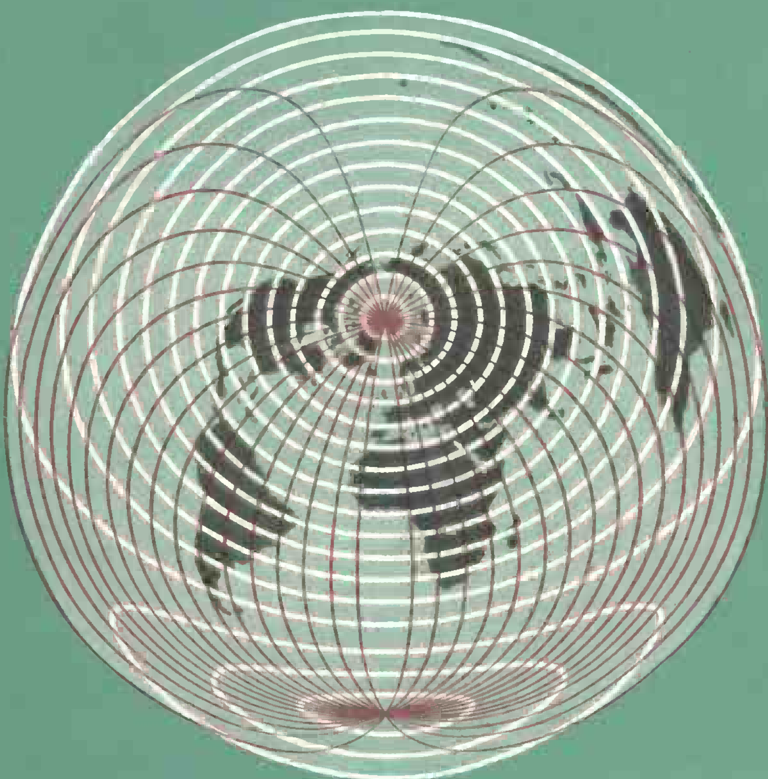
NOVEMBER 1956

TWO SHILLINGS

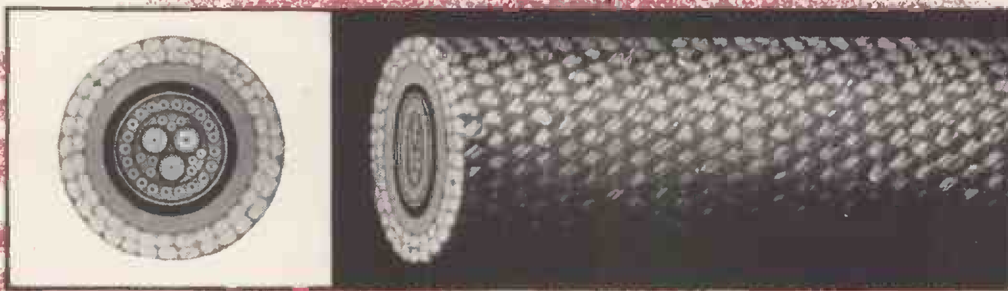
Wireless World

ELECTRONICS

Radio · Television



FORTY-SIXTH YEAR OF PUBLICATION



This cable carries weight

BICC Combined Camera Cable and Lifting Rope for underwater use.

This special multicore T/V camera cable is also used as a rope. It contains all the necessary electrical circuits, and supports the full weight of the underwater T/V Camera by means of an overall hemp loom braid. It was designed and manufactured by BICC to meet the requirements of Messrs. Pye Ltd.

During recent trials the camera was repeatedly lowered and operated by this cable. Depths of 83 fathoms were reached and clear pictures obtained. Throughout the trials the cable was subjected to many severe tests. ★ ALL CIRCUITS REMAINED INTACT.

BICC ARE ALWAYS PREPARED TO DESIGN AND MANUFACTURE CABLES TO MEET SPECIAL REQUIREMENTS.

★ *It withstood a 2½ cwt. shock drop of 20ft. out of water; towed the camera at speeds up to 12 knots; raised and lowered the camera at 250ft. per minute over narrow diameter pulleys and capstan.*

Subsequent examination proved the cable and coupling to be completely waterproof, resistant to twisting and electrically intact.

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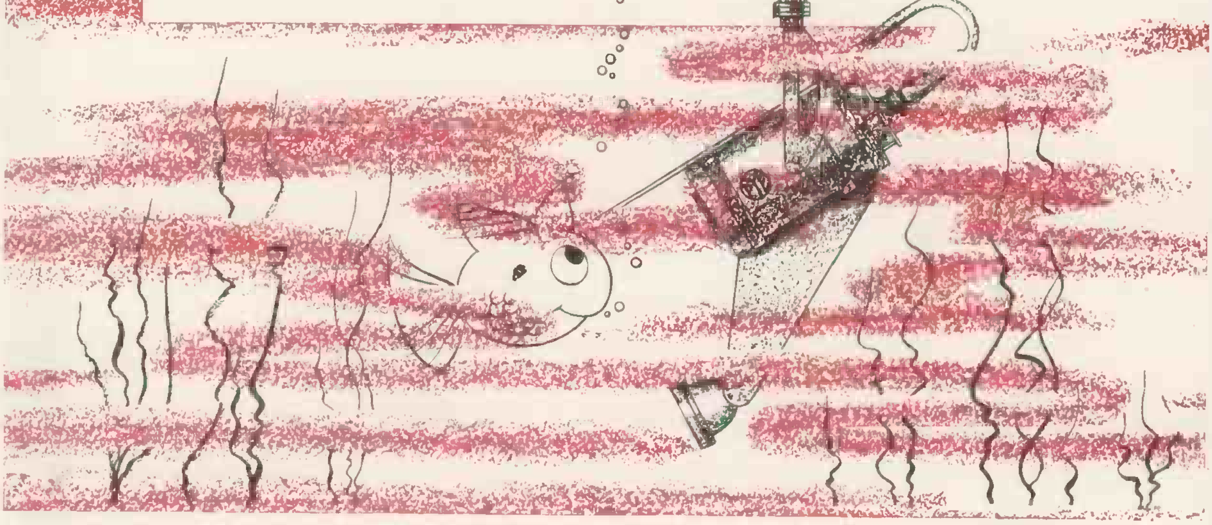

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Wireless World

ELECTRONICS, RADIO, TELEVISION

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NOVEMBER 1956

In This Issue

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FORTY-SIXTH YEAR
OF PUBLICATION

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D

Transistor High Gain Preamplifier

A high gain transistor preamplifier is described which uses a single OC70 in grounded emitter connection. The supply voltage is 250V and the load more than 330kΩ. The basic circuit arrangement is shown at 'A'.

The preamplifier has distinct advantages over a thermionic valve preamplifier. First, two valves would be required to get comparable gain. Second, thermal noise is sufficiently low for it to approach that of a valve circuit, and the transistor preamplifier is of course completely free from hum and microphony. The current drain is low, about 0.7mA from the 250V supply.

This preamplifier has comparatively high output impedance and best results are obtained when it is fed into the high input impedance of a thermionic valve amplifier. It can be used with low impedance microphones, pickups and tape heads. For a nominal circuit, with an input voltage of 5.5mV and a gain of about 330, the output voltage is about 1.8V. The input impedance at X-X is 200Ω and the output impedance at Y-Y is of the order of 5kΩ. The frequency response depends to a certain extent on the source impedance. With a 50Ω source a 3dB reduction in gain is reached at 15c/s and 12kc/s.

Although designed for a 250V supply voltage the preamplifier operates usefully with supply voltages down to as little as 100V. It can be used successfully with a 30Ω/50Ω microphone and a 100V supply coming from a valve amplifier into which it feeds.

The preamplifier can be fed from the same supply as a valve amplifier by rearranging the circuit as at 'B'. In the setup shown at 'B' one side of the output is earthed, whereas in 'A' the input and output are 'floating' at some voltage above the chassis. The input is fed between base and emitter through R1 and C1 so that R5 does not contribute a.c. negative feedback but forms part of the load. The output in 'A' can be taken from between C2 and chassis if desired, but it then becomes slightly smaller than when taken from C2-C3, because R5 no longer forms part of the load. Although the input terminals in both 'A' and 'B' are 'floating', there should be no risk of hum being introduced provided the preamplifier is mounted reasonably close to the microphone or pickup.

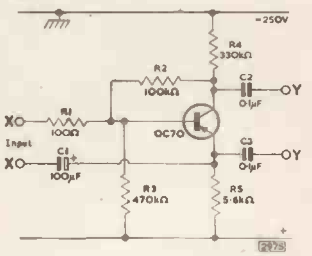
If the circuit is used in arrangement 'A' care must be taken not to short the input terminals to earth. In the arrangement shown at 'B' the current through the pickup or microphone will not be excessive if the input is accidentally shorted to earth.

High voltage gain is obtained from a transistor in the same way as for a pentode valve, by operating it with a high load and feeding from a high supply voltage. In both 'A' and 'B' sufficient d.c. stabilisation is provided by the potential divider R2-R3 and emitter resistor R5 to ensure satisfactory operation up to an ambient temperature of 45°C (110°F). Besides the d.c. feedback provided by R2, R3 and R5, there is an a.c. feedback path formed by R2, R1 and the source impedance, all in series. Part of the a.c. voltage developed across this potential divider is tapped off and fed back into the base. By including a 100Ω resistor R1 in the a.c. feedback path, effective feedback is ensured even when the source impedance is very small. Apart from improving the frequency response and reducing distortion, the a.c. negative feedback decreases the input and output impedances. If thought desirable a.c. feedback can be prevented by making R2 up of two nearly equal resistances and bypassing the common point to ground by a suitable capacitance, of the order of 0.5μF.

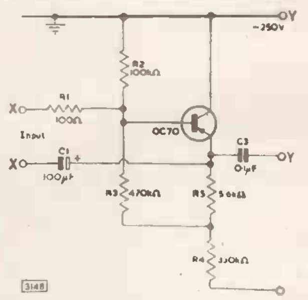
Even with a supply voltage of 250V the circuit is so designed that the collector to emitter voltage never exceeds the d.c. voltage rating of $V_c$max = – 5V for the OC70 under the worst possible combination of conditions. The effect of resistance tolerances, supply tolerances, change of ambient temperature, and spread in transistor characteristics have all been considered in the design. In order to keep available the maximum voltage across the transistor, while allowing a tolerance of ±10% on the supply voltage, the resistor tolerances must be within ±5% to prevent the 5V rating from being exceeded. High stability resistors should be used. For a nominal circuit the collector current is 0.7mA and the collector to emitter voltage approximately 4V. An OC70 with a low current amplification factor a' and low leakage current $I'_{c(o)}$ in grounded emitter causes the highest collector to emitter voltage of 5V. A transistor at the other extreme gives a collector to emitter voltage of about 0.8V at the maximum ambient temperature of 45°C, and allows an output of about 400mV (r.m.s.).

If resistors of ±10% tolerance are used, the collector to emitter voltage should be metered to ensure that it does not exceed 5V. The performance is the same as for resistor tolerances of ±5% except that possibly less collector voltage swing will be available if all the resistors have their lowest extreme value.

A



B



The circuit is similar to that described by James J. Davidson in an article called 'High Gain Transistor Amplifier,' published in Audio, *October 1955.*

Mullard

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MVM 368

Wireless World

NOVEMBER 1956

Vol. 62 No. 11

625 Lines Again

IN the August issue of *Wireless World* we printed an article comparing, in the simplest possible terms, the picture quality offered by the various television systems that have been adopted in different parts of the world. The 625-line came out rather badly from that comparison, the conclusion being that better value could be obtained for the bandwidth employed. Before that article was published there was a body of opinion strongly in favour of adopting the continental standards for the projected British colour service. Since then, enthusiasm for 625 lines has waned notably.

However, there are still those who consider the benefits of standardization outweigh other considerations. Among these is Sir Robert Renwick, who again writes in our correspondence columns this month to urge the advantages of 625 lines in the interests of the export trade.

Is it possible to reach a compromise that will satisfy the requirements of standardization and at the same time overcome the technical shortcomings of the normal continental system? Such a compromise might quite easily be reached by modifying the standard 625-line system by widening the video bandwidth by about 1 Mc/s. That would provide for a picture of sensibly equal horizontal and vertical definition and the slight deviation from complete standardization should be no great embarrassment to the export trade. If we are in fact to have colour television incompatible with the present service, can we do better than tentatively adopt these modified 625-line standards?

We say "tentatively" because these discussions of definition standards for colour television seem to become more and more unrealistic as one considers the other and far more pressing problems that have to be tackled before practical receivers can be produced at an economic price. These problems were frankly discussed at the official opening of the Sylvania-Thorn colour television laboratories at Enfield on October 3rd. The spokesman of both the American and British companies co-operating in this new enterprise expressed open dissatisfaction with colour techniques as they exist today, and the opinion was expressed that an entirely new system was needed.

A new series of colour test transmissions by both the B.B.C and I.T.A. was announced recently, and it was stated that these would be on both 405 and 625 lines. This seems to offer an opportunity for trying the wide-band 625-line modification to which we have referred.

Power by Radio

THE centenary of the birth of Nikola Tesla is being celebrated this year in his native Yugoslavia and in the United States, his adopted country. Tesla made many important contributions to electrical engineering; in radio, he is mainly remembered for his attempts to transmit power by wireless. Looking back, it is safe to say he would have achieved greater success by concentrating his efforts on the substance of radio communication instead of on the shadow of power transmission. After more than half a century, that objective is still almost as far from attainment as in Tesla's day.

But the modest power requirements of the transistor have made us change our ideas as to what is worth while in the way of power transmission. Very opportunely coinciding with the Tesla centenary comes an article in an American journal* on the use of radio-transmitted power for the operation of transistorized receivers, navigational aids and other electronic equipment. Though important practical applications of the idea do not readily come to mind, it is of some academic interest.

For its simplest application "free power", as Dr. Hollmann calls it, is obtained by rectifying the carrier of a nearby broadcasting station with a crystal diode. The rectified and filtered output is then fed to transistors, which amplify and detect the signals of more distant stations.

A still more intriguing possibility is to make the wanted station supply the power for amplifying its own signals. At first sight that sounds impossible, but Dr. Hollmann claims that a receiver working in that way does in fact give a performance superior to that of a plain non-amplifying crystal set. The explanation he gives is that the plain crystal receiver derives its output power from the modulation envelope only; the carrier energy is wasted. In the amplifying receiver, on the other hand, the carrier is rectified to provide power for the amplifier, and so a greater output is obtainable.

* "Free Power Receivers" by H. E. Hollmann; *Electronic Industries, Sept.* 1956.

Personal Paging System

SELECTIVE INDUCTION METHOD

THE advantages offered by transistors in the design of small, lightweight equipment of low power consumption are particularly well emphasized by the new selective paging system recently installed at St. Thomas's Hospital, London. Here each member of the staff on call is equipped with a small transistor "receiver" which clips into a top pocket like a fountain pen (Fig. 1). It measures 5$\frac{3}{8}$in long by 1in diameter and weighs only 5oz. The current consumption from the 1·35-V mercury cell is only 0·5mA in the quiescent condition (the receiver being permanently switched on) and 3mA when a call is being received, and this is reckoned to give a cell life of over two months.

Developed by Multitone in collaboration with St. Thomas's, the paging system works on the magnetic induction principle. A single loop of wire round the building carries audio frequency signals from a 70-watt amplifier and the magnetic field so generated is picked up in each "receiver" by a small coil with a laminated core (see Fig. 2). The system is made selective by assigning to each "receiver" a particular audio frequency which is transmitted as a call signal. There are 56 of these frequencies available altogether, in the range of 2-15 kc/s, and each "receiver" selects its own frequency by means of a high-Q tuned circuit. Reception of the call signal changes the bias of a local transistor a.f. oscillator, which emits an audible 1,000-c/s note through a miniature telephone earpiece in the "cap" of the "fountain pen."

In the transmitting equipment (Fig. 3) each call frequency is selected by pressing a combination of buttons. This operation also causes the signal to be automatically coded, by a gating pulse generator, into a pattern of marks and spaces which means something to the recipient at the other end when he hears the resulting bursts of 1,000-c/s tone. The duration of the call signal is also determined automatically. Usually the code signal means "go to the nearest telephone to receive a message." The equipment is, however, capable of conveying speech signals in addition to the code signals Here, a code signal is transmitted first which means "prepare to receive speech." The recipient then presses a button on the side of the "pen," which puts the high-Q selector circuit out of action (and also the 1,000-c/s oscillator), and he places the instrument near to his ear.

At the transmitter a "speech" key is operated which takes out of circuit the pulse generator producing the code sequences and switches in a crystal microphone and amplifier. The tendency for the speech signals (which, of course, cover a wide band) to trigger the selector tuned circuits of other "receivers" is avoided by transmitting the speech

Fig. 3. The transmitting equipment and control panel.

Fig. 1. The "receiver" clipped into a top pocket.

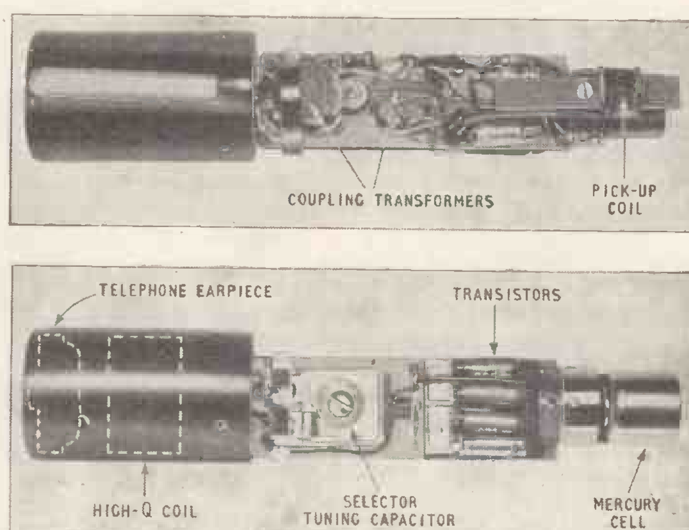


Fig. 2. Interior views of the receiver with the tubular housing removed.

on lower power. This occurs automatically because the loop is tuned for the individual code signal frequencies but not for speech.

The construction of the "fountain pen" receiver can be seen from Fig. 2. At the bottom end is the mercury cell, then the pick-up coil and the 3-stage transistor circuit which amplifies the induced currents. Transformer coupling is used between stages and all components are miniature types except the trimmer capacitor for tuning the high-Q selector circuit. The coil for this tuned circuit is enclosed in a ferrite "pot" core, built into the "cap" of the "fountain pen," and has a Q of about 30.

"A Restrictive Practice?"

UNDER this heading in our January, 1954, issue we announced that the question of the supply of valves and cathode-ray tubes was to come under the scrutiny of the Monopolies and Restrictive Practices Commission. It was stated in the official communiqué that the Commission was to "report about both the facts of the matter, and their bearing on the public interest."

In August this year, however, it was announced that the Commission's findings "are now to be a factual report only." All such reports must, of course, be factual, but the significance of this phrase is that it will describe the industry's arrangements, but will not give any views on whether or not they are in the public interest.

The report was received by the Board of Trade on September 17th, and "will be published in due course."

On October 4th the British Radio Valve Manufacturers' Association (B.V.A.)* issued a statement, which we quote in full below, announcing changes in the constitution and trading practices of the Association having effect from September 1st.

"It will be known that the Association abandoned its 'stop list' and allied provisions some years ago and it has now discontinued all arrangements for collective resale price maintenance on the part of the manufacturers. This has been made necessary by the Restrictive Trade Practices Act which, in effect, prohibits this practice. It will in future be for each individual manufacturer to maintain the prices of his own valves and tubes if he so desires.

"Hitherto 'B.V.A. Prices' have been fixed by agreement of all manufacturers who are members of the Association. This policy has also been abandoned. From knowledge of the structure of the industry, however, and in view of the present period of recession with continually rising costs, it will be appreciated that although prices are no longer to be fixed by agreement it does not follow that the prices of comparable valves and tubes will necessarily vary between one manufacturer and another in the immediate future.

"In coming to the decision to abandon collective fixing of prices, the Association has had in mind that if this practice were to be continued it would in all probability have to be justified in the very near future before the Restrictive Trade Practices Court in the light of the narrow economic criteria set out in the Act. The practice of fixing prices by agreement is not in the present state of the industry of the same degree of importance as it has been in the past or as it may well be in the future.

"Apart from the foregoing the Association is continuing its general policy in the interests of the public, the trade and the industry itself, including its vast field of technical collaboration between the manufacturers, with the Services and in international fields."

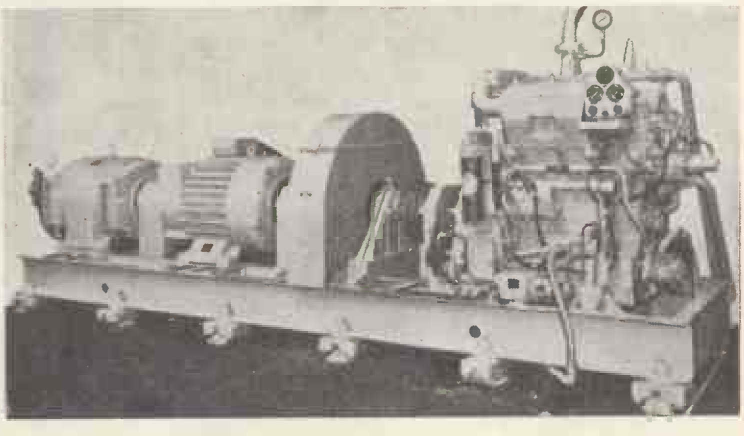
* Members of the B.V.A. are: Cossor, Edison-Swan, Ever Ready, Ferranti, G.E.C., Marconiphone, Mullard, Philips and S.T.C.

Continuity of Power Supply

Bridging the Gap Between Mains Failure and the Connection of an Auxiliary Source

IN all essential services normally dependent on power from the public electricity supply, it is customary to have a standby source available for use in case of failure of the mains. This may be a bank of storage batteries or an auxiliary generating plant, but in either case there will be a break in the supply while automatic changeover switches are tripped or the engine is started and run up to speed.

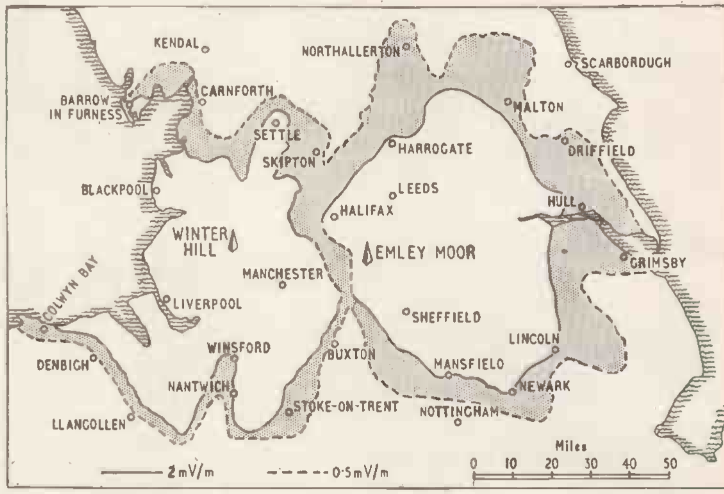
To overcome these difficulties a motor-generator power plant developed by Standard Telephones and Cables in conjunction with Pelapone Engines, Ltd., of Derby, incorporates a heavy flywheel which stores enough kinetic energy not only to start a standby diesel engine but also to drive the loaded a.c. generator until the engine has developed full power. A magnetically operated clutch between flywheel and engine is arranged to engage when the external power supply is interrupted.



"No break" power plant for telecommunication systems. Rated output 55kVA.

WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News



NORTHERN service area of the I.T.A. when Emley Moor joins Winter Hill in November.

I.T.A. Progress

THE fourth I.T.A. transmitter (on Emley Moor, near Huddersfield, Yorks.) opens on November 3rd—within 14 months of the opening of the Authority's first station.

It will use a directional aerial, vertically polarized, with an e.r.p. varying from 10 to 200 kW—the flat side of the polar diagram being towards the Pennines to avoid undue overlapping of the service areas of the two northern transmitters. It will operate in Channel 10 (199.75 Mc/s vision, 196.25 Mc/s sound).

It is hoped that it will be possible to transmit trade tests on high power for about a week before programmes begin. The present low-power pilot transmissions will continue to be broadcast daily, except on Sundays, until then.

V.H.F. Receiver Response

READERS in south-east England interested in knowing the frequency response of their v.h.f. sound receivers will be pleased to learn that the B.B.C. has introduced standard-frequency test transmissions from Wrotham. They are being radiated each Thursday afternoon from 4.45 until 5.10 by the Third Programme transmitter (91.3 Mc/s). The B.B.C. hopes to maintain the level of tone accuracy within about ± 1 dB after allowing for 50-μsec pre-emphasis and de-emphasis. The depth of modulation, excluding pre-emphasis, is 30 per cent, with the exception of the frequency marked with an asterisk which is 100 per cent.

The schedule is:—1645-1646, plain carrier; 1646-1648 1kc/s*; 1648-1650, 1kc/s; 1650-1653, half-minute transmissions of each of the following frequencies 50, 100, 440, 1,000, 5,000 and 10,000 c/s; 1653-1703, plain carrier; 1703-1710, as from 1646-1653.

B.S.R.A. Show

THE 1957 convention and exhibition of the British Sound Recording Association will be held in the autumn (September 20th-22nd), instead of in the spring as in previous years, and will again be at the Waldorf Hotel, Aldwych, London, W.C.2.

The Exhibition, which will be similar in general character to the eight previous shows organized by the Association, will emphasize the technical and engineering aspect of the equipment to be shown.

In addition to providing individual demonstration rooms for exhibitors, there will also be a communal demonstration hall.

"Importing an Instrument"

SINCE the publication of A. J. Reynolds' article under this heading in the October issue the Board of Trade has issued a revised form of application for the Duty Free Licence, which makes that part of the article referring to these licences meaningless.

The new form is in effect designed to make life so difficult for the applicant that he gives up the struggle and pays the duty. Question 8, for example, asks for copies of all correspondence with U.K. manufacturers during the search for an alternative.

Question 9 asks for the precise grounds on which exemption from duty is claimed, and, if superiority of performance is claimed, demands supporting evidence (in duplicate!) which "may be referred to the British manufacturers for their observations."

The new official attitude goes so far as to refuse duty-free importation of spares for instruments already in the country (and imported duty free) if a "similar" British instrument is now available.

PERSONALITIES

Sir Stanley Angwin, K.B.E., has retired from the chairmanship of the Commonwealth Telecommunications Board which he has held since 1951, and was succeeded on October 1st by **Sir Ben Barnett**, K.B.E., who recently retired from the Post Office where he was deputy director-general. Sir Stanley, who is 73, was Post Office engineer-in-chief from 1939 until his resignation in 1946 on his appointment as chairman of Cable and Wireless, which he relinquished on joining the Commonwealth Telecommunications Board. He was chairman of the Radio Research Board from 1947 to 1952 and a year later was awarded the Faraday Medal by the I.E.E.

Sir Lawrence Bragg, F.R.S., a director of the Davy Faraday Laboratory of the Royal Institution, will give the third Clerk Maxwell memorial lecture during the 1957 convention on "Electronics in Automation" being organized by the Brit.I.R.E. The lecture will be given on the first day of the convention, June 27th, in the Cavendish Laboratory, Cambridge.

In recognition of "his contributions to the advancement of radio science, and in particular for his long series of notable editorial articles in *Wireless Engineer*," **Professor G. W. O. Howe**, D.Sc., LL.D., Wh.Sch., M.I.E.E., has been elected an honorary member of the British Institution of Radio Engineers. Having been professor of electrical engineering at Glasgow University for 25 years (1921-1946), it is fitting that the proposal for his election should come from the Scottish section of the institution. He becomes the 15th honorary member of the institution, and the fourth elected since the end of the war.

Dr. Balth. van der Pol is due to retire from the directorship of the International Radio Consultative Committee at the end of the year. At the recent C.C.I.R. plenary assembly in Warsaw, **Ernest Metzler**, head of the radio section of the Swiss P.T.T., was elected to succeed him. Dr. van der Pol was appointed director of the C.C.I.R. in 1948, and his term of office was extended by two years to cover the recent plenary assembly. In 1953 he was awarded the Valdemar Poulsen gold medal by the Danish Academy of Technical Sciences for his work on the propagation of radio waves both in theory and practice. Prior to joining the C.C.I.R. he was a member of the board of the Physics Laboratory of the Philips organization in Eindhoven, Holland.

H. E. M. Barlow, B.Sc.(Eng.), Ph.D., M.I.E.E., Pender Professor of Electrical Engineering at University College, London, has joined the editorial advisory board of our sister journal *Wireless Engineer*. Professor Barlow has been a member of the academic staff of the Faculty of Engineering, University College, since 1925. He joined the Telecommunications Research Establishment in 1939, and in 1943 was appointed superintendent of the radio department at R.A.E., Farnborough.

"For their work in originating and developing the Decca Navigator System" **William J. O'Brien** and **Harvey F. Schwarz** have jointly been awarded the Gold Medal of the Institute of Navigation. Mr. O'Brien conceived the system of hyperbolic phase-comparison navigation in the United States in 1938, and with the help of Mr. Schwarz, then of the Decca Record Company, arranged for demonstrations in this country which culminated in its operational use as a mine-sweeping aid in the D-Day landings. There are now Decca chains covering the whole of the British Isles and most of the Western European seaboard.

O. W. Humphreys, B.Sc., F.Inst.P., M.I.E.E., director of the G.E.C. Research Laboratories, Wembley, has been elected president of the Institute of Physics. He has been a vice-president since 1952 and has been chairman of the International Special Committee on Radio Interference (C.I.S.P.R.) for the past three years.

A. J. Brunker, B.Sc.(Eng.), A.C.G.I., D.I.C., A.M.I.E.E., chief engineer of E. K. Cole, Limited, which he joined in 1947, has been appointed an executive director of the company. Before joining Ekco he was at the Ministry of Supply where for several years he held the post of deputy director, radio production. Mr. Brunker is also a director and general manager of Ekco Electronics, Limited.

A. Berkovitch has been appointed manager of Philips' car radio department in place of **A. F. D. Knight**, who has now taken up another appointment within the company's television and radio division. Mr. Berkovitch, who was with Philips for a short time before the war, was for nine years in charge of telecommunications and transport with the International Police Force in Trieste.

J. M. Bedford, A.M.Brit.I.R.E., until recently chief engineer of the radio section of Igranic, Ltd., has joined the research and developing department of Parmeko, Ltd., manufacturers of transformers, transductors and magnetic amplifiers.

T. C. Isaac, who joined Ambassador Radio and Television, Limited, as chief engineer in 1953, has been appointed technical director of the company. Before joining Ambassador he was chief engineer of Mains Radio-Gramophones, of Bradford, the manufacturing company for Radio Rentals, Limited. **K. H. Yandell**, who joined Ambassador this year, has also been appointed to the board as sales director. He has previously been with Philco, Regentone and R.G.D.

C. G. Allen, who has been with McMichael Radio for over 33 years, has ceased to be a director and sales manager of the company. He hopes to retain a connection with the radio industry.

OUR AUTHORS

H. de Laistre Banting, who writes on the design of multi-standard television receivers in this issue, has been in charge of the television department of the Société Belge de Télécommunications in Brussels since 1954 where he has been concerned with the development of receivers for the Benelux countries. Before going to Belgium he was for several years in the research department of Murphy Radio, having previously been with Bush Radio which he joined in 1941.

J. D. Smith, author of the article on recording characteristics, graduated in 1950 at Bristol University with second class honours in physics. After two years graduate apprenticeship with the General Electric Company at their radio and television works, he joined the staff of the company's applied electronics laboratories. His interest in sound reproduction is purely a leisure-time pursuit.

P. Tharma, who describes a transistor receiver in this issue, joined the transistor section of Mullard's valve measurement and applications laboratory last year. He was educated at Ceylon Technical College where he received a B.Sc. honours degree in engineering in the external examination of the University of London. On coming to this country he received his telecommunications training with the G.P.O.

OBITUARY

As a result of a motoring accident, **Roland Harris Dunn**, B.Sc., A.M.I.E.E., head of an advanced development section of the Telephone Division of Standard Telephones and Cables, died on September 7th at the age of 49. After graduating at Manchester University he was for a short while with B.I. Callender's Cables before joining the engineering staff of S.T.C. in 1930. In recent years he has specialized in various branches of electronics with particular reference to telemetering.

Maurice C. Jones, A.M.I.E.E., general manager of Gardners Radio Limited, of Somerford, Christchurch, Hants, for the past ten years, died in August aged thirty-nine. Before joining Gardners he was in the Telecommunications Research Establishment at Langton Matravers and later at Malvern.

IN BRIEF

As was anticipated, **television licences** reached the six million mark during August. The month's increase was 64,820, bringing the total at the end of the year to 6,044,330. The total number of sound receiving licences at the end of the year was 8,038,062, including 307,082 for car radio. The overall total of broadcast receiving licences current in the United Kingdom at the end of August was, therefore, 14,389,474.

The date of the Radio Industry Council's proposed **Scottish Radio Show** has been announced. It will be held at the Kelvin Hall, Glasgow, from May 22nd to June 1st next year. Although this is the first show to be organized in Scotland by manufacturers since 1935, the Scottish Radio Retailers' Association has held two Glasgow shows since the war.

PRODUCTION LINE at Ferranti's new Manchester works where Pegasus (shown here) and Mercury computers are being manufactured in quantity.

London Computer Group has been formed to enable people with different professional interests to examine, through study groups, common problems in computer use. Membership is open to anyone with an interest in computers. The joint honorary secretaries are at 19A, Coleman Street, London, E.C.2 (Tel.: Monarch 7822).

An **electronic instruments exhibition** is being staged by E.M.I. Electronics, Ltd., at the Royal Hotel, Woburn Place, London, W.C.1, from November 28th to 30th. In addition to some one hundred instruments being shown and demonstrated, it is also proposed to show computers for machine tool control in operation. The exhibition will be open from 10 a.m. to 6 p.m., and admission is by ticket obtainable free on written application to E.M.I. Electronics, Ltd., Hayes, Middlesex.

Membership of the **Brit. I.R.E.** increased during the year ended March 31st by 310, bringing the total to 5,392.

The R.I.C. panel of judges, on which Arthur Clarkson (G.E.C.) recently replaced W. M. York (E. K. Cole), is considering articles already submitted for the 1956 **premiums for technical writing.** Articles should be submitted to the R.I.C., 59, Russell Square, London, W.C.1, before December 31st.

A short course of evening lectures on the **microwave behaviour of ferrites** begins on October 16th, at Sir John Cass College, Jewry Street, Aldgate, London, E.C.3. The fee for those residing in the administrative county of London is £1.

Two courses on transistors have been organized by the Borough Polytechnic, Borough Road, London, S.E.1. The first, covering basic principles, began on October 9th, and the second, on special applications, begins on January 15th. The lectures will be given in the afternoon and repeated in the evening. The fee for each ten-lecture course is 25s.

Demonstrations of "hi-fi" equipment and stereophonic tapes are being given by Classic Electrical Co., Ltd., at the Croydon Civic Hall on November 26th and 27th. On the first day demonstrations will be given from 1.0-2.0, 6.30-8.0 and 8.30-10.30, and on the second day in the evening only.

S.I.M.A. Officers.—At this year's annual general meeting of the Scientific Instrument Manufacturers' Association, G. A. Whipple, M.A., M.I.E.E., F.Inst.P., chairman and managing director of Hilger and Watts, was installed as president. P. Goudime, of Electronic Instruments, was elected vice-president and the following as new members of the council: F. W. Dawe (Dawe Instruments), P. J. Ellis, O.B.E. (Pullin), J. M. Furnival, M.B.E. (Marconi Instruments), D. F. Newstead (Rank Precision Industries), J. A. Stafford (Taylor, Taylor and Hobson), W. H. Storey (Unicam Instruments) and N. Trepte (Griffin and George).

T.E.M.A.—The annual report of the Telecommunication Engineering and Manufacturing Association, of which H. Faulkner is director, deals largely with Post Office matters of policy and development as they affect the telecommunications manufacturing industry. In the section dealing with education and training in the industry it is announced that the Association is preparing a careers handbook for publication later this year.

Amateur Exam. Results.—Of the 518 candidates who sat for the radio amateurs' examination conducted by the City and Guilds of London Institute in May, 458 (88.4 per cent) were successful. Four of the candidates were blind and two bedridden; for these special arrangements were made for the tests to be taken at home.

Instruments—measurement and control—and components associated with them are classified under some 2,000 headings in the buyers' guide section of the 1956 edition of "The Instrument Directory" issued by *Instrument Practice.* The 244-page directory includes lists of manufacturers, trade names and industrial associations.

The annual report of the **Institute of Physics** records that during the past year the membership increased to over 5,000. The Institute's recently established graduateship examination was taken in four centres by 54 candidates, of whom only 11 passed.

BUSINESS NOTES

The Mervac Printer, an exposing unit produced by **Grant Production Company** (4, Rathbone Place, Oxford Street, London, W.1), can be used in a dual rôle in the production of printed circuits. It can produce the film negative from the original wiring diagram, and also print the circuit on the copper laminate. The company also provides a service for the production of printed circuits to manufacturers' requirements.

Webcor (Great Britain), Ltd., formed last year as a subsidiary of the American Webster-Chicago Corporation to market in this country record players and receivers, has temporarily suspended operations. Enquiries should be sent to Belcher (Radio Services), Ltd., 59, Windsor Road, Slough, Bucks. (Tel.: Slough 24501.)

The resistance wire **Evanohm,** to which "Diallist" referred in September, is of American origin but is obtainable in this country from Gilby-Brunton, Ltd., 47, Whitehall, London, S.W.1.

A 3½-acre site has been chosen at Harlow, Essex, for the erection of a group of buildings to accommodate the recently-formed **Siemens-Ediswan Research Laboratories** of which Dr. G. W. Sutton is director. Until the new buildings are occupied, laboratory space is being provided at the companies' works at Brimsdown, Woolwich and Blackheath.

Sound reinforcement equipment and multi-language interpretation facilities were provided by **Tannoy** for each of the 235 seats at the recent Suez Conference in Lancaster House, London.

The **Ekco** portable television receiver, which also incorporates v.h.f. sound, is being installed in the chauffeur-driven cars operated by Daimler Hire, Limited, London. Owing to the screening of the car's metal body and the limitation of space in the car, the receiver's telescopic built-in aerial has been replaced by one mounted externally. The screen can be seen only in the rear compartment.

Communal television aerial systems have now been installed in several Devon towns and at Sheringham, Norfolk, by **J. S. Fielden, Limited.** Work on other systems for the West Country, Lancashire and Cumberland is due to start this year.

Several radio applications of "Stick-a-seal" self-adhesive polyurethane foam are suggested by the suppliers, **Sealdraught, Limited,** of Chandos House, Buckingham Gate, London, S.W.1. Among them, loudspeaker mounting and sealing for glass panels of television sets. The material is available in three standard thicknesses (1/8th, 3/16th and ¼ inch) and a variety of widths up to 19 inches.

The production of **Ardente** hearing aids and miniature components has been transferred to the company's new factory at 8-12, Minerva Road, North Acton, London, N.W.10. (Tel.: Elgar 3923.)

Bel Sound Products Company, of Marlborough Yard, London, N.19, announce that they can supply p.t.f.e. machined from rod to any shape.

Welwyn Electrical Laboratories, Limited, component manufacturers of Bedlington, Northumberland, are now making thermistors.

The new offices and enlarged factory of **Partridge Transformers, Limited,** at Roebuck Road, Tolworth, Surrey, were recently opened by Mrs. V. R. Partridge, widow of the founder of the company.

Willesden Transformer Company, Limited, are now occupying a further 15,000 square feet at their new factory at Manor Park Road, Harlesden, London, N.W.10. (Tel.: Elgar 5445.)

Direct TV Replacements, of 134-136, Lewisham Way, New Cross, London, S.E.14, have been appointed distributors of Pinnacle valves.

Philips' new north-west regional headquarters at 20, Cannon Street, Manchester, include a specially-designed demonstration room where it is planned to hold regular gramophone recitals.

EXPORT NEWS

Communications equipment, including transmitters, receivers, aerials, power plant and ancillary gear, for Iran's Police Forces is to be installed by Redifon, Limited. The contract, valued at nearly £500,000, also calls for the setting up of a radio training school.

Loudspeaker Units.—The first consignment of Goodmans' recently-introduced "pressure" units—Trebax and Midax—was shipped to the United States at the end of August.

It was stated in a note on **television receivers** for Bangkok in this section last month that the 625-line standard was employed. Although this was originally adopted Thailand now operates on American standards.

A report on the market for **sound and television receivers** in Italy has been prepared by the Export Services Branch of the Board of Trade. It concludes "If United Kingdom manufacturers wish to arrest the decline in their position and fight back against the commanding position gained by Germany in the last four years they will need to undertake aggressive sales publicity and offer, at competitive prices, sets that incorporate all the gadgets that have become virtually standard in Continental sets and pay particular attention to the rising popularity of f.m."

British manufacturers of **domestic and marine radio equipment** may be interested to know that Gough Industries Inc., a leading firm of wholesalers and distributors, of 819, East First Street, Los Angeles, has approached the British Consulate General with a proposal to help firms to sell their products in Southern California, Arizona, Nevada, Utah and Hawaii. The plan is that the company would receive samples and arrange for them to be exhibited to selected distributors within the Gough organization.

Electronic Equipment.—Feedback Control, Inc., 899, Main Street, Waltham, Mass., U.S.A., would like to represent United Kingdom manufacturers of electronic (other than communications) equipment who are not already represented in the U.S.A. They would act as representatives and/or a servicing organization throughout the United States.

Television Receivers.—Tebag AG., Lavaterstrasse 66 (Postfach), Zurich 27, Switzerland, are interested in representing United Kingdom manufacturers of television sets. The Swiss standards are 625 lines, negative vision modulation and f.m. sound.

Radiogramophones.—The Pentron Corporation, 777, S. Tripp Avenue, Chicago 24, Illinois, U.S.A., is interested in distributing good quality radiogramophones manufactured by British firms. They should cover the m.w. band as well as v.h.f./f.m.

CONTROL ROOM in the mobile studio recently brought into service by the B.B.C. for outside sound broadcasts. Provision is made for recording and reproducing programmes and sound effects, and a receiver is installed to pick up transmissions from commentators equipped with walkie-talkies. Two Mullard transmitter-receivers are provided for linking the studio to the nearest B.B.C. centre when Post Office lines are not available.

Disc Recording Characteristics

STANDARDIZATION AT LAST ?   SOME NOTES ON B.S. 1928 : 1955

By J. D. SMITH, B.Sc.

THERE has in the past been much controversy over the subject of recording characteristics. Numerous writers have quoted characteristics, often with considerable divergencies of opinion. Indeed the very mention of "recording characteristic" has been sufficient to unleash a spate of correspondence in the technical Press. In view of this it is very surprising that the revised British Standard 1928:1955*, issued over a year ago, has provoked almost no comment other than brief notices of its existence. Can it be that the new Standard settles once and for all every possible argument on the subject, or is the recording-characteristic-conscious section of the public largely unaware of its existence? Be this as it may, it is perhaps worth while to examine this new characteristic, in view of the fact that the specification or its equivalent is now being adopted by many record manufacturers in this country and abroad.

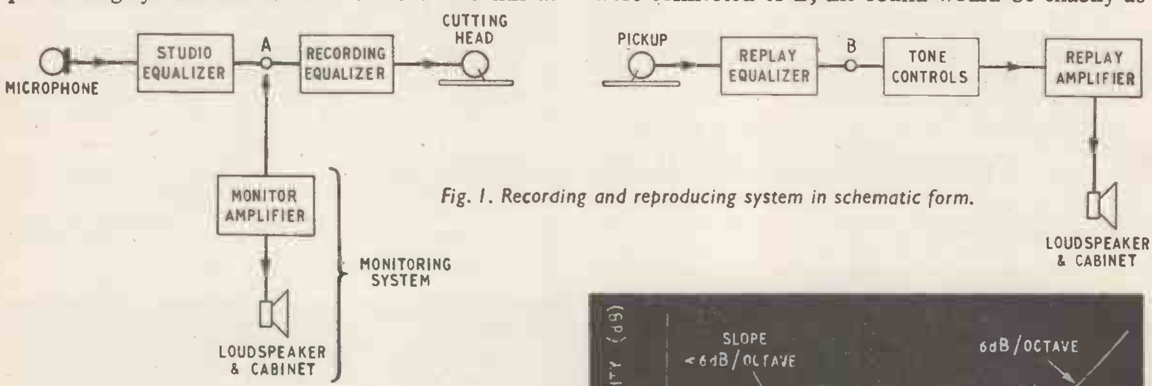


Fig. 1. Recording and reproducing system in schematic form.

Limitations of Standardization.—B.S. 1928 covers most aspects of recording and reproducing gramophone records and transcription recordings on discs. Speeds of rotation and various dimensional features of discs and reproducing equipment are specified. This much is relatively straightforward but the question of standardizing recording characteristics is very much more involved as the committee responsible for the Standard have been at pains to point out in an appendix.

