
2. Technicians to form the above groups.
3. Electronic Design Engineers to co-ordinate design and development of prototype equipment.
4. Technicians experienced in light electro-mechanical engineering.

Applicants for the senior posts should possess associate membership of the I.E.E. or Brit. I.R.E., H.N.C. or equivalent, with general electronic experience. Knowledge of missile telemetry and monitoring systems is desirable but not essential.

Applicants should write to the Chief Engineer, Weapons Research Division, A. V. Roe & Co., Limited, Woodford, Cheshire.

RANK PRECISION INDUSTRIES (B.A.F.) LTD.

have vacancies for

EXPERIENCED INSPECTORS in ELECTRICAL AND MECHANICAL TEST DEPARTMENTS.

H.N.C. (Mech.) or (Elect.) Engineering an advantage. Permanent and pensionable appointments. Five-day week Sports and Social Club. Applications in writing stating age, experience and qualifications to, or call for interview,

PERSONNEL MANAGER,
RANK PRECISION INDUSTRIES (B.A.F.) LIMITED,
Woodger Road, W.12.

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.

ARMAMENTS DIVISION

SENIOR ELECTRONIC AND ELECTRICAL ENGINEERS

A number of Senior Engineers both Electronic and Electrical are required for work associated with the flight trials of guided weapons.

The work is of a very varied and interesting character and includes system testing and the analysis of the behaviour of complex installations including mechanical and hydraulic components, in addition to electronic and electrical components.

A number of years' experience in electronic and/or electrical engineering is essential for these positions, and service experience of radar, radio and telecommunications is a very suitable qualification.

A university degree is not essential for these positions but practical experience and experience of experimental work is highly desirable.

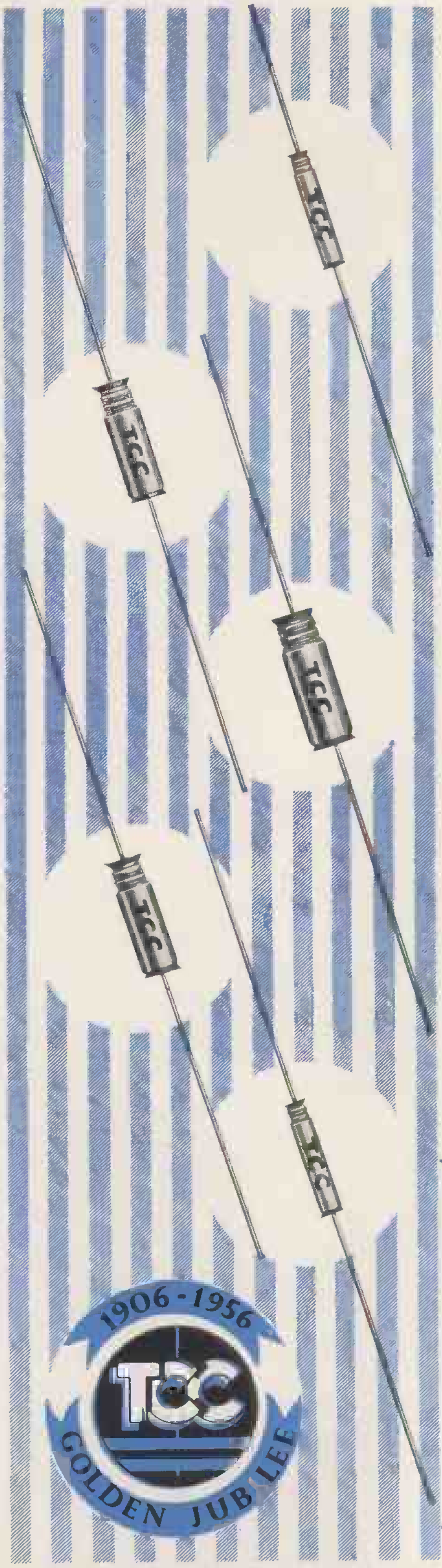
These positions are responsible posts and carry attractive salaries and excellent prospects.

Pleasant working conditions and amenities are provided and an attractive superannuation scheme is in operation.

All replies should be addressed to: Technical Appointments Officer, Sir W. G. Armstrong Whitworth Aircraft Ltd., Baginton, Nr. Coventry. Quoting reference FT/91/ARM/TAO.

INDEX TO ADVERTISERS

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford St., London, S.E.1, by CORNWALL PRESS LTD., Paris Garden, London, S.E.1. *Wireless World* can be obtained abroad from the following: AUSTRALIA AND NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd., William Dawson & Sons (S.A.), Ltd. UNITED STATES: The International News Co.



T.C.C.

SUB-MINIATURE ELECTROLYTICS

for transistor circuitry

The introduction of transistors has created fresh impetus to the design of ancillary components of comparably small dimensions. For this purpose we have produced a range of Sub-Miniature Electrolytic Condensers, which we believe to be the smallest of their type ever made. These diminutive condensers are equally suitable for use in miniature walkie-talkie equipment, hearing aids, and similar assemblies where every component is scaled down to the absolute minimum physical size.

Terminations: these condensers are supplied with tinned copper wires, $1\frac{1}{2}''$ long.

Temperature range is —30°C. to +60°C.

Tolerance of capacity —25% to +50%.

Capacity in μF.	Peak Working Volts	Dimensions in inches		T.C.C. Type Number
		Length	Diameter	
6	1·5	$\frac{5}{8}''$	$\frac{1}{8}''$	CE58
4	4	$\frac{5}{8}''$	$\frac{1}{8}''$	CE58AA
2	8	$\frac{5}{8}''$	$\frac{1}{8}''$	CE58A
1	12	$\frac{5}{8}''$	$\frac{1}{8}''$	CE58B
0·25	25	$\frac{5}{8}''$	$\frac{1}{8}''$	CE58C
6	3	$\frac{9}{16}''$	·18	CE68AA
10	3	$\frac{9}{16}''$	·18	CE68AA
1	25	$\frac{9}{16}''$	·18	CE68C
8	6	$\frac{11}{16}''$	·2	CE69A
4	12	$\frac{11}{16}''$	·2	CE69B
32	1·5	$\frac{11}{16}''$	$\frac{1}{4}''$	CE67
8	15	$\frac{11}{16}''$	$\frac{1}{4}''$	CE67B

T.C.C. *Patent Nos. 578487, 578509, 587072.*

THE TELEGRAPH CONDENSER CO. LTD

RADIO DIVISION · NORTH ACTON · LONDON · W.3 · *Tel: ACOrn 0061*