The nature of these difficulties becomes apparent on examining Fig. 1, in which a complete recording and reproducing system is shown schematically. The studio equalizer is adjusted to compensate for studio and microphone deficiencies and to obtain the desired balance between high and low frequencies. The electrical signal at point A is then such that when reproduced by means of a specified monitor chain consisting of amplifier, loudspeaker and listening room, it has the balance and quality that the manufacturer desires: presumably a subjective judgment. To prevent adjacent grooves from overlapping at low frequencies, and to improve signal/noise ratio at high frequencies, this electrical signal is equalized to a known recording characteristic before being fed to the cutting head. During replay the output from the pickup is fed via an equalizer having a response which is the inverse of the recording characteristic, so that, save for any deficiencies in the system, the signal at B will be a replica of that at A. Then, if the *same* monitor chain as before were connected to B, the sound would be exactly as the manufacturer intended. In practice the signal at B is reproduced by a different system, usually incorporating yet another equalizer, the "tone controls," by which the listener introduces his personal preferences. The sound as finally reproduced may, therefore, differ from what the manufacturer had intended, but it does so in a manner determined by the listener.

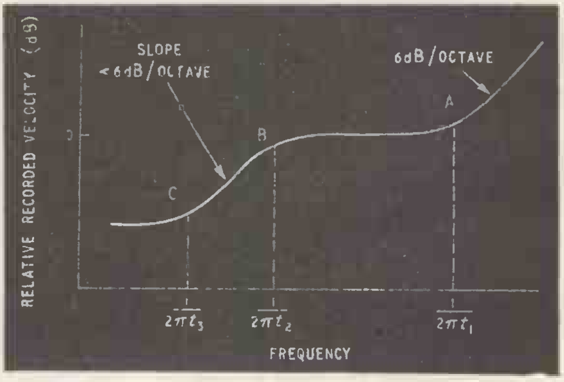


Fig. 2. General form of standard recording characteristic.

Now if a second manufacturer were to make a record of the same performance he would, in general, use a different monitor system and would equalize to produce a balance which *he* regarded as satisfactory. The signal at A would, therefore, differ from that produced by the first manufacturer at that point. The same is true of the replayed signal at

* British Standard 1928 : 1955. "Gramophone Records, Transcription Disk Recordings and Disk Reproducing Equipment." Revised May, 1955. Obtainable from British Standards Institution, 2, Park Street, London, W.1.

TABLE 1.

Time constant	Coarse groove	Fine groove
Treble rise t_1	50 μsec	75 μsec
Bass fall t_2	450 μsec	318 μsec
Bass rise t_3	3180 μsec	3180 μsec

B, provided that matched recording and replay characteristics be used (though not necessarily similar to those used in the first case). This signal at B would have to be reproduced by the second manufacturer's monitor system in order to obtain the sound as intended by him.

Thus the whole picture becomes somewhat confused and all that standardization can do at present is to specify recording and replay characteristics which could be adopted by all manufacturers. This ensures that the listener can with certainty obtain at point B in his reproducing chain the electrical signal intended by the manufacturer. This the British Standard does and no more. Having done this there are still the differences between the various manufacturers' monitor systems: as pointed out in the Standard, it would be highly desirable to standardize these but at present this is impracticable. The manufacturer's preferences in the matter of balance and so forth must be regarded as part of the actual performance and as such may not be subjected to standardization; the same is true of adjustments made by the listener.

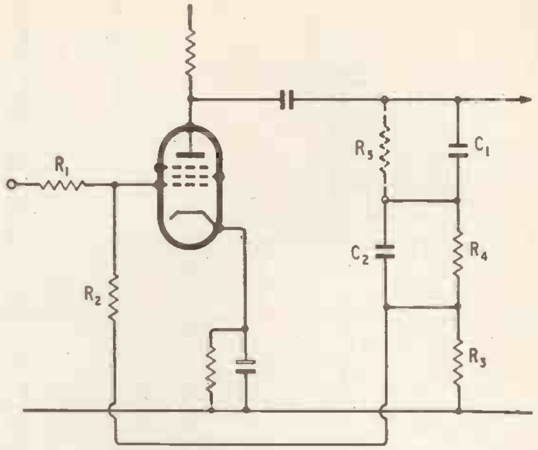
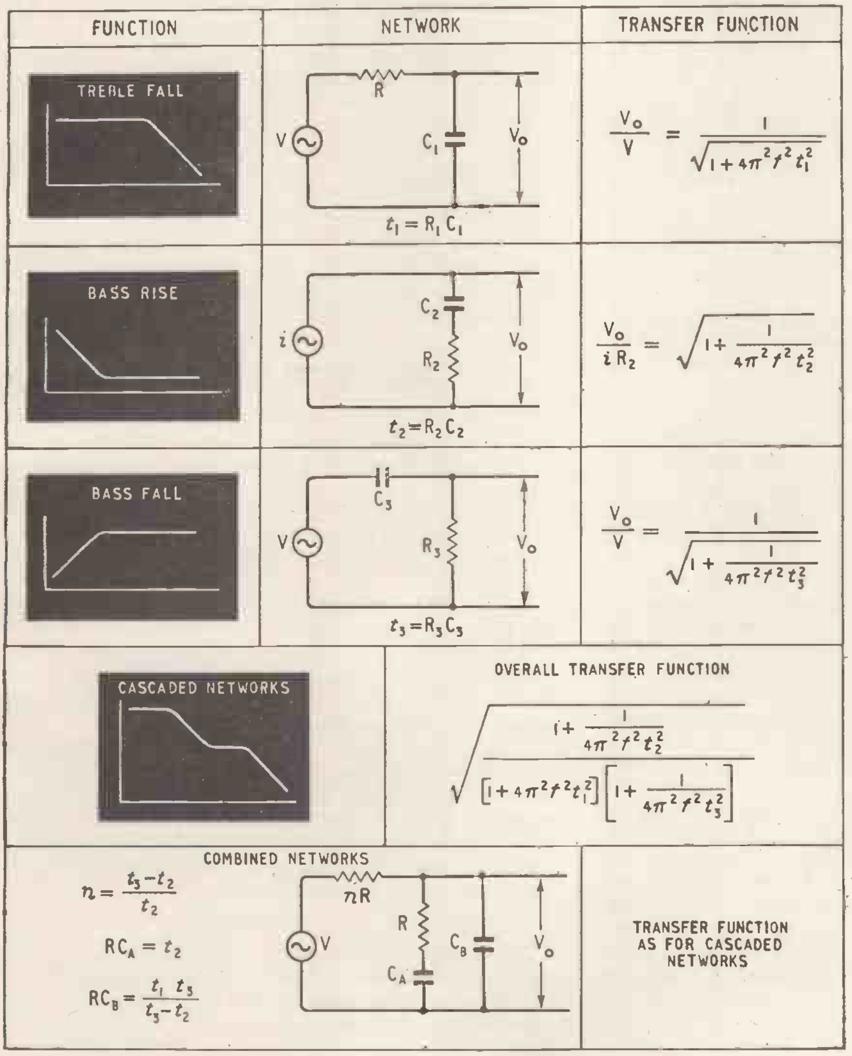


Fig. 4. Equalizer employing negative feedback. The resistor R_5 (shown dotted) is normally omitted, but may be included if necessary to limit the low-frequency boost.

Fig. 3. Basic passive networks comprising a replay equalizer.



The above discussion seems to suggest that there are still many loopholes in the Standard. There is perhaps some truth in this but nevertheless it is a great step forward to have two characteristics, one for "coarse groove" and one for "fine groove" recordings, clearly and simply defined so that the listener is no longer at the mercy of opinion in this matter. It is certainly to be hoped that all manufacturers will adopt them.

The New Standards.—The new standard characteristics are very conveniently defined in terms of the time-constants of equalizing networks. Fig. 2 shows diagrammatically a recording characteristic. There are three portions to this curve: at A there is a treble rise defined by time-constant, t_1, so that at high frequencies the curve rises at a rate of 6 dB per octave. At B

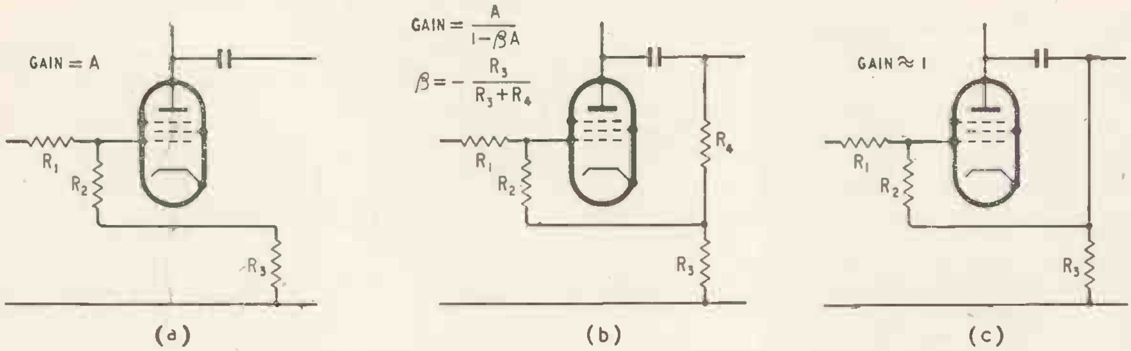


Fig. 5. Equivalent circuits of Fig. 4 at (a) low, (b) mid-band, and (c) high frequencies.

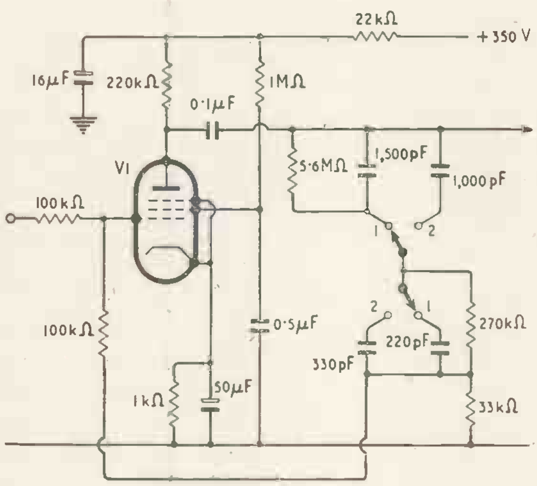


Fig. 6. Complete equalizer for B.S.S. 1928 : 1955 characteristics. V1 may be Z729, EF86, 6BR7, etc. Mid-band gain approx. 10. Switch positions: 1—B.S.S. Coarse Groove, 2—B.S.S. Fine Groove.

there is a bass fall and a second time-constant, t_2, defines this. At low frequencies the response does not fall away indefinitely because a bass rise of time-constant, t_3, is included. Table 1 gives the values of the time-constants as set out in the Standard.

Replay Equalizers.—A replay equalizer could be constructed using passive networks chosen to give the appropriate time-constants, remembering that a rise in recording characteristic must be matched by a fall in replay characteristic. The three networks must be cascaded in such a manner that they do not interact one with another; alternatively a single passive network incorporating all the necessary time-constants may be used. Such networks are shown in Fig. 3.

It is preferable, however, to use a valve with selective feedback to provide equalization and to incorporate the time-constants in the feedback loop. Fig. 4 shows such a circuit. In Fig. 5 are shown the three circuit conditions at low, mid-band and high frequencies. Notice that, as Fig. 5(a) shows, the gain at low frequencies, where maximum boosting is required, is limited to that available from the valve. In this way the required bass fall is provided without actually including a further time-constant: the ratio of the effective time-constant of this bass fall to that of the bass rise is the ratio of the maximum gain of the stage to that at mid-band, where a moderate amount of feedback is applied as shown in Fig. 5(b). If in a particular circuit this ratio is too great, R_5 may be included to provide a small amount of feedback at low frequencies. In a similar way there is a limitation of the high-frequency attenuation when the condition of Fig. 5(c) is reached, the gain then being unity (if $R_1=R_2$). However, this undesired limitation is not serious in a properly designed circuit. The actual time-constants are given by $C_1(R_3+R_4)$ for bass rise and C_2R_4 for treble fall.

Fig. 6 shows a circuit with suitable component values. Note that the switch may have as many positions as desired so as to incorporate equalization for older recordings. The load on this stage should not be heavier than 1 megohm or the available gain will be reduced and full bass boost will not be provided. If the stage must be more severely loaded it is possible by reducing R_2 to obtain the necessary bass boost at the expense of overall gain.

DO YOU KNOW?

THE length of the dipole for a Band II aerial?

The relationship between m.k.s. and c.g.s. units?

The address of the International Amateur Radio Union?

The base connections for a LN309 valve?

What external resistance is needed in series with a 25-volt meter (1,000 ohms/V) to read voltages up to 500?

If a licence is required to operate a transmitter for the control of a model?

The answers to these and innumerable other technical and organizational questions can be found in the 1957 *Wireless World* Diary—the *vade mecum* of all who have an interest in radio.

The Diary, now in its thirty-ninth year of publication, includes, in addition to the usual week-at-an-opening diary pages, an eighty-page reference section. It is obtainable from booksellers and newsagents, price 6s (leather) and 4s 3d (Rexine) including purchase tax. Overseas prices are, respectively, 5s and 3s 6d, plus 2d postage.

"Full-Range Electrostatic Loudspeakers."—The third line from the bottom of column 2 of p. 486 of the October issue should read ". . . C=equivalent capacitance = $4t_r^2/K$, where K = motional stiffness. . . ."

Transistor D.C. Amplifier

LOW-NOISE CIRCUIT FOR MILLIMICROAMPERE SIGNALS

By D. M. NEALE and FRANCIS OAKES†*

An amplifier is described which provides a current gain of 1,000; power gain, 45 dB: zero stability, 0·001µA (10µV); and a frequency response extending beyond 20 kc/s. A push-pull grounded-emitter stage is followed by a push-pull grounded-collector stage. A fifth transistor in a negative feedback loop limits the effects of collector leakage current variations, and by stabilizing the first-stage collector voltage restricts the effect of transistor noise. The amplifier was developed for use with barrier-layer photocells at very low light intensities. It has excellent linearity and can also be used in conjunctian with a semiconductor diode to provide a high-impedance low-level r.f. voltmeter usable up to frequencies limited only by the performance of the diode.

FOR the amplification of small direct currents, a battery-fed transistor amplifier offers several advantages. Warm-up time is greatly reduced and problems of supply voltage stabilization are virtually eliminated. The effects of low-frequency noise[1] and the rapid rise of leakage current with rise in temperature can be controlled by careful design so that, where a medium input impedance is required, the transistor-operated amplifier provides a better performance than a thermionic amplifier.

Whereas it is possible to eliminate the effects of temperature by carefully matching transistor characteristics and also by applying negative feedback, there seems to be no way of countering the effects of noise. The simple circuit of Fig. 1 was therefore used to find how small an input current could be definitely distinguished from noise. It was soon found that, as has been reported before[2], there is a marked increase in semiconductor noise at higher collector voltages. A collector voltage of at least 0.2 V is of course required to make the transistor operate in the high-alpha region, but it seems that the noise remains substantially constant until the collector voltage exceeds 1.0 V.

With collector voltages between these two limits, the noise fluctuations were observed when a sensitive galvanometer was used as a balance indicator. With Mullard OC71 transistors, fluctuations due to noise were equivalent to about 0.001 μA at the input. Since a comparable stability is not readily produced in a thermionic amplifier of comparable input impedance (5 to 10 kΩ), an effort has been made to reduce to an insignificant level the drift due to other causes.

The most difficult part of the design appeared to be that of keeping the collector-emitter voltage, V_c, in the range 0.2–1.0 V over a reasonable range of ambient temperatures. Using a push-pull grounded-emitter input stage and collector load resistances of the order of 20 kΩ, changes in collector leakage current limited the range of satisfactory operation without stabilization to about 20°F, e.g. 60°–80°F.

The standing current in a transistor stage may be stabilized[3] by the insertion of a resistance in the emitter circuit. The resistance provides negative feedback restricting the variations in the d.c. component of the collector current. Its effect on the a.c. component is usually minimized by the provision of a bypass condenser. In a single-ended d.c. stage, this type of stabilization offers no advantage, since drift and gain are reduced in the same proportion. In a push-pull stage, however, a common emitter resistance provides stabilization against the effects of in-phase current changes due to leakage current variations, whilst making no reduction in the gain so far as push-pull signals are concerned.

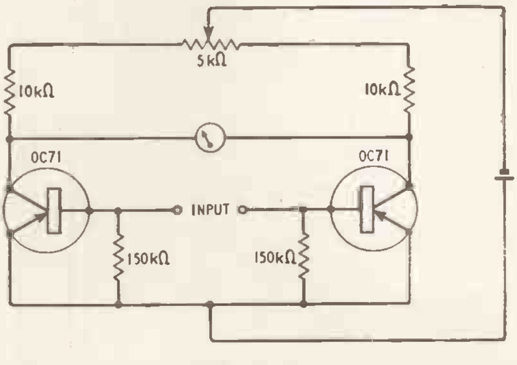
For the type of circuit shown in Fig. 2 it can be shown[3] that the stability factor S is given by

$$S = \frac{dI_c}{dI_{co}}$$

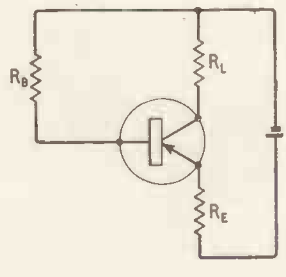
$$= \frac{1 + R_B/R_E}{1 + (1 - \alpha)\, R_B/R_E}$$

In order to keep V_c substantially constant, a low

* Ilford, Ltd.
† Ferguson Radio Corporation



Above: Fig. 1. Simple push-pull amplifier circuit



Right: Fig. 2. Stabilized single-ended amplifier.

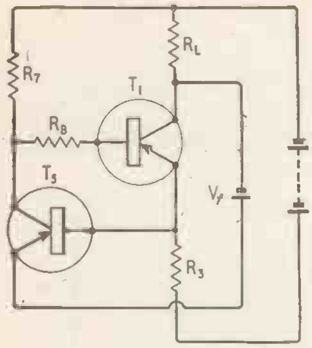
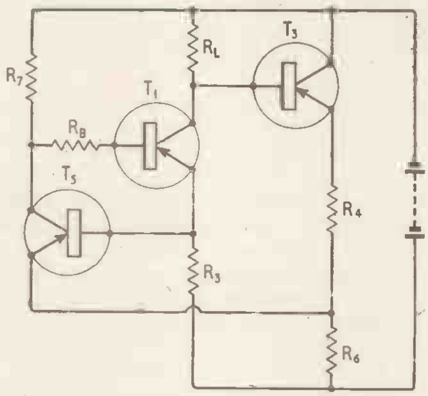


Fig. 3. Addition of a transistor (T_5) to provide amplified feedback.

Below: Fig. 4. Modification of circuit of Fig. 3 to eliminate the separate stabilizing battery.



value of S is required. The above equation shows that S falls to unity when $R_B \ll R_E$. Since R_B must be kept high in order to avoid unnecessary shunting of the input signal, however, a low value of S necessitates a high value of R_E. As the collector leakage current passes also through R_E, the voltage drop across R_E reduces V_c and largely neutralizes the stabilizing action provided.

A more useful criterion for design is the collector-emitter slope impedance, dV_c/dI_{co}. Assuming limiting values of V_c and I_{co} of 0.8 V and 16μA respectively, the highest acceptable value of $-dV_c/dI_{co}$ is 50 kΩ. The value realized in a given circuit is given, using conventional symbols, by

$$\frac{dV_c}{dI_{co}} = \frac{dI_c}{dI_{co}} \cdot \frac{dV_c}{dI_c}$$

$$= -S\left(\frac{R_E}{\alpha} + R_L\right) + \frac{R_E}{\alpha}$$

If $R_E \gg R_B$ and $R_E \gg R_L$,

$$S \approx (1 + R_B/R_E)$$

and
$$\frac{dV_c}{dI_{co}} \approx -\left(1 + \frac{R_B}{R_E}\right)(R_E + R_L) + \frac{R_E}{\alpha}$$

$$\approx \frac{R_E}{\alpha'} - (R_B + R_L)$$

Hence, to obtain low values of dV_c/dI_{co} with reasonable values of R_L, it is necessary to put $R_B \ngtr 3R_L$ and $R_E \approx \alpha' R_L$. This high value of R_E results in an inconveniently high battery voltage which must, to provide a satisfactory value of V_c, have high stability.

Although simple forms of negative feedback are of little use when the collector voltage must be stabilized within narrow limits, good results may be obtained by using an additional transistor to apply amplified feedback.

Fig. 3 is the schematic circuit of an arrangement of this type. T_1 represents the transistor to be stabilized, T_5 the transistor used for applying an amplified control signal to the base resistor, R_B, of T_1. If the collector current of T_1 increases, the reduction in collector-emitter voltage of T_1 is transferred by the feedback battery, V_f, to increase the emitter-base potential of T_5. Any such increase in emitter-base potential results in a large increase in base current in T_5, limited only by the internal base and emitter resistances. The increased base current in T_5 in turn produces a large increase in the collector current of T_5, so increasing the voltage developed across R_7 and reducing that across R_B. In consequence, the base current of T_1 is substantially reduced, enabling the collector current through R_1 to be maintained practically constant. It is fortunate that the effect of a temperature rise of T_5 serves to assist the temperature compensation applied to T_1. Since the emitter-base potential of T_5 is very small so long as a positive base current is flowing, the collector voltage of T_1 is stabilized at the voltage of the battery V_f.

The additional battery, V_f, was eliminated in the final amplifier by modifying the circuit of Fig. 3 to that shown in Fig. 4. The transistor T_3 represents the grounded-collector stage which follows the grounded-emitter transistor T_1. As the emitter-base potential of T_3 is very small, the potential of the emitter of T_3 is effectively the same as that of the collector of T_1. If a relatively high battery voltage is used, e.g. 13.5 volts, 1 volt may be dropped across R_4, whilst at least 90% of the collector excursion of T_1 is still developed across R_6. The circuit therefore works in the same way as Fig. 3, stabilizing the collector-emitter voltage of T_1 to the voltage dropped across R_4.

The circuits shown in Figs. 3 and 4 provide a high degree of negative feedback not only for variations of collector current due to changes in the collector leakage current, I_{co}, but also for changes in collector current due to the amplification of intentionally introduced signal currents fed in at the base of T_1. In the complete push-pull amplifier, however, the emitter circuit resistors R_3 and R_6 are common to both transistors in each stage It follows, therefore, that push-pull signal currents will cancel in these resistors, whereas the effect of leakage currents will be additive.

A circuit developed on these principles is shown in Fig. 5. It will be seen that a single transistor T_2 is used to control the standing base currents of the transistors T_1 and T_2 in the first stage. At any given temperature the output indication for zero input current may be made independent of source impedance by a simple setting-up procedure. The input terminals are first short-circuited and P_z is adjusted to set the output meter to zero. The input terminals are then open-circuited and P_c is adjusted to correct any consequent shift in the zero. Provided the characteristics of T_1 and T_2 are reasonably well matched, the setting of P_c produces negligible effect on the zero for short-circuited input.

Algebraic analysis of the final circuit leads to cumbersome expressions which cannot be simplified without sacrificing accuracy. The slope resistance dV_c/dI_{co} was therefore established experimentally, and found to be of the order of 2 kΩ. This represents an improvement by a factor of 15 over the circuit of Fig. 2.

It was found that the short-circuit zero was commendably stable over the temperature range 50° to 85°F. The open-circuit zero varied considerably however, because the leakage current, internal base- and emitter-resistances of the transistors T_1 and T_2 vary with temperature in such a way that a setting of the potentiometer P_c which is satisfactory at one temperature is not satisfactory at another. Some means was sought whereby the open-circuit and short-circuit zero could be made coincident at two points in the ambient temperature range, with a reasonable agreement in between.

Reversal of the sense of P_c occurs when the collector-base voltage of T_5 falls sufficiently to equal the base-emitter voltages of T_1 and T_2. Under these conditions the base currents of T_1 and T_2 become zero and their collector currents are given by

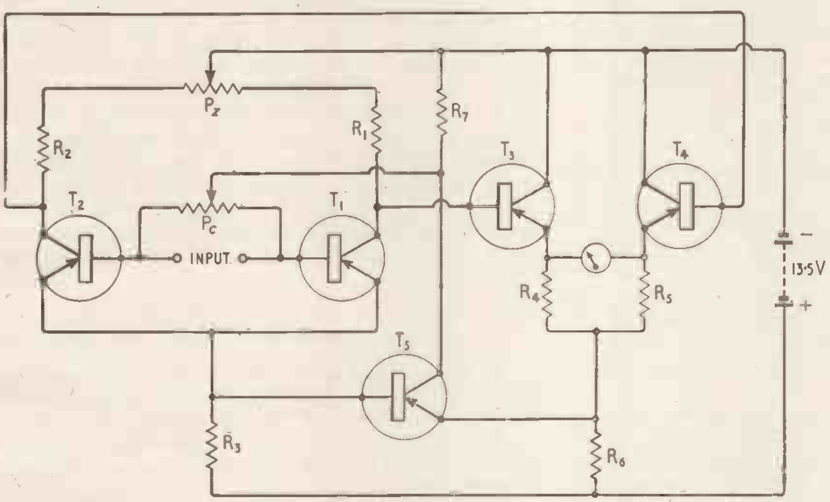
$$I_c = (1 + \alpha') I_{co}$$

With representative values of α', I_{co}, and internal base and emitter resistances, it may be deduced that the base-emitter voltage amounts to some hundred millivolts. At temperatures higher than that of this special case, the collector-base voltage of T_5 will become smaller than the base-emitter voltages of T_1 and T_2. The base currents of T_1 and T_2 are then reversed and it is therefore to be expected that the sense of P_c will be reversed also; whereas a reduction of base resistance of T_1 increases both base and collector currents at moderate ambient temperatures, at higher temperatures it increases the negative base current and so reduces the collector current.

In the final amplifier circuit, shown in Fig. 6, this reversal of sense of P_c is used to provide compensation for the effects of temperature on the open-circuit zero. A further potentiometer P_b is used, the sense of which is not reversed by temperature effects. The slider of this control is returned to the emitter of T_5 which is at a potential a few millivolts positive relative to the emitters of T_1 and T_2. The addition of P_b makes it possible to use a setting of P_c which provides temperature compensation and which at the same time allows the short-circuit and open-circuit zeros to be made coincident. This is done without seriously reducing the temperature stabilization provided by T_5.

The optimum setting of P_c is deduced by plotting (with open-circuit input) the meter current versus ambient temperature for various combinations of settings of P_c and P_z. Coincidence of open-circuit and short-circuit zeros is effected by adjusting P_b according to the procedure described above in connection with Fig. 5.

When the three controls P_b, P_c and P_z are adjusted to their optimum positions, very fair temperature compensation is provided over the ambient temperature range 55° to 85°F and, as shown in Fig. 7, a reasonable coincidence is main-



Above: Fig. 5. Amplifier with zero adjustments to make output for zero input current independent of source of impedance.

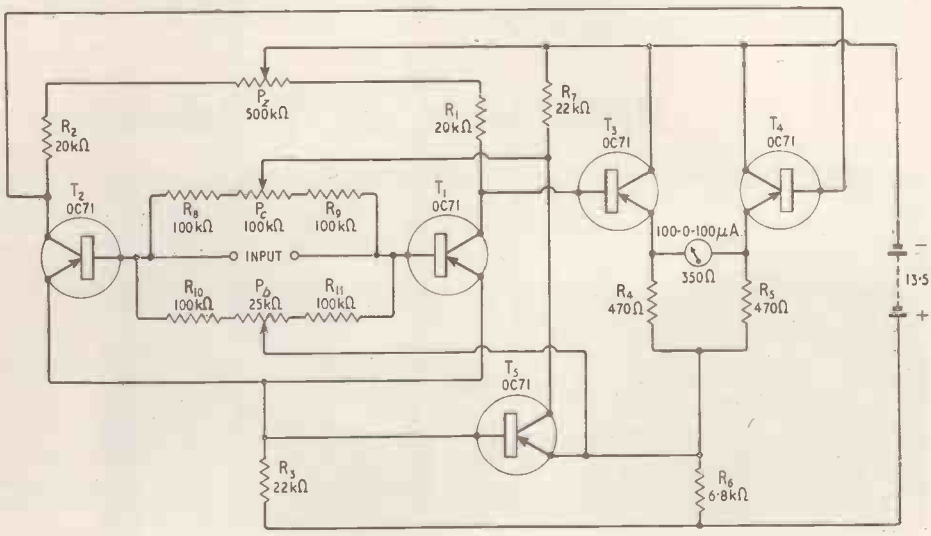


Fig. 6. Final circuit with additional compensation for the effect of temperature on the zero setting.

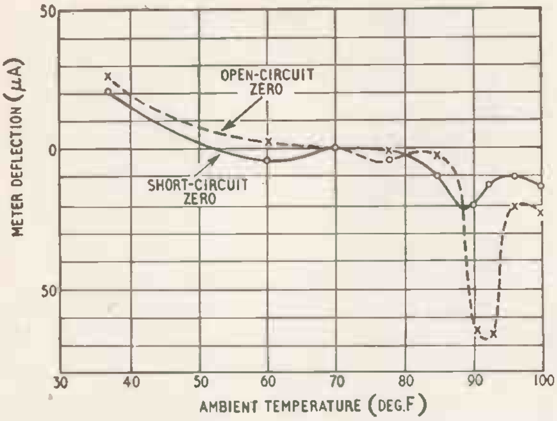


Fig. 7. Measured variation of zero setting with temperature in the circuit of Fig. 6.

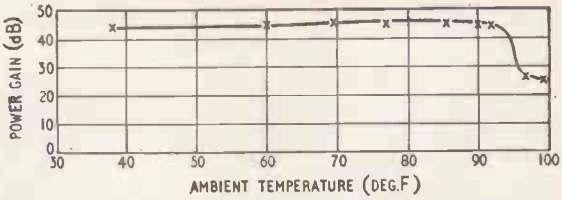


Fig. 8. Power gain variation with temperature in the circuit of Fig. 6.

tained over this range between the open-circuit and short-circuit zeros. At its worst, the zero drift in this range amounts to about 10 millimicroamps at the input.

The amplifier was, however, required for use with apparatus demanding a short-term stability of 1 mμA. This was attained by mounting the transistors in holes drilled in a block of brass and subsequently wrapping the whole amplifier in several layers of foamed rubber. These measures ensure that the temperatures of the transistors are identical and that their temperature drift is very slow. If a correspondingly good long-term stability had been required, it could have been obtained by using a simple bimetallic thermostat to maintain the outer case of the amplifier at a substantially constant temperature. To eliminate initial drifts due to internal dissipation in the transistors, the amplifier is left in operation continuously. The total current consumption is less than 3 mA and a battery life of several months is obtained from three 3-cell torch batteries.

The amplifier gain has been measured over a useful range of ambient temperatures. It will be seen from Fig. 9 that a substantially uniform gain is maintained from 37°F (the lowest temperature at which tests were made) to 93°F. The upper limit is set by the bottoming of T_5.

Simple tests show no phase shift or irregularity in the frequency response of the amplifier below the limit imposed by the alpha cut-off frequency. The main limitation on the value of the amplifier arises from the low-frequency noise, corresponding to about 0.001μA at the input.

Experimentally the Mullard Type OC71 transistors used for the first stage of the amplifier were replaced by Type OC70 transistors. The manufacturers' literature indicates that the noise level of the OC70 is some 6dB lower than that of the OC71. Consequently the unsteadiness of the zero might have been expected to be halved by using the low-noise type. In practice, however, no improvement could be discerned. The OC70 provides a slightly lower gain and it is more difficult to select matched pairs. Consequently Type OC71 transistors were retained throughout.

The transistors used in each stage were selected so that, as nearly as possible, those in each pair had identical values of α' and I_{co}. The pair having the lower value of I_{co} was, of course, used for the input stage. Although only a limited number of transistors were available at that time, it was found fairly easy to match values of α' to about 3% and I_{co} to about 10%.

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[2] H. C. Montgomery, "Transistor Noise in Circuit Applications." *Proc. I.R.E.*, Vol. 40, pp. 1461–1471, November 1952.

[3] F. Oakes, "The Stability of Transistor Circuits." *Wireless World*, Vol. 61, pp. 164–167, April 1955.

Mobile Sound and TV Laboratory

TO facilitate the testing of prototype sound and television receivers in different parts of the country Cossor's have brought into use a mobile radio laboratory. The vehicle, which is equipped with its own power supply, carries an extendible aerial system remotely controlled from the test bench. The equipment includes Model 1322 "Telecheck" and marker generator for Bands I and III, an f.m. receiver alignment generator and oscillographs.

AUTOMATIC WAVEMETER CALIBRATION

PHOTOGRAPHIC METHOD GIVING TABULAR NUMERICAL RESULTS

By D. P. THURNELL,* B.Sc. (Eng).

THE precision of wavemeter measurement cannot exceed the accuracy of the calibration, which is commonly recorded in a handbook or a calibration chart attached to the instrument. Re-calibration is necessary at intervals dependent on the use made of the wavemeter. Where the instrument is subjected to rigorous working conditions, as experienced with the Armed Services, the necessity of frequent re-calibration becomes onerous.

The Type BC221 heterodyne frequency meter, for instance, occupies a skilled technician for fifteen days, for it has 3,252 calibration points. The wavemeter in question is one used in large quantities and in order to speed up re-calibration an automatic apparatus† has been designed. The whole process of re-calibration from the generation of standard frequencies to the photographic recording of dial readings is entirely automatic and the apparatus can deal with five wavemeters per day.

A series of calibration frequencies (of the order of one part in 10^7 accuracy) are provided by a frequency standard. These are compared with the output frequency of the wavemeter under test. The wavemeter output frequency is continuously varied by a mechanical drive which simultaneously operates a mechanical counter. There is always a direct relationship between the counter and the position of the wavemeter tuning control.

The calibration frequencies and the continuously changing output frequency of the wavemeter are compared, using the heterodyne principle. After comparison an output is obtained which causes indications of the counter to be automatically recorded upon the occurrence of each zero-beat frequency.

Fig. 1 is a block diagram showing the technique employed. The output from the crystal-controlled standard frequency oscillator (1) is fed to an electronic frequency divider (2). The output obtained from the divider is at a frequency equal to the required increment of frequency between successive calibration points. This output is applied to a combined squaring and pulse-generating circuit (3) which provides at its output a series of squared waveform pulses at a recurrence frequency equal to the chosen increment of frequency. Each pulse is of a suitable amplitude and of a sufficiently short time duration to ensure a spectrum of substantially equal amplitude harmonics up to the upper limit of the frequency range of the instrument undergoing calibration. The pulses are applied as one input to a mixer circuit (4).

The output from the wavemeter (5) under test passes to an amplifier (6) and thence to the mixer (4). The wavemeter has its tuning dial firmly coupled to a mechanical drive consisting of an electric motor (7) and a precision gear box (8).

The output from the mixer circuit is amplified by a low-frequency amplifier (9), and applied as the input to a mono-stable trigger circuit (10).

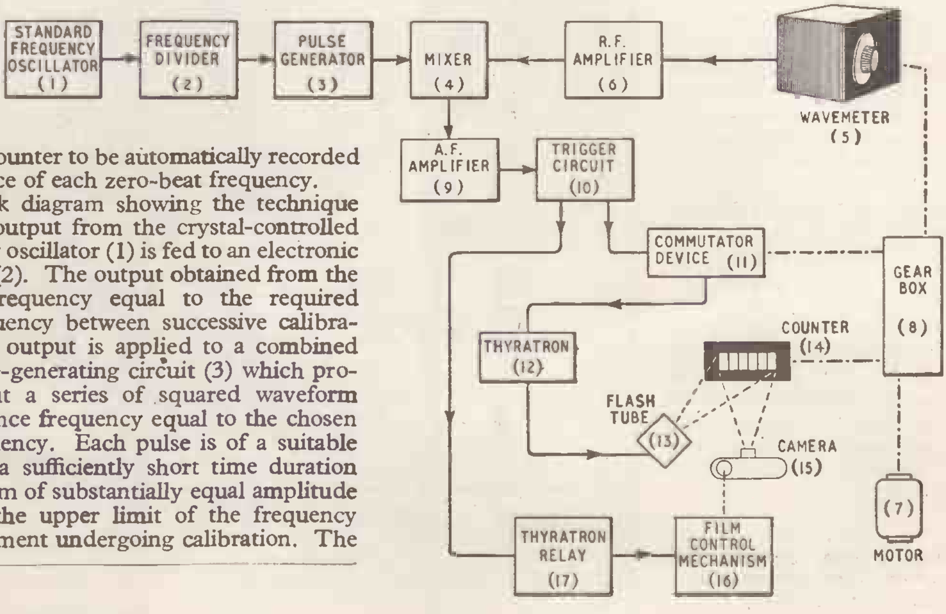
One pulse output from the trigger circuit is fed via a commutator device (11) to effect the triggering of a thyratron circuit (12) which provides a firing pulse for the photographic flash tube (13) arranged evenly to illuminate a mechanical multi-digit counter (14). This is driven at a suitable speed to synchronize with the tuning control of the wavemeter and indicates the same figures as the wavemeter dial reading. Alternatively, it can be arranged to indicate the angular position of the wavemeter dial. When used with the BC221 heterodyne frequency meter the former arrangement is employed.

In correct alignment with the viewing aperture of the counter is a camera (15). At each flash of the tube (13) an image of the counter is recorded. The camera has a film wind-on control which is mechanically coupled to a solenoid-actuated mechanism (16).

* G. and E. Bradley, Ltd., Wembley.

† Patent applied for.

Fig. 1. Block diagram showing main components and functions of the equipment.



The film control mechanism is supplied with energizing current pulses from a thyratron and relay circuit (17) whose control input is connected to an output from the trigger circuit (10) to ensure that the film is moved on for each exposure.

It will be assumed that the wavemeter has a frequency range of 100 to 200 kc/s, that its tuning control is capable of being read to one part in 10,000 of its complete range of movement, and that calibration is to be effected at every 2 kc/s over the wavemeter frequency range. In such circumstances the desired recurrence frequency for the pulse output from the circuit (3) is 2 kc/s and the standard frequency source (1) may operate at, say, 100 kc/s with the divider (2) effecting division by a ratio of 50 : 1. The motor (7) will be arranged to cause movement of the control of the wavemeter (5) over its complete range of movement while counter (14) is being moved from zero to a count state of 10,000.

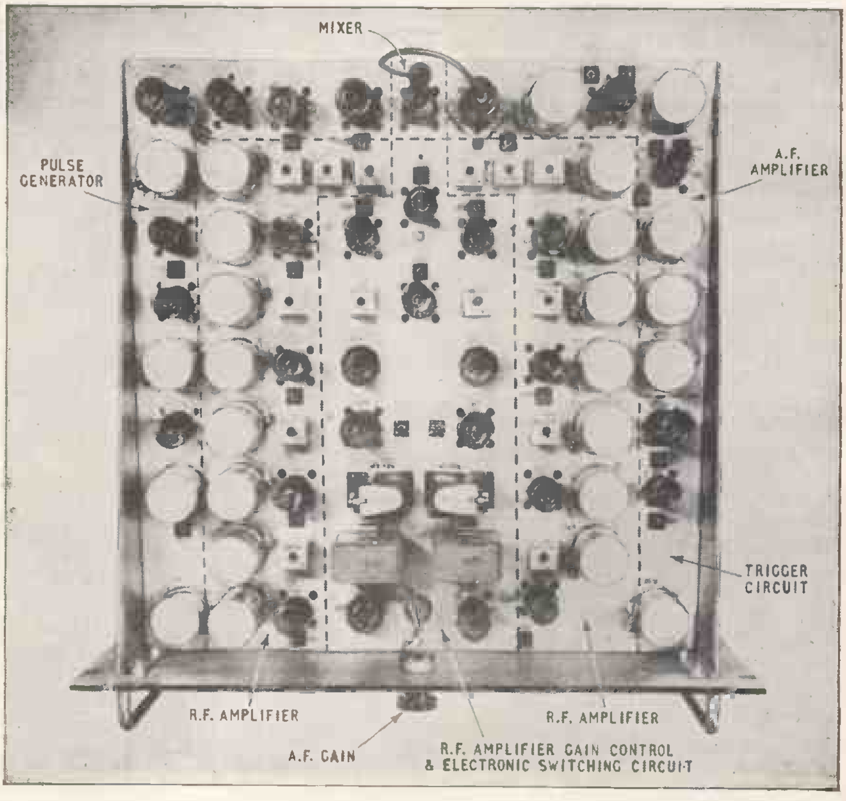
The pulse input to the mixer (4) from circuit (3) comprises a series of equal-amplitude harmonics of the recurrence frequency (i.e., 2, 4, 6, 8 kc/s and so on upwards) to a frequency above the maximum operating frequency (200 kc/s) of the wavemeter. This implies a pulse width less than 1 μsec. In consequence there will be produced at the output of the mixer circuit (4) a succession of zero beats, the first occurring when the wavemeter output is 100 kc/s, the second when the output is 102 kc/s, the third when the output is 104 kc/s and so on. The other harmonics of the 2-kc/s pulse repetition frequency are filtered from the mixer output in the amplifier (9) in which the bandwidth is arranged to be of very limited and low value, say 50 c/s in the present instance, so that a trigger input will be supplied by the amplifier to the trigger circuit (10) just before, but sufficiently close to, each occurrence of a zero beat output from the mixer. The small error so introduced (in this case about 0.05%) can be compensated for, if the wavemeter-dial rotation/frequency law is substantially linear, by offsetting the counter indication by a suitable amount from the dial indication. If this is not possible, increased accuracy can be obtained at the expense of speed by reducing the bandwidth of the amplifier (9).

When triggering of the circuit (10) occurs, an output of appropriate polarity is available to operate the commutator circuit (11). This commutator is necessary in order to delay the photographic exposure until the next occasion on which the counter figures are all in line, since the least significant digit drum is continuously in motion. This is achieved by switching a bi-stable (flip-flop) circuit "on" with the pulse from the trigger circuit (10) and "off" with the next pulse derived from a photocell pick-up head energized by light interrupted by a slotted disc. This disc has ten slots and is fixed to the counter input shaft, the position of each slot corresponding to one of the ten positions in which all figures are in line. To avoid a blurred image a flash duration of approximately 100 μsec is employed. When this occurs a photographic recording is made of the instantaneous indication of the counter.

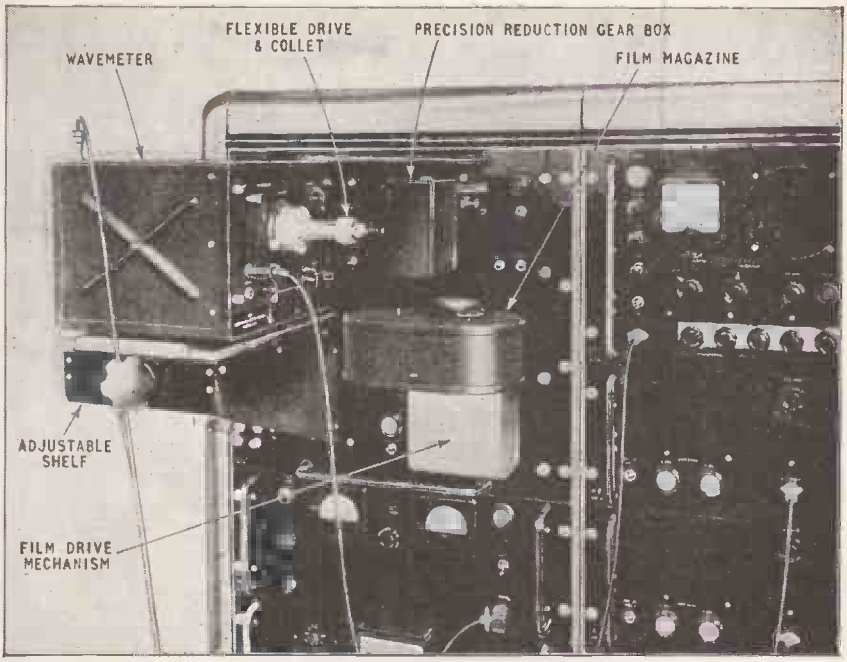
The output pulse from the trigger circuit (10) terminates after a pre-determined time interval which is made long enough (with respect to the speed of movement of the wavemeter control) to prevent another triggering of the circuit (10) until the next zero beat is approached. Fig. 2 shows the amplitude/time output of the amplifier (9) during operation The thyratron and relay circuit (17) operates after the exposure. By closing the associated relay contacts the solenoid-actuated mechanism (16) winds on the camera film to the next recording position in readiness for the next cycle of operation which occurs when the next zero beat is reached.

This procedure is repeated at wavemeter output frequency intervals equal to the recurrence frequency (i.e. 2 kc/s) of the pulses fed to the mixer over the whole of the frequency range for which calibration of the wavemeter is desired.

The characteristics of the optical system are so chosen that the developed film is produced at the correct size and pitch of figures and with a positive



Plan view of chassis. The dotted lines indicate sub-divisions of function.



Part of the automatic calibration equipment showing mechanical drive for wavemeter tuning control.

image (black on white) so that it may be cut and mounted directly into a calibration booklet for the particular instrument, in which columns of the appropriate frequencies have already been printed.

The range of instruments which may be calibrated by the apparatus described can be extended by the employment of ancillary equipment, such as a frequency divider interposed between the wavemeter and the r.f. amplifier, when the wavemeter is one operating at very high frequencies. It may also be more convenient to use a servo-mechanism for the drive system between the motor (7) and the elements (5), (11) and (14).

Operation of the apparatus over other frequency ranges can best be described by examples. For instance, calibration has been effected at 10-kc/s intervals from 20 to 40 Mc/s. This required the generation of a pulse of duration less than 10μsec with a time jitter less than 1μsec.

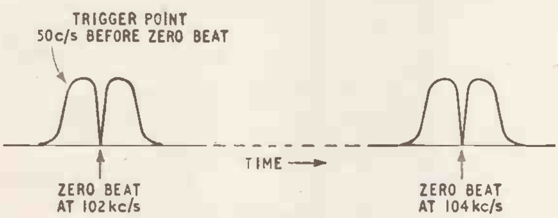
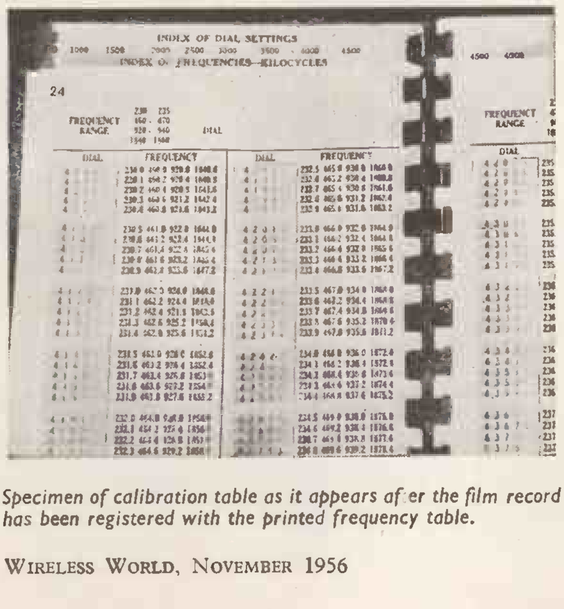


Fig. 2. Output amplitude/time characteristic of amplifier (9) during operation.



Specimen of calibration table as it appears after the film record has been registered with the printed frequency table.

In general, almost any frequency-calibration problem can be tackled by similar equipment. An important application is the automatic calibration of radio receivers where a high order of accuracy and a large number of calibration points are involved. The calibration record may then be in the form of a flexible scale (e.g., 35-mm film), coupled to the tuning mechanism, on which are recorded the frequencies to which the receiver may be tuned.

Further Developments

In order to eliminate the complication involved in photographic processing, a printing counter is under development. This is designed to replace the optical system and is provided with a mechanical storage device which enables a print to be made without interrupting the continuous drive to the input shaft.

The advantages of the system described may be summed up as follows:

(1) The elimination of human error during calibration;

(2) The elimination of human error in copying figures or in interpolation;

(3) The reduction of electrical error due to long-term temperature changes, thus disposing of the necessity for using a temperature-controlled calibration room;

(4) The increased speed of output and consequent reduction of staff.

As in other fields to which automation can be introduced, these advantages are economically realized where adequate numbers of similar instruments are to be dealt with and where the requirements of accuracy and multiplicity of calibration points are such as to justify the design of suitable equipment. Where large numbers of instruments are involved, a considerable economic advantage may be gained over hand-calibration methods.

LETTERS TO THE EDITOR

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

Television Systems

IN your July issue you again return to the question of choice between a 625-line television system and a 405-line system for colour TV. Although I put my arguments at some length in my previous letter, there is one point in your Editorial to which I must reply.

You assert that any county sufficiently developed industrially to have any kind of TV service would probably make its own receivers. This is indeed a most defeatist attitude to adopt in view of the vital importance of our own export market. It will be many years before some of the underdeveloped countries can possibly start making television receivers, especially those for colour reception, though popular demand may well bring a television service to them. Are we then to sit back and see our competitors reap a rich harvest by exporting to these countries while we must wait to see whether or not factories are erected to make receivers on the spot? You may be sure that the introduction of television in a country will not await the indigenous production of receivers.

I am told that in Iraq, for instance, about 100 people watch each set whenever programmes are transmitted. This is surely a fair indication of the popularity of television and of future demand for imported sets. A radio set is much easier to make than a television set, yet in 1955 Germany sold some twelve million pounds worth of radio sets overseas while Britain also sold about three and a half million pounds worth in the same period. Surely, if it is possible to export these large quantities of radio sets, then there can be no possible justification for assuming that television sets will not be a profitable export.

As I said before, a healthy export market must be based on home demand. Colour television is certainly on its way and the great potential markets which will arise in these, at present, underdeveloped countries will undoubtedly be for sets operating on the 625-line system. All the more reason why we in this country should not only fall into line but lead our competitors in this field.

London, W.1. ROBERT RENWICK.

WITH reference to your article "Television Picture Quality" in your August issue, reprinted from *Wireless Engineer*, May I ask why W. T. C., in studying the vertical definition does not mention the 0.7 coefficient, which is normally accepted, due to the fact that not all the active lines are capable of representing separate resolution lines?

Madrid. MARIANO MATAIX.

Comment:

THE coefficient of 0.7 does not in any way affect comparisons of the vertical definitions obtainable with different television systems because it affects them all equally. It does, however, affect a comparison of vertical and horizontal definition, in that when it is included the nominal figure for the relative definition in the two directions is altered.

The mechanisms limiting definition in the two directions are quite different both physically and in their visual effect. Any method of comparison is thus largely arbitrary. If I had said that the vertical definition is to be considered as equal to 0.7 of the number of active lines some of my statements about the relative definitions in the two directions across the picture would have been modified, but the comparisons of one system with another would have been unaffected.

The experimental fact that a 405-line picture with unrestricted bandwidth is more pleasing than a 625-line picture with 5Mc/s bandwidth is not affected by whether one says that the normal 405-line system has roughly equal horizontal and vertical definition, as I did, or whether one says that it has lower vertical than horizontal definition, as I should have done had I introduced the 0.7 coefficient. W. T. C.

I HAVE been much interested in the controversy on colour standards for television. The need for some standards to be laid down if we are to make any practical advance towards obtaining a colour service is obvious, and I should have thought that the unknowns are at present too numerous for any reasonable estimate of the economics of receiver production, let alone the manufacture of equipment for programme transmission.

It would be interesting to know what the official Post Office attitude is towards colour. The main trunk lines for both B.B.C. and I.T.A. networks are limited by design to a 3-Mc/s bandwidth, and to convert them to a wider bandwidth would take time and is probably out of the question while the I.T.A. is still expanding. Similar considerations apply to the local and temporary circuits, due to the P.O. amplifier design. Colour in less than five years would therefore seem to be geared to a 3-Mc/s bandwidth and existing communications.

I think it important not to overlook the communication aspect of this problem. Programme operation entails remote control of the transmitter, and transmitter and receiver design are therefore only part of the problem.

Among other parameters which have been little mentioned but whose standardization is probably essential before a colour service can be considered seriously are the transfer characteristic of the receiving tube, and the stray light factor at the receiver. In the U.S.A. this transfer exponent is standardized at 2.2. Is this a correct standard? Again, would 3 per cent of maximum luminance be regarded as a reasonable stray light factor? Unless they are given these two parameters, it is difficult to see on what basis the designers of commercial camera chain equipment for colour would work.

Woking. R. F. COLVILE.

Noise in Carbon Resistors

I AM indebted to Dr. D. A. Bell for his comments on my article on "Characteristics of Fixed Resistors". Regarding the point of current noise, I have endeavoured to be cautious when making statements concerning resistors generally, as I would not like to state that *all* resistors have the same characteristics with regard to noise until all types of resistor have been measured. Chipman, in addition to Hollins and Templeton, has shown the low-frequency power spectrum to be true for certain types of resistor, and as more data is obtained on, for instance, metal film and oxide film resistors the figure "below about 10 c/s" should certainly be changed to "below about 1 c/s".

The reference to log f_2/f_1 is correct, and if my book is referred to (on page 49) it will be seen to be correct there; the omission occurred in the process of transcription from the book.

Whilst the figures given in Table 3 are acceptance limits they are, in fact, based on the results of a large number of measurements and they do represent what is implied—the maximum noise one would normally expect on typical resistors. The formula 0.5μV/V is still used in RCS 112 for cracked carbon resistors but I would agree that this does not purport to reflect the true noise level. In the absence of precise data it serves as a good guide to the design engineer and it is clear from Table 3 that if an engineer assumes the limit given in RCS 112 then he will find that he will not go very far wrong.

The + and − signs in Fig. 6 should be omitted. With regard to the rule that film-type resistors should be used, this is generally correct. Fig. 8 was made up as a composite graph, based on the results of measurements on carbon composition, carbon composition film and cracked carbon film resistors. In all cases the r.f. performance of the film resistors was superior to that of the composition resistors.

If I may be allowed to comment on the last paragraph addressed to "Cathode Ray", it is useful to check by c.r.t. methods composition resistors used as noise standards with no current flowing, as sometimes additional noise may be superimposed from sources such as poor terminal contacts on slightly faulty resistors.

I would like to thank Dr. Bell for his valuable service in, as he says, "dotting i's and crossing t's" and I hope the above comments will also be found useful.

Great Malvern. G. W. A. DUMMER.

Fringe Area Reception

ON Sept. 16 an unsuccessful attempt was made to receive the Crystal Palace TV signals in America. At the same time many thousand attempts to receive the same signal were being made in East Anglia and surrounding counties which were also unsuccessful. After six years of promises, it is disheartening to those who purchased receivers for some reception from Alexandra Palace to now have their receivers rendered nearly useless because of fading down to 10 μV/metre nearly every day. The south coast has received a better service at the expense of the northern limits of the area.

The B.B.C. charter makes some mention of bringing its services to the widest audience and the B.B.C. claims (I think) 98 per cent of the population served, which means one million without a TV service. Whilst not wishing to belittle the Corporation's magnificent efforts, a million is a lot of people and I suspect that signals of 100 μV/metre are included in the service area. If so the B.B.C. is satisfied with very low picture standards and there must be few areas that average 100 μV/metre without severe fading. In some areas of Huntingdon county a three element array at 50ft will hardly guarantee one evening per week without loss of picture. Ponder on this those who have forgotten where the contrast control is situated.

A wide strip of land extending to the Wash has no satisfactory sound or television service of any kind, yet the full licence fee is demanded by law from those who valiantly try to obtain some entertainment. If fees were payable according to the service, would these forgotten (except on January first) areas be included in future plans?

St. Ives, Huntingdon. H. S. KING.

IN some fringe areas, car ignition noise is beyond description in intensity.

On vision, it is comparatively easy, by attention to line sync-circuits and use of a simple diode limiter to eliminate 99 per cent of the effects, but on sound it is a different story. No amount of "limiting" seems to have much effect—I, personally, have installed three limiters, all at once!—yet experience shows that with f.m. noise reduction is fairly easy.

One is led to believe that the reason the U.S.A. is fairly free of complaints about ignition noise is due to the use of flywheel sync and f.m. sound, therefore I would like, on behalf of long-suffering fringe viewers in the south, to stake out a claim for, specifically, an f.m. sound carrier between Channels 1 and 2.

Peacehaven. R. G. YOUNG.

Underwater Television

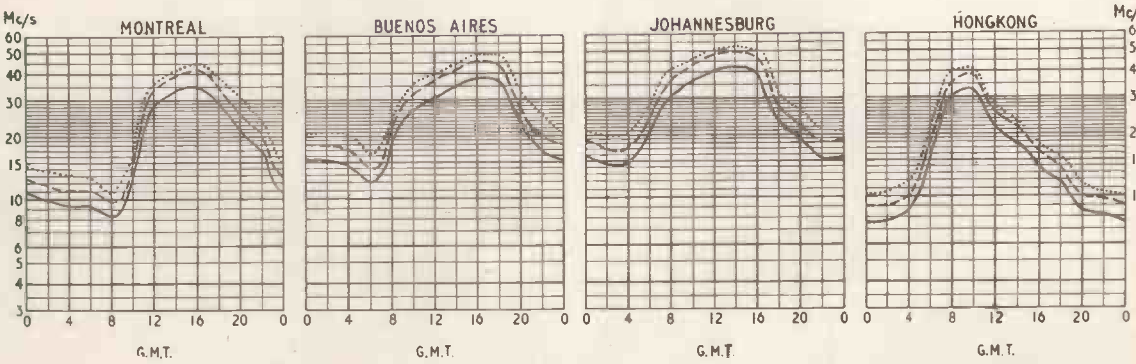
"DIALLIST'S" reference to underwater television (September issue) cannot pass without comment. Several instances where the medium was used occurred before 1951. Perhaps the first use was made in Germany prior to the last World War; certainly in 1947 it was used in connection with the atomic bomb explosion at Bikini Atoll. In 1948 the Scottish Marine Biological Association began preliminary work using an underwater camera for the study of marine life. Actually in 1949 a demonstration was given at the London Zoo using an E.M.I. C.P.S. Emitron camera.

The operation to locate the ill-fated *Affray* in 1951 was probably the next important use and also the first use as an aid to marine salvage. The Admiralty Research Laboratories at Teddington made the chamber to house the camera, which was a normal Marconi broadcast type about to be supplied to the B.B.C.

The first television camera to be designed purely for submarine use was the work of Pye, Ltd. The design was in an advanced stage just prior to the operation to locate the "Comet" off Elba. A suitable casing was designed for work down to 1,200 feet and the camera was subsequently used in this operation with great success.

Southampton. B. A. HORLOCK.

SHORT-WAVE CONDITIONS *Prediction for November*



THE full 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 November.

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

Pocket Transistor Receiver

Long-wave Regenerative Circuit with Novel Stabilizing System

By P. THARMA,* B.Sc (Eng.)

THE receiver described in this article is the result of an investigation to determine the smallest and the most economical design for a personal set. As the receiver was to be self-contained it was necessary to use a small ferrite rod aerial and this type of aerial, in turn, demanded a highly sensitive circuit. High sensitivity can be obtained either with a super heterodyne circuit, which requires about four transistors, or by using regenerative detection, when only two transistors are required. By suitable circuit design the regeneration can be made reasonably stable and gives good results.

The use of the OC71 transistor limits the frequency of reception to below about 400kc/s. Hence the design of the receiver has been confined to reception of the Light Programme transmission on 200kc/s.

The useful range of this receiver with the ferrite rod aerial is about 120 miles from Droitwich, depending somewhat on local conditions. Adjustments become unduly critical for greater distances. The receiver is directional, having a figure-of-eight pick-up characteristic. An external capacitive aerial can be used where practicable and gives much greater sensitivity. Owing to variations of transistor characteristics with temperature, occasional readjustment of the controls will be necessary.

The receiver, which operates into a hearing-aid type earpiece, can be made not much bigger than a packet of 20 cigarettes.

A complete circuit diagram is given in Fig. 1. The first transistor functions as the regenerative detector, with signal input to the emitter, regeneration being provided by means of the feedback coil L_2. D.C. bias to the base is provided by means of the potential divider R_8 and R_3. Resistors R_1, R_2, R_3 and R_8 provide stabilization of the collector current, which is 100μA. Capacitor C_7 decouples the base for r.f. and a.f. Capacitor C_5 decouples R_1 for r.f. only and provides stabilization of regeneration, as explained later. Capacitor C_6 decouples R_2 for r.f. and a.f. The a.f. circuit design is conventional except for a small amount of positive current feedback which gives an increase of gain.

A Ferroxcube rod is used for the aerial. Grade A4 of this material has the highest useful permeability at 200kc/s and is therefore specified. A fairly short rod has been used in this design to give ready portability. Much greater pick-up can, however, be obtained with a longer rod. An external capacitive aerial can be used by coupling directly to the tuned circuit via a 22-pF capacitor. An earth should then also be connected.

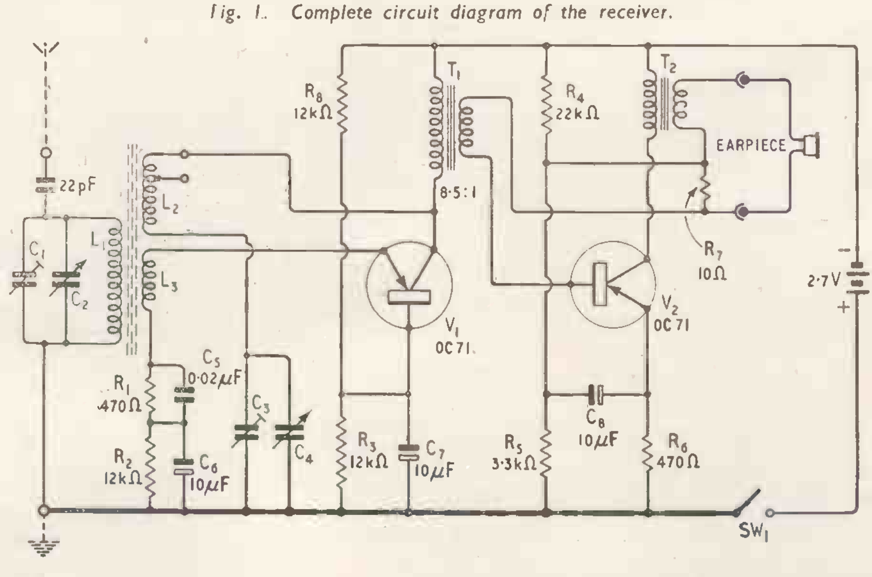
A regenerative detector performs two functions: (a) detection, and (b) providing r.f. feedback to reduce the damping of the input circuit. Detection takes place in a transistor circuit at low currents due to non-linearity of the input characteristic and is most efficient at very low currents. However, the r.f. gain decreases with decreasing current. This decrease is gradual to 75μA and rapid for lower currents. Satisfactory operation was obtained at a collector current of 100μA using the transistor in the earthed-base mode.

Positive feedback to produce regeneration can be introduced in several ways. The sensitivity of the circuit increases as the feedback is increased towards the point of oscillation and the maximum usable sensitivity depends largely on the smoothness of controls and the stability of the circuit. Smooth regeneration control and adequate stability have been attained by careful coil design and the use of a stabilizing circuit, which may be of interest also in other applications.

In this circuit (see Fig. 1) the capacitor C_5 is chosen so that only the r.f. is bypassed. This provides stabilization of regeneration.

Suppose that the input characteristic of the transsistor is similar to that shown in Fig. 2(a). This type of demodulator characteristic gives the same detection efficiency for all signal levels and the r.f. gain is constant provided the working point is at 0.

Fig. 1. Complete circuit diagram of the receiver.



*Mullard Ltd.

The actual input characteristic of the transistor is approximately exponential, as shown in Fig. 2(b). This type of characteristic gives at all working points detection efficiencies and r.f. gains dependent on the signal amplitude.

Variation of detection efficiency results in a.f. distortion and is undesirable. A more important consequence when regeneration is used is the variation of r.f. gain with signal. If the circuit is adjusted near the point of oscillation for low signals, it will burst into oscillation for higher signals (due to rise in signal level or on peaks of modulation).

A resistance in series with the emitter makes the characteristic of Fig. 2(b) approach that of (a) but also reduces r.f. gain as well as detection efficiency. A large amount of regeneration is therefore required to get any sensitivity. This is both undesirable and difficult to obtain.

A resistance shunted by a capacitance (R_1, C_5 in Fig. 1) where the capacitance is large anough to bypass only the r.f. frequencies, has a much smaller effect on the r.f. gain, thus making efficient regeneration possible. The a.f. voltage across R_1 moves the operating point in phase opposition to the a.f. output provided by the demodulation process. This negative feedback greatly reduces the non-linearity of the latter process, and by so doing also reduces the variation in r.f. gain, which variation is proportional to the non-linearity of demodulation. This makes the characteristic of Fig. 2(b) approach that of (a) as far as dynamic operation is concerned. The system also tends to counteract variations in those characteristics of the transistor affecting gain. These advantages normally outweigh the loss in a.f. gain. However, occasional readjustment of controls may be necessary due to the influence of temperature.

The coils are wound on the Ferroxcube rod as shown in Fig. 3. This design takes into account Q factor, coupling coefficients, optimum wire size and variation of transistor characteristics. One or other of the tappings gives better results and this can be determined by experiment.

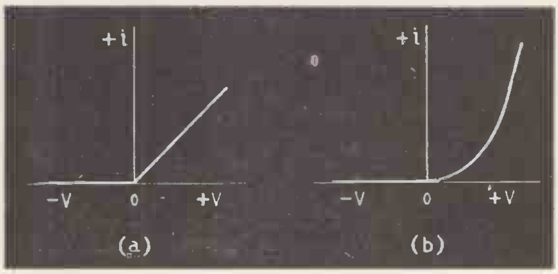


Fig. 2. Transistor demodulation characteristics: (a) an ideal curve giving linear demodulation; (b) the actual characteristic with demodulation and gain non-linear.

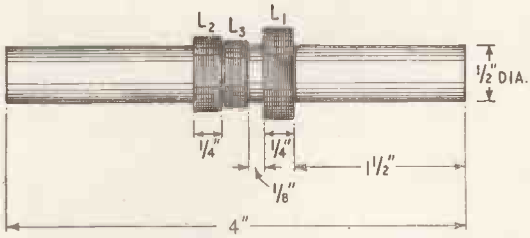


Fig. 3. Details of the coils wound on the Ferroxcube rod aerial.

COIL WINDING DATA

All three coils are wound with 35 s.w.g. enamelled double-silk-covered wire on a core consisting of a Ferroxcube rod 4in long and ½in in diameter (Grade A4, FX1091).

L_1 = 100 turns wound multilayer over ¼in.

L_2 = 57 turns with tap at 40 turns, wound multilayer over ¼in.

L_3 = 17 turns, single layer, close wound.

The coils are all wound in the same direction and are insulated from the core with Sellotape. Tuning coil characteristics: Q = 150, C = 425 pF at 200kc/s, unloaded.

LIST OF COMPONENTS

Resistors (all 1/20W, although larger types could, of course, be used)

R_1 = 470Ω, 10% tolerance
R_2 = 12kΩ, 10% „
R_3 = 12kΩ, 10% „
R_4 = 22kΩ, 5% „
R_5 = 3.3kΩ, 5% „
R_6 = 470Ω, 5% „
R_7 = 10Ω, 5% „ (see text)
R_8 = 12kΩ, 10% „

Capacitors

C_1 and C_3 = Compression trimmer, max. capacitance 400pF, or suitable fixed values.

C_2 and C_4 = Ceramic trimmer, sweep 5–40pF, TCC type TCK0540, or 8–50pF (Erie Resistor No. 557/8–50pF) with drive for external adjustment.

Capacitors (*continued*)

C_5 = 0.02μF paper, 150V working.

C_6, C_7, C_8 = 10μF, 3V working, electrolytic, TCC type No. CE68AA/W or equivalent.

Lower values of C_6, C_7 and C_8 (down to 2μF) can be used without noticeable effect on the audio response.

Transformers

T_1 = Ratio 8.5:1, Fortiphone type N23 or equivalent.
T_2 = Ratio 4.5:1, Fortiphone type N22 or equivalent.

Transistors

V1 = Mullard OC71.
V2 = Mullard OC71.

Earpiece

Fortiphone type "L," 250-Ω impedance or equivalent.

Cord

Hearing-aid type, 4ft length, to suit earpiece and socket.

Socket

For cord plug.

Battery

TR152 Mallory.

Switch

Miniature slider switch, Fortiphone type SW/5.

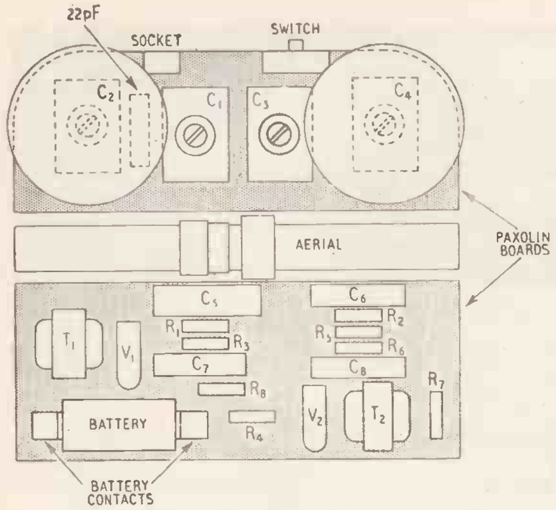


Fig. 4. Constructional details of the receiver.

The following considerations guided the design. A value of 6 : 1 for the ratio of the number of turns in the tuning coil to the number of turns in the emitter coil gave optimum matching between the tuned circuit and emitter input. The reaction winding has to be tightly coupled to the emitter coil. Too large a number of turns on the reaction winding necessitates a small capacitance for C_3 and makes the reaction control coarse and difficult to adjust and introduces a backlash effect on it. If the number of turns on the reaction winding is small it may not be possible to obtain regeneration close to the point of oscillation. From this it appears that the reaction winding has an optimum value for each transistor. Best results are obtained when the winding is such that the capacitance of C_3 is about 300–400 pF when adjusted for maximum sensitivity.

Transformer coupling is used between the detector and output stage. As the output impedance of the detector transistor is high, due to operation at low current, a ratio of 8.5 : 1 is used for the coupling transformer. The primary inductance must be high enough to give an adequate frequency response (38H gives a drop of 3dB at 300 c/s).

An output transformer is used to match into the earpiece, which has an impedance of 250 ohms at 1,000 c/s. The choice of the output transformer ratio is a compromise between gain and output power. A transformer ratio of 4.5 : 1 with a battery supply of 2.7V gives good results, providing sufficient power for comfortable listening.

Positive current feedback is applied to the output stage via the resistor R_7. If this is selected to give an increase of gain of about 10dB, there is no serious effect on quality and the stability margin is adequate. The value of R_7 required depends on the transistor V2 and is of the order of 10Ω. This positive feedback may be omitted if the receiver is intended for use in high field-strength areas. D.C. stabilization of the operating point of the output transistor is provided by means of the resistors R_4, R_5 and R_6.

In certain applications it may be preferable to feed the a.f. signal into an existing high-gain amplifier system, such as a hearing aid. Under these circumstances the output stage may be omitted and the a.f. signal taken directly from the detector stage. If a low impedance output ($1{,}000\Omega$) is required, this could be taken from the secondary of the transformer T_1. A high-impedance output can be taken from the junction of the transformer T_1 and collector of V1 via a r.f. choke.

Regarding the battery, mercury type dry cells are best suited for use with this receiver. The good voltage stability of these cells allows the transistor to operate under optimum conditions during the whole battery life. The total drain is about 1mA and cells such as the Mallory type TR152 would give about 350 hours life at a cost of less than 1/6th penny per hour.

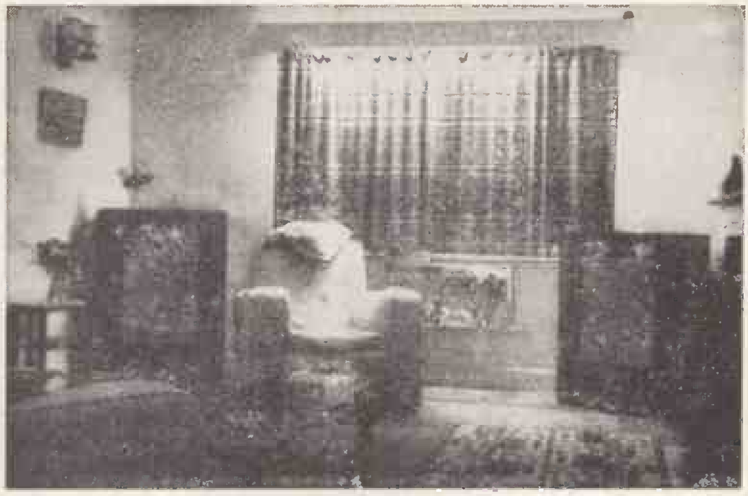
Fig. 4 shows a possible layout of the components. The layout is not critical, except that the transformers T_1 and T_2 should be spaced far apart to prevent interaction. Trimmers C_1 and C_3 are preset, whilst trimmers C_2 and C_4 are adjusted in use. Small variable capacitors of the required sweep are not easy to obtain. Compression trimmers have been modified by replacing the existing trimming screw with a larger screw to which a knurled disc is attached. These are mounted so that the edges of the discs project through slots in the case.

For the setting-up procedure, the lower of the two tappings of the reaction winding should be tried first. The variable capacitors C_2 and C_4 are set in mid-position. The reaction capacitor C_3 is set at maximum and the receiver switched on. If the circuit is in oscillation a whistle will be heard as the capacitor C_1 is varied, when the frequency of oscillation approaches the signal frequency. The reaction capacitor C_3 is then gradually reduced and by alternate adjustment of C_1 and C_3 the signal can be tuned in. (If the circuit does not oscillate the higher tapping of the reaction winding should be tried.) The external aerial and earth are then disconnected. Some retuning and adjustment of the reaction control is then necessary to obtain optimum reception with the Ferroxcube rod aerial alone.

The author is indebted to L. H. Light for valuable advice in the design of the circuit.

ON-THE-SPOT fitting of car radio within the Greater London area is now provided by Rootes Ltd., who have equipped a van specially for the task. It is a combined installation-demonstration vehicle and is itself fitted with the new 20X Radiomobile receiver. Being on call (Ladbroke 3232) it obviates motor traders carrying stocks of radio parts.

The author's living room (reverberation time 0.46 sec) showing placing of the loudspeakers for stereophonic sound reproduction.



AN APPRECIATION AND SOME EXPERIMENTS IN PSYCHO-ACOUSTICS

By J. MOIR,* M.I.E.E.

Stereophony in the Home

IN every key cinema in the country a stereophonic sound film system is now installed, and as the sound quality that can be obtained from a proper stereophonic recording is so impressive it is natural to apply similar techniques to domestic sound reproducer systems. The recently released musical film "Oklahoma" is an excellent example of the results that can be obtained in the cinema from a stereophonic recording of music and singing.

The advantages of stereophonic sound reproduction are at least as great in the home as in a large hall, and the following notes are based on experience gained in running a two-channel stereo system in ordinary domestic surroundings. The views may be a little coloured by a professional interest in the design of stereo sound systems for cinemas.

It is not proposed to recapitulate the fundamentals of stereophonic sound reproduction, for this aspect has been adequately dealt with in previous contributions to *Wireless World*† but it will be remembered that two, three or five separate channels must exist between the recording studio and the reproducing room, the stereo performance improving as the number of channels is increased. Practical considerations restrict the number of channels to two when domestic equipment is considered.

Stereophonic recordings were made many years ago by Blumlein of E.M.I. using simultaneous lateral and vertical modulation of a single groove on a gramophone record, but magnetic tape has so many advantages over discs that all current British releases are on twin-track magnetic tape. It seems likely that tape will become the standard storage medium though some of the smaller American companies issue a few discs having two recorded grooves.

In England the recordings available so far have been released on ¼in magnetic tape by the E.M.I. group under the "H.M.V." and "Columbia" labels and these are the only ones of which experience has been obtained. Without waiting for the end of the story it can be said at once that stereophonic reproduction in the home is a thrilling experience and one that results in a strong desire to "ask for more".

First a few words about the recorded tapes. The standard ¼in tape provides space for only two tracks and a 30-mil space (approximately) between them to minimize crosstalk. The dimensions are as in Fig. 1.

A stereophonic recording demands that the two recording heads be in an agreed position and that the replay heads be in the same relative position. This is essential if the recording system is to preserve the time differences that are so important to a good stereo performance. E.M.I. arrange their recording heads in line across the tape and it is thus essential that the replay equipment should also use heads with their replay gaps in line.

The microphone technique now employed in the E.M.I. is based on the Blumlein proposals, two directional microphones being mounted one above the other and mutually at right angles. However, our present purpose is to discuss the results obtained under domestic conditions rather than the studio techniques.

Equipment Used

Commercial equipment for playing "Stereosonic" tapes is available from several advertisers in *Wireless World*, but the price of a complete replay chain is a little on the high side for anybody on an engineer's salary; in consequence the writer's equipment shows signs of cinematic connections! For the enthusiast willing to assemble his own equipment several firms have available tape decks, including two compensated pre-amplifiers with an output in the region of one volt across 500 ohms. At a still lower price a tape deck can be obtained and the pre-amplifiers and main amplifiers assembled at home.

The tape reproducer used in my experiments is a

* Electronics Engineering Dept., British Thomson-Houston Company.

† "Stereophonic Sound." J. Moir, March, 1951. "Two-Channel Stereophonic Systems," F. H. Brittain and D. M. Leakey, May & July, 1956.

Ferrograph 2C/NF having in-line heads and an output of about one volt from the two internal pre-amps. The main amplifiers are some standard units used in the smaller cinemas and having frequency characteristics within 1dB of each other over the whole audio-frequency range. Several types of loudspeakers have been tried, but it is still unfortunately true that the most expensive loudspeakers give the best reproduction. These particular examples are dual-channel, horn-through-the-centre-pole type (B.T.H. Type K10A) mounted in ported cabinets. They can be seen in the accompanying photograph of the living room. If the room is large enough high-quality speakers of this type are ideal, but they are not essential, a point that will be referred to later. The seating, a settee and two easy chairs, was arranged across the room about 10-12 feet away from the speakers.

With this arrangement the results obtained are outstandingly good and represent a much greater improvement over long-playing records than the l.p. records show over the old 78-r.p.m. recordings. The ordinary technical criteria, low harmonic distortion, wide frequency range, greater volume range, and low background noise, are inherently satisfied in a good magnetic tape recording and all the tapes tested set a standard much higher in these respects than any but laboratory examples of disc recording.

Surprisingly enough these characteristics received little comment from the 20-30 friends who have heard the results. What did receive comment from everybody, whether technically or non-technically minded, is the extraordinary improvement in clarity, the complete separation of orchestra and singers, the apparent size of the orchestra and the ease with which one can listen. This last point is a rather unsuspected and rather under-emphasized advantage of stereo recordings. One listening session ran into a couple of hours without the slightest sign of fatigue though the playing of a good l.p. record immediately brought the comment of "How hard that is to listen to after hearing the tapes".

Loudness Levels

The work of Somerville and Brownlees in England, and Chinn and Eisenberg in America has shown that the public have a marked preference for lower-than-original sound loudness levels when reproducing music at home. This has been confirmed on many occasions in the present house, peak levels greater than about 85 phon always raising adverse comment from the other members of the family. After ten minutes playing of the first stereo tape it became obvious that peak loudness levels well above 85 phon were being experienced, so the sound level meter was brought out. This confirmed that the peak levels were in the region of 95-98 phon, a loudness level that would certainly arouse protests if the standard monaural system was being played. Even when disaster was courted by a direct question "What about the loudness?" only one listener in the group of six thought that "it was a bit loud".

A few words about some of the tapes that have been played "The Marriage of Figaro" by the Glyndebourne Opera Company (HMV SAT 1007) is an outstanding example of the advantages of a stereophonic recording. Normally I have no special liking for opera sung in Italian, but this tape was played at least ten times during one day for the sheer pleasure

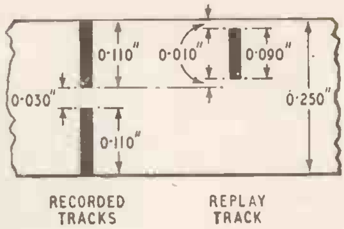


Fig. 1. Track dimensions of E.M.I. "Stereosonic" records.

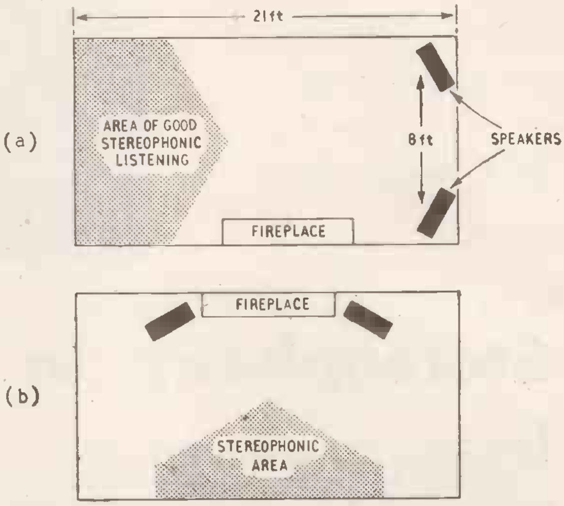


Fig. 2. Alternative positions tried for the loudspeakers in a living room.

of hearing the performance with all the spatial characteristics of the original. The orchestra is a separate group spaced from the singers, and the principal singers appear against the choral background without the least confusion. This is a recording to demonstrate to friends who believe they have a high-quality disc recording system!

Orchestral music is almost equally impressive, the Classical Symphony (Prokofiev, No. 1 in D Major) SDT 1750, being most satisfying both technically and musically. This was another recording that was replayed at least ten times during one week-end, always bringing all domestic activity to a standsill. A long experience of high fidelity at home suggests that continued satisfaction is a rarity if records are being played.

It must not be thought that a stereo system is only suitable for "serious" music; Phil Green and his orchestra in "Interlude for Melody," Columbia BTD 701, is another outstanding example of the advantages of stereo recording, though my eleven-year-old daughter informs me that Phil Green and his band are a "square". I am not sure what this means, but I suspect that he plays *music* rather than merely making a row. Perhaps somebody more attuned to the younger mind or having access to a suitable dictionary can translate the expression into English. A fair number of other recordings have been played, all with real delight, but those quoted might make a good foundation for a tape library.

Some twenty people have listened to the equipment at various times, most of them being high-quality enthusiasts though diluted by a wifely accompaniment. Without exception all their comment has been extremely favourable, but perhaps the greatest compliment is that three ladies sat for more than an hour listening to opera in Italian and music by Prokofiev and Sibelius without saying a single word to each other except in the intervals. In a very long experience of domestic high quality I have never known this happen when playing records. The explanation is probably fairly simple; the reproduction is so realistic that it would just be sheer bad manners to indulge in conversation.

Some of the more technical conclusions reached as a result of experiments are probably of interest. The loudspeakers used each have a fairly uniform polar distribution over an angle of about 60 degrees. Speakers having a less uniform angular distribution need to be placed more carefully but give very good results if this care is taken. The two ported cabinets were placed in the corners of the room, pointing down the length of the room and turned outwards to make an angle of about 30 degrees with the wall behind. The cone centres were then about 8ft apart and the best listening position about 10-12ft away. At greater distances the stereo effects existed over the whole floor area out to the end of the room 21ft away. Listening positions closer to the loudspeakers than the speaker spacing lose a good deal of the stereo impression.

Several types of speaker have been tried and in general the better the individual speakers, the better the stereo result. However, the quality of the speaker and particularly the frequency range covered appear much less significant when using a stereo system. Any enthusiasts thinking of trying domestic stereophony need not be deterred by the absence of two speakers of top-class quality. When listening to a real orchestra the quality is not judged by the frequency range of the instruments, and the same attitude develops when using a stereo reproducing system. The frequency range that is reproduced seems much less important than the sense of size and spatial distribution produced by the system.

Loudspeaker Positions

Speaker positioning is a bit of a problem if the best listening position is to be integrated with normal domestic activity and the viewing of television. Speakers placed across the end of the room as in Fig 2 (a) give very satisfactory results, but are generally difficult from other points of view. A speaker placed at each side of the fireplace as in Fig. 2 (b) has advantages, in that it faces listeners seated round the hearth but the heating system needs to be a little better than "standard British" in order that the audience should be comfortable eight or ten feet from the fire. Seating positions outside the area demarcated by the speaker positions are not very satisfactory. The room used for the majority of the tests is fairly good acoustically (measured reverberation time 0.46 seconds at 500 c/s) but the acoustics of the listening room appear very much less important with a stereo reproducer system than with a monaural system. The acoustics of the recording studio are the predominating factor, a point well brought out when listening to the Glyndebourne recordings. Room size also appears to be a less significant factor, very good results being secured in a room only 12ft × 9ft with the speakers across the end of the 9ft wall.

One very important factor is the relative volume level from the two speakers. Any 2-channel stereo system must depend for its main effects on the intensity difference that is produced at the two ears, the intended result being secured by the correct positioning of the microphones at the recording studio. A reproducer system having separate gain controls in each channel allows the stereo result to be completely spoilt by incorrect setting of the gain controls. The ideal arrangement is undoubtably to have a single knob with the two channel controls ganged on the same spindle, though each channel must have a separate gain control that can be pre-set to equalize the acoustic output from the two channels. From this point of view it would be a great convenience to have available a "balance tape" with short bursts of 1,000 c/s tone recorded alternately on each track. This would allow the acoustic outputs of the two speakers to be balanced and the gain control settings noted for future use. Such "loudspeaker balance" films are available to the cinema engineer. (A loop of tape only 3 or 4ft long is quite adequate.) The necessity of balancing, in some manner, cannot be too strongly emphasized, for lack of balance leaves the orchestra and all the singers on one side of the room, completely ruining any stereo effects.

The amplifiers used should have similar characteristics, a tolerance of $\pm$ 1 dB over the frequency range being suggested. If variable tone controls are fitted these need to be set to give the same overall frequency characteristic, or the orchestra tends to be concentrated towards the loudspeaker having the best high-frequency response. Differences in frequency characteristic of more that 2 or 3 dB lead to a peculiar "stretching" of the orchestra, while the individual instruments move about the stage as the player moves up and down the musical scale.

Finally about the future. In the cinema world stereophonic sound reproduction has been seriously jeopardized by the widespread release of films with identical sounds on all three tracks though advertised as having "stereophonic sound". In many films these have been dubbed on to the magnetic tracks from a single original photographic track. This is killing the goose with a vengeance. It is hoped that no one will attempt to foist such counterfeit on the domestic market.

In my opinion, stereophonic tape recordings of the present standard are sufficiently outstanding to ensure that they will be the accepted practice for all domestic high-quality systems in perhaps a couple of years time. Cost remains an obstacle at present, but it is to be hoped that prices will fall steeply as the demand rises.

APPRENTICESHIPS

AN outline of the opportunities open to graduates and others in the **Philips** organization in this country is given in "Careers in Philips." It covers mainly the opportunities in the manufacturing organization but also touches upon the openings for technical staff in the commercial departments.

Two brochures available from **Metropolitan-Vickers** cover the apprenticeships which the company offers to graduates ("The Training of the Professional Engineer") and public, secondary grammar and technical schoolboys ("From School to Professional Engineering").

"Opportunities in Electronics for University Graduates" is the title of a booklet issued by **Mullard**. It outlines the opportunities open to science graduates in the company's research laboratories and production organizations.

Transistor R.F. Amplifiers

2—PRACTICAL CIRCUITS WITH NEUTRALIZATION AND AUTOMATIC GAIN CONTROL

By ***D. D. JONES,**** *M.Sc., D.I.C.*

(Concluded from page 496 of October issue)

IT was mentioned in Part I, last month, that if a voltage appears at the output terminals of a transistor amplifier, internal feedback due to r_{bo} and C_c results in a voltage also appearing at the input terminals. Consider a common-base amplifier working into a load Z_L. If an a.c. current I is made to flow in the input circuit a voltage approximately equal to αIZ_L will appear across Z_L; the phase relationship between this and the applied signal will depend on the phase change introduced by the complex nature of α. Part of this voltage will now be fed back into the input circuit via C_c and r_{bo} and will modify the input impedance of the amplifier; the extent of this modification depends on the magnitude of Z_L as well as on α, C_c and r_{bo}. The input impedance does therefore depend on the load; as was mentioned in the introduction this effect does not arise in thermionic valves until the frequency is comparatively high.

* Research Laboratories, The General Electric Company.

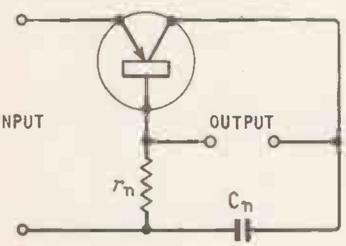


Fig. 5. Method for neutralizing common-base transistor amplifier; a.c. circuit only is shown.

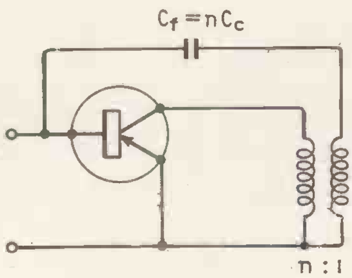


Fig. 6. Method for neutralizing a common-emitter amplifier.

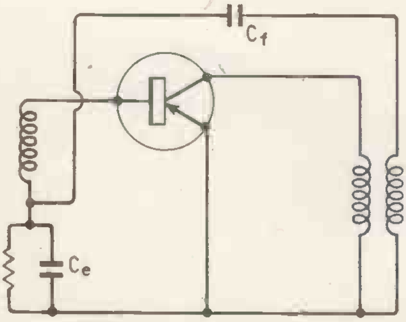


Fig. 7. Method similar to that shown in Fig. 6, but with r_e and C_e taken into account.

If a tuned circuit forms part of the load, Z_L will vary with frequency; this can give rise to considerable variations in input impedance over the bandwidth of the tuned circuit (and hence, of the amplifier). It is desirable to introduce a subsidiary network into the amplifier circuit to produce another feedback component which cancels out that produced by the transistor.

Neutralizing networks of this kind play an important part in present-day transistor circuits.

There are a number of possible neutralizing arrangements, but so far only two or three of them have been extensively used. A useful method both for seeing the necessity for neutralization, and also for aligning the circuit itself, is to measure the input impedance of an amplifier as a function of frequency over the pass band; the amplifier load includes the tuned circuit in these measurements.

In the common-base amplifier the input impedance can increase to very high values in the pass band; it can in fact become infinite, change its sign and give rise to oscillations. In the case of the common-emitter amplifier, the input impedance decreases over the pass band and can again become negative and cause oscillations. In properly neutralized amplifiers there should be no significant changes of input impedance over the pass band.

The circuit shown in Fig. 5 is found to be satisfactory for neutralizing the common-base amplifier. Any voltage appearing across the output terminals will give rise to a voltage across the input terminals due to internal feedback provided by r_{bo} and C_c; however, a voltage will also be fed back into the input terminals via C_n and r_n and if

$$r_nC_n = r_{bo}C_c$$

these fed back voltages will be equal and will cancel each other out.

The circuit shown in Fig. 6 can be used for the common-emitter amplifier. In this case the capacitance C_c feeds a voltage back into the input circuit; by means of the phase inverting transformer and the capacitor C_f, an out-of-phase voltage of equal amplitude is also applied to the input circuit. The effectiveness of this method depends on r_{bo} being low. A more satisfactory result can be achieved if the circuit of Fig. 7 is used; however, since r_e varies rapidly with emitter bias current it is found that this bias must be kept reasonably constant for the method to be effective.

Any practical amplifier is expected to give satisfactory performance over a range of operating conditions. A fair test of the performance of any neutralizing circuit, therefore, is to observe its variation with operating conditions, e.g., with change of supply voltage.

When using GET4 transistors in 465-kc/s i.f. amplifiers, it is found that the common-base circuit with the neutralizing method shown in Fig. 5 can withstand large changes in supply voltage. It is also found that the amplifier is more stable if r_nC_n is slightly less than $r_{bo}C_c$; using the mean values of r_{bo} and C_c, obtained from the production "spread" of the transistor, is also found to be adequate.

The higher the dynamic impedance of the tuned circuit used, the more critical does the design of any neutralizing network become.

Fig. 8 shows a two-stage 465-kc/s i.f. amplifier using GET4 transistors. A dynamic impedance of about 50kΩ is used in this case to avoid the necessity for very accurate neutralization. A gain of about 36dB is obtained with such an amplifier. This gain is considerably lower than would be obtained if transistors having much higher M_g were used; however, it does show that using transistors in what are undoubtedly "marginal" circuits, useful gain can be obtained if neutralization is employed.

In order to obtain as much gain as possible it is necessary to use interstage transforming circuits. The transformation ratio depends on the dynamic impedance of the tuned circuit forming the collector load of one transistor and the input impedance of the next stage. In the amplifier shown in Fig. 8 a turns ratio of about 20 : 1 is used, though this could be increased at the expense of rather more critical neutralization.

Of the various types of matching circuits that can be used, that shown in Fig. 9(a) is widely employed in practice. In experimental work the circuit of Fig. 9(b) is often useful.

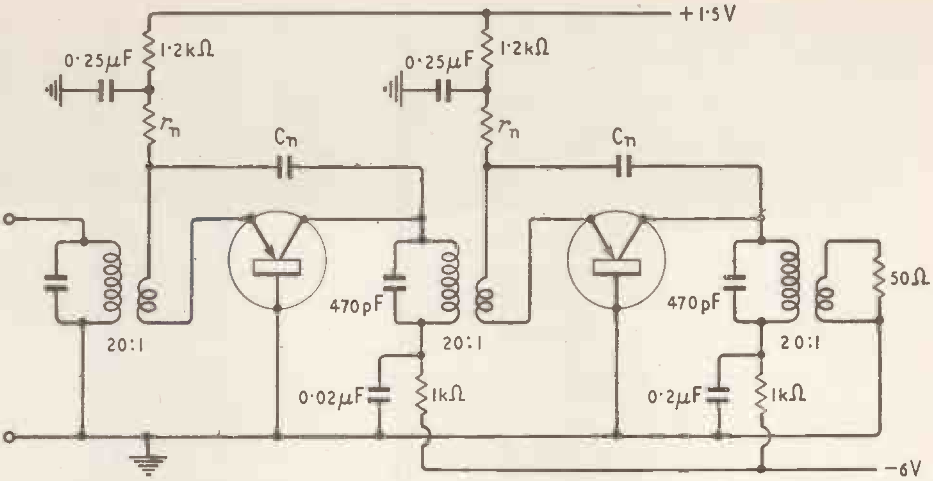


Fig. 8. A two-stage 465-kc/s i.f. amplifier using GET4 transistors.

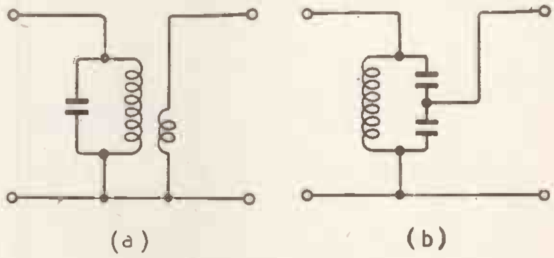


Fig. 9. Interstage coupling networks.

Since C_c and C_n form part of the tuned circuit it is important to remember that C_c varies with supply voltage. To minimize this effect, the tuning capacitor should be large.

It is often desirable that the gain of an amplifier can be automatically adjusted according to the mean level of the input signal. Unless the gain is controlled in this way the amplifier may be overloaded at high levels of input signal.

Automatic gain control can be achieved in two ways. In the first method, the actual d.c. voltage at the collector is reduced as the mean signal level increases; both the current gain factor and the collector capacitance vary with collector voltage and contribute to a reduction in the gain of a tuned amplifier. The second method is based on reducing the emitter bias current as the mean signal level

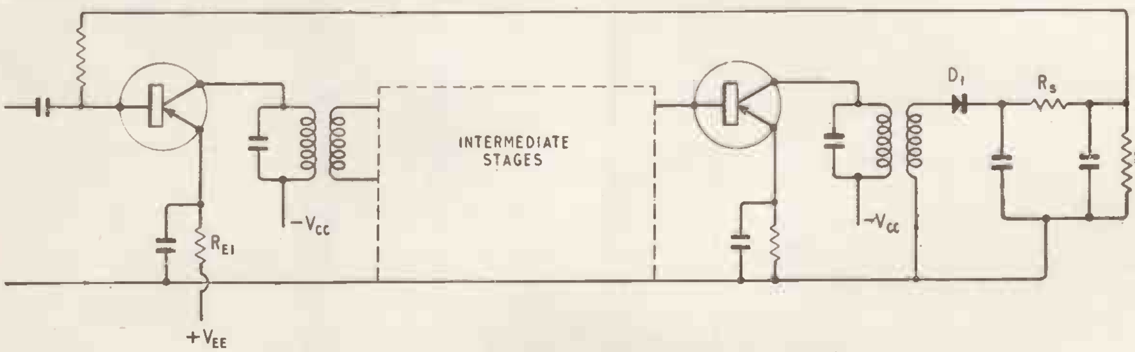


Fig. 10. Automatic gain control of a common-emitter amplifier.

increases; this technique is used more extensively than the former and is therefore discussed in greater detail.

In Part I of the article it was mentioned that the input impedances of the common-base and common-emitter amplifiers, when working into low load impedances, are given by

$$Z_{in} = r_e + r_{bo}\ (1-\alpha) \text{ for common-base.}$$

$$Z_{in} = r_{bo} + \frac{r_e}{1-\alpha} \text{ for common-emitter.}$$

(C_e being ignored for the moment). When the load impedance is comparatively high it is found that the parameter r_e still plays a dominant role in the expression for input impedance. It was also mentioned earlier that r_e is inversely proportional to the emitter bias current I_e. If this current is varied Z_{in} will be varied in both amplifiers.

The emitter bias current, I_e, is related to the base bias current, I_b, by the expression

$$I_e \sim \frac{1}{1-\alpha} I_b$$

Since $1/1-\alpha$ is, typically, 40 it will be seen that large changes in I_e and hence in r_e can be achieved by small changes in I_b. In both common-base and common-emitter amplifiers it is general to arrange the d.c. bias circuit so that the value of I_b can be varied.

Fig. 10 shows a circuit used experimentally for providing a.g.c. In this, the output from the amplifier is rectified by diode D_1 to give a positive output voltage. This is then fed back to the base of the first amplifier and reduces the base bias current (which is negative in sign). The emitter resistor R_{E1} should be as low as possible because it produces an undesirable increase in the d.c. input resistance of the amplifier; the a.g.c. may be regarded as being substantially d.c. The resistance of R_D is made fairly large ($\simeq 20\text{k}\Omega$) and, as a result, much of the positive bias voltage V_{EE} is developed across it. This biases the diode in the reverse direction, thereby giving rise to a delayed a.g.c. characteristic. As the signal input to the diode is increased, the positive voltage between emitter and base, and hence the gain of the amplifier, is reduced.

In amplifiers where a transistor is used as a second detector a similar principle can be employed to obtain a.g.c.

BOOKS RECEIVED

Radio Research 1955. Report of the year's work by the Radio Research Board (D.S.I.R.), which included phase changes in ground waves of low frequency, propagation at v.h.f. and u.h.f. (including direction finding at these frequencies), measurement of atmospheric noise and investigation of ferrite and semi-conductor materials. Pp. 56; Figs. 8. Price 3s 6d. Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.

Automatic Integrator for Determinating the Mean Spherical Response of Loudspeakers and Microphones by A. Gee, M.A., and D. E. L. Shorter, B.Sc.(Eng.), A.M.I.E.E. No. 8 in the series of Engineering Monographs published by the B.B.C. describes the use of a modified kilowatt-hour meter for integrating the response while plotting the polar diagram on an automatic recorder. Pp. 16; Figs. 10. Price 5s. B.B.C. Publications, 35, Marylebone High Street, London, W.1.

Frequency Modulation Engineering by Christopher E. Tibbs, M.I.E.E., M.Brit.I.R.E., and G. G. Johnstone, B.Sc. Revised second edition of a comprehensive survey of the principles and practice of transmitting and receiving f.m. signals. Includes mathematical treatment to the level required for the design of components and systems. Pp. 435; Figs. 254. Price 45s. Chapman and Hall, 37, Essex Street, London, W.C.2.

Radio (Vol. 3) by J. D. Tucker and D. F. Wilkinson, B.Sc.(Eng.), A.M.I.E.E. Text book covering the syllabus of the Radio III examination of the City and Guilds of London Institute. Pp. 249; Figs. 237. Price 12s 6d. English Universities Press, Ltd., 102, Newgate Street, London, E.C.1.

Radio Servicing (Vol. I. Electrotechnology) by G. N. Patchett, B.Sc., Ph.D., M.I.E.E., M.Brit.I.R.E. Fundamental electrical concepts underlying the theory and practice of radio (including television) servicing. Designed to cover the syllabus of the City and Guilds and R.T.E.B. examinations. Pp. 80; Figs. 84. Price 5s. Norman Price (Publishers), Ltd., 283, City Road, London, E.C.1.

Hi Fi Loudspeakers and Enclosures by A. B. Cohen. Lucidly illustrated analysis of the construction and principles of operation of loudspeakers, cabinets and folded horns (principally of American design and manufacture) with an appendix giving constructional details of 18 representative types. Pp. 360; Figs. 183. Price 37s 6d. Chapman and Hall, 37, Essex Street, London, W.C.2.

Introduction to Colour TV M. Kaufman and H. E. Thomas. Second edition of a general description of the NTSC system with stage-by-stage analysis of a receiver and a full circuit diagram. Pp. 156; Figs. 81. Price 25s. Chapman and Hall, 37, Essex Street, London, W.C.2.

Mandl's Television Servicing by M. Mandl. Revised second edition of a teaching manual for students with new material on transistors and printed circuits. Illustrated by examples from American practice. Pp. 460; Figs. 314. Price 45s 6d. The Macmillan Company, 10, South Audley Street, London, W.1.

An Approach to Modern Physics by E. N. da C. Andrade, D.Sc., Ph.D., LL.D., F.R.S. Non-mathematical survey for the layman of recent developments in theoretical and experimental physics. Pp. 232; Figs. 7 and 16 plates. Price 25s. G. Bell and Sons, Ltd., York House, Portugal Street, London, W.C.2.

From Microphone to Ear by G. Slot. Philips Technical Library Popular Series introduction to modern sound recording and reproducing technique. Deals primarily with disc recording but includes a chapter on magnetic tape. Pp. 169; Figs. 118. Price 17s 6d. Cleaver Hume Press, Ltd., 31, Wrights Lane, London, W.8.

Les Antennes by L. Thourel. Comprehensive mathematical treatise on aerials with particular emphasis on decimetre and centimetre wavelengths. Includes chapters on horns, slots, and lenses. Pp. 440; Figs. 252. Price 4,800 Fr. Dunod, 92 rue Bonaparte, Paris, 6.

Informationstheorie Vol. 3 of "Nachrichtentechnische Fachberichte." A collection of 12 papers by authors of many nationalities on applications of information theory, with summaries in English and German. Pp. 118; Figs. 125. Price 16.50 DM. Verlag Friedr. Vieweg and Sohn, Postfach 185, Braunschweig, Germany.

The Second International Congress on Acoustics was held at Cambridge, Massachusetts, in June this year in conjunction with the Annual Meeting of the Acoustical Society of America. These Congresses, which are sponsored by the International Commission on Acoustics, one of the specialized commissions of the International Union of Pure and Applied Physics under UNESCO, are being held at intervals of three years. The first was held at Delft in 1953.

International Acoustics Conference

Some Impressions of this Year's Meeting in the U.S.A.

FROM A CORRESPONDENT

THE opening ceremony and the first two days' technical sessions were held at the Massachusetts Institute of Technology. The following two days' technical sessions took place in Harvard University and the fifth and final days' meetings were again at M.I.T. In addition to the technical sessions, some visits, a concert and a banquet were arranged for the delegates.

The meetings at Harvard were of particular interest because of the associations with W. C. Sabine who originally postulated the concept of reverberation time. Some of the meetings were held in the Sanders Theatre which was one of the auditoria in which he conducted his experiments. His original reverberation chamber was on view, as were some of the famous cushions which he used in providing absorption experimentally. The concert was given by the Boston Symphony Orchestra in the Boston Symphony Hall which is an important acoustic design by W. C. Sabine.

Because this Congress was held in conjunction with the Annual Meeting of the Acoustical Society of America the attendance was much greater than at Delft. In all there were about 900 delegates and almost 300 papers in various classifications. In addition to the delegates there were, of course, associates, bringing the total to the region of 1,200. The variety of papers was great, covering all the aspects of acoustics. Typical classifications were as follows:—

- Architectural Acoustics
- Musical Acoustics
- Speech Analysis and Synthesis
- Physical Acoustics and Sonics
- Loudspeakers and Sound Reproduction
- Noise Control and Measurements
- Bioacoustics
- Geophysical Acoustics
- Radiation and Scattering of Sound

On the evening of the first day a demonstration of speech analysis and synthesis was given by W. Lawrence of S.R.D.E., which was exactly similar to the demonstration he has already given in this country to the I.E.E. and to the Acoustics Group of the Physical Society. Following this another demonstration of speech synthesis was given by G. Fant of Stockholm which, although in some respects it did not reach the standard of the S.R.D.E. demonstration, appeared to indicate a more flexible system which might be capable of great development. A very humorous finale to these demonstrations took the form of a duet sung by both pieces of equipment.

For the benefit of all the delegates, a survey paper was read by Georg von Békésy on the mechanics of the cochlea. Békésy, who has now worked at Harvard University for many years, is well known for his investigations into the theory of hearing.

In the field of loudspeakers and sound reproduction various interesting papers were read. For example, papers were given on "Directional Loudspeakers for Sound Reinforcement" by S. Hill (S.T.C.); "The E.M.I. Stereo Recording and Reproducing Systems" by G. F. Dutton; "Displacement Pickup for Measuring the Motion of a Loudspeaker Cone at Many Points" by K. R. McLachlan. A paper was also read on the latest apparatus for the alteration of the playback time of a sound record by A. M. Springer, who now claims that this equipment, which is basically similar to the "Tonschreiber B" used by the Germans during the war, can expand the time of reproduction of speech and music by as much as 200 per cent and give satisfactory compression of 50 per cent. An interesting paper was read by R. Kirk on "Learning, A Major Factor Influencing Preferences for High-Fidelity Reproducing Systems". This paper describes an attempt to evaluate the effect of experience on the opinions of subjects listening to high-quality electro-acoustic reproducing systems. Two groups were used; one listening to music reproduced between 30 and 15,000 c/s, while the other group listened to 180-3,000 c/s. After they had listened for two hours a week for 13 weeks, tests were carried out which seemed to show that the subjects preferred the particular bandwidth to which they had been listening.

Papers on architectural acoustics reflected the work going on at present to provide effective objective means for measuring the properties of enclosures, but developments are so slow that it will be many years before complete reliance on objective methods will enable satisfactory designs to be carried out.

In the field of musical acoustics several papers described methods of synthesizing sounds, which in some cases were intended to represent normal musical instruments and in other cases to produce sounds entirely different. Some workers are concentrating on the analysis of musical sounds mainly with the object of being able to synthesize them.

A considerable number of papers were devoted to the study of problems of noise and its measurement. This aspect of acoustics assumes greater importance every day because of the new sources of noise, such as jet aircraft, which are now becoming so disturbing that they cannot be ignored. In the case of buildings, the desire to economize leads to lighter forms of construction which are sometimes quite inadequate for sound insulation.

This Congress was very successful in bringing together all the workers in the various fields of acoustics. The delegates enjoyed the proceedings and appreciated the excellent organization. It is perhaps unfortunate that the large number of papers to be read reduced the time for discussion, a point which requires consideration in planning future congresses. Most of the papers read are to be published either in *Acustica* or in the *Journal of the Acoustical Society of America.*

At the concluding session it was announced that the Third International Congress on Acoustics will to be held at Stuttgart in 1959.

Amateur Television

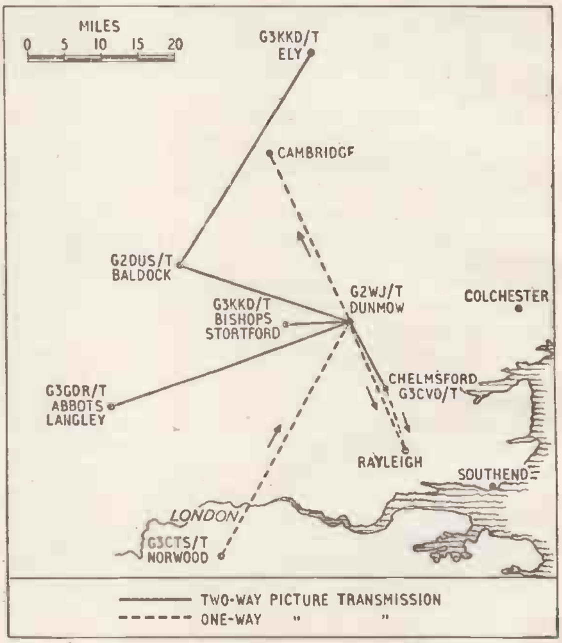
Progress in Colour Transmission

By M. BARLOW (G 3CVO)

SINCE the last general report on amateur television published in *Wireless World* over two years ago, steady progress has been maintained, resulting in some spectacular results. Perhaps the most interesting of these is the work on colour television. As already reported, C. G. Dixon, of Ross-on-Wye, obtained first results over a closed circuit with a home-made frame-sequential colour camera in early 1954, using 150-line 100-frames per second standards. Further development of the colour gear produced a simple colour slide scanner and colour bar generator of a reasonably transportable size. All this equipment was shown in use (closed circuit) at the 1955 British Amateur Television Club Convention, and as a result it was arranged that as soon as practicable, a colour transmission over the air should be tried. By early spring of this year, reliable two-way television transmission had been established between G2WJ/T at Dunmow and G3CVO/T at Chelmsford. Mr. Dixon's colour bar generator and rotating disc monitor were later incorporated in the monochrome apparatus at these two stations, and on April 7th successful colour patterns were transmitted between them. Mr. Dixon was unable to bring the colour camera for this test, but plans are in hand to use it for the transmission of colour pictures from Ross-on-Wye to Birmingham once the path is established.

Naturally, much interest has been aroused by these tests, and although the system is not compatible, it is relatively easy for the amateur to use. Simultaneous colour systems, such as the "British-N.T.S.C.," are, so far as amateurs are concerned, at present limited to slide and film scanning, or to flying-spot studio scanning. On the other hand, simple frame-sequential receivers built to receive N.T.S.C.-type transmissions can easily be modified to receive amateur colour transmissions. For this reason, several colour monitors are being built, especially in the London area.

On the r.f. side, very great strides have been made. Following the continued success of the G2WJ/T (Dunmow) to G3GDR/T (Abbots Langley) transmissions, admittedly over a very good v.h.f. path, contact has been established between six stations in East Anglia. Due to siting difficulties, not all of these stations can work all the others, and attempts are being made to relay pictures from one station to another. Unfortunately, the size of aerial required on some of the more difficult "hops" makes it awkward to mount two arrays at a reasonable height, with consequent reduction of signal-to-noise ratio. Similarly, attempts to work simultaneous duplex between two stations—a realization of a "television-telephone"—have not so far succeeded. It should be explained that all the vision signals are trans-



Television links established by amateurs in East Anglia.

mitted in the 430-440 Mc/s region, with the sound channels, normally duplex, on lower frequency amateur bands such as 1.9 Mc/s or 145 Mc/s. Attempts to space the sound channel the correct 3.5 Mc/s below the vision carrier are only successful over the better paths, as otherwise the loss of vision signal-to-noise ratio is too great to be tolerated as the receiver bandwidth is increased. To overcome this, and for weak-signal reception generally, it is becoming common to lock the amateur TV equipment to B.B.C. or I.T.A. synchronizing pulses at each end of the path; considerably weaker signals can then be resolved quite easily.

There are now 23 amateur television stations licensed, and 14 of these have actually radiated pictures. In Birmingham, G3KBA/T is in a very bad location, surrounded by tall steel-framed buildings, and in order to send pictures from his 16mm telecine scanner to G3KQJ/T at Wolverhampton, a relay *via* a nearby station is necessary. G3KFH/T at Worthing has put out some test transmissions, and hopes to send pictures across the channel. With G3BLV/T (Sunderland) and G2DUS/T (Baldock) thinking in terms of portable television transmitters, no doubt the present record of 38 miles will soon be broken.

As was to be expected, the photo-conductive pick-up tube has replaced all other camera tubes as the first choice for the amateur, on account of its sensitivity, small size and modest power and scanning requirements. Cameras are built along similar lines to industrial TV cameras, often with lens turrets and built-in viewfinders for which second-hand projection tubes run at reduced e.h.t. are popular. Existing cameras of the image iconoscope and image orthicon types are still used, of course, but their size is a distinct disadvantage in the average small workshop. Some surplus American airborne TV cameras have also been used with success, but the tube sensitivity is very low. With photo-conductive tubes, normal room lighting is usually sufficient to produce excellent pictures.

Flying-spot scanning remains the standby for most amateurs; newer blue-trace c.r. tubes enable first-class pictures to be produced for a very small outlay. Tubes in domestic television sets can be pressed into service to give fair results, and considerable attention has been given to the problem of scanning cine film. Thus one 16mm scanner consists of an unmodified Kodascope projector, with a 9-in MW22-14 tube as the scanner, using a 4in by 3in raster. The projector is driven by a synchronous motor, but asynchronous running is possible with slight flickering. A 931A photocell is used, with gamma correction in the video amplifier to correct for receiver tube characteristics. More favoured are the types of scanner in which the film is wrapped round a glass or perspex polygon in the same way as in a simple film editor. This system has the very great advantage for the amateur that a picture is produced at all film speeds without any synchronizing troubles. Scan reversing switches are normally fitted for quick saving of face when the film has been incorrectly loaded! For those with photo-conductive-tube cameras, the problem is much simpler; with the camera pointed at the projector (suitably dimmed), very reasonable pictures are produced with no synchronization whatsoever.

Miniaturization and economy in components are pressed to the limit, and several members are using

BRITISH AMATEUR TELEVISION STATIONS

Call sign	Location	Vision		Sound Frequency (Mc/s)
		Frequency (Mc/s)	e.r.p.	
G2WJ	Dunmow, Essex ...	436.0	250W	432.5 or 145.3
G3GDR	Abbots Langley, Herts.	434.1	250W	434.1 or 144.7
G2DUS	Baldock, Herts. ...	434.5	250W	434.5 or 144.5
G3KKD	Ely, Cambs.	434.1	2W	434.1
G3KOK/T	Bishops Stortford, Herts	437.0	60W	433.5
G3CVO	Chelmsford, Essex ...	430.36	200W	426.86 or 1.97
G3KBA/T	Birmingham, Warwick.	436.8	50W	
G3BLV	Sunderland, Durham	435.1		
G5ZT	Plymouth, Devon ...	427.0	50W	
G3FWF	Belfast, N. Ireland ...	437.75		434.25
G3CTS	Norwood, London ...	427.0	1kW	423.5
G3KRA/T	Chelmsford, Essex ...	442.0	2W	438.5
G3KQJ/T	Wolverhampton, Staffs.	438.75		435.25
G3KFE	Enfield, Middx. ...			
G3JVO/T	St. Albans, Herts. ...	445.5	10W	
G3BAY	Leicester			
G3FNL	Upminster, Essex ...	445.0	250W	441.5
G3KPX/T	Maidenhead, Berks. ...			
G3AST	Luton, Beds.	434.25	50W	144.75
G3KFH/T	Worthing, Sussex ...	433.0	50W	
G3ACK	Blyth, Northumb. ...	432.6		
G3LCM/T	Coulsdon, Surrey ...			
G3LDW/T	Birmingham, Warwick.	434.7	25W	

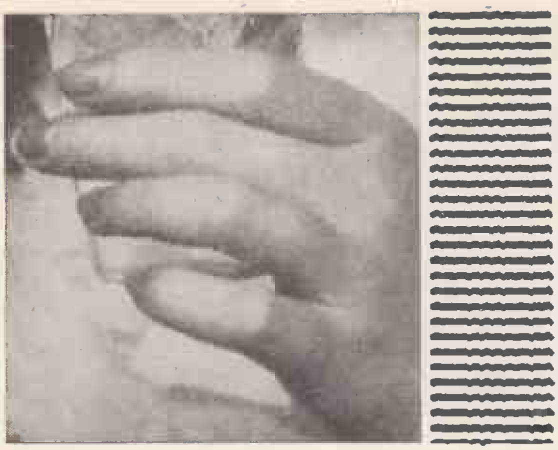
Amateurs with a general transmitting licence add the suffix "/T" when transmitting television.

a simple frame pulse of one half-line duration rather than the full B.B.C.-type waveform. For the latter, some 14 valves are usually required, and the possibilities of transistors are beginning to be explored. As an idea of the size of a typical amateur TV equipment, it may be mentioned that G2DUS/T (Baldock, Herts) has in a rack 36in high by 15in wide the following units: 405-line sync generator, 45-Mc/s oscillator and distribution amplifier, vision mixer, Staticon camera control unit, monoscope unit (Test Card C) and pattern generator, and power supplies. The camera is 10in long by 4in wide and 6in high, and is fitted with 75mm, 35mm and 25mm lenses. With the addition of a domestic TV receiver, a complete closed circuit television station is available.

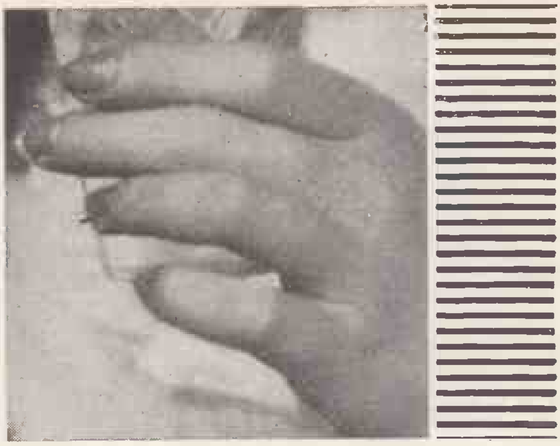
With a view to informing and instructing amateurs in the problems of television transmission, booklets, a film and six instructional tape lectures have been produced. In addition, B.A.T.C. groups have been formed in Southampton, Worthing, North and South London, High Wycombe, Romford, Chelmsford and Birmingham, where meetings are frequently held. There is little doubt that we are in this country well ahead of everyone else in this particular field, although there are active enthusiasts in the U.S.A., the Netherlands, South Africa, Australia and New Zealand.

Future developments are difficult to prophesy; a link between London and Birmingham, and between the United Kingdom and the Continent, are obvious targets. In the meantime experiments continue with a microwave link, pulsing banks of fluorescent coloured tubes for frame-sequential work in colour, simpler sync generators, better film scanners and more effective transmitters and receivers. No doubt when G3CTS/T, the station of the Television Society, at Norwood, starts regular transmissions this autumn, more and more people will be tempted to try it for themselves.

A representative selection of the equipment mentioned in this article will be shown in operation at the third Amateur Television Convention to be held on October 27th at the Bonnington Hotel, Southampton Row, London.



(a)



(b)

Fig. 1. The effect of insufficient tape speed control is shown at (a) both on the received picture itself (a small section) and on the horizontal test bars to the right. At (b) is shown the improvement effected when the control equipment is in operation

RADIO PICTURES ON TAPE

DURING the Olympic Games this winter, some of the news pictures arriving from Australia by radio phototelegraphy are likely to have undergone the intermediate process of storage on magnetic tape. The storage equipment will be operating at Singapore, which is the normal Cable and Wireless relay point on the "eastabout" route between Australia and the U.K. The purpose of the scheme is to facilitate the transmission of pictures when radio conditions are not good enough on both sections of the route simultaneously for direct relaying. Quite often when conditions are good on the first section they are bad on the second, and *vice versa*. With the intermediate storage, however, it will be possible to send a picture from Australia to Singapore even when radio propagation is bad between Singapore and Britain—then to forward it over this second section when the conditions improve.

In the past any storage has been done simply by printing the picture at the relay station and re-scanning it when required. This, however, tended to degrade the picture quality, mainly because of interaction between the two scanning patterns, and Cable and Wireless considered it desirable that the signal itself should be stored, preferably on magnetic tape. Here, the main difficulty arises from possible variations in the speed of the tape. Any such variations between successive scan lines* of the picture produce timing errors, which are particularly noticeable from the ragged reproduction of horizontal edges on the received picture, as shown in Fig. 1(a).

To overcome this problem the Cable and Wireless tape storage equipment incorporates an automatic system of speed control comparable with an a.f.c. loop. This makes use of a stable reference frequency of 2 kc/s from a crystal oscillator, which is recorded on one track of the tape while the other track is taking the incoming picture signal. (An orthodox twin-track tape deck is used, running at 13 inches per second.) On playback this reference frequency is compared with the original from the oscillator, and any difference resulting from a change in speed is used to produce a correction signal which controls the tape drive until the frequency difference is reduced to zero. Since the picture information on the tape and the reference frequency bear a constant relationship to each other (being recorded simultaneously) any correction applied to one means a correction to the other.

The actual comparison of frequencies is done by an electromechanical system. To begin with, the normal tape-drive motor is replaced by a phonic motor which, for the recording operation, is energized from the 2-kc/s crystal oscillator through a power amplifier. On playback, the recorded reference frequency from the tape and the output from the crystal oscillator are both amplified and used to operate two further phonic motors which drive the two input shafts of a differential gear. The cage, or output shaft, of the differential then rotates with a speed and direction corresponding to the difference between the two input speeds (and hence frequencies).

This "error signal" rotation, amounting to perhaps 1° of angular movement, is used to drive a variable capacitor which controls the frequency of one of a pair of 100-kc/s oscillators in a b.f.o. arrangement. The beat frequency obtained is arranged to be 2 kc/s, and this, after amplification, is used to energize the tape-drive phonic motor. Any error signals from the differential gear will cause this 2-kc/s beat to be varied (a matter of 3 or 4 c/s per degree of angular movement) and as a result corrections are applied to the speed of the tape-drive phonic motor in the right sense to reduce the error signals to zero.

The actual stability of tape speed obtained by this method is ± 1.5 parts in 10^4 over the period of one drum revolution (short-term stability) and better than ± 1 part in 10^5 over the period of a complete picture (long-term stability). Fig. 1(b) shows how the timing errors are reduced and the picture quality is improved compared with (a).

* Which are, of course, vertical on the drum scanning system used and are, in fact, 100 lines to the inch.

Colonial Broadcasting

By *JOHN W. MURRAY**

BROADCASTING within the colonies, which has been in operation for not much more than ten years, is posing problems that demand a fairly early solution. The fundamental problem is similar to that which led the B.B.C. and other European broadcasting authorities to introduce a v.h.f. service, although the attendant circumstances are in general very different.

Twelve bands[1] within the high-frequency section of the radio spectrum (3-30 Mc/s) are allocated for broadcasting; some for certain regions and others world-wide. Allowing a "guard" of 5 kc/s at both ends of each band, there is a total available bandwidth of 2,800 kc/s, which, assuming 10 kc/s per channel, provides 280 channels. In order to eliminate "skip" effect close to the transmitting station and to ensure that the greater part of the power radiated is concentrated, as far as possible, within the territory to be covered, it is necessary to arrange for high-angle radiation. This means that, in practice, the maximum usable frequency cannot be higher than the critical frequency.

For the broadcasting services under consideration, therefore, it is unlikely even at periods of maximum sunspot activity that frequencies much higher than 10 Mc/s will be used. The lower limit is imposed by the high noise level below 4 Mc/s. Thus, ignoring all bands above 10 Mc/s, we are left with a total bandwidth for local colonial broadcasting of 1,225 kc/s, providing for only 122 clear channels.

Even supposing that it were possible to achieve complete international agreement on the allocation, clearing and sharing of frequencies (and this, unfortunately, is far from being the case) it is obvious that it is utterly impossible to attempt to accommodate all the required colonial broadcasting stations within the usable part of the h.f. bands. The result of trying to do so is interference on most channels and, moreover, there is no room in the h.f. bands for future expansion. The conclusion to be drawn is that some alternative to the use of short waves must be explored for the efficient internal coverage of individual colonial territories. The obvious alternatives are: medium frequencies and very-high frequencies. The use of medium frequencies, although fairly satisfactory, suffers from two major limitations. First the medium-wave band is relatively uneconomical because of the necessity to use fairly high powers to overcome atmospheric noise, and, secondly, because of the possibility of interference from distant stations after dark. V.H.F. transmissions suffer from neither of these disadvantages.

The use of v.h.f. does, however, suffer from some important limitations. The first is the lack of cheap receivers, whether f.m. or a.m., battery- or mains-operated. Clearly, if a decision is made in favour of the use of v.h.f. broadcasting in under-developed countries, the change-over from short-wave broadcasting will have to be spread over a period of perhaps five to ten years. It would be preferable, therefore, for a "general purpose" receiver to be made available, providing for reception on short and medium waves as well as on the v.h.f. bands. This would be desirable, in any case, so as to make it possible for listeners to tune to overseas stations as well as to their own domestic v.h.f. channels. At the present time such a receiver would not cost less than £30 and, while this might find a fairly ready sale in towns, the rural inhabitants with a much lower income would find it quite impossible to afford such a sum. It is thought that a receiver of the type envisaged could be made available much more cheaply than at present if it were possible for several colonial territories to co-operate so that an initial order of not less than 30,000 receivers could be placed with a single manufacturer. Preliminary discussions have already taken place on this subject with one manufacturer. The servicing of the sort of "combination" receiver suggested might conceivably present major difficulties, particularly if it were decided to use a frequency-modulated v.h.f. system. More complicated test equipment and much greater knowledge and skill would be required to service such receivers compared with the "rule-of-thumb" servicing of a medium-wave or even a medium- and short-wave receiver. A further limitation to the use of both v.h.f. and m.f. broadcasting, particularly in large colonial territories without reliable internal telephone communications, is the problem of expense in supplying programmes to each transmitter. Granted that much could be done to solve this by careful siting and design of aerials (more particularly with v.h.f.), so that some transmitters would also form part of the programme distribution chain.

PROBLEMS OF PROVIDING A DOMESTIC SERVICE

To summarize, it is certain that there can be little expansion of domestic broadcasting in colonial territories on the h.f. bands, whether by an increase in the number of channels or of the powers used. The alternatives are v.h.f. or m.f. Transmitters for v.h.f. might be considered to have greater range for less power than m.f. transmitters, because of the noise limitation on the m.f. band, and, therefore, be cheaper to run. On the other hand, the use of v.h.f. poses some major problems because of the necessity to provide and service much more complicated receivers. I think that this whole problem of the choice of method of coverage is fundamental to broadcasting in every colonial territory, and that discussions should be held, in the near future, between British radio manufacturers and technical representatives of every colonial territory concerned.

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* Nigerian Broadcasting Service.

[1] Broadcasting bands (3-30 Mc/s). Those shared with other services are marked with an asterisk. 3.2—3.4*; 3.9—4.0*; 4.75—4.995*; 5.005—5.06*; 5.95—6.20; 7.1—7.3*; 9.5—9.775; 11.7—11.975; 15.1—15.45; 17.7—17.9; 21.45—21.75; 25.6—26.1.

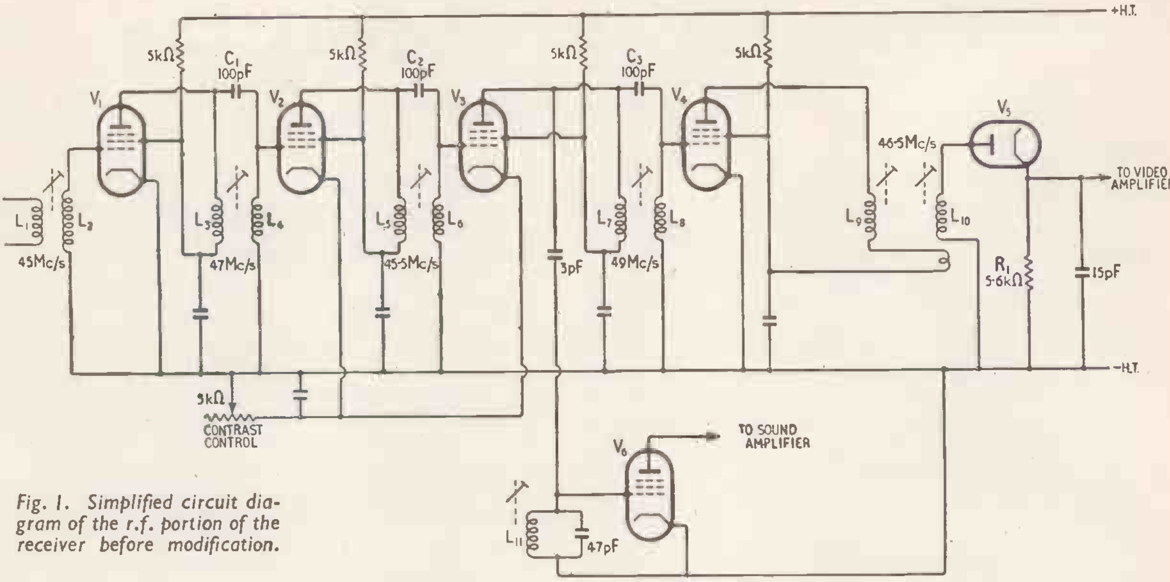


Fig. 1. Simplified circuit diagram of the r.f. portion of the receiver before modification.

Modifying
Upper-Sideband Television Receivers

Alterations to T.R.F. Sets for Reception of the Crystal Palace Transmissions

By G. J. CONWAY

A NUMBER of t.r.f. television receivers built to receive the transmissions from Alexandra Palace were designed to accept the upper vision sidebands and are now giving unsatisfactory reception of the Crystal Palace transmissions which have a vestigial upper sideband (up to 750 kc/s). This article describes the modifications which are necessary to obtain good results from such a receiver.

The original decision to tune the vision receiver to the upper sideband was made in order to reduce, as far as possible, breakthrough of sound signals into the vision receiver and of vision signals into the sound receiver. The outermost lower vision sideband is only 0.5 Mc/s from the sound carrier frequency and, in a television receiver designed to accept the lower or both sidebands, the response of the vision r.f. circuits must fall away sharply (by say 40 dB) in this frequency range. Such a response requires the use of at least two sound rejector circuits in the vision receiver. This problem is considerably eased by tuning the vision r.f. circuits to the upper sideband because the separation becomes 3.5 Mc/s, so large that one rejector is usually adequate.

The receiver which was modified was an Alba Model T432, which may be taken as typical of receivers of the upper-sideband type. A simplified circuit diagram of the r.f. circuits of this receiver before alteration is given in Fig. 1. Of the r.f. circuits L_1L_2, L_3L_4, L_5L_6, L_7L_8 and L_9L_{10} the last is a true bandpass double-tuned circuit but the others are, in effect, single-tuned circuits with a single tuning slug. The top-end capacitors C_1, C_2 and C_3 are 100 pF each which has negligible reactance at the operating frequency and hence L_3L_5 and L_7 behave as r.f. chokes. Originally these circuits were stagger-tuned to give a passband covering the range 45 to 48 Mc/s, the alignment frequencies being indicated on the circuit diagram. These circuits were retuned by adjustment of the dust-iron slugs to give a passband from 42 to 45 Mc/s. The alignment frequencies are indicated in Fig. 2 and it was necessary to add 5 pF of capacitance to certain of the circuits where the slug adjustment gave insufficient inductance. The passband was checked by a voltmeter connected across R_1, the vision detector load, the readings being noted whilst a signal-generator output was swept over the frequency range.

After realignment the picture detail was acceptable but, as expected, there was severe breakthrough of sound on vision. The breakthrough of vision signals into the sound receiver was not as objectionable as expected and could be eliminated with some sacrifice in picture detail by careful alignment of the common r.f. stages. The protection due to the sound rejector circuit L_{11} was inadequate and a second (L_{12} in Fig. 2) of similar design was added to V_4 anode. The details of the inductor used are given in the Appendix. The trap is adjusted by means of C_5 to give minimum output at 41.5 Mc/s at the vision detector.

With the addition of the second sound trap, the receiver performed much better, there being no horizontal bars across the picture due to sound break-

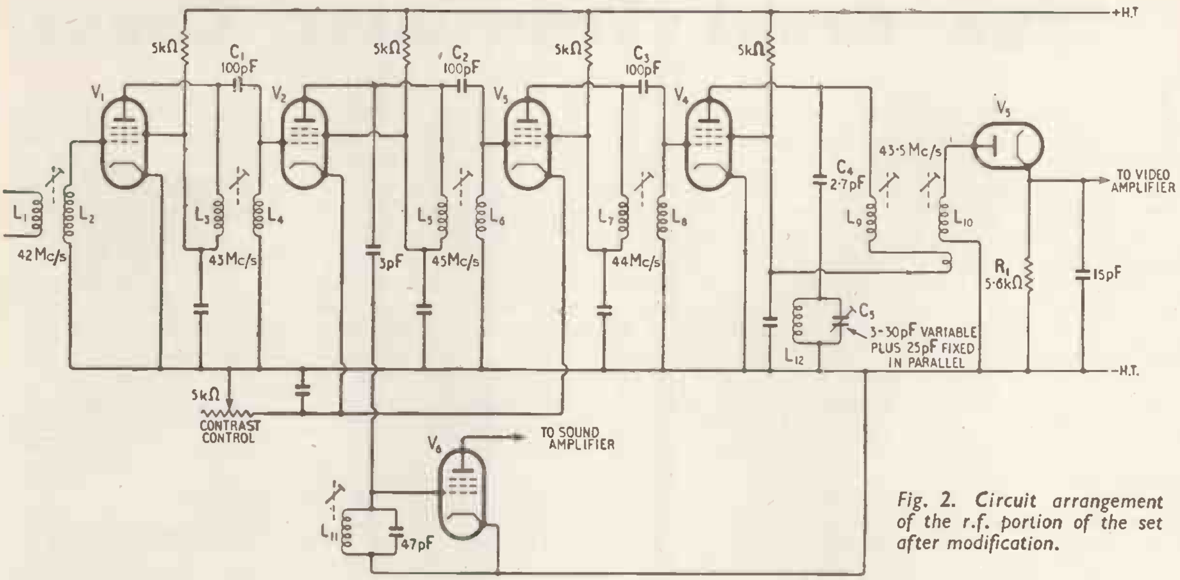


Fig. 2. Circuit arrangement of the r.f. portion of the set after modification.

through. However, there was slight evidence of vision signals breaking into the sound receiver, particularly near maximum or minimum setting of the contrast control. Moreover, there was also visible on the screen a very fine stationary pattern ultimately traced to inter-modulation between the vision and sound carriers. The non-linearity causing this pattern occurred at V_3 grid due to the large sound signal there. The realignment of the common r.f. circuits at a lower frequency had brought about a considerable increase in sound gain and the signal at V_3 grid was large enough to cause cross-modulation. To reduce the sound signal at V_3 grid the sound take-off point was transferred from V_3 to V_2 anode, which still left more than adequate sound gain but eliminated the sound patterning and a slight tendency towards instability in the sound receiver. A small capacitance (3.3 pF) was required at V_3 anode to make up for the loss due to removal of the sound rejector. After realignment the performance of the receiver was satisfactory.

APPENDIX

Details of Sound Rejector Coil L_{12}

10 turns of No. 18 s.w.g. tinned copper wire wound as a self-supporting air-spaced coil of ¼in internal diameter occupying a length of 1in.

COMMERCIAL LITERATURE

Ionospheric Scatter.—Transmitter of 40kW output, covering 35-55Mc/s, for frequency shift keying of 4-9kc/s. Duplicate r.f. amplifiers, normally operating in parallel, for continuity of service. Double diversity receiver, 30-60Mc/s, with triple frequency changing, using separate "mark" and "space" receiving chains. Leaflet from Marconi's W.T. Company, Marconi House, Chelmsford, Essex.

Communications Receiver, 15-45kc/s and 100kc/s-30Mc/s, with exceptionally long tuning scale of about 4ft for each of seven ranges. Has incremental tuning control over constant 100-kc/s range and incorporates crystal calibrator giving 100-kc/s check points throughout frequency range. Specification on a leaflet from Airmec, High Wycombe, Bucks.

Television Waveform Generator; valve-voltmeter; audio frequency meter; power supply units; and television and f.m. pre-amplifiers and distribution amplifiers. Illustrated catalogue from Channel Electronic Industries, Dunstan Road Estate, Burnham-on-Sea, Somerset. Also a leaflet on a portable **Moisture Meter** with a battery life giving about 10,000 readings before replacement.

Closed Circuit Television Equipment for educational and demonstration purposes. Comprises miniature camera, using 16-mm lenses, portable control equipment using plug-in units, and direct-viewing monitor. Also two projection equipments available for larger audiences. Leaflets from General Precision Laboratory, 431, Fifth Avenue, New York 16, N.Y., U.S.A.

V.H.F. Aerials for television and f.m.; general aerial accessories; connectors; cables; and a range of test gear. Catalogue, including many items of British manufacture, from Rudolph Schmidt, Gl. Kongevej 64, Copenhagen 5, Denmark.

"Transistors for the Experimenter" is the title of a new booklet giving application notes and 17 practical circuits built around the OC70, OC71 and OC72 Mullard types. Characteristics and circuit configuration are discussed, with sections on large- and small-signal a.f. stages, d.c. stabilization of working point, and oscillator and switching circuits. From Mullard, Technical Service Dept., Century House, Shaftesbury Avenue, London, W.C.2.

Impregnation Recording Equipment for use in manufacture of cables, transformers, capacitors, etc. Gives continuous record on paper chart of insulation resistance, self-capacitance (of cables), and temperature and vacuum inside impregnation tank. Leaflet from Addison Electric Company, 10-12, Bosworth Road, London, W.10.

Germanium Diodes and Transistors. Manual giving full characteristics with curves, application notes and specimen circuits of 18 Telefunken types. A power transistor, OD604, when used in a Class B push-pull audio output stages gives 3.5W with a 6-V supply. From Telefunken, Mehringdamm 32-34, Berlin S.W.61, Germany.

Power Supply Units, voltage regulated, for 105-125V, 60c/s. Have recovery time of less than 50μsec and are suitable for square wave pulsed loading. Voltage range continuously variable, and either positive or negative may be earthed. Leaflet from Kepco Laboratories, 131-138, Sanford Avenue, Flushing 55, N.Y., U.S.A.

Projection Television Screen, 24in × 18in, for use in larger receivers (back projection type) in schools, hotels, clubs, etc. Made of plastic material and has Fresnel and lenticular patterns embossed, as in smaller types. Leaflet from Mullard, Century House, Shaftesbury Avenue, London, W.C.2.

Magnetrons and Travelling-Wave Tubes. Theory of operation, performance characteristics, application notes and techniques for measuring important electrical parameters are given, as well as data on commercially available types, in a booklet from R.C.A. Great Britain, Lincoln Way, Windmill Road, Sunbury, Middlesex, price 4s 6d.

The Great Transistor Chaos

IT is sometimes said that one doesn't have to know how a transistor works in order to be able to use it. In a sense, that is true; but it is as well to consider what sense. For instance, what is meant by " using " a transistor?

In one sense, all the people who are going to buy transistorized portable sets will be using the transistors contained therein. Obviously they will not find it necessary to take a course on the physics of semiconductors in order to be able to do so. Most of them will know nothing whatsoever about how transistors work, and probably would not recognize one if they saw it. In the same sense, users of motor vehicles would include passengers, who in that capacity secure no appreciable advantage from a study of thermodynamics.

But it is rather different for those who drive. Though it is true that very many motorists have only the haziest idea of the means by which their operation of the controls achieves the desired results, this is regrettable; to get the best out of a machine, intelligent understanding is better than memorized rules. It would, however, be pressing the point rather far to insist that drivers ought to be competent in the theory of thermodynamics as well as in practical mechanics. But when we come to a third class —those who design the things—practical mechanics might be enough for turning out some sort of vehicle, but certainly not a good one by present standards.

Too Many Data ?

I assume that *Wireless World* readers are not content just to listen to transistor radio, or even to control it, but want to apply transistors to their own problems without having to receive word-by-word instructions. In my view, it is not enough to regard transistors as little three-terminal boxes having certain characteristics as set forth on the makers' data sheets. Without at least a rough idea of their internal electronics, one is quite likely to ruin them at a very early stage of the practical proceedings. In any case, a willingness to accept them as boxes of mystery is surely rather a poor state of mind?

Hence my recent efforts* to impart the aforesaid rough idea.

The next step is to learn what the makers' data mean. And that is where trouble really begins. If, when studying the electronic side of the subject, one finds the Fermi levels and Pauli exclusion principle too much, one can always give up; such knowledge, though desirable, is far from necessary for ordinary purposes. But if one is in a state of confusion about transistor characteristics, that state is bound to affect everything from there on.

The full extent of the difficulty may not appear at first sight. After all, having learnt what transistors are, one is prepared for their characteristics to be a little more complicated than a valve's. Looking at the first data sheet we find α, the current amplification. That is all right; we know that a transistor is basically a current amplifier, so it is natural to have this α in place of a valve's μ. Then instead of the familiar r_a there are four resistances: r_e, r_b, r_c and r_m. Well, we have been prepared for the fact that the input electrode of a transistor, unlike the biased grid of a valve, is highly conductive, so it is natural for there to be a r_b (presumably base resistance) or—and possibly and—r_e (emitter resistance) as well as r_c (collector resistance). But what is r_m? Something analogous to $1/g_m$? Certainly all these resistances are going to make transistor calculations more complicated than valve calculations. And of course there are the alternative methods of connecting it, resulting in widely different amplification factors such as α and α'. Come to think of it, though, the effective μ of a valve is also altered very much if the valve is connected as a cathode follower instead of with the more usual earthed cathode; so that is no new complication.

Thus we may comfort ourselves.

Then we look up another data sheet and find a set of completely mysterious quantities called h_{11}, h_{22}, h_{12} and h_{21}, to say nothing of h_{11}', h_{22}', h_{12}' and h_{21}'. And that is far from all. We look up a book to get a bit of know-how, and discover that it prefers to deal in r_{11}, r_{22}, r_{12} and r_{21}, which are not (as we had dared to hope) just different symbols for the same things. Worse still; in another book—or perhaps the same one—we encounter g_{11}, g_{22}, g_{12} and g_{21}. And we learn that the foregoing r and g groups apply only at low frequencies and really ought to be the " complex" quantities z and y. And another book, while using the known r_e, r_b, r_c and r_m, also throws in r_d. And while one technical periodical extols the merits of r_{in} and r_{out} in place of r_{12} and r_{21}, another advocates a " reverse current amplification," β. And when we come to equivalent circuits for the transistor (to compare with the two alternative kinds we know for the valve) we find that one book alone† shows dozens of different varieties, merely as samples of many more!

Before you instruct your newsagent to stop the *Wireless World* and decide to seek admission to the Royal Horticultural Society instead of the I.E.E., may I prevail upon you to do nothing rash. I entirely agree with you that the situation just outlined is one which would excuse, if not justify, a breach of the peace or other departure from normal civilized behaviour. Nor am I able to offer any hope that its obscurities can be dispelled by a few crisp words of explanation. But although there is something to be said for every one of these systems, in the course of time the principle of survival of the fittest will presumably operate; and meanwhile there exist tables for " translating " transistor data from one system to another.

I feel we would be better equipped to find our way through this rank technical jungle if we turned back to review what was done with the valve. This is the approach adopted by W. T. Cocking in his excellent series " Transistor Equivalent Circuits," in the July to October issues last year. Part 1 of that series, in fact, is devoted entirely to the valve; and I recommend you to read (or re-read) it before going any further—even though he did adopt the opposite

*In the July to September issues inclusive.

†" Transistor Electronics," by A. W. Lo and others. (Prentice-Hall, Inc.)

convention to the one I favour‡ with regard to the direction of anode current. He had a good reason for doing so, because instead of beginning with the usual "small signal" or a.c. equivalent circuit (which might have puzzled beginners unused to the idea of neglecting such things as h.t. and grid bias sources) he started from the static or d.c. characteristics and thereby was logically almost obliged to decide on the direction of the anode current as being the same as the d.c. component supplied by the h.t. source, even though that source forms no part of the purely a.c. equivalent circuit and its intrusion conflicts with the usual convention of reckoning voltages relative to the cathode. Here, for brevity, I must assume that everyone who had not already grasped the idea of omitting the d.c. parts in an equivalent circuit has made good that deficiency by learning from Mr. Cocking.

And since this subject is complicated enough at the best, I am going to restrict it to (1) triodes (three-electrode valves and transistors) and (2) low-frequency operation (ignoring electrode capacitances, hole storage, and other high-frequency effects). It is, of course, assumed that operation of both valves and transistors is confined to nearly linear parts of their characteristic curves and that, owing to appropriate negative bias, valve grid current is negligible.

‡"The Valve 'Equivalent Generator'," *Wireless World*, April 1947.

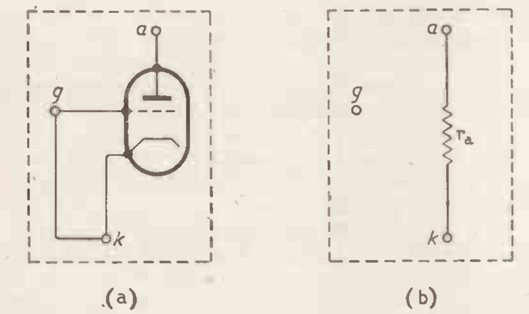


Fig. 1. (a) represents an actual valve, with its grid signal voltage relative to cathode kept at zero by short-circuiting g to k. (b) is the equivalent circuit of the valve under these conditions; it can be substituted for (a) for purposes of a.c. signal calculations.

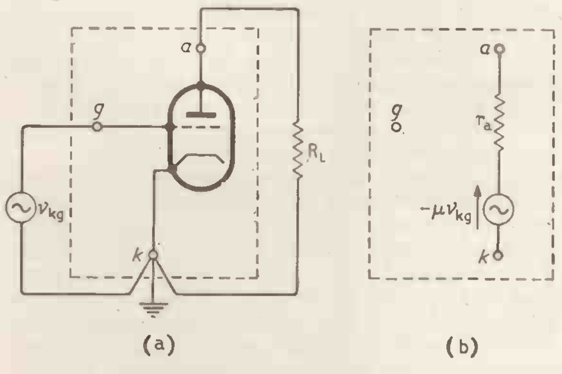


Fig. 2. (a) The essentials (so far as a.c. is concerned) of the most familiar basic type of valve circuit, in which the input (a signal source) is connected between g and k, and the output (a load resistance) between a and k. (b) The valve equivalent.

Because of this absence of grid current, there is only one current path through the valve—between cathode and anode. The current through this path depends on the voltage across it, just as with any resistor. It also depends on the grid voltage relative to the cathode, but if we wish we can exclude that from the problem by short-circuiting it to cathode, as in Fig. 1(a). So far as a.c. is concerned, the valve so connected behaves as a resistor of approximately constant resistance, which is customarily denoted by the symbol r_a. The equivalent circuit of the valve is therefore as shown at (b). The value of r_a is invariably included among valve data. It can be measured in the same way as any other a.c. resistance, if provision is made for the appropriate d.c. through the valve. Alternatively its value can be derived from the slope of the anode-current/anode-voltage characteristic curves within suitable limits; e.g., if an additional 15V is needed to increase the anode current by 1mA, then $r_a = 15/0.001 = 15{,}000\,\Omega$ or $15\,k\Omega$.

A Familiar "Equivalent"

The next step is to represent what happens when the grid voltage is variable. The means of varying it is shown in the valve circuit diagram, Fig. 2(a), as a generator giving an alternating voltage v_{kg}. Note that this symbol signifies the e.m.f. in the direction *k* to *g*, which means that when it is positive it makes *g* positive (relative to *k*, which is reckoned as zero potential). Again, the valve—the part of the diagram within the dotted line—can for purposes of calculation be replaced by the equivalent circuit, Fig. 2(b). The influence of v_{kg} is represented here by a generator in series with r_a delivering a voltage $-\mu v_{kg}$, where μ is the universally accepted symbol for the valve's voltage amplification factor, equal to the number of anode volts that have to be applied to offset minus one grid volt. This too can be measured, or derived from sets of characteristic curves which show the effects on anode current of both anode and grid voltage. Because there is no grid current the grid terminal in the equivalent diagram is not connected internally, and indeed is often omitted, except in diagrams where inter-electrode capacitances are taken into account.

A valve is normally connected at two points to an input and at two to an output, making four connecting points altogether; but as there are only three electrodes one electrode must be common to both input and output, being joined to them either directly or through negligible a.c. impedance. In each case it is the low-potential terminal of the pair that is "commoned," and these terminals are often kept at their constant potential by earthing, as shown in Fig. 2(a). The basic valve circuit "configurations," as they are termed in America, are distinguished by the electrode that is common to both input and output. With a triode there are therefore three of them, called by true Britons "earthed-cathode,"

" earthed-anode " (or, for other reasons, " cathode follower ") and " earthed-grid." Americans, in accordance with national custom and therefore quite logically, say " grounded " instead of " earthed." Certain persons in this country, contrary to national custom and even their own custom in other contexts and therefore quite illogically, also say " grounded ". In view of this situation, which almost led to an unedifying fight between a contributor and the Editor,§ I have decided to fall in with a growing practice on both sides of the Atlantic and abandon both words in favour of " common." Not only is this free from any taint of nationalism but it more truly describes the condition, earthing not being the really essential feature. The earth symbol in Fig 2(a) and other diagrams is there mainly to call attention to which is the common low-potential electrode.

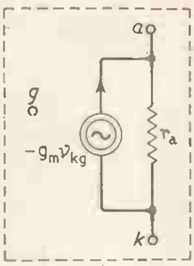
The Preferred Circuit

Theoretically, one could argue that there are six basic configurations. For each of the three choices of common terminal there is a choice of which of the other two is to be input and which output. But in each case only one of these gives amplification, so the other is not usually counted.

With valves, the common-cathode arrangement is the original and by far the most commonly used, so the accepted practice has always been to measure valve characteristics in this condition and to reckon voltages relative to cathode—hence my strong preference for the convention shown in Fig. 2(b), where the artificial anode generator gives *minus* μv_{kg} volts relative to k, and the positive direction of signal current is from k to a as indicated by the arrow, opposite to the steady d.c. component. Otherwise one has to suppose that this generator acts from a to k, contrary to the convention of regarding k as the starting point.

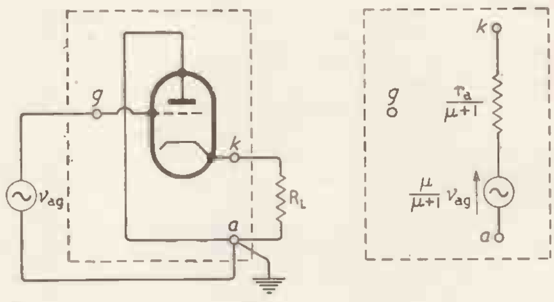
But that is by the way. The important thing just now is the fact that there is, and always has been, no doubt at all about which of the three configurations is assumed when mentioning the two essential triode " parameters," as they are called: r_a and μ. If the first use of triodes had been as cathode followers it would have been quite different: as we shall soon see, μ would always have been less than 1, and r_a much less than we are used to, and conversion formulae would have been necessary to derive the values applicable in Fig. 2(b).

Another important point is that, thanks to the non-conducting grid path, there are only these two basic parameters, r_a and μ. But what, you may say, about the mutual conductance g_m? Although g_m is nearly always included among valve data it does not make a third basic quantity, because if the first two are known it is known too, being equal to μ/r_a. Moreover it is not needed at all in the well-known form of equivalent circuit we have seen—Fig. 2(b). But as an alternative to this equivalent, with its voltage generator in series with r_a, there is another form, with a current generator¶ in parallel with r_a—Fig. 3. One can show (as I did in the April 1951 issue—" That Other Valve Equivalent ") that it



Left: Fig. 3. An alternative to the voltage generator in series with r_a is a current generator in parallel.

Below: Fig. 4. (a) the cathode follower or common-anode circuit. (b) The circuit equivalent of the valve, adapted to be in terms of the signal e.m.f. v_{ag}.



always gives exactly the same results. But it is sometimes more convenient; especially with tetrodes and pentodes, which are covered by the triode equivalent circuits so long as the extra electrodes are tied down to constant potentials. Their μ and r_a are so high that Fig. 3 is the more natural choice; in fact, if the load impedance is very low compared with r_a, r_a can be omitted without making much difference to the calculations.

Since in Fig. 3 the load impedance comes directly in parallel with r_a, it is more logical to think of it as a load *admittance*, which can be added directly to the anode *conductance* g_a $(= 1/r_a)$ to give the total admittance fed by the current generator. I just mention this to show that although (within the restrictions we have assumed) there are only two basic valve parameters, one can make for oneself quite a wide choice as to which two, some being more convenient for some purposes and others for others. Fortunately the relationships between them are simple, so that (as we have seen) it is quite easy to transfer from μ to g_m or from r_a to g_a. And there is no risk of the situation getting out of hand; there are clear reasons for quoting primarily μ and r_a for triodes and g_m and r_a or g_a for tetrodes and pentodes, and nobody is in any doubt about the common-cathode being the configuration to which they apply.

But the other two configurations are used quite frequently, so we must see what happens about their equivalent circuits. Let us take the common-anode circuit or cathode follower first. Fig. 4(a) is the circuit diagram in its simplest form. The valve could of course be drawn with its terminals in the same positions as in Fig. 2(a), but the diagram would then be difficult to recognize as a cathode follower, so I have drawn it in the customary manner with the low-potential terminal brought down to the foot. In a practical circuit, of course, there would be a blocking capacitor between this and the anode so as not to short-circuit the h.t., but to signals there is (or should be) effectively a short-circuit.

§" 'Grounded Grid' A.F. Amplifier," by Thomas Roddam, *Wireless World*, May 1954, p. 214.

¶There seems to be no standard circuit symbol for a current generator; the one shown here is often used, but I am sure it could be bettered. An important requirement is that a current-generator symbol should suggest a source of infinitely high impedance, incapable of acting as a shunt to r_a.

Fig. 2(b), let us take care to note, is still a valid circuit equivalent of the valve, because within its dotted line the valve itself is no different for being in a cathode-follower circuit or any other, provided it gets its proper ration of d.c. But Fig. 2(b) is not a convenient equivalent now, because it is based on v_{kg}, which is not shown in Fig. 4(a). Moreover, although true, it is misleading, because v_{kg} is affected by any external voltage applied across *ak*, which causes the equivalent internal generator to behave in such a way as to make the resistance seem lower than r_a.

So the normal practice is to recalculate the resistance and generator e.m.f. in terms of the external signal voltage v_{ag}, and the result is shown in Fig. 4(b). Note that although the generator arrow is still pointing upwards the path itself has been reversed to match diagram (a), since the low-potential terminal of the output is now *a* instead of *k*. This reversal cancels out the minus sign that was needed in Fig. 2(b), and means that the output voltage has the same polarity as the input. Note that the equivalent generator e.m.f. and resistance are in terms of the common-cathode parameters r_a and μ, but that is simply a tribute to the relative importance of the common-cathode configuration. There is nothing to stop anyone measuring valves' internal resistances and amplification factors with the common-anode connection and inventing symbols for them, say r'_a and μ'. However, as these would be relatively seldom used and their equivalents in Fig. 4(b) are not difficult to remember, there would be no great point in the exercise, so they are not included in published valve data.

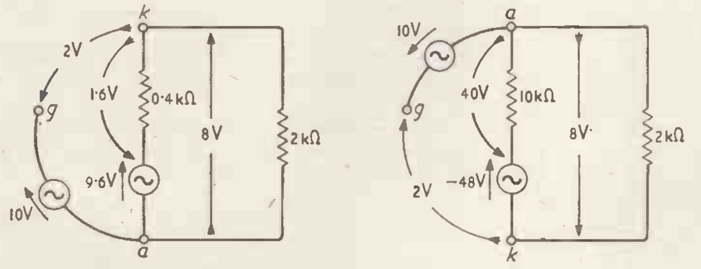
Just in case there are any lingering doubts about the two equivalent circuits, Figs. 2(b) and 4(b), being equivalent to one another, let us take a simple numerical example. Suppose the valve used in the cathode follower circuit, Fig. 4(a), has a μ of 24 and r_a of 10 kΩ, and that the load resistance R_L is 2 kΩ and the input (v_{ag}) is 10V. Then, using the Fig. 4(a) equivalent circuit we calculate the internal resistance as $10/25 = 0.4$ kΩ, and the internal generator voltage as $24/25 \times 10 = 9.6$V. This 9.6V is distributed between the internal resistance and R_L in proportion to their resistances, to R_L's share works out at $9.6 \times 2/(2 + 0.4) = 8$V, as shown in Fig. 5(a). Note that this makes the *net* input to the valve—from *cathode* to grid—2V, being the difference between the gross input of 10V and the 8V output fed back as a result of the signal being connected from anode.

Now make the same calculation using the other equivalent, Fig. 2(b). Here the internal generator voltage is $-\mu$ times the net input v_{kg}, which we now know to be 2V. It is therefore -48V. But this apparent increase in voltage is exactly offset by the higher internal resistance, 10 kΩ. So the output is again 8V—Fig. 5(b). The minus sign for the generator voltage doesn't make any difference, because in this equivalent circuit the generator voltage is reckoned from cathode. The output voltage is still in the same direction as with the other equivalent, reckoned from anode. Although the second method of calculation gives the same answer as the first, it is less convenient, because we had to know the answer in order to find it. The first method, on the other hand, gives it direct from the gross input, v_{ag}.

More Like a Transistor

Lastly, the common-grid circuit, Fig. 6(a). Though not drawn in quite the usual way, it should be easily recognizable. Again, Fig. 2(b) is still a true equivalent, but again it is misleading. Unlike the other two circuits, with this one the load is connected between anode and *grid*, which means that the signal source is in series with the current-carrying path through the valve, and so the impedance of this source comes into the problem and must be shown. In Fig. 6(a) it is the resistance R_s. Because of it, the e.m.f. of the source is not the same as the voltage between *k* and *g*, so cannot appropriately be called v_{kg}. I have, therefore, marked it v_s; and as that label does not indicate its direction an arrow is shown instead, to make quite clear that this time, because *g* is the low-potential terminal, the *input* is reversed. The high-potential terminal of the output is *a*, the same as in Fig. 2, so again there is one reversal to cancel out the minus, giving the output the same polarity as the input.

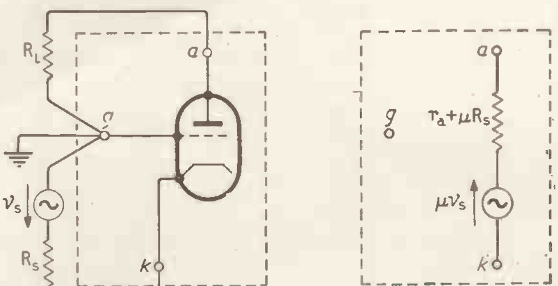
Although the valve equivalent generator voltage, μv_s, makes no allowance for the loss in R_s, that is all right because the loss is exactly allowed for by



(a) (b)

Left: Fig. 5. Numerical calculation of a particular cathode follower, using (a) the valve equivalent devised especially for cathode followers and shown in Fig. 4(b), and (b) the common-cathode equivalent shown in Fig. 2(b).

Below: Fig. 6. (a) Common-grid circuit, showing the signal source resistance R_s because this affects the signal voltage actually reaching the valve. (b) Equivalent circuit of the valve, in terms of the source e.m.f. v_s.



(a) (b)

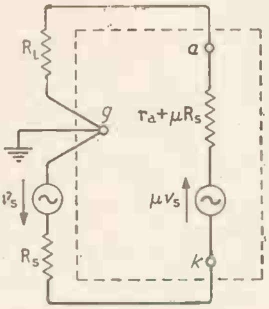


Fig. 7. Circuit diagram for calculation purposes, obtained by substituting Fig. 6(b) in Fig. 6(a).

the addition of μR_s to r_a in the internal resistance. The reason for the multiplier μ is that the voltage drop across R_s affects the voltage between cathode and grid, and this effect is amplified by the valve.

The fact that the input and output circuits are connected directly in series with one another means that the resistance "seen" by each when it is connected depends on the resistance of the other—that is to say, something outside the valve—and makes this configuration more like a transistor circuit than the other two. This point of resemblance to the transistor is interesting, and to get ourselves in training for transistor circuits let us reckon what the input and output resistances are. By "input resistance" I don't mean R_s, the resistance of the input circuit, but the resistance the input circuit works into between *g* and *k*.

Input and Output Interaction

Take the output resistance first. Substitute Fig. 6(b) for the valve in (a), to give Fig. 7, and add up the resistances from *a* to *g* through the valve and input circuit. There is $r_a + \mu R_s$ and R_s, so the total is $r_a + (\mu + 1)R_s$. Clearly that could be a lot higher than r_a, which is what one gets in the common-cathode circuit.

Now the input circuit. One might suppose that it sees $R_L + r_a + \mu R_s$. But just as in Fig. 4 a voltage applied between the output terminals gets to the grid and causes an amplified current to flow through the source of the voltage, giving it the impression that it is feeding a much lower resistance than r_a, so in Fig. 6 the source of input voltage drives a current through itself, since it is in series with the output circuit. That current is equal to the total e.m.f. acting (which Fig. 7 shows to be $(\mu + 1)v_s$) divided by the total resistance, $R_L + r_a + (\mu + 1)R_s$:

$$i = \frac{(\mu + 1)v_s}{R_L + r_a + (\mu + 1)R_s}$$

But the signal source, knowing nothing about the internal generator, imagines its own e.m.f. is causing all this current, and judges the input resistance to be v_s / i, less its own internal resistance R_s:

$$R_{in} = \frac{R_L + r_a + (\mu + 1)R_s}{\mu + 1} - R_s$$
$$= \frac{R_L + r_a}{\mu + 1}$$

That is very low—much lower than the output resistance—so this valve circuit resembles a transistor amplifier quite closely. But there is still the absence of grid current to simplify the equivalent circuit. It may help us to tackle the more difficult problem next month if we sum up the points about valves that we should keep in mind:

(1) There are three possible two-terminal paths through a triode (including a tetrode or pentode if the extra grids are tied down to other electrodes)—grid to cathode, grid to anode, and cathode to anode—but under working conditions there is no grid current, so only the last of these three is a current-carrying path and, therefore, is the only one to appear in any equivalent circuit diagram.

(2) Consequently there are only two basic parameters—one to specify the resistance of the single current-carrying path, and the other to specify the control over it possessed by the grid.

(3) Because the valve has only three terminals, the input and output pairs of terminals must have one in common.

(4) Depending on which of the three valve electrodes is connected to the common input-output terminal, there are three "configurations" or basic arrangements of a valve in its circuitry.

(5) Of these three configurations, the common-cathode one is by far the most important, so is universally accepted as the choice for measuring the valve parameters. The standard symbols for these parameters—r_a and μ—are therefore well understood to refer to common-cathode connection.

(6) The parameters for the other two configurations are usually given in terms of the common-cathode symbols; no special symbols for them have been officially appointed.

(7) Although any equivalent that may be devised to represent the valve is valid for any circuit configuration in which the valve may be placed, for practical convenience the equivalent is devised so as to be in terms of the quantities that are known in that particular configuration.

(8) For some purposes it is convenient to use derivatives from the two basic parameters, especially μ/r_a and $1/r_a$. These are sufficiently important to have been given the special symbols g_m and g_a respectively; and often g_m is the quantity to be directly measured, rather than μ.

(9) Because there are two elements in each equivalent circuit diagram there are two varieties of it—series and parallel.

It will be by comparison with these valve facts that we will attempt to bring some order out of the transistor chaos.

STEREOPHONIC HEAD

A COMBINED playback and recording head for twin-channel stereophonic tape records has been developed by Truvox, Ltd., 15, Lyon Road, Harrow, Middlesex. It is available as a separate unit and costs £14 10s.

Truvox TR2049 stereophonic recording / playback head

The windings are of high-impedance type (50 kΩ at 10 kc/s), and are stated to have a frequency range, with suitable amplifiers, of 50 c/s to 15 kc/s. The gap width is 0.00025in.

For recording a bias voltage of 120V, r.m.s. is recommended with a recording current of approximately 0.1 mA. The output on playback is of the order of 1 to 3 mV.

Four-Standards Television

Problems of Receiver Circuit Design in Belgium

By *H. de LAISTRE BANTING*, A.M.Brit.I.R.E.

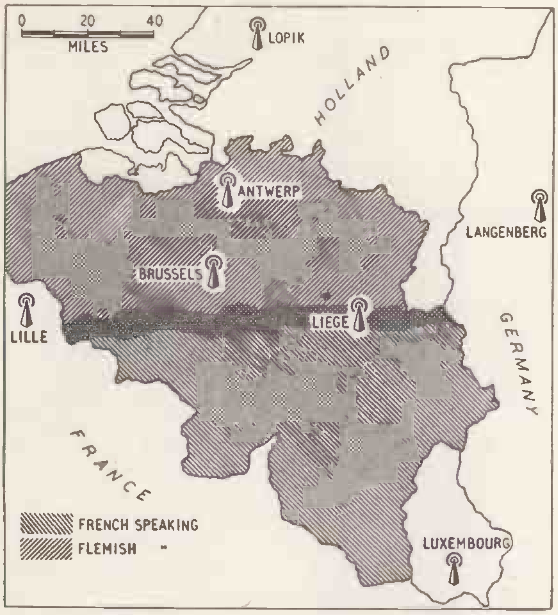


Fig. 1. Map showing relationships between the Belgian language groups and the television stations of neighbouring countries providing a useful signal for Belgian viewers.

TELEVISION engineers visiting Belgium are usually surprised to find that the four-standards problem which we have here must be solved for almost every viewer. The present receiver market, although small by comparison with that in Britain, is expanding rapidly. Even so, the call for simple television sets able to receive one or two stations of similar transmission characteristics is virtually non-existent, a fact which will be more readily understood if one takes into account the psychological factors present.

There are two major languages spoken in this small country of 8,000,000 inhabitants, French in the south and part of the east, and Flemish in the north and part of the west. In addition, in parts of the south-east, German is spoken, although a large part of the population is able to understand both French and Flemish more or less fluently. A glance at a map, Fig. 1, will therefore indicate the origin of some of the problems. The Flemish living on the French border wish to receive Dutch and German transmissions, while the French-speaking viewers on the Dutch and German borders go to extraordinary lengths to get acceptable pictures from Lille.

One may look hopefully towards the Grand Duchy of Luxembourg, which transmits in French. This is very acceptable to the sparse population of southern Belgium, but most upsetting to the viewers in the Grand Duchy, who normally speak German and tune their sets to the German station situated in the Black Forest. At all events the Luxembourg transmissions are, in fact, intended for France!

It will thus be seen that for a very long time to come the demand for all receivers in Belgium and the Grand Duchy must inevitably be for "fringe-area" models able to receive any type of transmission current in Europe except the "8-Mc/s channel C.C.I.R." from the U.S.S.R., which is nevertheless receivable in some parts of Benelux. Furthermore, except for Lopik in Channel 4, Liége in Channel 3 and Antwerp in Channel 2, all stations are in Band III.

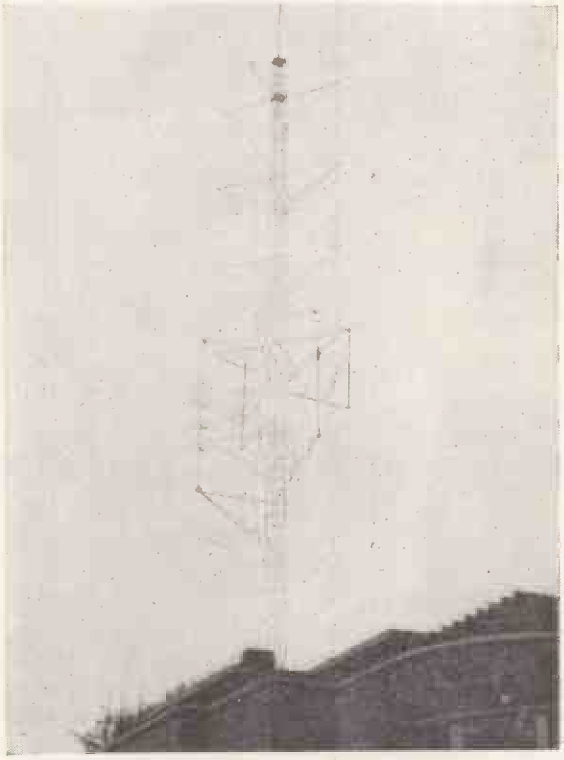


Fig. 2. Elaborate television aerial on a private house in the Avenue Terveuren, Brussels.

The aerial systems are necessarily in keeping with the viewer's determination not to miss anything! Fig. 2 shows one of the more exaggerated private installations in Brussels. Throughout the country, and in the Grand Duchy, one can see 7 to 10-element stacked Yagis mounted on masts well over 100ft high. In fact one of the standard masts sold is 30 metres high and fitted with a rotary mechanism. This sort of thing is more understandable when one considers the location of many of these people living in the country districts without other forms of entertainment, to which is added the language difficulty already explained above. As elsewhere in Europe, a great deal of Belgian television is to be found in the cafés.

From Table I we see the principal differences between the various standards. It is not often realized abroad that during a Belgian programme the announcer will ask viewers to switch from 819 lines to 625 lines or vice versa. This is because Belgian stations retransmitting a Eurovision programme do not "convert" the number of lines except in the case of programmes originating from the B.B.C. This state of affairs immediately precludes coupling the line timebase frequency switch to the channel selector, which would have seemed the obvious thing to do.

The reader will no doubt have thought of the hum problem, which could be solved only by synchronizing the mains of all neighbouring countries. There is another aspect which is fraught with danger. The daily retransmissions in Belgium of the Paris programme are done by using only the picture (on half-bandwidth), and substituting the Belgian sync waveform. In the early days this was disastrous for the flywheel line timebase. Synchronizing the frame timebase in the presence of heavy impulse interference is especially difficult when using the French transmission direct from Lille, due to the fact that the frame sync waveform consists of a single pulse of 20 μsec duration. This has the advantage of giving a somewhat better result on interlace, but the sync is made very much "weaker" by the technique.

Table I

Origin	No. of lines	Video bandwidth (Mc/s)	Sound/vis. separation (Mc/s)	Sound car. relative to vision car.	Modulation:	
					sound	vision
France ...	819	10.4	11.15	lower	A.M.	pos.
Belgium ... (Flemish)	625	4.5	5.5	higher	A.M.	pos.
Belgium ... (Fr. lang.)	819	4.5	5.5	higher	A.M.	pos.
Luxembourg	819	4.5	5.5	higher	A.M.	pos.
Holland ...	625	4.5	5.5	higher	F.M.	neg.
Germany ...	625	4.5	5.5	higher	F.M.	neg.

Note.—All Belgian stations change from 625 to 819 lines or vice versa depending upon Eurovision relays.

Necessary Compromises

After a little experience of the conditions obtaining in Belgium one is forced to certain conclusions on the need for applying a number of compromises, in order to have reasonably acceptable pictures from all directions.

Due to the uncertainty of the black-level in Belgian transmissions, plus the inherent difficulties encountered in d.c. restoration on negative modulation, it is necessary to abandon the d.c. component. Automatic gain control is universally used, but is never a fully gated system. This attitude seems to be justified on the double basis that the pictures do not suffer visibly on peak-white, and that when one has a fairly large number of fringe transmissions more or less within range the inexpert viewer is not able to cope with a contrast variation depending upon the synchronization of one or other of the timebases. This is particularly important when the viewer is not sure if the transmitter in question is receivable and has no set sequence of operations to apply.

All channel selectors are fitted with coils for the C.C.I.R. Channels 2-11; in the 12th position is the French Channel 8A for Lille. This is "rearranged" by changing the oscillator from the high to the low frequency side of the vision carrier. This keeps the vision i.f. the same for all channels, but gives a second sound i.f. which is 5.65 Mc/s lower than that for the other channels. The remaining position is normally left without coils and can be used for local f.m. broadcast reception if required. Reference to Table I will make this clear.

The introduction of "transformerless" techniques was greatly complicated here by the existence of three mains voltages, 110, 130 and 220 volts. Fortunately one can ignore the d.c. mains but not so the 130 volts, which is very common. This naturally makes all voltage-doubler arrangements unpleasantly complicated, added to which the fluctuation in the mains at various times of the day is quite extrava-

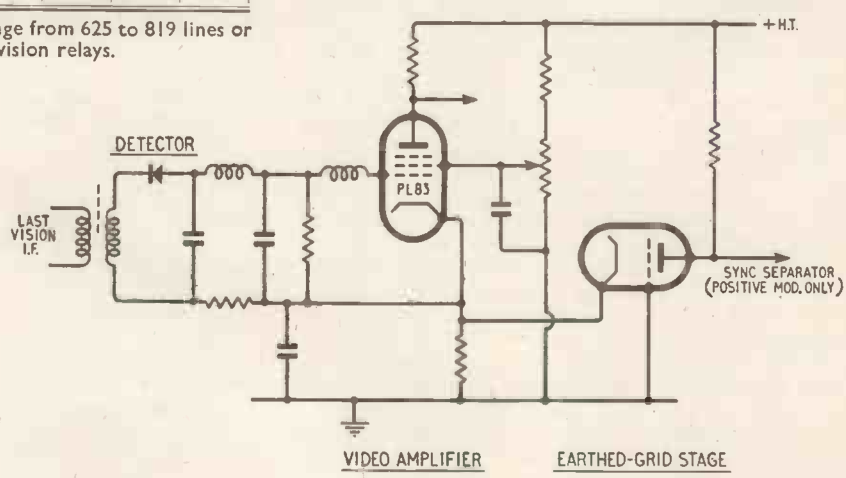


Fig. 3. Typical arrangement for automatic interference reduction. On positive modulation, negative-going interference peaks cut off PL83. Earthed-grid stage provides amplified signal of same phase for sync separator. On negative modulation, sync is taken from PL83 anode.

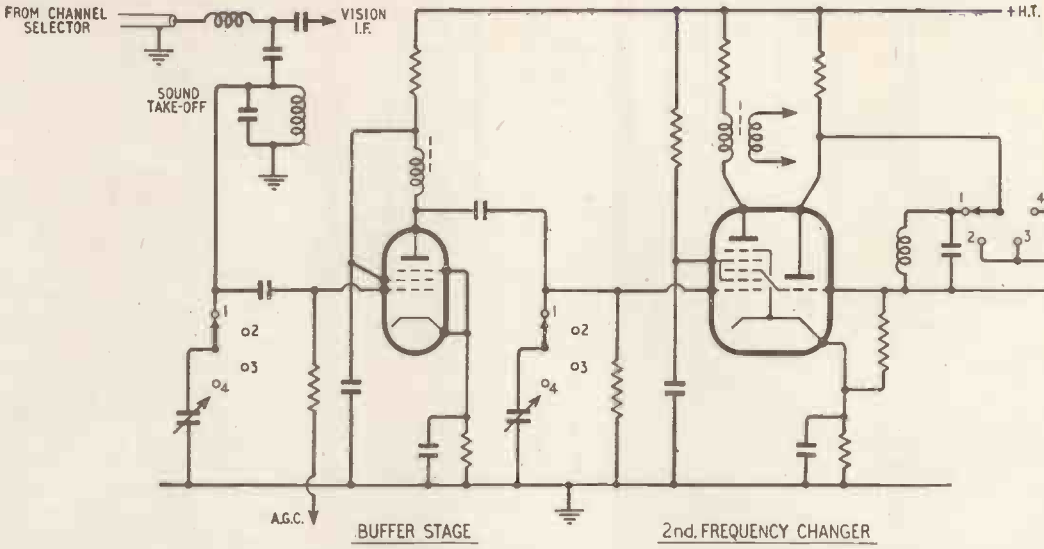


Fig. 4. Use of a second frequency changer for sound, giving a second i.f. of either 11.8 or 7 Mc/s. The buffer stage is switched between 27.75 and 33.4 Mc/s. (Switch positions: 1, France; 2, Belgium and Luxembourg; 3, Belgium and Luxembourg; 4, C.C.I.R.)

gant. One finishes by finding that the saving in cost is very much less than in Britain. In the author's opinion the only simple solution is to design for 220 volts and add an auto-transformer for the lot.

Under the conditions described the simple type of vision interference limiter used in British receivers is quite insufficient. It is usual to start with vision demodulation in the negative sense and then apply the negative-going video signal to a video amplifier which reduces the interference to a little over the maximum modulation. This is very effective but entails the use of an earthed-grid triode stage to amplify the composite video signal across the cathode resistance of the video amplifier without changing its phase, in order to provide a suitable signal for the sync separator (see Fig. 3).

Major Difficulties

Of the three purely "four-standards" problems, the sound is probably the most untidy. There are three principal systems: the use of two entirely separate sound amplifiers; the switching by capacitance of the frequency of a single amplifier; and the use of a second frequency changer. This last is the most popular because of the opportunity it presents to make use of a relatively low frequency ratio detector for the f.m. on the C.C.I.R. transmissions. The ratio detector is at present the most effective solution for the f.m. since the simpler methods of demodulation result in far too much noise on the majority of receivable transmissions.

The difficulty of this solution is to choose a frequency for the oscillator which will be the least troublesome from the point of view of r.f. or i.f. harmonics. To reduce these bad effects it is found necessary, in addition to the more obvious precautions, to use a buffer amplifier between the take-off point in the vision i.f. and the second frequency changer (see Fig. 4). This buffer must be switched in frequency for the transmissions from France because, as has already been explained, the sound

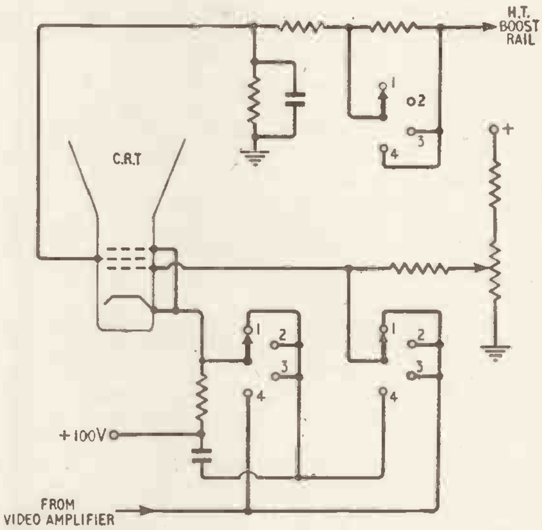


Fig. 5. Switching of c.r.t. modulation. Also, c.r.t. anode voltage compensation to maintain constant brightness when changing from 625 to 819 lines. (Switch positions: same as in Fig. 4.)

i.f. output from the tuner under these conditions is 5.65 Mc/s lower than normal. The second sound i.f. is then made either 7 Mc/s or 11.8 Mc/s. Once again the question of interference limiting is of great importance, and a simple limiter will not suffice.

Coming now to the video circuits, reference has already been made to the fact that many manufacturers prefer to use permanent negative demodulation. In this case the positive/negative switching is achieved either by switching in or out a second low-gain video stage, or more usually by switching the modulation of the c.r. tube from the grid to the cathode (see Fig. 5). In other cases the detec-

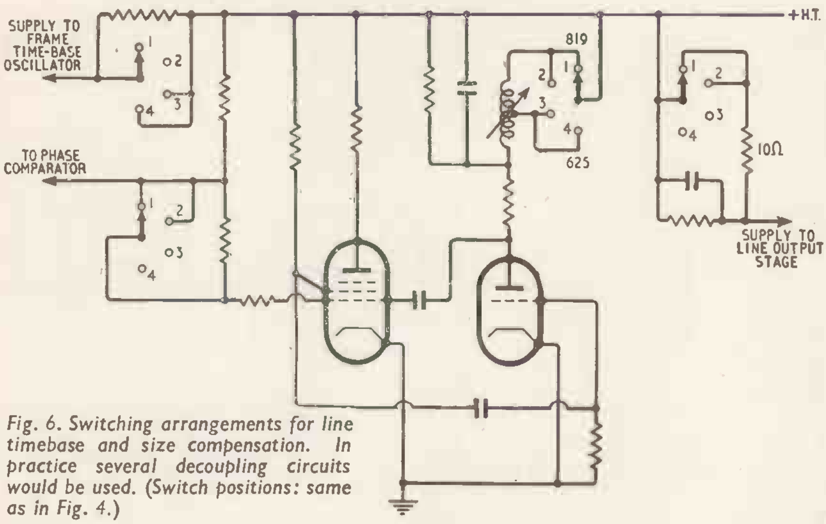


Fig. 6. Switching arrangements for line timebase and size compensation. In practice several decoupling circuits would be used. (Switch positions: same as in Fig. 4.)

tion is switched by germanium diodes, by switching the heaters of a double triode where the two "diodes" are permanently connected, or by various systems of biased diodes, which introduce decoupling difficulties. In the cases of switching the detection, it is normal to a.c. couple to the video stage, otherwise additional switching would be required to change the bias of the valve.

Although there exist receivers which employ a special amplifier to preserve the large bandwidth on French transmissions, these do not represent a significant proportion of the market. All well-known receivers use a 4.5-Mc/s vision i.f. for all signals. Of course, the channel selector must preserve the complete bandwidth in order to provide the sound signal. For this reason the gain on the Lille channel is about half that on the other channels.

Finally, there are the practical difficulties encountered in switching the line timebase speed. This naturally gives rise to a change in the e.h.t. and the h.t. boost rail, causing changes in height, width and picture brightness. These all have to be corrected, entailing a four-circuit switch. It is normal practice to adjust picture width for 819 lines and to switch a series resistance into the h.t. supply of the line output valve to give the same width on 625 lines (see Fig. 6). Vertical compensation will depend upon whether the normal h.t. or the boost rail is used for the frame timebase. The change in brightness is mostly due to variation of the anode voltage of the c.r. tube, and this is corrected by short-circuiting a section of a fixed potentiometer to give the desired correction (see Fig. 5).

Regarding the general prospects in Belgium, one may be consoled by the belief that conditions will tend to become simplified—at least so long as one does not take too seriously the recent German statements on their intentions for colour television in the near future. In Belgium, too, there is much talk of colour for the 1958 exhibition.

Naturally, as the transmissions improve technically we can hope for increased programme value. This could have the far-reaching effect of reducing interest in the four-standards receiver to the point where simple receivers would be saleable. In fact, the Belgian broadcasting authorities could assist this process technically by either converting all Eurovision to the local standard, or, better still, abandoning the use of two different standards—if this can be done without provoking a political crisis.

A receiver with a 17in tube costs on the average £100, but more precise figures are difficult to arrive at. A customer does not normally pay the price on the ticket; he will usually insist on a rebate of 10-20% and the dealer will have to pay at least a proportion of the sales tax, which totals 13%. On the other hand, the customer seems quite happy to pay from £25 to £50 for a very ordinary aerial array mounted on his roof.

The desirable evolution of Belgian television towards a reasonably priced, simple piece of apparatus, providing a standard of entertainment high enough to attract the customers, is a definite possibility during the course of the next year or two, if only the broadcasting authorities are not forced to take some precipitous action in colour television as a result of pressure from outside interests.

CLUB NEWS

Barnsley.—"Specialized frequency meter" is the title of the talk to be given by W. Richardson (G8VX) at the meeting of the Barnsley and District Amateur Radio Club on November 9th. A fortnight later the club will hold an exhibition and demonstration of members' equipment. Meetings begin at 7.0 at the King George Hotel, Peel Street. Sec.: P. Carbutt (G2AFV), 33 Woodstock Road, Barnsley.

Belfast.—At the September meeting of the City of Belfast Y.M.C.A. Radio Club, an American spoke on amateur radio in the U.S.A. The October meeting (17th) will consist of amateur and professional tape recordings. The club meets at the Y.M.C.A., Wellington Place. Sec.: R. J. Boal (GI3AXI), 127 Hillman Street, Belfast.

Birmingham.—At the meeting of the Slade Radio Society on November 9th, T. J. Hayward, of the R.A.F. School of Radio, will deal with microwave techniques. Meetings are held at 7.45 at the Church House, High Street, Erdington, Birmingham, 23. Sec.: C. N. Smart, 110 Woolmore Road, Erdington.

Bradford.—The 1956/57 syllabus of the Bradford Amateur Radio Society includes, in addition to a variety of lectures, a number of visits to works, etc., among them Mains Radio Gramophones Limited, Beckside Works, on October 23rd. Meetings are held on alternate Tuesdays at 7.30 at Cambridge House, 66 Little Horton Lane, Bradford. Sec.: F. J. Davies (G3KSS), 39 Pullan Avenue, Eccleshill, Bradford, 2.

Newbury.—W. H. Allen (G2UJ) will speak on "A Ham in peace and war" at the meeting of the Newbury and District Amateur Radio Society on November 9th at 7.30 at Elliott's Canteen, West Street.

Sidcup.—The next meeting of the Cray Valley Radio Club will be held on October 23rd and will comprise an exhibition of members' home-built gear. Meetings are held at 8.0 at the Station Hotel, Sidcup. Sec.: S. W. Coursey (G3JJC), 49, Dulverton Road, New Eltham, London, S.E.9.

Inexpensive Variable-Slope Filter

SIMPLE TREBLE ATTENUATION CIRCUIT FOR USE IN HIGH-QUALITY AMPLIFIERS

By D. M. LEAKEY, B.Sc.(Eng.), Grad. I.E.E., A.C.G.I.

This article describes a simple m-derived single LC filter section which provides a variable slope of cut-off between about 40dB/octave and 6dB/octave at any selected roll-off frequency. It requires no close tolerance components and requires no initial adjustment.

IT is now generally accepted that in wide-band high-quality amplifiers it is almost essential to provide an adjustable means of limiting the high frequency response of the system in order that the best results may be obtained from the wide range of programme sources available. For the best results this high frequency cut-off should be both adjustable in frequency and in the rate of cut-off. Resistive networks as part of a feedback system can be used for this purpose. To obtain the necessary maximum rate of cut-off however it is necessary to employ twin-T resistance capacitance networks which unfortunately require close tolerance components and relatively complex switching arrangements. The filter to be described produces the same results as the feedback twin-T network but avoids the two above difficulties.

The use of an inductor might be regarded by many as undesirable but in this application the foundations for this opinion are in general almost groundless. Hum pick-up can be troublesome but, especially with relatively simple hum-bucking arrangements, in most applications can be made negligible. Harmonic distortion originating in the inductance has been found to be negligible providing the unit is used where the signal level is not too high. As a very general guide, with normal small iron-cored inductors, this level is about two volts. Similarly, ringing in the circuit is often put forward as a fault, but in general it can be shown that this is no worse than when using R-C networks producing the same frequency response.

The basic circuit for the filter is the single section, resistance terminated, constant-*k* filter section as shown in Fig. 1. This provides a response as shown in Fig. 2, the slope of cut-off being about 20 dB/octave. A steeper slope than this would be desirable and this can be achieved by shunting the inductor with a small capacitor so producing a simple m-derived section. The resulting response is shown in Fig. 3 from which will be seen that although a steeper cut-off is achieved the response rises again after the resonant point. In order to limit this rise so that it only approaches to within about 25 dB of the mid-frequency level it is necessary to limit the value of C_3 to about one-tenth of C_1 or C_2. With this value an initial cut-off slope of

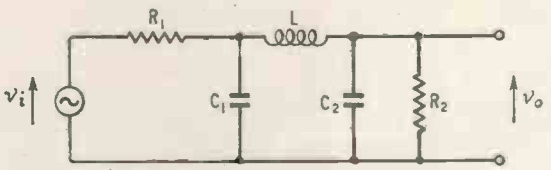


Fig. 1. Basic constant-*k* filter section.

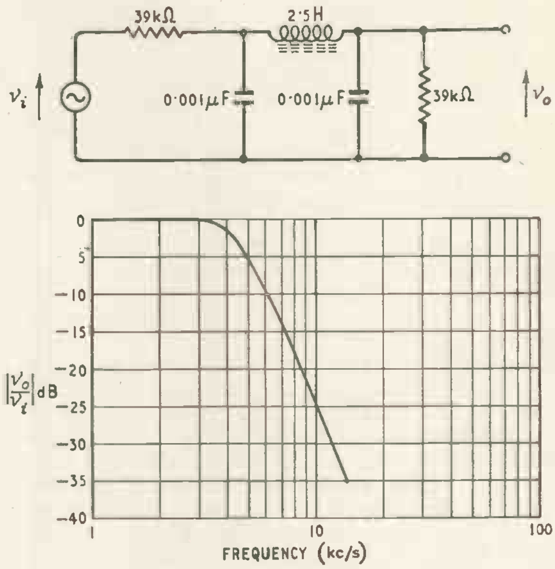


Fig. 2. Typical response of the circuit of Fig. 1.

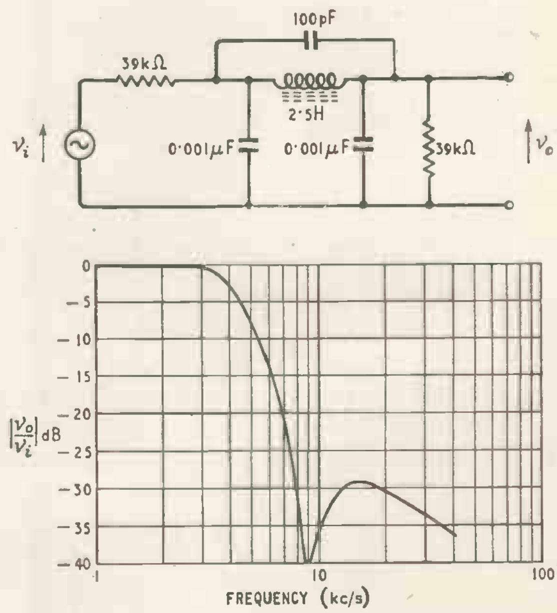


Fig. 3. A steeper slope is obtained when the series inductance is shunted by a capacitance.

40 dB/octave can be achieved whilst the response above the cut-off frequency never returns to more than within 25 dB of the mid-frequency level. A return level of 25 dB has been chosen only as an arbitrary figure which in practice has been found to be satisfactory. Actually when the m-derivation was included (i.e., the connection of C_3 across the inductor) the initial values of C_1, C_2 and L should have been slightly modified, but due to the fact that C_3 is only one-tenth of C_1 or C_2 the error produced by leaving them at their original values is, for this application, negligible.

To achieve a variable slope of cut-off it is necessary to vary the Q of the tuned circuit formed by L and C_3. The result of this is shown in Fig. 4 where a variable resistor R_3 is placed across L. As can be seen, the initial cut-off slope can easily be varied between 40 dB/octave and 6 dB/octave whilst leaving the cut-off frequency substantially constant.

In the above circuits a constant-voltage source is shown. This is not necessary since the input resistor R can be modified to allow for a finite source resistance. Similarly R_2 can be modified if an external load is placed across the output or C_2 modified to allow for any input capacitance of the load.

A practical circuit giving a variable slope of cut-off at about 5kc/s, 7kc/s and 10kc/s is shown in Fig. 5. It will be noticed that resistors and capacitors are switched, leaving the inductance value constant. This is purely for economic reasons bearing in mind the possible relative price of the components. For smooth slope control the variable resistor should be of the logarithmic law type. The circuit can be fed from any low-impedance source such as a low-impedance triode, or a pentode with heavy negative feedback. For the 5-kc/s cut-off condition the resonant dip can be adjusted by means of C_3 to occur at 9kc/s and so be useful as a whistle filter on medium-wave broadcast reception.

The components in the above circuit are not critical, although at least a $\pm 10\%$ tolerance on the components is preferable. The one-henry inductance can conveniently wound on a Mullard Ferroxcube LA7 core, with about 40 s.w.g. enamelled wire. The experimental coils required about 1,100 turns for 1 henry. In practice however it is preferable to wind on say 1,200 turns, measure the inductance and remove the correct number of turns to reduce the inductance to 1H, remembering that the inductance is very nearly proportionally to the square of the number of turns.

Humbucking can be achieved after complete assembly of the core and coil by winding turns over the complete core in reverse to the main winding. The number of turns can be found experimentally by measuring the hum pick-up of the coil when it is near a source of magnetic hum. Only a very few turns are normally required, insufficient to materially alter the inductance from the required one henry.

APPENDIX: Design of filter

It is assumed that the known quantities are the required cut-off frequencies and the value of inductance available.
L in henrys.
C in farads.
R in ohms.
f_c = cut-off frequency in c/s.

$$\left.\begin{array}{l} C_1 = C_2 = \dfrac{1}{2\pi^2 f_c^2 L} \\ R_1 = R_2 = \pi f_c L \end{array}\right\} \text{Choose the nearest } \pm 10\% \text{ value for components.}$$

R_3 = 200,000 L (approx.) exact value is unimportant.

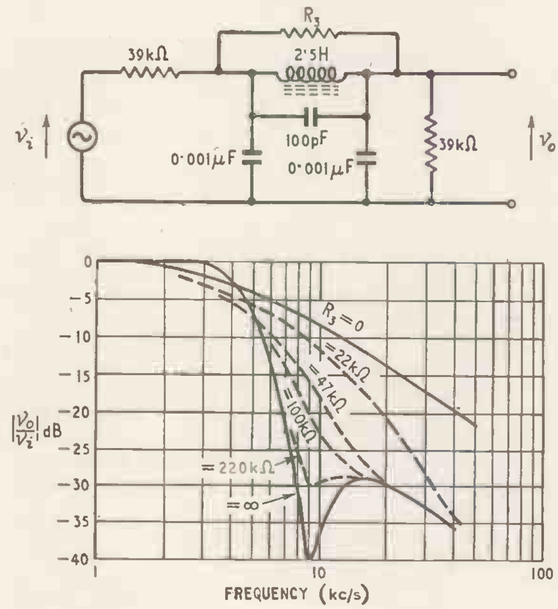


Fig. 4. Variation of slope is achieved by altering the Q of the LC circuit by means of R_3.

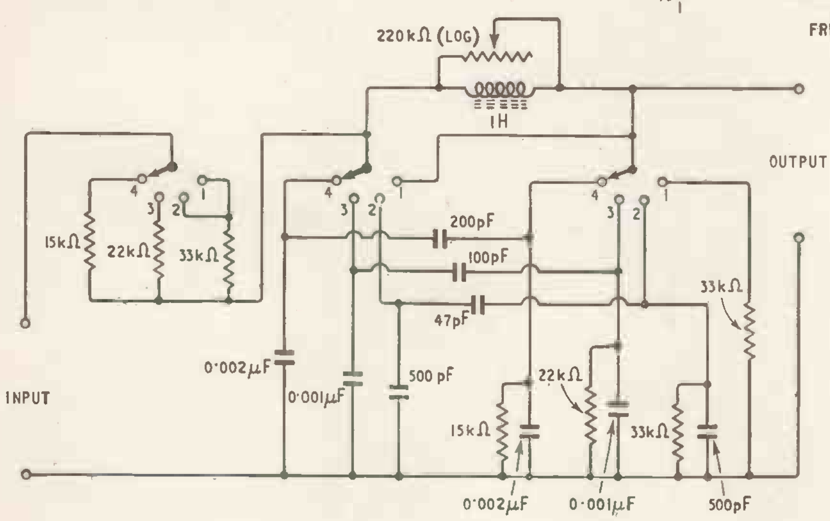


Fig. 5. Practical circuit for three switched cut-off frequencies of 5, 7 and 10 kc/s. The insertion loss at low frequencies is approximately 6dB.

NOVEMBER MEETINGS

LONDON

9th. Television Society.—"New techniques in receiver construction: printed circuits" by W. I. Flack at 7.0 at 164 Shaftesbury Avenue, W.C.2.

13th. I.E.E. (Students).—"Digital computers and how they may help the engineer" by Dr. M. V. Wilkes at 6.30 at Savoy Place, W.C.2.

14th. I.E.E.—"Frequency diversity in the reception of selectively fading binary frequency-modulated signals with special reference to long-distance radio-telegraphy" by J. W. Allnatt, E. D. J. Jones and H. B. Law. "An investigation of the spectra of binary frequency-modulated signals with various build-up waveforms" by J. W. Allnatt and E. D. J. Jones. "An improved fading machine" by H. B. Law, F. J. Lee, F. A. W. Levett and R. C. Looser. "The detectability of fading radiotelegraph signals in noise" by H. B. Law. "The signal/noise performance rating of receivers for long-distance synchronous radiotelegraph systems using frequency modulation" by H. B. Law. At 5.30 at Savoy Place, W.C.2.

14th. Radar Association.—"Infra-red: its problems and possibilities" by Dr. F. E. Jones at 7.30 at the Anatomy Theatre, University College, Gower Street, W.C.1.

16th. B.S.R.A.—"Practical aspects of design and application of audio transformers" by R. B. Gilson at 7.15 at Royal Society of Arts, John Adam Street, W.C.2.

20th. I.E.E.—Discussion on "Data processing equipment for experimental work" at 5.30 at Savoy Place, W.C.2.

22nd. I.E.E.—Discussion on "The presentation and demonstration of the theory of semi-conductors to students" at 6.0 at Savoy Place, W.C.2.

22nd. Television Society.—"Alternatives to the N.T.S.C. colour system" by Dr. E. L. C. White at 7.0 at 164 Shaftesbury Avenue, W.C.2.

27th. Society of Instrument Technology.—"Television technique applied to observation and control" by Professor J. D. McGee at 7.0 at Manson House, Portland Place, W.1.

28th. Brit. I.R.E.—"Colour Television" by Dr. G. N. Patchett at 6.30 at the School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

30th. R.S.G.B.—Discussion on "1250-Mc/s operation" at 6.30 at the I.E.E., Savoy Place, W.C.2.

BIRMINGHAM

26th. I.E.E.—Informal evening on electronics and automation at 6.0 at the James Watt Memorial Institute, Great Charles Street.

CAMBRIDGE

13th. I.E.E.—Address by Dr. R. C. G. Williams, Chairman, Radio and Telecommunication Section, at 8.0 at the Cavendish Laboratory.

20th. I.E.E.—Discussion on technical education to be opened by Professor E. B. Moullin and J. Wooding at 6.30 at the Cambridgeshire Technical College, Collier Road.

CARDIFF

12th. I.E.E.—"Germanium and silicon power rectifiers" by T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell at 6.0 at the South Wales Institute of Engineers, Park Place.

CATTERICK

22nd. I.E.E.—"Communication by tropospheric and ionospheric scatter" by Dr. J. A. Saxton and W. J. Bray at 6.15 at Catterick Camp.

CHELTENHAM

21st. Society of Instrument Technology.—"Problems in the manufacture of semi-conductors" by F. C. Carpenter at 7.0 at the North Gloucestershire Technical College.

EDINBURGH

6th. I.E.E.—"TRIDAC—a large analogue computing machine" by Lt.-Cdr. F. R. J. Spearman, J. J. Gait, A. V. Hemingway and R. W. Hynes at 7.0 at the Carlton Hotel, North Bridge.

23rd. Brit. I.R.E.—"Information Theory" by L. C. Stenning, Dr. P. Jones and P. Holroyd at 7.0 at the Department of Natural Philosophy, University of Edinburgh.

GLASGOW

7th. I.E.E.—"TRIDAC—a large analogue computing machine" at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

8th. Brit. I.R.E.—"The oscilloscope for engine testing" by R. K. Vinycomb at 7.0 at the Institution of Engineers and Shipbuilders, Elmbank Crescent.

LIVERPOOL

7th. Brit. I.R.E.—"Industrial Television" by J. E. H. Brace and R. Swinden at 7.0 at the Chamber of Commerce, 1 Old Hall Street.

LOUGHBOROUGH

20th. I.E.E.—"Ultrasonics in industry" by C. F. Brocklesby at 6.30 at Loughborough College.

MALVERN

1st. Brit. I.R.E.—"Principles of the light amplifier and allied devices" by Dr. T. B. Tomlinson at 7.0 at the Winter Gardens.

MANCHESTER

1st. Brit. I.R.E.—"Electronics applied to physiology" by H. W. Shipton at 6.30 at Reynolds Hall, College of Technology, Sackville Street.

7th. I.E.E.—Informal evening on electronics and automation at 6.45 at the Engineers' Club, Albert Square.

NEWCASTLE-UPON-TYNE

14th. Brit. I.R.E.—"Some practical aspects of echo-sounding" by A. M. Sutton at 6.0 at Neville Hall, Westgate Road.

OXFORD

14th. I.E.E.—"Automation and electronics in industry" by F. W. Highfield at 7.0 at 37 George Street.

SHEFFIELD

21st. I.E.E.—"Germanium and silicon power rectifiers" by T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell at 6.30 at Grand Hotel.

STONE

19th. I.E.E.—"The generation and synthesis of music by electrical means" by A. Douglas at 7.0 at Duncan Hall.

WOLVERHAMPTON

14th. Brit. I.R.E.—"Electronic techniques in automation" by J. A. Sargrove at 7.15 at the Wolverhampton and Staffordshire Technical College.

RANDOM RADIATIONS

By "DIALLIST"

819 Lines on Band I

THE first French 819-line television station operating in Band I was opened recently at Mont-Pinçon, near Caen. With its vision on 52.4 Mc/s and its sound on 41.25 Mc/s the station needs a good deal of elbow room in the ether. It occupies actually a wider band of frequencies than our Channels 1 and 2 put together; but even so the 13-Mc/s modulation range normal for 819-line transmissions has had to be somewhat reduced which must, of course, affect the picture definition. The French broadcasting authorities were afraid that it might interfere in this country with Rowridge and adopted horizontal polarization as a safeguard against this. So far, I haven't heard of any such interference, even in this present period of freak radio effects; but *Toute la Radio* states that there has been some trouble to the south of Caen in places where Mont-Pinçon and Rowridge have about the same bearing.

Slow to Catch On

THOUGH the development of the French television broadcasting network has gone forward quite rapidly, the increase in the number of TV receivers in that country has been curiously slow. There were roughly 220,000 sets in use a year ago and the number now stands at not much over 350,000. That's a 60 per cent increase, admittedly, but even so it looks as if much water will flow beneath the bridges of France before television becomes anything like the national hobby that it is in this country, where there are now well over 6,000,000 receivers in use—the licence figure at the end of August was 6,044,330.

Nelson Effect?

IT takes some little time for *W.W.* to make the journey to New Zealand that's why I have only just received from a kind Wellington reader two pieces of information which throw a bright light on the "Bournemouth Effect." (June issue). That, if you remember, concerned an outburst of "chuffs" from a f.m. receiver every time a train left the station. One correspondent suggested that the effect might be due to a static charge generated by the friction of water particles driven at high velocity through air. The writer from New Zealand sends two proofs that this can happen. The first is a description published about 1870 by a lecturer at the Royal Polytechnic Institution of apparatus then used there for demonstrations and experiments. By means of a boiler, working at 60lb per square inch and provided with 46 bent iron tubes fitted with wooden nozzles, electricity was regularly generated and sparks up to 22 inches long were obtained. His second instance seems to clinch the point, for it shows the effects of such electric charges on wireless reception. At certain times every working day there was an outbreak of horrid noises from loudspeakers in Nelson, N.Z. It was a long time before an engineer who had been trying to find the cause stumbled on the solution. He happened one day to look out of the window whilst the noises were in full blast and saw a plume of steam issuing from a factory whistle some distance away. Subsequent observations confirmed that the outburst occurred only when the whistle was in action. No one had thought of the connection since owing to the distance travelled the sound of the whistle arrived after the noises had stopped. My correspondent suggests that since Nelson, N.Z., had the effect years before Bournemouth "Nelson Effect" would be a more appropriate term—provided that the Senior Service doesn't object!

Canned Vision

A GOOD many attempts have been made to devise some workable system of recording vision on magnetic tape. Most, if not all, of these have proposed to record vision signals along a single straight-line path and one of the big snags encountered is that this would mean tape speeds of some 13,000 inches per second. In his recent application for a vision-on-tape recording system* Dr. R. D. A. Maurice, of the B.B.C. Engineering Division's Research Department, strikes out on an entirely new line. He proposes to scan a tape 1.3 inches wide by the use of what he terms "a magnetic Nipkow disc." This consists of a pair of copper discs, each containing 100 small equally-spaced slots filled with ferrite. The discs, whose distance apart is no more than about three-thousandths of an inch greater than the thickness of the tape, are locked together and driven by a motor at 6,000 r.p.m. This method would reduce the tape speed required to no more than 25 inches per second; but owing to the very

* Appended to B.B.C. Engineering Monograph No. 8.

small aperture used the tape would have to be capable of retaining a maximum flux density fifty times that now used.

Between Wind and Water

THE East-Coast town in which I now live has possibly had rather more than its fair share of the gales and gusty winds which have been amongst the more unpleasant features of 1956's apology for a summer. Very few aerials have been damaged by them, but a good many feeders which were not well enough anchored to prevent them from swaying to and fro have had to be replaced owing to breaks in their "inners." The most spectacular wind effect occurred here one afternoon when almost tropical rain was accompanied by gusts of the "Force 7 to 9" variety. Each gust produced ear-splitting noises from loudspeakers and firework displays on television screens. Our electricity supply is conveyed to us by overhead three-phase mains on poles. At one place the wind was swaying the sodden branch of a tree on to the cables at frequent intervals.

The Mystery that Wasn't

"THERE'S a television mystery in my house," said a friend the other day, "what happens is exactly the opposite to what you'd expect." When I asked for further enlightenment he told me that he'd had things so arranged that he could use his receiver in either of two rooms. "And here's the strange thing," he went on. "One of the rooms is much nearer to the aerial; but despite the much shorter length of feeder, you get nothing like so good a picture in it as you do in the other." I promised to drop in next time I was passing his way and when I did so I found exactly what I'd expected. The socket in the room nearer the aerial was simply Tee'd into the feeder. Hence with the set in use in that room there were yards of unused dead-end to upset the matching. The proper method is, of course, to connect the feeder to a socket in the nearer room and then to run a separate length to the other. At the far end of this length is a socket; the near end is fitted with a plug. If you want to use the set in the first room, you plug its aerial lead into the socket and the extra length of feeder is entirely unconnected. For reception in room No. 2 you plug the extension feeder into the first socket and the set's aerial lead into the second.

UNBIASED

By FREE GRID

The 1957 Exhibition

ALTHOUGH it is almost a year before the next National Radio Exhibition opens its doors it is none to soon for the organizers to begin scratching their heads in an effort to think out how an improvement can be made on this year's effort.

Now without in the least decrying the efforts of the R.I.C. this year I can think of one very great improvement which I should like to see next August. To explain what I want, I should mention that whenever I wish to buy a set, tape recorder or what have you, I invariably go to the stand of one of the big wholesalers. The reason is that on these stands I can see the products of most of the manufacturers—some possibly, who are not themselves exhibiting at the Show. There I can compare sets side by side without rushing all over the exhibition.

It is, however, not easy for an ordinary member of the public to examine the goods on these stands. They are meant only for members of the industry and the gentlemen who staff some of them are apt to freeze off outsiders in the manner of a duchess dealing with a gate-crasher. I have no difficulty as I know enough of the trade jargon to be able to pass myself off as a dealer.

I would suggest that a large section of the hall be reserved for special stands each exhibiting one class of goods only. Each stand should be staffed by people who could be relied upon not to favour one manufacturer at the expense of others.

This idea would not prevent each manufacturer having a stand of his own as at present. These special stands would be extraordinary ones in the literal sense of that word. The idea is not new, of course. For some years we had a Television Avenue at each Show, where some dozens of sets could be seen operating, but, for some unknown reason, that disappeared from this year's show.

I hope the R.I.C. will consider my idea and if it does not receive favour, I hope the learned councillors will write and tell the Editor why.

Literally Nostalgic

RECENTLY I had a personal letter from a friend living in the colonies deploring the fact that the sound of Big Ben has not been broadcast while the clock which is associated with this famous bell was out of action.

Apparently Great Tom proved an inadequate substitute. Dwellers in what used to be called the "far-flung Empire" have a sentimental interest in hearing the voice of Big Ben. It has meant "home" to them for 30 years past and for once the B.B.C.'s overworked word "nostalgic" is literally correct.

It cannot be often that Big Ben has been out of action during the past three decades. Even if this is not the first time it is most certainly the longest period it has been silent. The B.B.C. had ample warning of the clock's long period of inaction and it seems a pity that they are so insensitive to the nostalgia associated with Big Ben in the colonies that they didn't bother to make a special recording of it. It would have been a simple technical matter for arrangements to have been made for the recording to have been triggered off at the appropriate times by signals from Greenwich.

The B.B.C. ought to be ashamed of themselves for not thinking of this idea instead of leaving me to do it for them.

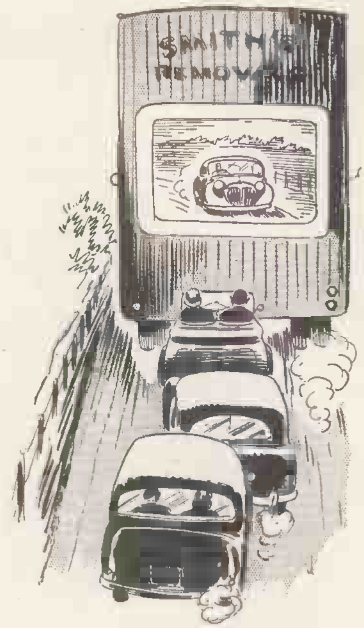
*Wrinkles for ROSPA**

IN the September issue I discussed an article on road safety which appeared in the American journal *Tele-Tech and Electronic Industries*. Among other things it was suggested that a capacitative system should be used so that if a car approached too close to an obstacle ahead, the brakes would be applied. I concluded, however, the range of such a system would be far too small.

The ideal solution would be for cars to be fitted with radar as the range of operation would thereby be greatly increased. Unfortunately this would mean that the car would have to tow a trailer to house the necessary apparatus. I have actually been experimenting on these lines recently and my radar trailer attracts a good deal of attention as the high superstructure necessary to house all my experimental apparatus seems to the onlookers to block my rear view entirely and they gather with ghoulish glee at strategic road junctions in anticipation of a crash.

What the crowd don't know is that, in fact, I have a perfect 180-degree rear view. I have replaced the normal driving mirror in my car by a small TV screen which is coupled to a small camera in the rear of the trailer. I see that an American car at the London Motor Show is fitted with an "electronic rear viewer." Great minds think alike.

Talking of my radar trailer reminds me that one of the worst causes of car accidents is the slow-moving pantechnicon-type vehicle which completely blocks the forward view of following cars. The drivers cannot see the road ahead and dare not pull out to overtake. Eventually somebody loses patience and frequently a crash occurs. In my opinion this trouble could be overcome if all these juggernauts were compelled to carry a television camera in front, coupled to a screen in the rear, so giving drivers of following cars a clear view of the road ahead.



A new rôle for TV.

* Royal Society for the Prevention of Accidents.

Heard but Not Seen

WE are so used to hearing the clumsy and ugly expression "loudspeaker" to describe what would be better called the reproducer or acoustic reproducer that I was considerably surprised recently to hear it spoken of as a "soft speaker." When I queried the name I was told that there was no mistake and this correctly describes the large number of instruments which are to be installed in Guildford cathedral.

This massive new building is slowly rising on a high hill outside Guildford. It is the last word in modernity and its p.a. system has been designed to be in keeping with it. The idea of the architect is that p.a. should be heard but not seen. Special pendant chandeliers are to be designed so that each will have what is to be termed a soft speaker built into it as an integral part of its structure. Each of these instruments will give a comparatively low acoustic output but, as there will be a large number of them, the overall volume will be adequate.

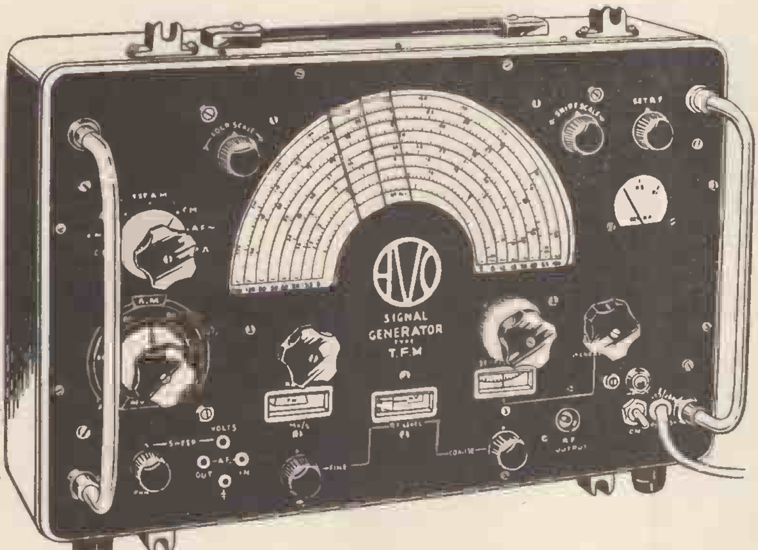
Needless to say, the designer is to collaborate with the leading lights in acoustics and in loudspeaker—or "soft speaker"—design.

AVO

Regd. Trade Mark

WIDE BAND SIGNAL GENERATOR
Type T.F.M.

The design of this new Wide Band Signal Generator, **operating throughout on fundamentals,** is the outcome of considerable research and development work to meet the stringent requirements imposed by new frequency modulation and commercial television stations.



The frequency bands have been chosen in such a manner as to ensure maximum convenience when servicing and aligning T.V. and F.M. receivers.

Provision has been made for spot R.F. frequency calibration.

Facilities are provided to ensure adequate discrimination throughout the very wide frequency band covered by the instrument.

Sine and square wave audio frequency modulation provided.

The instrument is fitted with an R.F. carrier level meter.

A double-ratio slow-motion mechanism, together with interpolation dial, enables the instrument to be set with a high degree of accuracy. On the F.M. range an internal phasing control enables the modulating signal to be applied to the X-plates of an oscillograph to produce a picture of a discriminator response curve.

This compact and versatile instrument not only meets all U.K. requirements, but will also prove useful in many other parts of the world.

A M COVERAGE

5-220 Mc/s in 8 ranges, CW or 400 c/s sine/square wave modulation. Accuracy ± 1%. Provision for spot frequency calibration.

F M COVERAGE

65-120 Mc/s. Accuracy ± 1%. Maximum deviation ± 150 Kc/s.

OUTPUT:

Minimum (about 2μV) to 100 mV continuously variable with decade multiplier. Force output 250 mV.

OUTPUT IMPEDANCE:

80Ω, 200Ω, balanced 80Ω and 300Ω, isolated unbalanced 80Ω

OPERATING VOLTAGES:

100-120, 200-260 V, 50-60 c/s A.C. mains.

DIMENSIONS:

15¼ x 10¼ x 10ins. approx. with lid closed.

WEIGHT: 16 lbs. approx.

LIST PRICE: £89

Sole Proprietors and Manufacturers: The AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO. LTD

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SG.5

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Easier setting-up Adjustment of electrostatic focus for absolute minimum of aberration can be made quickly and without special skill.

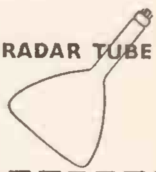
Simpler E.H.T. The focus voltage swing required is only ±200V about cathode—e.h.t. units need no longer be loaded with the current wasting potential dividers associated with earlier electrostatic focus tubes.

Lower cost No focus magnet or coil is required. Ordinary carbon track potentiometer across normal low-voltage supply is all that is needed to achieve fine focus.

Space saved Focus at ordinary h.t. potential means that e.h.t. generators can be smaller, and bulky high voltage potential dividers eliminated.

9 IN. RADAR TUBE

AL 22-10



AL 31-10

12 IN. RADAR TUBE

ABRIDGED DATA FOR BOTH TUBES

	Typical Operating Conditions			
Focus: Electrostatic	V_{a2+a4} (kV)	V_{a1} (V)	$-V_g$ for cut-off (V)	V_{a3} focus (V)
Deflection: Magnetic Heater: 6.3V, 300mA Phosphor: long persistence	12	300	30 to 70	±200

Write to the address below for full details of these and other cathode ray tubes in the Mullard range.

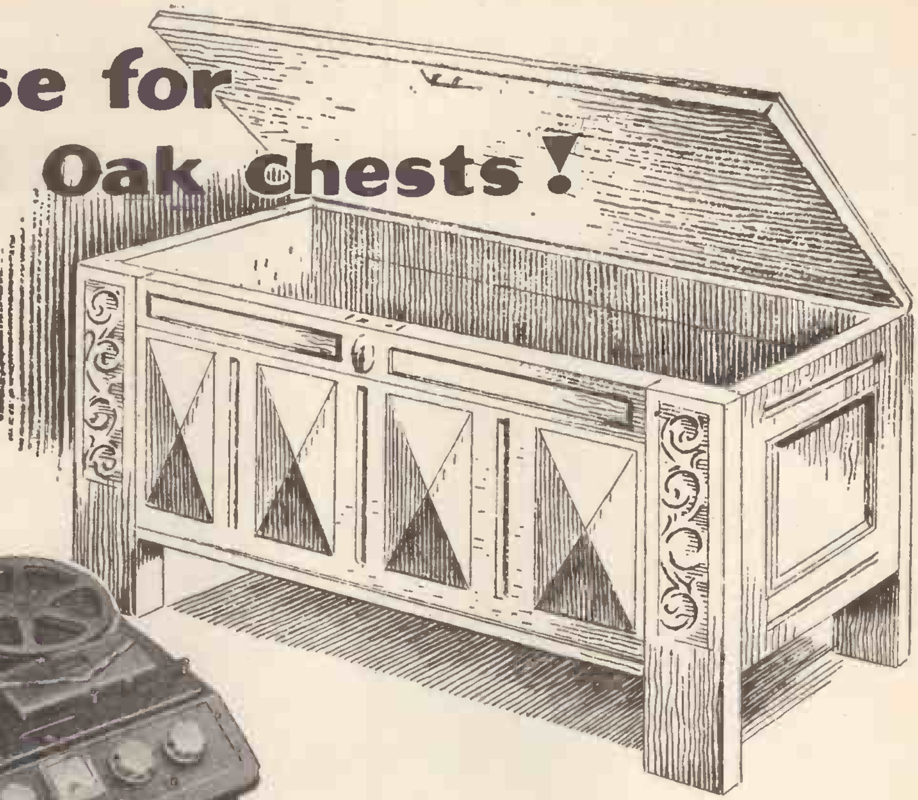
Mullard

Mullard

MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

MVT 187

NEW use for old Oak chests!



All metal construction, with overlap to fit snugly on any flat surface with opening 15$\frac{3}{8}$" x 16$\frac{1}{2}$". Incorporating all Ferrograph proved features of design, including synchronous main drive motor, separate tone controls, two speeds, 2$\frac{1}{2}$ watts undistorted output, source selection switch, automatic motor cut-off. Finished in gold bronze with cream knobs and accessories.

Model 66N	Model 66H
3$\frac{3}{4}$" & 7$\frac{1}{2}$" p.s.	7$\frac{1}{2}$" & 15" p.s.
84 gns	**88 gns**

(including 1,750 ft. Ferrotape on 8$\frac{1}{4}$" reel)

IN great-grandma's time the old oak chest was generally the place where the household linen was stored. But to-day it has another use—at least in the home of Mr. Geoffrey Parnell, of Leeds. He writes : "Wondering how I could house the Ferrograph 66 I had on order, I suddenly noticed an old oak chest which had belonged to my wife's grandmother. It offered the ideal solution because not only did it take the Ferrograph but there was ample room, in addition, for a Garrard turntable and an F.M. Tuner unit".

Yes—you've certainly got something there, Mr. Parnell! The combination of these three units in one permanent installation—with an external loudspeaker—is the last word in home entertainment forecasting an important trend for the future. For not only does it permit tape recordings of the highest quality to be made from radio, disc or microphone at the touch of a switch, but the owner can use the high fidelity amplifier incorporated in the Ferrograph with the F.M. tuner as a superb radio receiver or with the turntable as a luxury gramophone. He has, in fact, three instruments in one at a very substantial saving in cost and space.

Ferrograph "66"

BRITISH FERROGRAPH RECORDER CO. LTD

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Photographs of 'Eclipse' magnets are reproduced by courtesy of the manufacturers James Neill & Company (Sheffield) Limited.

The remarkable efficiency of these 'Eclipse' magnets is due to their composite construction, using 'Araldite' to bond the component parts. The manufacturers of these magnets state that they use 'Araldite' because it enables them to produce shapes and sizes otherwise impracticable, to ensure that the magnets cannot be taken apart and to avoid bolted assemblies. 'Araldite' provides a bond which is truly permanent, and its strength is proved by the fact that facing and boring operations and also grinding are carried out after bonding.

'Araldite' epoxy resins have a remarkable range of characteristics and uses.

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- ★ **for casting high grade solid insulation.**
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- ★ **as fillers for sheet metal work.**
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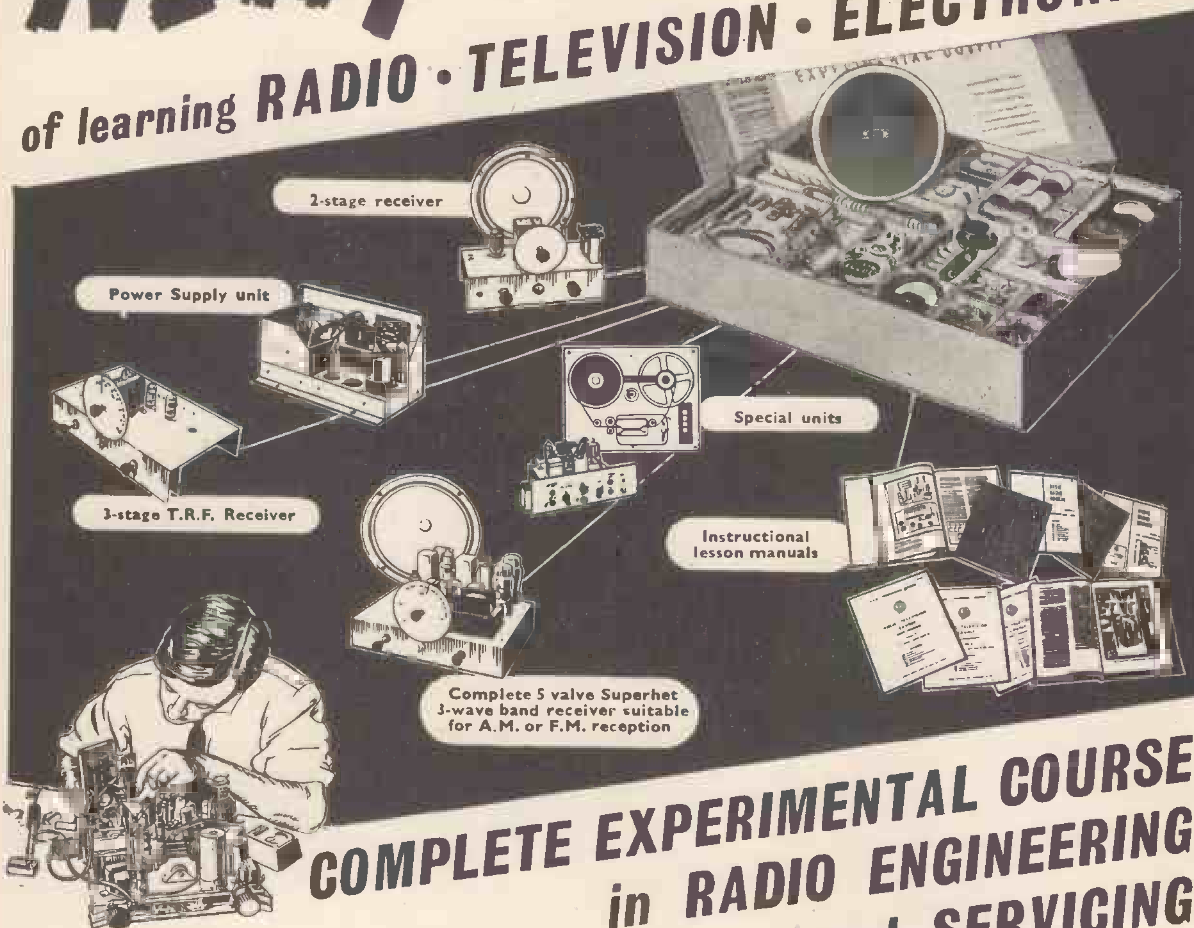
NEW! THE PRACTICAL WAY of learning RADIO · TELEVISION · ELECTRONICS

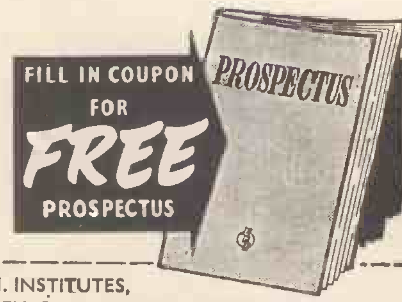


COMPLETE EXPERIMENTAL COURSE in RADIO ENGINEERING and SERVICING

An entirely new series of courses designed to teach Radio, Television and Electronics more quickly and thoroughly than any other method. Specially prepared sets of radio parts are supplied and with these we teach you, in your own home, the working of fundamental electronic circuits and bring you easily to the point when you can construct and service radio receivers, etc.

Whether you are a student for an examination; starting a new hobby; intent upon a career in industry; or running your own business — these Practical Courses are ideal and may be yours at very moderate cost.

With these outfits, which you receive upon enrolment and which remain your property, you are instructed how to build basic Electronic Circuits (Amplifiers, Oscillators, Power Units, etc.) leading to designing, testing and servicing of complete Radio and Television Receivers.



NEW TELEVISION COURSE including a complete set of equipment dealing with the design, construction and servicing of a high quality television receiver.

Courses (with equipment) also available in *many other engineering subjects.*

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Subject(s) of interest ____________________

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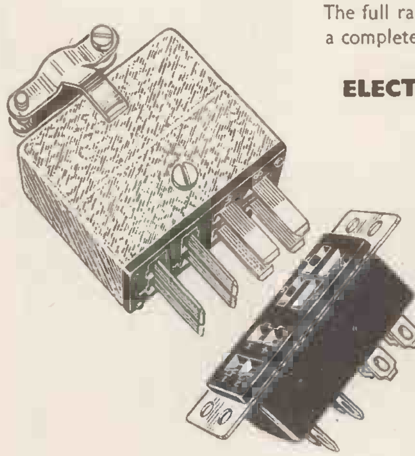
NOVEMBER/5 IC.68A

PAINTON

By Appointment to the Professional Engineer

'MULTICON' PLUGS AND SOCKETS

The full range consists of 2, 4, 6, 8, 10, 12, 18, 24 and 33-pole sizes, and there is a complete variety of Plugs and Sockets with alternative mounting arrangements, cable-fixings, retaining devices and cover earthing facilities.



ELECTRICAL SPECIFICATION AND PERFORMANCE

VOLTAGE RATING 1. Working Voltage :	(a) 1,000 Volts D.C. or A.C. (peak). This applies to use in temperate climates under normal conditions. (b) 500 Volts D.C. or A.C. (peak). This applies to tropical use.
2. Voltage Proof :	All plugs and sockets will withstand a voltage proof test of 2.5 KV between contacts, and 3.0 KV between contacts and the mounting flange or cover.
3. Breakdown or Flashover Voltage :	The breakdown voltage is approximately 3.3 KV. The properties of the mouldings are such that even after flashover there is no evidence of tracking, and the plugs and sockets will still withstand the Voltage Proof specified above.
CURRENT RATING	5 Amps. D.C. or A.C. (R.M.S.) per contact.
CONTACT RESISTANCE	1. Average Contact Resistance : Below 0.002 Ohm. 2. Maximum Contact Resistance : 0.0025 Ohm.

DESIGN FEATURES

(1)
The terminal numbering is moulded into both the plug and socket bodies, and appears not only in proximity to the appropriate soldering-tag, but also on the mating face.
This not only facilitates wiring, but enables complete cable forms to be tested prior to inclusion in equipments without removing the plug or socket covers.

(2)
Four small distance pips are moulded on to the plug body and they keep the mating faces slightly apart even when the plugs and sockets are fully engaged.
This eliminates the possibility of free moisture remaining between the plug and socket face, and is instrumentol in the superior tropical performance of "Multicon" plugs and sockets.

(3)
The single-piece body mouldings are nylon-filled *to provide a high insulation and tracking resistance.*

(4)
All socket clips and plug blades are located in recessed cavities in the mouldings.
This also provides a high tracking resistance between contacts, and, in the socket version, the enclosed contacts enable the maximum voltage to be safely utilised (provided the direction of voltage supply feed is from socket to plug).

(5)
Each socket clip has split limbs, so that there are four individual areas in contact with each plug blade.
This ensures absolute reliability of contact, with a minimum life of 10,000 operations at low and constant contact resistance.

(6) Panel or chassis mounting flanges are available with side or end fixing holes. Cut-out information given relates to Panel thicknesses up to $\frac{3}{32}$".
This enables rows of plugs or sockets to be mounted either end-to-end or side-by-side with a maximum saving in panel or chassis space.

(7)
In the 24 and 33-pole sizes the plugs are normally supplied with a large pin locator, which is also an electrical contact.
This is provided to facilitate the engagement of these larger sizes, especially in unitor applications.

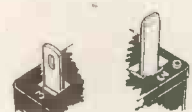
(8)
Covers are provided with either a top cable-entry hole and clamp or a side cable-entry hole and clamp, *to suit the needs of particular equipments and designs.*

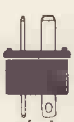
(9)
Two alternative facilities can be provided for earthing the plug or socket covers.

(9A.)
In one version an earthing tag attached to the moulding connects the inside of the cover to the highest numbered contact so that an earth lead in the cableform, connected to the highest numbered contact, automatically earths the cover.

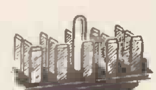
(9B.)
In the alternative form, an earth tag is rivetted directly to the outside of the cover and is suitable for the direct connection of an earth lead.
By either method the cover is earthed to ensure the safety of the users of equipments in which "Multicon" plugs and sockets are incorporated.

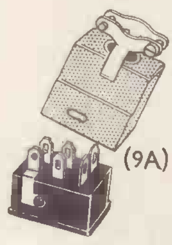
(10)
All sizes of plug or socket covers can be fitted with retaining blades to secure the unit to the panel or chassis.
Even under the most severe vibration conditions, therefore, or in the case of accidental interference with the cableform, there is absolute reliability of contact.

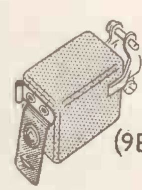

(1)

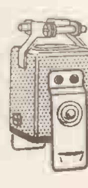

(2)


(5)


(7)


(9A)


(9B)


(10)

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Northampton England


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acknowledged leaders for over 30 years in the design, development and manufacture of loud-speakers for all purposes . . . world famous for quality of reproduction, sensitivity in performance and long life under all climatic conditions.
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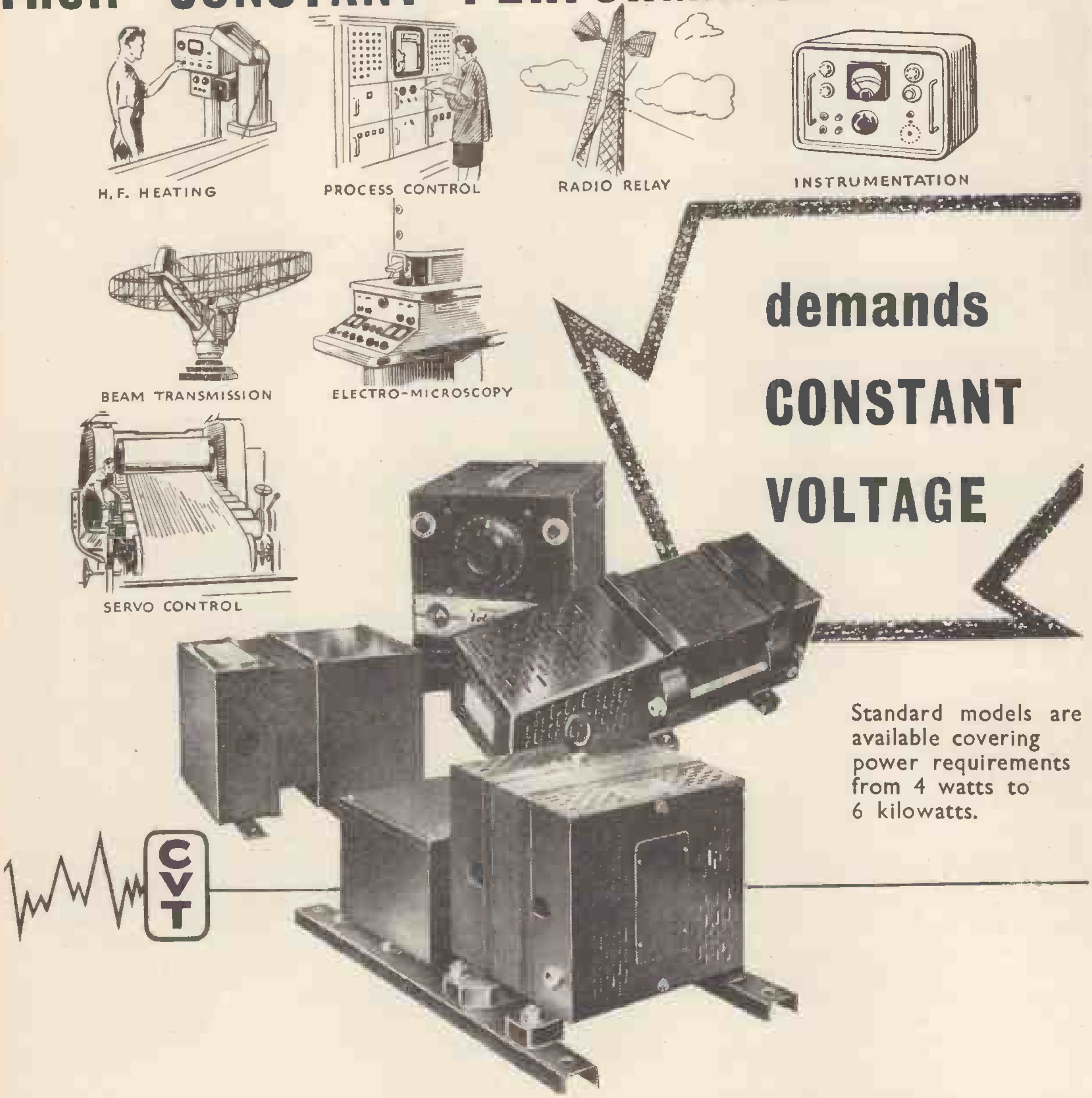
Their CONSTANT PERFORMANCE....



In much of today's highly sensitive electronic equipment and processes consistent high performance is possible only if the supply voltage is stabilised to the specific value for which the equipment is designed. Without constant voltage, instruments become unreliable, communications are interrupted, process control becomes erratic, products become degraded and discredit falls on the manufacturer. Advance Constant Voltage Transformers provide the answer to these problems. Entirely automatic, with no moving parts, they can accommodate wide voltage variations in the supply over a range of $\pm$ 15% of nominal, *providing a stabilised voltage within* $\pm$ *1%*.

AC voltage stabilisation is our business and our technical representatives are at your service if you encounter difficulties of this nature. We shall be most pleased to forward to you fullest details upon request. Write for folder W.28.

Advance

CONSTANT VOLTAGE TRANSFORMERS

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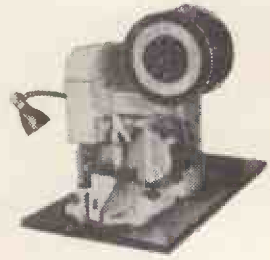
Solderless terminals speed assembly eliminate rejects

The AMP precision method of wire termination reduces production costs and provides connections of the highest electrical and mechanical efficiency. The use of AMP precision crimping tools and automatic machines achieves exceptionally high rates of output, a uniformly high standard of quality and the elimination of human error. AMP terminations and connections are of particular value in electronics and aircraft installations. They withstand vibration, corrosion and provide high tensile strength, with low resistance, and no noise at R.F.



Automatic wire terminator operates at up to 4,000 an hour

Pneumatic hand tool eliminates operator fatigue.

Certi-crimp hand tool. Positive closure ensured.

Brochure W.W. sent or demonstration at your own works on request.

AMP terminals are made for every type and size of wire.

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INSTRUMENTS

ADMITTANCE BRIDGE TYPE B.801

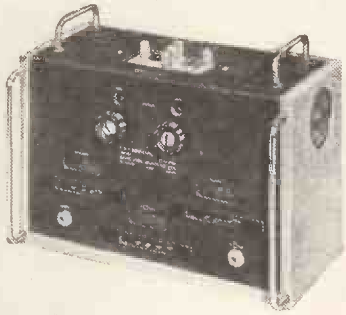
1 Mc/s – 100 Mc/s

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

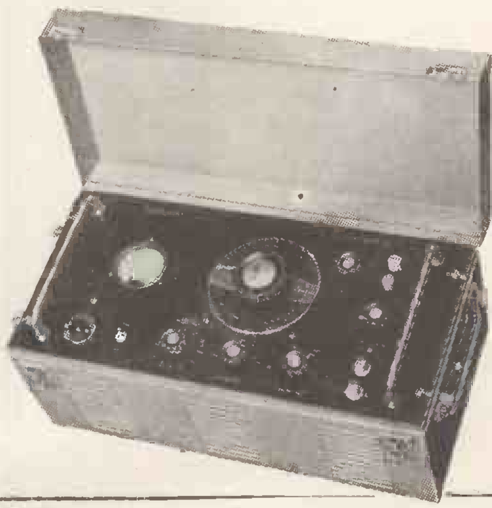
A general purpose 50 cps 3 terminal transformer ratio arm bridge for the measurement of Resistance, Capacitance and Inductance in the ranges 3-100 MΩ, 1 pF-100μF and 100 mH-10,000H, accuracy ±2%. Direct readings of the resistive and reactive components of impedance and facilities for "in situ" measurements 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



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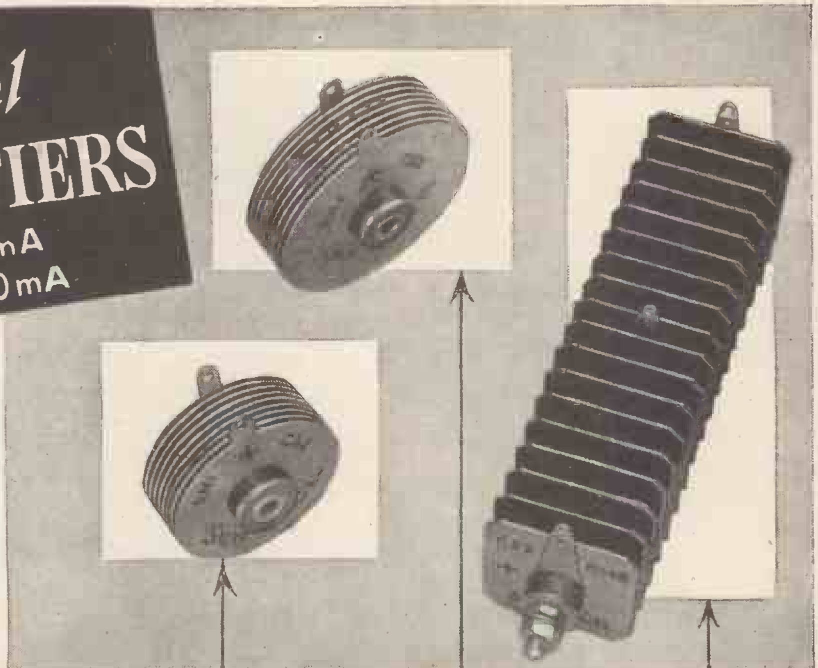
SenTerCel H.T. RECTIFIERS

from 125V 30mA to 250V 300mA

Specially designed for use in domestic Radio & Television receivers, these miniature rectifier stacks have an established position with manufacturers to whom reliability, small dimensions and low costs are important.



TYPE	RM0	RM1	RM2	RM3	RM4	*RM5
Maximum ambient temperature	35°C 55°C	35°C 55°C	35°C 55°C	35°C 55°C	40°C 55°C	40°C 55°C
Maximum output current (mean)	30mA 15mA	60mA 30mA	100mA 60mA	120mA 90mA	250mA 125mA	300mA 150mA
Maximum input voltage (r.m.s.)	125V	125V	125V	125V	250V	250V
Maximum peak inverse voltage	350V	350V	350V	350V	700V	700V
Max. instantaneous peak current	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Weight	0.82 oz.	1 oz.	1.4 oz.	2 oz.	4.5 oz.	4.75 oz.

* For use in voltage-doubler circuits the peak inverse and maximum input voltages are halved, current output being as for half wave operation.

- **Instant starting—no warming-up period**
- **Unlimited instantaneous overload**
- **No limit to size of reservoir capacitor**
- **Simple mounting—no valve holder**
- **Withstand overloads such as charging current of de-formed electrolytic capacitors**
- **Low heat dissipation**
- **Practically indestructible in service**
- **Simple wiring—two connectors only**
- **Small size . . . low weight**
- **Low cost**

SELENIUM SenTerCel RECTIFIERS

STC

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The Hermetically Sealed 595HS

★ The 595HS can be controlled by ultra sensitive contacts handling 0.4mA. at 2V. Contacts will handle 5A, at 230V. A.C.

★ The 595HS is made to withstand exceptionally heavy shock and vibration.

★ The 595HS is made to withstand dirt and humidity indefinitely.

★ The 595HS can be obtained with various contact assemblies.

★ The 595HS is low in price because of its novel design.

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MAGNETIC DEVICES LTD., A.I.D. & A.R.B. approved
EXNING ROAD, NEWMARKET, SUFFOLK.
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MD 14

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.

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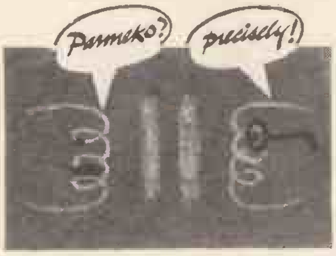
If you have a genuine interest in Audio Engineering and a sound technical background, we will be pleased to discuss the possibility of your joining our Company.

PARMEKO TRANSDUCTORS for MAGNETIC AMPLIFIERS



There are 14 standard types in the Parmeko 'Saturn' series of transductors for operation at supply frequencies of 400~ and 1600~ and some for 50~. They are used in overload protection devices and servo-motor amplifiers, voltage and frequency regulators and high speed sensitive relays, high power gain amplifiers and D.C. amplifiers giving a linear output from 0 to 10 microamperes, and other industrial and Service equipment. Illustrated leaflet 854-2 gives complete specifications.

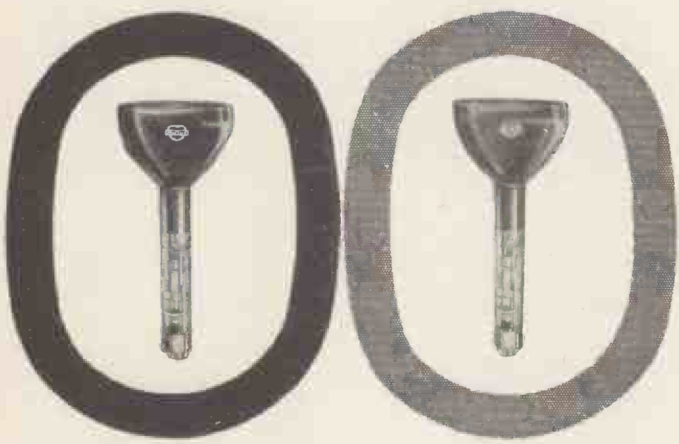
PARMEKO LIMITED

PERCY ROAD, LEICESTER, ENGLAND

television monitor comprehensive

every tube has these advanced features

- Metal backed screen.
- Straight gun (no ion trap) permitting highest spot quality.
- Resolution to highest monitor standards, satisfying 625 line system even at high brightness of 50 ft. lamberts in peak whites.
- Screen blemishes reduced to the absolute minimum.
- Quality control throughout manufacture to ensure highest picture standards and maximum life.
- Magnetic and electrostatic focused equivalent available to suit individual design requirements.



5-inch TUBES

These tubes are designed for use as electronic view-finders in television cameras, but they also satisfy the requirements for compact monitor equipment in broadcast and industrial television.

14-inch TUBES

These tubes are designed for use in television studio monitors but they also satisfy the requirements for large screen displays in industrial television systems.

AW13-36 Electrostatic Focus

Max. final anode voltage 14kV
Typical focus voltage range —200V to +200V about cathode potential
Deflection angle 53°
Overall length 12 inches

MW13-35 Magnetic Focus

Maximum final anode voltage 11kV
Deflection angle 53°
Overall length 11 inches

Mullard

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MULLARD LTD · CENTURY HOUSE · SHAFTESBURY AVENUE · W.C.2

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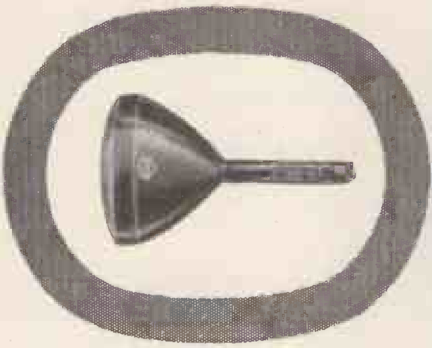
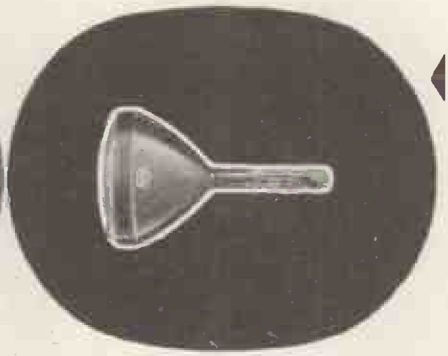




9-inch TUBES

These tubes are designed to a size convenient for use in mobile outside broadcast television equipment. They are also employed in studio floor monitors.

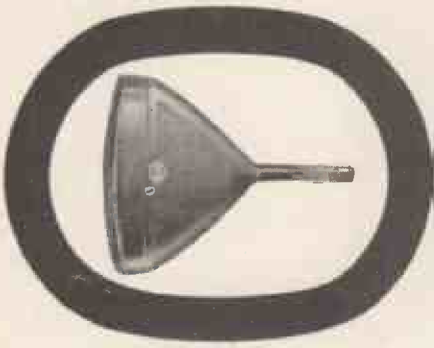
AW22-10 Electrostatic Focus

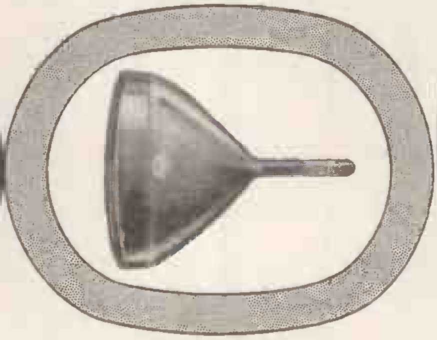
Max. final anode voltage 14kV
Typical focus voltage range —200V to +200V about cathode potential
Deflection angle 58°
Overall length 16 inches

MW22-22 Magnetic Focus

Max. final anode voltage 14kV
Deflection angle 64°
Overall length 15 inches

17-inch TUBE





AW36-48 Electrostatic Focus

Max. final anode voltage 15kV
Typical focus voltage range —200V to +200V about cathode potential
Deflection angle 70°
Overall length 17½ inches

MW36-67 Magnetic Focus

Max. final anode voltage 15kV
Deflection angle 70°
Overall length 17½ inches

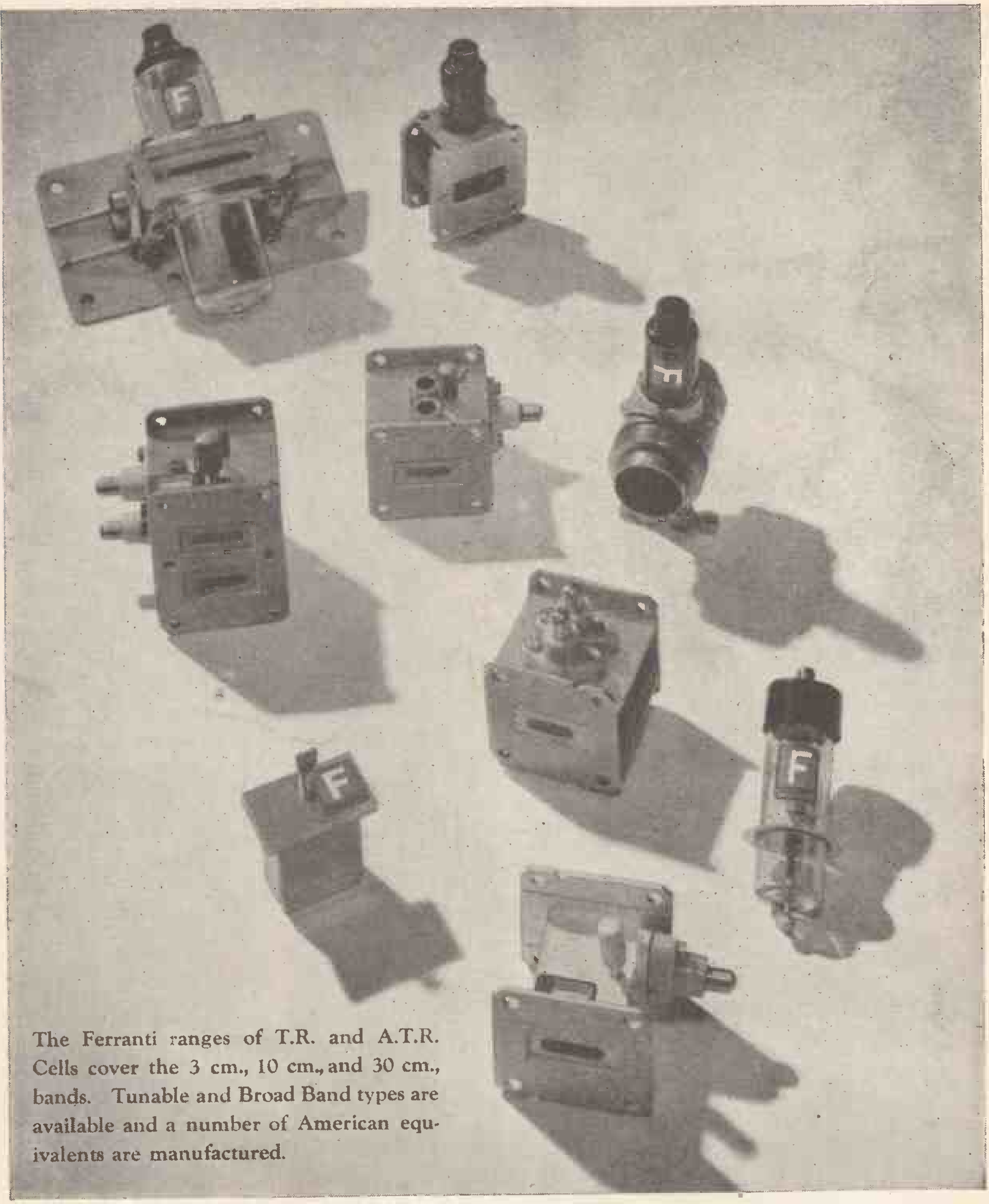
This tube is primarily intended for use as a television studio monitor tube.

MW43-67 Magnetic Focus

Max. final anode voltage 15kV
Deflection angle 70°
Overall length 20 inches

MVT303a

FERRANTI T.R. and A.T.R. CELLS for RADAR EQUIPMENT



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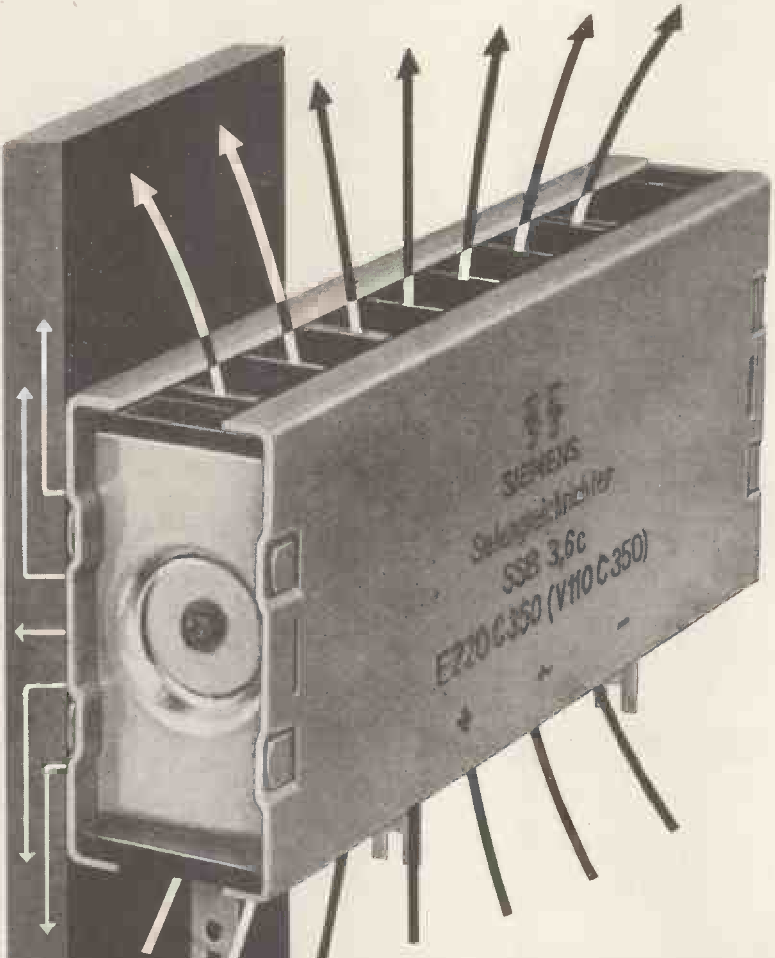
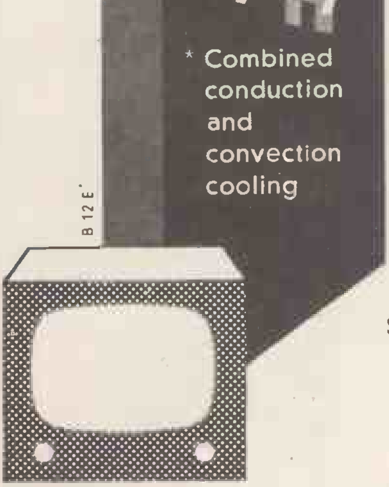
SIEMENS

SELENIUM BLOCK RECTIFIERS





Longer life through improved cooling

The problem of heat dissipation has been neatly solved.

Double cooling* increases reliability and lengthens life.

A television component of outstanding dependability!

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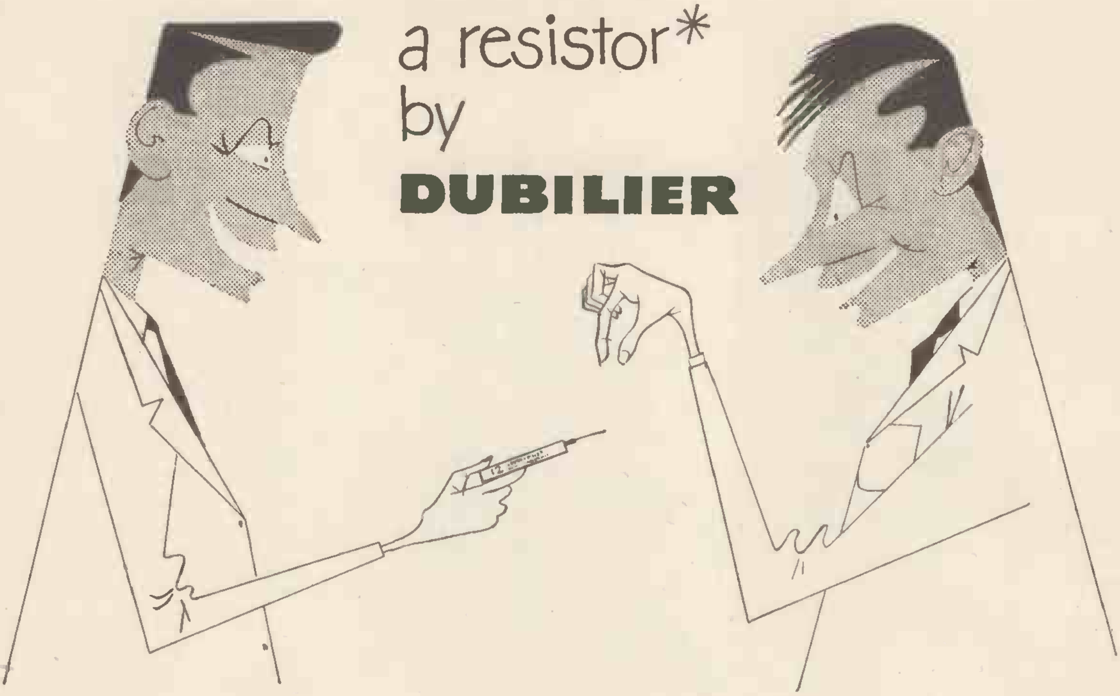
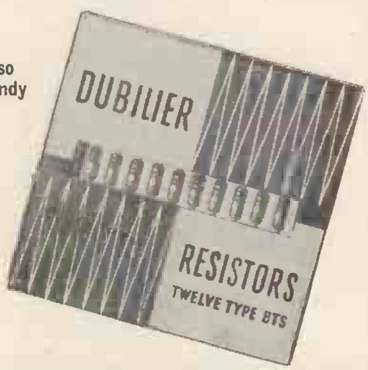
No engineer can resist a resistor* by DUBILIER



* 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.

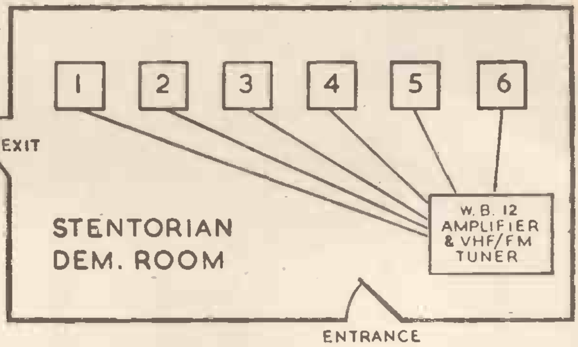


DUBILIER

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

DN 159B

Hi-Fi Fans besiege Stentorian Dem. Room *at Radio Show*



1 Stentorian H.F. 816 in Junior Bass Reflex Corner Cabinet
2 Stentorian H.F. 1012 in standard Bass Reflex Console Cabinet
3 W.B. 12" Concentric Duplex in special Cabinet
4 Stentorian H.F. 1214 standard Bass Reflex Cabinet with T. 816.
5 Stentorian H.F. 1012 with T.10 tweeter in Senior Bass Reflex Corner Cabinet
6 Stentorian H.F. 812 in Corner Console Cabinet

The demonstrations were carried out in conjunction with the W.B. 12 Amplifier and VHF/FM Tuner which were housed, together with a record player, in a W.B. Hi-Fi Console Cabinet.

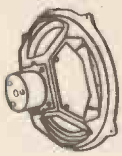
FROM morning to night the Stentorian Demonstration Room—with a limited seating accommodation for only 50 people at a time—was one of the main attractions at Earls Court. For word had got around that W.B. was demonstrating Hi-Fi of outstanding quality at prices that were astonishingly low.

And for once Dame Rumour was no lying jade! During the period of the Exhibition, in fact, no fewer than 11,000 Hi-Fi fans heard for themselves — and were convinced — that there was no finer equipment *at any price* than Stentorian.

Time and again people came back and said : "We've heard other demonstrations but yours is the best". Of course, we are gratified at the enthusiasm shown, but not surprised. For we've been in the Loud Speaker business right from the beginning. Everything that goes into a W.B. Speaker has been designed and made in our Mansfield works. We even make our own magnets.

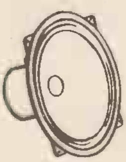
We maintain a fine team of research engineers with many 'firsts' to their credit. Perhaps you did not know that the first "tweeter" ever to be produced in this country was made by us. But if W.B. has always been associated with high quality—and real Hi-Fi can only be achieved with high quality equipment—we have always set our face against high prices.

Compare the prices shown here and you'll appreciate that Hi-Fi is now available at realistic cost. See and hear Stentorian Hi-Fi at your Dealer's — we are content to await your verdict.



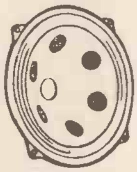
Type H.F. 1012
10" unit, die cast, 12,000 gauss magnet, cambric cone, 10 watts capacity. 30-14,000 c.p.s. Bass resonance 35 c.p.s. £4 . 19 . 9

Type H.F. 812
8" unit, 12,000 gauss magnet, cambric cone, 5 watts capacity. 50-12,000 c.p.s. Bass resonance 65 c.p.s. Die cast chassis: £4 . 3 . 6

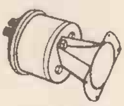


Type H.F. 816
8" unit, die cast, 16,000 gauss magnet, cambric cone, 6 watts capacity. 50-14,000 c.p.s. Bass resonance 63 c.p.s. £6 . 17 . 0

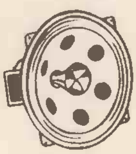
Type T. 816
Special 8" mid-range unit for use with H.F. 1214, 16,000 gauss magnet, 15 watts capacity with 1,500 c.p.s. cross-over. Up to 17,000 c.p.s.
Impedance 15 ohms. £6 . 10 . 0



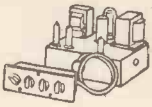
Type H.F. 1214
12" unit, die cast, 14,000 gauss magnet, cambric cone, 15 watts capacity. 25-14,000 c.p.s. Bass resonance 39 c.p.s. £9 . 15 . 6



Type T. 10
Tweeter unit, m/c pressure type, 14,000 gauss magnet, 2,000-14,000 c.p.s. 5 watts. Recommended for use with H.F. 1012. £4 . 4 . 0



12" Concentric Duplex
Combined bass and tweeter unit with cambric cone and mid-range frequency stabilizers. Handling capacity, 15 watts. Frequency response, 25 c.p.s. to 17,000 c.p.s. Bass resonance, 35 c.p.s. £25 . 0 . 0



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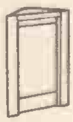
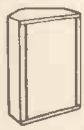
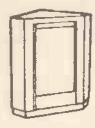


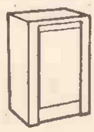
Corner Console
26" x 17" x 7½" for use with Stentorian H.F. 812. £5 . 10 . 0



Junior Bass Reflex Corner Console
For use with 8" or 10" units with provision for tweeter. 33" x 22½" x 18½" £9 . 9 . 0



Senior Bass Reflex Corner Console
For use with 10" or 12" units with provision for tweeter. 35" x 30" x 19" £11 . 11 . 0



Standard Bass Reflex Console
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All prices in this advertisement are inclusive of Purchase Tax.

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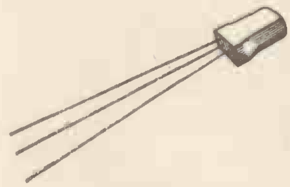

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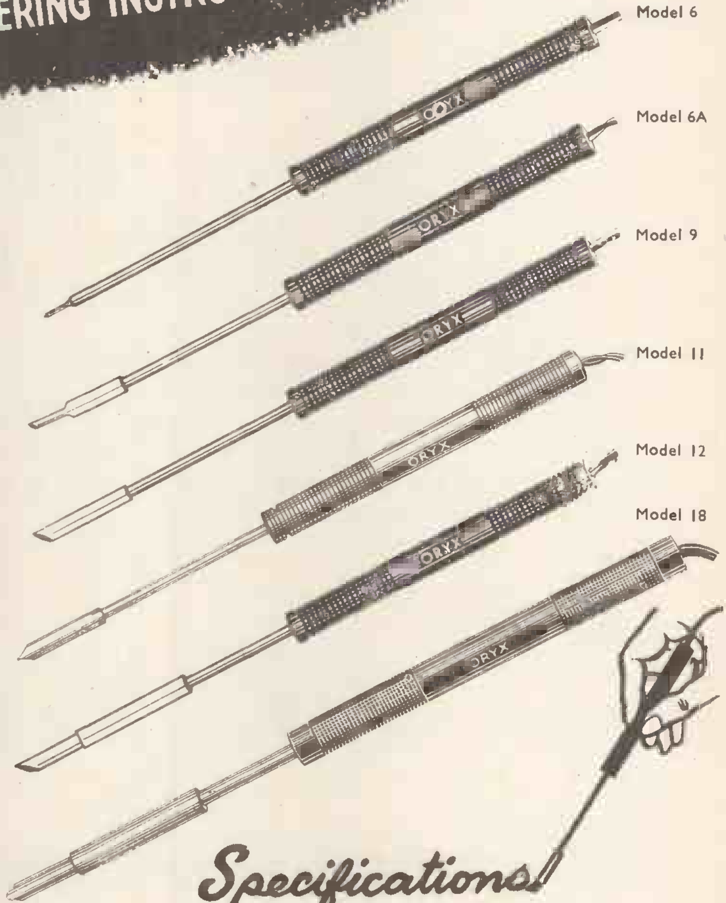

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Mod.	Consumption	Bit Dia.	Weight	Length	Price	Sp. Bits
18	18 watts	$\frac{3}{16}$in.	$\frac{3}{4}$ oz.	$7\frac{1}{4}$in.	35/-	3/6
12	12 watts	$\frac{3}{16}$in.	$\frac{1}{2}$ oz.	6in.	25/-	2/-
9	8.3 watts	5/32 in.	$\frac{1}{4}$ oz.	6in.	25/-	2/-
6A	6 watts	3 32 in.	$\frac{1}{4}$ oz.	6in.	25/-	2/-
6	6 watts	$\frac{1}{16}$in.	$\frac{1}{4}$ oz.	6in.	25/-	—
11	10 watts	5/32 in.	$\frac{1}{2}$ oz.	6in.	35/-	7/6

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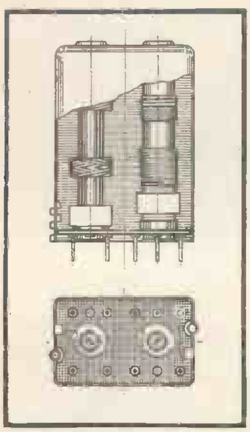
I.F. TRANSFORMERS AND RATIO DETECTORS FOR AM AND FM.



TYPE P.23/1R

COMBINED AM/FM TRANSFORMERS 470 KC/S AND 10.7 MC/S. AM BANDWIDTH 8 KC/S AT —3DB. FM BANDWIDTH 200 KC/S AT —1.5 DB.

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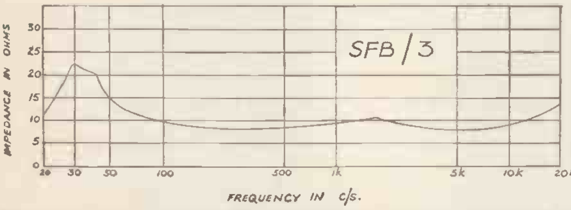

SPECIFICATION. Size 34in. × 31in. × 12in. Weight 64 lbs. Impedance 8/15 ohms. Bass Resonance 30/35 c/s. Max. input 15 watts.

UNITS. W12/SFB, 10in. Bronze/SFB, Super 3. The 12in. and 10in. units are in parallel. This arrangement gives very smooth results over the full range with a 3 DB gain at low frequencies. The Super 3 is again parallel via 4 Mfd. capacitor and is mounted on a small baffle facing upwards. The efficiency of the system is high and will give full domestic volume from any good 5-watt amplifier. The baffle is sandfilled; there is no cabinet resonance because there is no cabinet.

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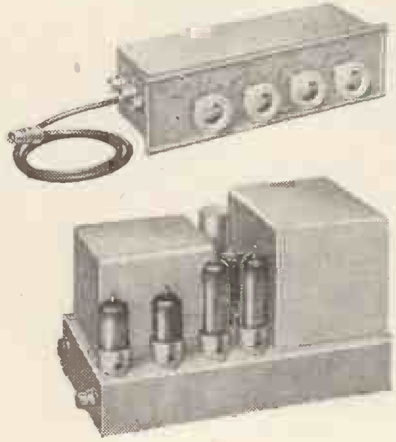

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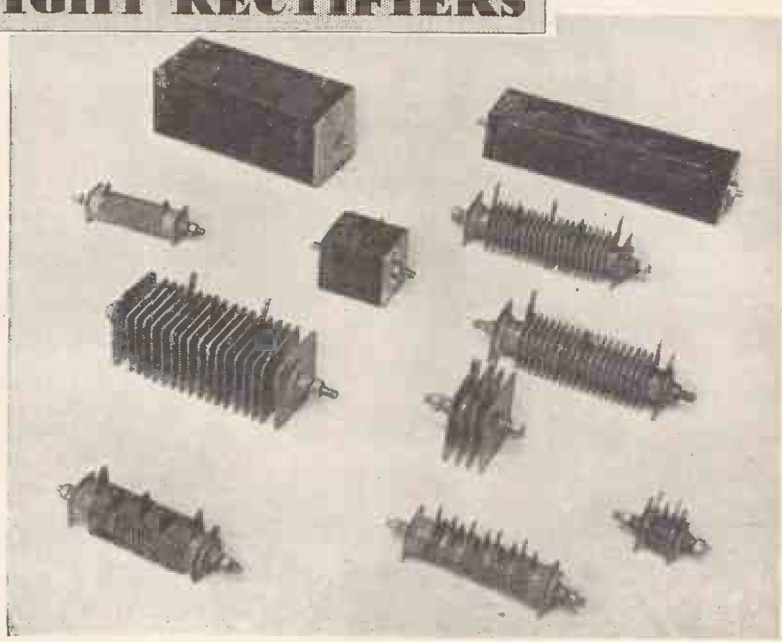

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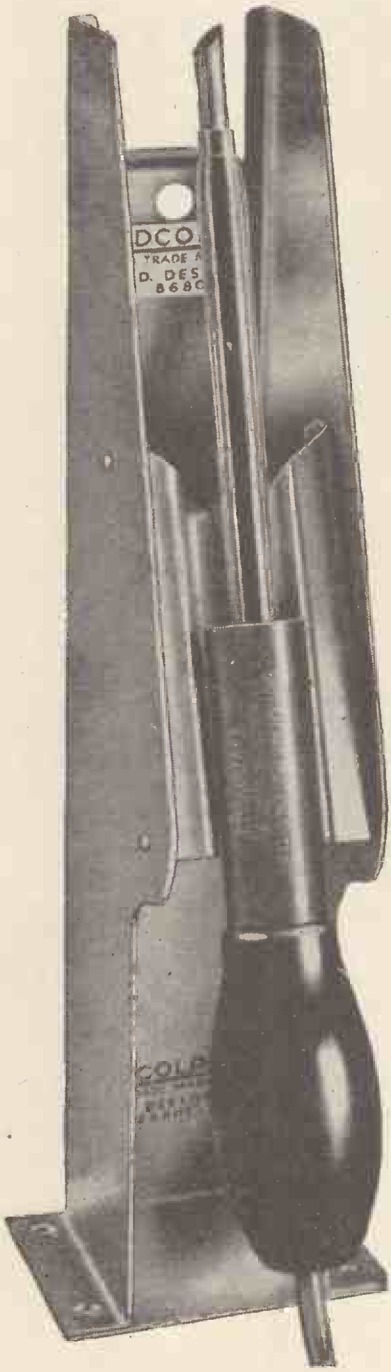

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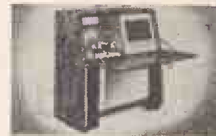

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TYPE AT.23.

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★ Balance ratio better than 20dB rising to over 60dB at low frequency end of band.

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AIR THERMOSTATS (Kleft—brand new). Range 30/90 deg. F., differential only 2 deg. F., capacity 15 amps. A.C. in smart ivorine housing $4\frac{3}{4}$in. × 2in. × 2in. Easily installed—instructions with each, the ideal thermostat for greenhouse, rooms, labs., etc. 45/6 (des. 1/-).

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OPERATION COUNTERS, latest G.P.O. type, electromagnetic, brand new, 1in. sq., by 4in. long, counting up to 9,999. Resistant 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 $2\frac{1}{2}$in. These count 1 digit per rev. and can be used for testing motor speeds. 15/6 (des. 1/-).

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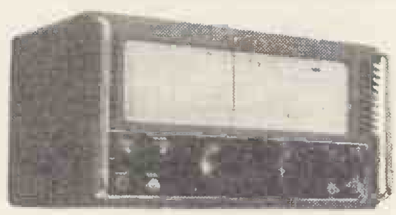

Model 840A illustrated.

Cash Prices and Statutory Terms

Model	Cash Price	Deposit	12 monthly of
820	£38 0 0	£19 0 0	£1 15 0
840A	£55 0 0	£27 10 0	£2 10 0
750	£78 0 0	£39 0 0	£3 11 8
888	£110 0 0	£55 0 0	£5 0 0
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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.

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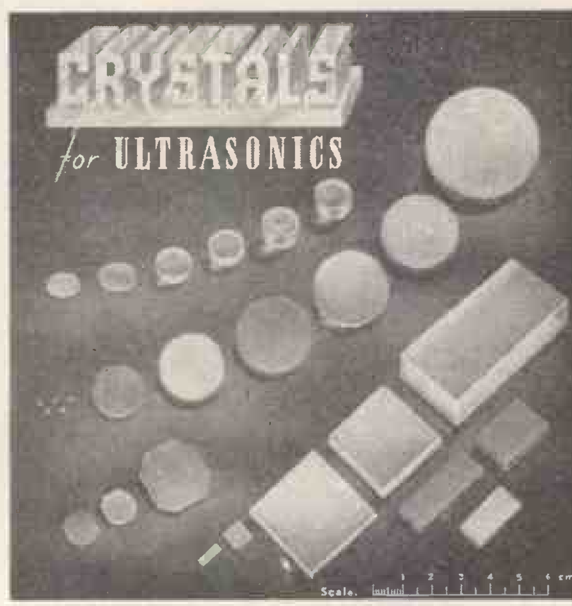

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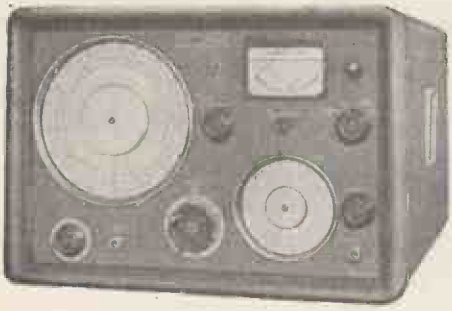
TYPE TF 1058



U.H.F. SIGNAL GENERATOR
TYPE TF 1060

Marconi U.H.F. Signal Generator
TYPE TF 1060

Marconi U.H.F. & S.H.F. Signal Generator
TYPE TF 1058

These two Marconi Signal Generators simplify a wide variety of measurements in the ranges 450 to 1250 and 1700 to 4000 Mc/s. The range of each is covered in one band and frequency is directly indicated on a large, clear dial; incremental tuning facilities coupled with inherent high stability provide for the most exacting bandwidth measurements. The wide range of output levels, directly indicated on the dial of a piston attenuator, is suitable for a diversity of applications extending from slotted-line measurements to the testing of high-sensitivity receivers.

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TF 1060 *Frequency Range:* 450 to 1250 Mc/s. *Incremental Tuning:* 20 to 200 kc/s per division, with interpolation by fine tuning control. *Frequency Stability:* Better than 0·005% per 10-minute period. *R.F. Output:* 0·15μV to 445mV; also higher outputs up to approximately 3 volts. *Output Impedance:* 50 ohms. *Modulation:* Internal sine and external pulse a.m.

TF 1058 *Frequency Range:* 1700 to 4000 Mc/s. *Incremental Tuning:* 60 to 350 kc/s per division, with interpolation by fine tuning control. *Frequency Stability:* Better than 0·001% per 10-minute period. *R.F. Output:* 0·1μV to 445mV; also higher outputs up to approximately 3 volts. *Output Impedance:* 50 ohms. *Modulation:* Internal square a.m.; external f.m. and pulse a.m.

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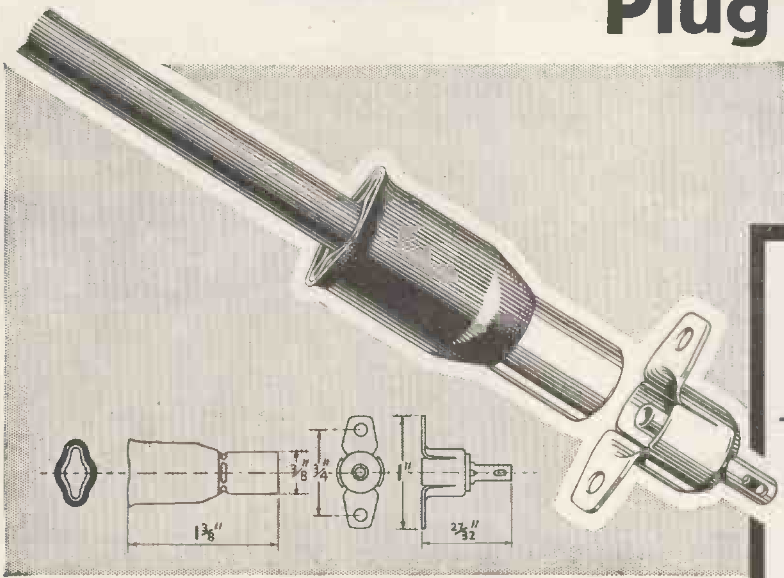
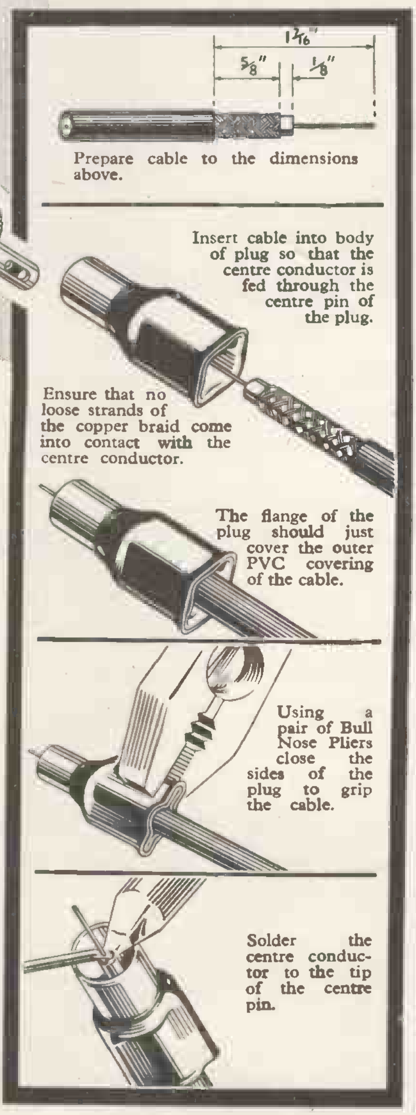
WORLD-WIDE REPRESENTATION

TC 88

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

This new Standard Plug and Socket fully conforms to the R.E.C.M.F. Electrical and Mechanical Specifications and whilst it is interchangeable with all similar plugs and sockets, it incorporates many advantages.

DESCRIPTION OF PLUG

- **ROBUST CONSTRUCTION**
Constructed as a "one piece" unit with no small parts to dismantle. 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.

- **FULLY INSULATED**
Fitted with a NEOPRENE insulating sleeve—a new and important safeguard.

- **EFFICIENT IN OPERATION**
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.

- **SIMPLE TO FIT**
Can be fitted in a few seconds after preparation of the cable WITHOUT removing the neoprene insulating sleeve from the plug.

DESCRIPTION OF SOCKET

Constructed of high quality brass with heavy nickel plating. It embodies a resilient pin-retaining socket which ensures smooth action and positive contact.

HIGHLY COMPETITIVE PRICE

Both the Plug and the Socket are ...... **8d** EACH

CO-AXIAL PLUG TVP/1
CO-AXIAL SOCKET TVS/1

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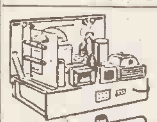
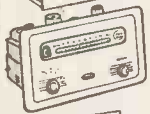
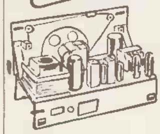
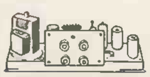
UNIT		DESCRIPTION	REMARKS	PRICE
	H.4.T	MODEL H.4.T. A.M./F.M. TUNER CHASSIS (Self Powered). Four Wavebands. Circuit incorporates B.V.A. glass seal miniature valves of latest type specifically designed for F.M. receivers. Full A.G.C. chassis size $8\frac{3}{8}$in. × 12in. × $7\frac{3}{4}$in.	Highly sensitive. Built to give trouble free quality reproduction. Has slow motion tuning (by glass cored nylon drive). For operation on 200/250 v. A.C. mains.	£20 . 17 . 0 INC. TAX
	F.M. TUNER	AN F.M. (V.H.F.) self powered tuner chassis. 200/250 V.A.C. mains operated. 3 stage I.F. amplifier, magic eye tuning. Valve line up E.CC 85, two E.F. 89, EABC 80, EM 80, 6x4. Overall size $10\frac{1}{2} \times 5\frac{7}{8} \times 7\frac{1}{2}$in.	Designed for use in conjunction with Radiograms, Receivers with P/U sockets. Tape Recorders and Quality Amplifiers. Switching is arranged to give direct intercommunication.	£17 . 10 . 3 INC. TAX
	F.3.PP.	Model F.3.PP. Seven valve superhet Radio/Radiogram Chassis. Three wavebands. Ferrite rod aerial. 6 watt output. B.V.A. latest type glass miniatures.	Designed to give first class reproduction on radio and gramophone. Negative feedback—separate wide range bass and treble controls.	£18 . 15 . 4 INC. TAX
	4 WATT Amplifier	4 watt amplifier. 4 valve circuit using latest B.V.A. glass miniatures. Frequency response 40-15,000 c.p.s. Control panel on fly leads for universal mounting.	Controls include output selection switch with provision for switching to Radio, L.P. and 78 R.P.M. records. Independent treble and bass controls giving wide range of lift and cut.	£9 . 9 . 0 INC. TAX

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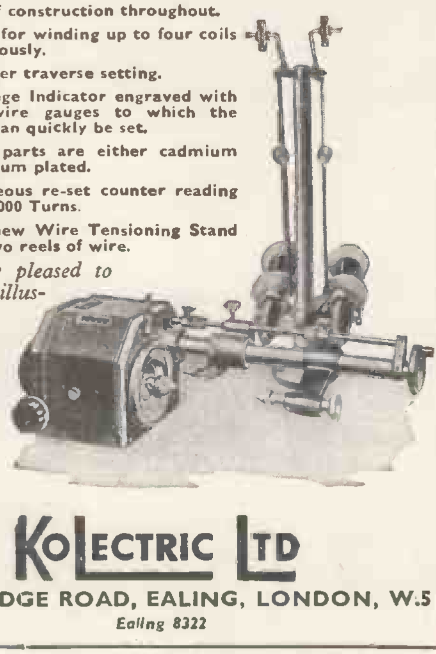

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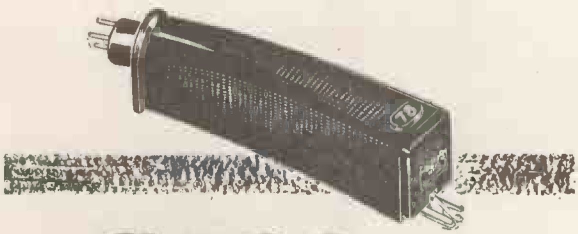

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Type CT84

Type CT52

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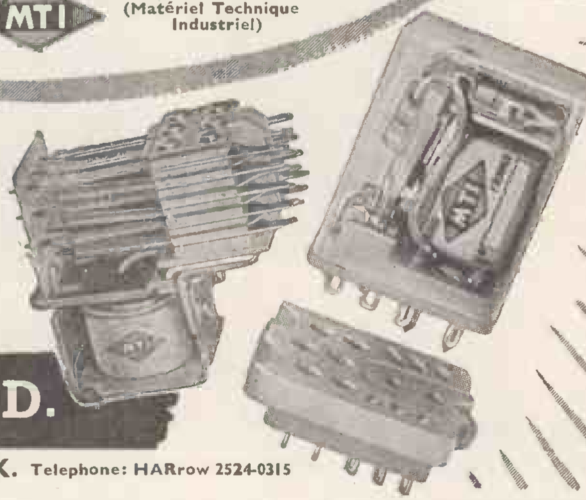

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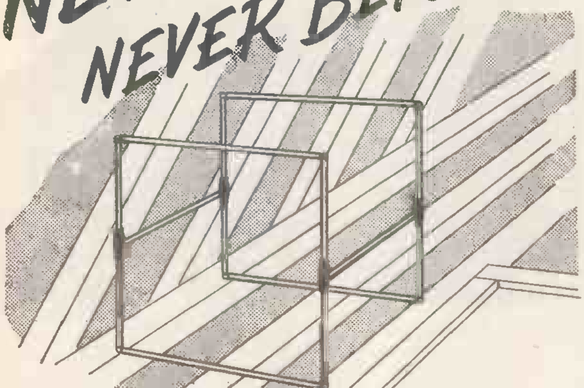

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-and the NEW *Spiral*

(Patent pending)

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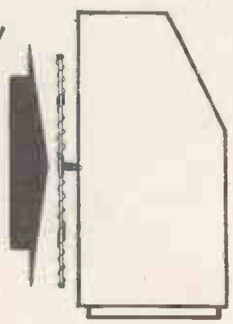
Neat, compact, unobtrusive—approximately 30 inches in length. Simply plug it into the set; no extra fittings, no untidy flex, cables or "extras." Gives reception on both Band I and Band III. Four versions: London, Midlands, North Western and North Eastern. Average maximum range: 10 miles approximately. And the Spiral sells for only 39/6 complete.



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Authorised distributors for Yorkshire: Northern Aerials Ltd., 147, Park Lane, Leeds, 1.

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Telephone: Cambridge 2494. Telegrams: Labgear, Cambridge.

A NEW VALVE VOLTMETER

RANGE: 0-10mv, 0-100mv, 0-1v, 0-10v, 0-100v, RMS FSD
FREQUENCY RESPONSE: 20 c/s to 1 mc/s
ACCURACY: ± 2%
INPUT IMPEDANCE: 1 MΩ and 5 μμf.

Price: **£55 0 0**
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IN 30 DAYS

15 complete Conversational lessons for beginners in Spanish, German, French, Italian and Russian. One Single Tape comprises a complete elementary course in any of the above languages.

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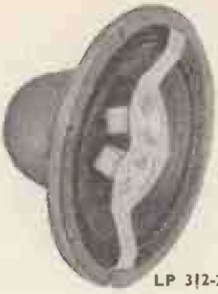


LP 312-2

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.

LPH65

IMPROVE ANY

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

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).

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 fidelity 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.*

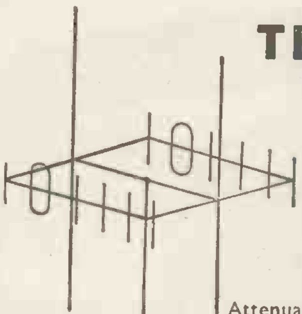
SPECIFICATION LPH65

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).

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

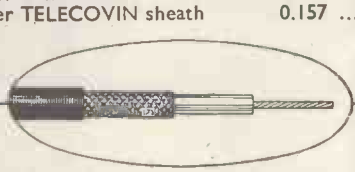


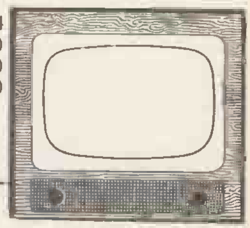
TELCON CELLULAR POLYTHENE INSULATED DOWNLEADS

This new range of 75 ohm coaxials has been especially designed for the reception of Band II (FM sound 87.5 - 100 Mc/s.) and Band III (Television 174-216 Mc/s.).

Attenuation db/100ft.	ET5M	ET6M	ET7M	ET8M	ET10M
10 Mc/s.	1.3	... 1.5	... 1.0	... 1.1	... 0.6
50 „	3.0	... 3.4	... 2.3	... 2.6	... 1.5
100 „	4.3	... 4.8	... 3.2	... 3.6	... 2.2
200 „	6.3	... 7.2	... 4.9	... 5.3	... 3.3

Dimensions (Inches)					
Centre Conductor	1/0.022	7/0.0076	1/0.029	7/0.010	1/0.044
Over Cellular TELCOTHENE	0.093	... 0.093	... 0.128	... 0.128	... 0.200
Over Wire Braid	0.117	... 0.117	... 0.152	... 0.152	... 0.230
Over TELECOVIN sheath	0.157	... 0.157	... 0.202	... 0.202	... 0.290





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THE TELEGRAPH CONSTRUCTION & MAINTENANCE CO. LTD., TELCON WORKS, GREENWICH S.E.10 TEL.: GREENWICH 3291

BRANCHES: BIRMINGHAM, CARDIFF, LONDON, MANCHESTER, NEWCASTLE AND NOTTINGHAM.

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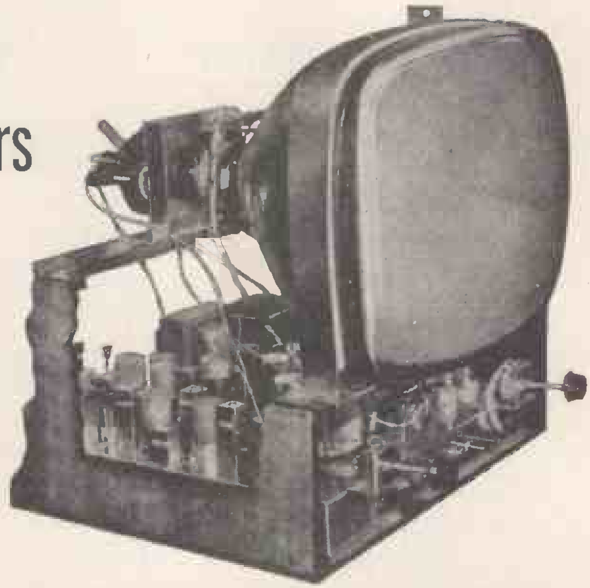
SAFETY FIRST!

Build these PREMIER Televisors



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. Half door, 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. and carr.

... which give complete safety to the constructor

These Televisors use a double wound mains transformer which gives you complete safety from contact with the mains supply when handling the chassis or controls.

★ **ALL CHANNELS B.B.C. & I.T.A. DESIGN No. 1**
MAY BE BUILT FOR £32-7-11 PLUS COST OF C.R.T.

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BUILD IN 5 EASY STAGES. FULL CONSTRUCTION DETAILS AVAILABLE. INSTRUCTION BOOK 3/6 POST FREE INCLUDES BOTH DESIGNS.

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★ Case finished in Brown and Antique Fawn. Size 15in. × 12¾in. × 7¾in., with the very latest type continental gilt fittings. For A.C. mains 200-250 volts, 50 cycles.
★ Two speeds 7½ and 3¾in. per sec., playing time of 1 hour and 2 hours.
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★ One knob deck operation.
★ Amplifier may be used for gramophone or microphone purposes giving high-quality reproduction.
★ Superb reproduction of pre-recorded tapes.
★ Microphone compartment.
★ Complete with reel of Scotch Boy Tape (1,200ft.), and spare reel.
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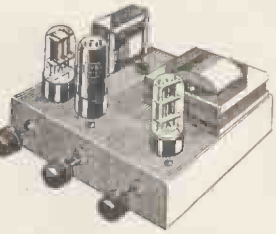


4 WATT AMPLIFIER

MAY BE BUILT FOR **£4 . 10 . 0** Plus 2/6 Pkg. & Postage

Instruction Book 1/- post free.

A steel case is now available, complete with engraved panel, for 15/6 extra. The amplifier may be supplied complete for £5/5/- plus pkg. and post 3/6, or fitted in case at £6 plus pkg. and post 3/6. Engraved panel 3/6. Post Free.

2-BAND TRF RECEIVER MAY BE BUILT FOR £5.15.0

plus pkg. & post 3/-

3 BAND SUPERHET RECEIVER

MAY BE BUILT FOR **£7 . 19 . 6** Plus 3/- Pkg. & Postage

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.

T.S.L. LORENZ SOUND SYSTEM

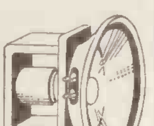
Type LP 312-2

Consists of a 12in. Unit and two LHP65 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 17,000 gauss. This Speaker system gives a level response from 20 to 20,000 cycles.

Leaflet available giving full details. Price £14/19/6. H.P. Terms available. Postage and packing 7/6 extra.

Cross-over Unit designed for the LP 312-2 £2/2/- plus p. & p. 1/6.

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.

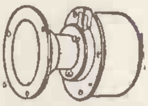
We shall be only too pleased to demonstrate any of the above equipment.

THE NEW "WHARFEDALE" SFB/3

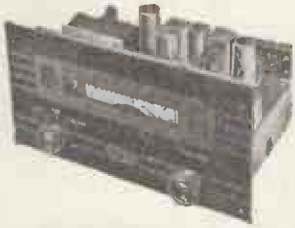
3-SPEAKER SYSTEM

Consists of Speakers W12CS, Bronze 10CSB, Super 3HF and a special Crossover Unit fitted into a very attractive Cabinet, size 34in. × 31in. × 12in. Weight 60 lb. Cash £37/10/-. Credit deposit £4/14/- and 8 monthly payments of £4/12/3, or H.P. deposit £18/15/- and 12 monthly payments of £1/14/9. Packing and carriage 21/-.

New GOODMAN TREBLE UNIT THE TREBAX

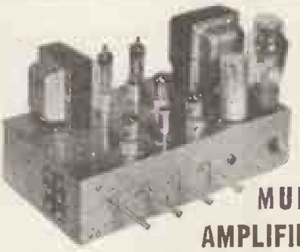


At £5/9/3 is a high efficiency pressure driven reproducer covering 2,500 c.p.s. to 16 kc/s. It makes an excellent 2-speaker system when used with the Axiom 150 Mark II at £10/15/9. A special Crossover Unit type X05000 is available at £1/19/-. The complete system £18/4/- cash. Credit terms deposit £2/5/6 and 8 monthly payments of £2/4/10, or H.P. Terms deposit £9/2/- and 9 monthly payments of £1/2/6. Packing and carriage 7/6.



THE NEW TSL FM TUNER HIGH STABILITY MODEL

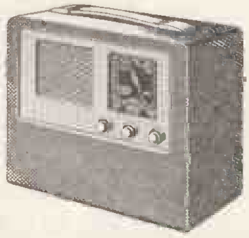
6 Valves including Magic Eye and Power Supply using the latest type Gorler permeability Unit complete with first audio stage and preset output volume control. Maximum radiation less than 10 microvolts per metre. Sensitivity better than .5 microvolts. Cash price £17/10/- (inclusive) or on H.P. terms, 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.



Why not make the best !

MULLARD AMPLIFIER KIT

All the components for model 510, PLUS pre-amplifier on one chassis (total six valves) chassis gold hammer finished. 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.



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. × 5½in., in two contrasting colours, wine with grey panel Instruction book 1/6 post free, which includes full constructional details and list of priced components.

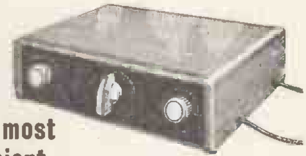
WILLIAMSON AMPLIFIER

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.



The most efficient BAND III CONVERTER available

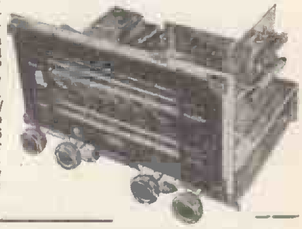
Includes 2 valves plus metal rectifier utilising the latest circuit technique. Midland, North and London Models A.C. Mains only 200/240 v., complete with power supply. Provision is made by means of a four position switch to cover all Band III channels. Size—Height 2½in., Width 5½in. Length 8½in.

PRICE COMPLETE **£8 . 8 . 0** *Plus 2/6 pkg. & carr.*

Credit Terms: Deposit £1/1/4 and 8 monthly payments of £1/2/1.

AM/FM RADIOGRAM CHASSIS

The latest "Dulci" Model H.4



7 Valves (including Magic Eye). Ferrite Rod Aerials on medium and long "Gorler" permeability Unit on F.M. A.C. mains 200/250 volts. Cash price £27/16 or on H.P. or Credit Terms. *Plus packing and carriage 7/6 extra.*

AM/FM TUNER CHASSIS

DULCI MODEL H4T (Self Powered)

4 Wavebands. V.H.F. Short, Med., Long. "GORLER" F.M. Unit. Preset output Volume Control. Cash price £20/17/- or on Hire purchase or credit terms. Plus packing and postage 5/- extra.

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ALL GOODS OFFERED ARE NEW AND UNUSED

HEADPHONES
Type CLR, low resistance **6/6**; Type CHR, high resistance 12/6. Type DLR5, sensitive balanced armature, low resistance, **7/6**. Type DHR5, the most sensitive 'phone ever made, high resistance, balanced armature, **17/6**; Type HS30, American lightweight "Stethoscope" type, low resistance **21/-**. Packing and carr. 1/6.

TRANSMITTING VALVES.
Guaranteed new, unused in perfect condition. RCA813, **£3/10/-**; RCA 832A, **£3/15/-**; 807, **6/6**; GEC TT16 (4-125A), **£4/10/-**. Packing and carr. 1/-.

U.S.A. "COMMAND" RECEIVERS.
Type R28/ARC5. Covers 100/156 Mc/s., 4 motor switched preset crystal channels. Complete with 10 valves and one crystal (any desired frequency) originally designed for 24/28 v. operation but heaters may be rewired for 12 v. Motor and relays will operate on 12 v.
In original carton with circuit, **£3/3/-**, plus packing and postage 3/-.
Extra Crystals, **6/-** each.
24 v. Plug-in Dynamotor for above **22/6**.
12 v. Plug-in Dynamotor for above **45/-**.
Available only with the above.

U.S.A. COMMAND TRANSMITTERS.
Type BC-950A. Covers 100/156 Mc/s., 6-10 watts, 4 motor switched crystal channels employs a 1625 as harmonic oscillator, a 1625 as 1st harmonic generator 832A as 2nd harmonic generator, 832A as RF amp. 815 as modulator. In original carton complete with valves, instruction manual and one crystal (any frequency) **£8/8/-** plus packing and carr. 5/-. Extra crystals 6/-.
Designed for 24/28 v. operation but heaters may be rewired for 6 v. or 12 v. Relays and motor will operate on 12 v. Requires 500 v. plate supply.
TYPE BC-950A-400. An identical transmitter but covering 100/124 Mc/s only. WITHOUT valves or crystals, **£4/4/-**. With valves and one crystal **£7/7/-**.
TYPE BC457A. Covers 4-5.3 Mc/s consists of Stable VFO driving pair of 1625 valves, complete with V.F.O. calibration crystal in original carton **29/6**, plus packing and postage 3/-.
TYPE BC459. As above but covers 7-9.1 Mc/s. **29/6**, plus pkg. and post. 3/-.
TYPE BC697. As above, but covers 2.1-3 Mc/s. **29/6**, plus pkg. and post. 3/-.

RT37/PPN2 BEACON TRANSMITTER RECEIVER.
Frequency coverage 214/234 Mc/s consists of 2 built-in vibrator packs for operation off 2 volt accumulator, valves 5-3A5, 3-1S5, 1-1R5. Complete with telescopic antenna mast ($9\frac{1}{2}$ft.) headphones, technical manual, carrying haversack, cords, plugs etc. Size 13 × 10 × 5in. total weight 28lb. **72/6**. Packing and carr. 5/-.

RCA 50 WATT AMPLIFIER TYPE 4288-1.
Ideal for public address or large halls when used with a 2-valve pre-amplifier, details of which can be provided. Valves 2-6J5's feeding into 4-6L6's in parallel push-pull. Output 50 watts into 250, 60, 15, 8 or 4 ohms, frequency response plus/minus 1 db from 30-10,000 cycles, dimensions, width 16in. × depth $11\frac{3}{4}$in. × height $7\frac{1}{2}$in. Price **£10/10/-** complete with valves plus packing and carr. 7/6.

VIBRATOR PACKS.
12 v. Mallory, output 275 v. 80 m/a. in original carton. **25/-**, plus pkg. and post. 3/-.
6v. R.C.A. output 275 v. 80 m/a. in original carton with battery leads and clips. **35/-** plus packing and postage 3/-.

R/F UNITS.
With valves, in original carton. RF24 **9/6**; RF25 **9/6**; RF26 **25/-**, plus packing and postage 2/- each.

PAPER BLOCK CONDENSERS.
8 mfd. 500 v.w. **2/6**; 8 mfd. 600 v.w. **5/6**; 8 mfd. 1,000 v.w. **7/6**; 4 mfd. 1,000 v.w. **3/9**. Packing and carr. 6d.

TYPE 62A INDICATORS
Useful for constructing an oscilloscope or T.V. Unit. Valves VCR97, 12-VR91 (EF50), 2-VR54 (EB34) 3-VR92 (EA50), 4-CV118 (SP61), 93.5 Kc/s crystal, size $8\frac{1}{4} \times 11\frac{1}{2} \times$ 18in. New in wooden packing cases. **£3** plus packing and carriage 7/6. OR less slow motion dial **£2/15/-** plus packing and carriage 7/6. OR less dial and EF50 valves **£1/15/-** plus packing and carriage 7/6.

AUTO TRANSFORMERS. Input 200-260 v. in 10 v. steps. Output 100-155 v. in 3 v. steps, 500 watts. **42/6** plus packing and carriage 5/-.

ISOLATION TRANSFORMERS. Input 200-250 v. Output 100-155 v. in 3 v. steps. **39/6** plus packing and carriage 5/-.

AERIAL RELAYS.
Heavy duty D.P.D.T. plus S.P.S.T. ceramic insulation. 12-24 v. D.C. operated. **12/6**. Packing and carr. 1/6.

MICROPHONE STANDS.
An excellent quality, fully collapsible, studio type floor stand, **£1/10/-** plus packing and post. 5/-.

SOUND POWER MICROPHONES. Complete with transformer. A complete P.A. system when used with a 12 v. battery and a suitable loudspeaker **£1/5/-**. Packing and carr. 1/6.

PARMEKO RE-ENTRANT P.A. SPEAKER. A twin horn unit of amazing sensitivity handles 10 watts, in Bakelite moulding with weatherproof (tapped) line transformer, **37/6** plus packing and carr. 5/-

VCR97 TUBES.
Guaranteed unused, full picture. **£2** plus packing and carr. 2/-. Mu-Metal screen for same **7/6**.

INDICATOR UNIT TYPE BC929A
Consists of 3in. tube 3BP1, with Mu-metal shield, two 6SN7GT, two 6H6GT, one 6X5G, one 2X2, one 6G6G, 24 v. aerial switched motor and numerous components, size $8\frac{1}{4} \times 8\frac{1}{4} \times 13\frac{3}{4}$in., in black crackle box, **65/-**, plus packing and postage 5/-. OR less motor (not required for oscilloscope use). **55/-** plus packing and postage 5/-.

H.T. TRANSFORMERS. Input 200-250 v. Output 620-550-375-0-375-550-620 v. 200 m/a., 5 v. 3 a. twice. These are Admiralty ratings which may be safely exceeded by 70%. Price **39/6** plus packing and carr. 5/-.

L.T. TRANSFORMERS. Input 110-260 v., output 40 v. 13 a. and 180 v. .7 a., both multi tapped (70%, etc., as above). May also be used as a 1 Kw. auto, 110/230 v. Price **59/6** plus packing and carr. 5/-.

HEATER TRANSFORMERS.
6.3 v. 4 a., 6.3 v. 2 a., 2 v. 1 a. Price **8/-** plus pkg. and post 2/-.

VALVES GUARANTEED NEW
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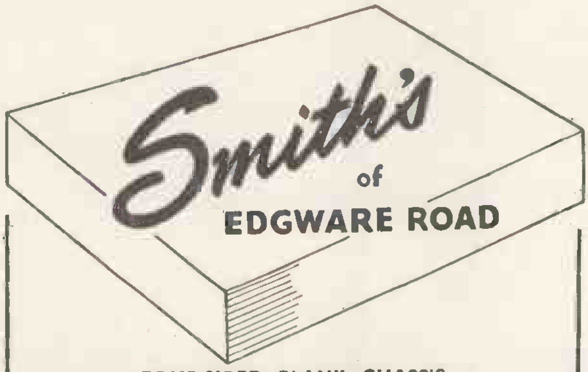

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Standard stock sizes (in inches) are as follows:—

6 × 4 × 2	5/-	12 × 5 × 3	7/11	13 × 10 × $2\frac{1}{2}$	9/9
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10 × 4 × $2\frac{1}{2}$	6/4	11 × 8 × $2\frac{1}{2}$	8/3	12 × 10 × 3	10/3
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12 × 4 × $2\frac{1}{2}$	6/10	13 × 8 × $2\frac{1}{2}$	8/10	17 × 10 × $2\frac{1}{2}$	11/3
9 × 8 × $2\frac{1}{2}$	7/6	12 × 9 × $2\frac{1}{2}$	8/11	17 × 9 × 3	11/6
10 × 8 × $2\frac{1}{2}$	7/10	14 × 7 × 3	9/6	17 × 10 × 3	12/3

The above are sizes for which we have most demand, but we can also make other sizes to order (at a small extra charge) within the following limits:—
Depths 1in., $1\frac{1}{2}$in., 2in., $2\frac{1}{2}$in. and 3in. only.
Maximum length 17in.
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Minimum width for $2\frac{1}{2}$in. depth is 4in.
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Minimum width for $1\frac{1}{2}$in. depth is 3in.
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We cannot undertake to make odd shapes, extra bends, lips, etc.
To arrive at the approximate cost of a special size of chassis take the nearest standard size above and add 2/6.

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ELECTRONICS, RADIO, TELEVISION

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Transistor High Gain Preamplifier

A high gain transistor preamplifier is described which uses a single OC70 in grounded emitter connection. The supply voltage is 250V and the load more than 330kΩ. The basic circuit arrangement is shown at 'A'.

The preamplifier has distinct advantages over a thermionic valve preamplifier. First, two valves would be required to get comparable gain. Second, thermal noise is sufficiently low for it to approach that of a valve circuit, and the transistor preamplifier is of course completely free from hum and microphony. The current drain is low, about 0.7mA from the 250V supply.

This preamplifier has comparatively high output impedance and best results are obtained when it is fed into the high input impedance of a thermionic valve amplifier. It can be used with low impedance microphones, pickups and tape heads. For a nominal circuit, with an input voltage of 5.5mV and a gain of about 330, the output voltage is about 1.8V. The input impedance at X-X is 200Ω and the output impedance at Y-Y is of the order of 5kΩ. The frequency response depends to a certain extent on the source impedance. With a 50Ω source a 3dB reduction in gain is reached at 15c/s and 12kc/s.

Although designed for a 250V supply voltage the preamplifier operates usefully with supply voltages down to as little as 100V. It can be used successfully with a 30Ω/50Ω microphone and a 100V supply coming from a valve amplifier into which it feeds.

The preamplifier can be fed from the same supply as a valve amplifier by rearranging the circuit as at 'B'. In the setup shown at 'B' one side of the output is earthed, whereas in 'A' the input and output are 'floating' at some voltage above the chassis. The input is fed between base and emitter through R1 and C1 so that R5 does not contribute a.c. negative feedback but forms part of the load. The output in 'A' can be taken from between C2 and chassis if desired, but it then becomes slightly smaller than when taken from C2-C3, because R5 no longer forms part of the load. Although the input terminals in both 'A' and 'B' are 'floating', there should be no risk of hum being introduced provided the preamplifier is mounted reasonably close to the microphone or pickup.

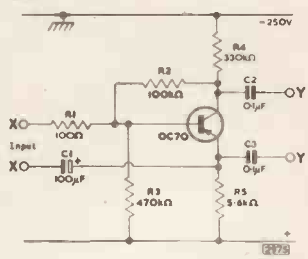
If the circuit is used in arrangement 'A' care must be taken not to short the input terminals to earth. In the arrangement shown at 'B' the current through the pickup or microphone will not be excessive if the input is accidentally shorted to earth.

High voltage gain is obtained from a transistor in the same way as for a pentode valve, by operating it with a high load and feeding from a high supply voltage. In both 'A' and 'B' sufficient d.c. stabilisation is provided by the potential divider R2-R3 and emitter resistor R5 to ensure satisfactory operation up to an ambient temperature of 45°C (110°F). Besides the d.c. feedback provided by R2, R3 and R5, there is an a.c. feedback path formed by R2, R1 and the source impedance, all in series. Part of the a.c. voltage developed across this potential divider is tapped off and fed back into the base. By including a 100Ω resistor R1 in the a.c. feedback path, effective feedback is ensured even when the source impedance is very small. Apart from improving the frequency response and reducing distortion, the a.c. negative feedback decreases the input and output impedances. If thought desirable a.c. feedback can be prevented by making R2 up of two nearly equal resistances and bypassing the common point to ground by a suitable capacitance, of the order of 0.5μF.

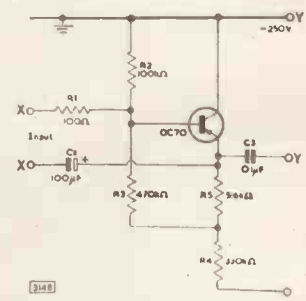
Even with a supply voltage of 250V the circuit is so designed that the collector to emitter voltage never exceeds the d.c. voltage rating of $V_c$max = – 5V for the OC70 under the worst possible combination of conditions. The effect of resistance tolerances, supply tolerances, change of ambient temperature, and spread in transistor characteristics have all been considered in the design. In order to keep available the maximum voltage across the transistor, while allowing a tolerance of ±10% on the supply voltage, the resistor tolerances must be within ±5% to prevent the 5V rating from being exceeded. High stability resistors should be used. For a nominal circuit the collector current is 0.7mA and the collector to emitter voltage approximately 4V. An OC70 with a low current amplification factor a' and low leakage current $I'_{c(o)}$ in grounded emitter causes the highest collector to emitter voltage of 5V. A transistor at the other extreme gives a collector to emitter voltage of about 0.8V at the maximum ambient temperature of 45°C, and allows an output of about 400mV (r.m.s.).

If resistors of ±10% tolerance are used, the collector to emitter voltage should be metered to ensure that it does not exceed 5V. The performance is the same as for resistor tolerances of ±5% except that possibly less collector voltage swing will be available if all the resistors have their lowest extreme value.

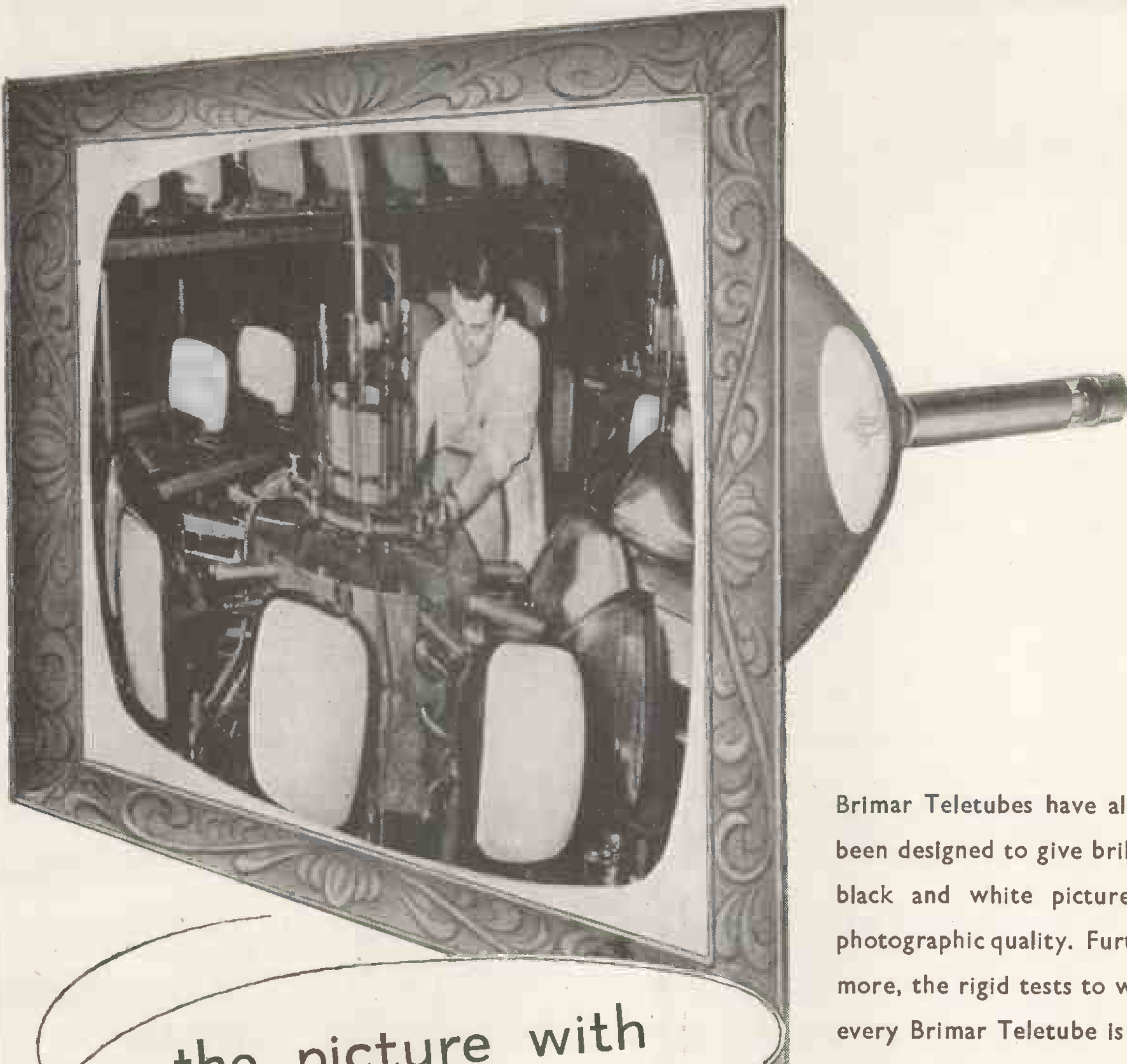
A



B



The circuit is similar to that described by James J. Davidson in an article called 'High Gain Transistor Amplifier,' published in Audio, *October 1955.*



"BELLING LEE" NOTES

T.V.—V.H.F.—F.M.

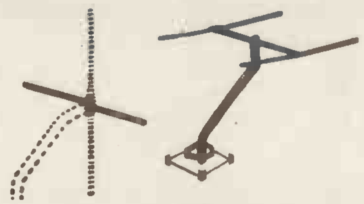
To many layman this is all very confusing. Television and the new F.M. sound transmissions from Wrotham and elsewhere are all V.H.F. and all V.H.F. transmissions are subject to multipath or reflected signals. In the case of television the result is multiple or ghost images due to the reflected signals arriving a split second after the direct signal, and the most likely cure lies in the use of a correctly sited directional aerial.

Now in the case of F.M. reception reflected signals are just as likely to manifest themselves but in this case they result in a form of distortion in speech or music which is sometimes just as difficult to eradicate as are the ghosts in television.

It is most unfortunate that so much was written in the early days of F.M. stressing the fact that only primitive aerials were required. It is a fact that F.M. can be picked up over astonishing distances either with a "built in" aerial, or with an added piece of wire. But remember, reflected signals are just as common as on television and where they occur there is distortion, so there is not the slightest sense in assuring yourself that because it is F.M. it must be perfect.

Whereas a vertical dipole is omnidirectional a horizontal one is directional at right angle to its plane. This helps, but get it high up, preferably out of the house and on a chimney for best results. It may be necessary to use a two or even a three-element array before the programme really comes in as the B.B.C. would like you to receive it.

Please ask us for a copy of the B.B.C. V.H.F./F.M pamphlet; it is well worth reading.



Dipole Adaptor L892 — "H" Type Array L922/FM/J

Advertisement of BELLING & LEE LTD.
Great Cambridge Rd., Enfield, Middx.
Written 20th Sept., 1956

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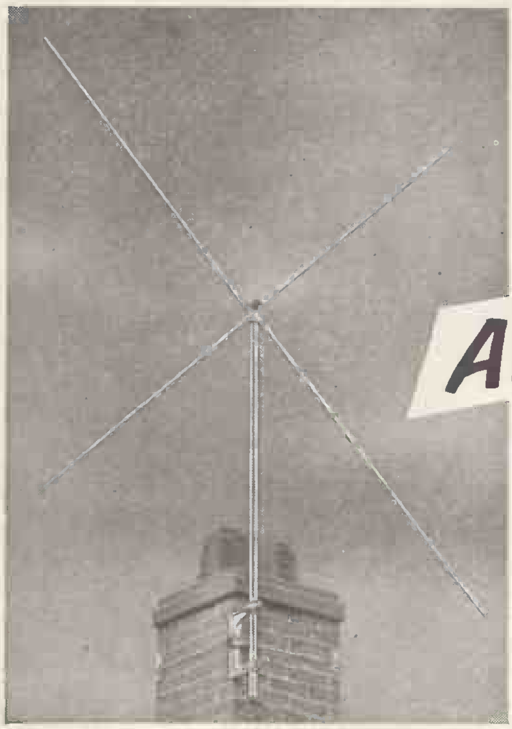

AN "X" AERIAL

A long-life Collapsable band I array

A recent addition to the "Belling-Lee" range of band I aerials, the "X" will find favour with the many members of the trade and the public who have asked for an aerial of this shape as an alternative to the Junior "H" mentioned below.

The new "X" is built to the usual high "Belling-Lee" standards. It has been developed from the original "Belling-Lee" "V" type array produced in 1946, and in fact consists of two "V's" placed "back-to-back".

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L.830/1-5/L 6 ft. mast and lashings. £3 17 6

U.K. PATENT APPLICATION NUMBER 19222/56

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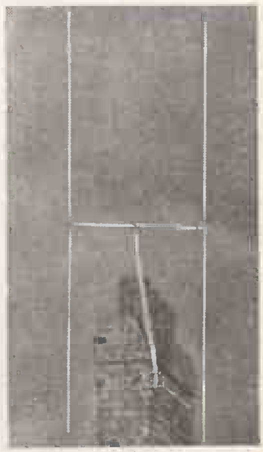

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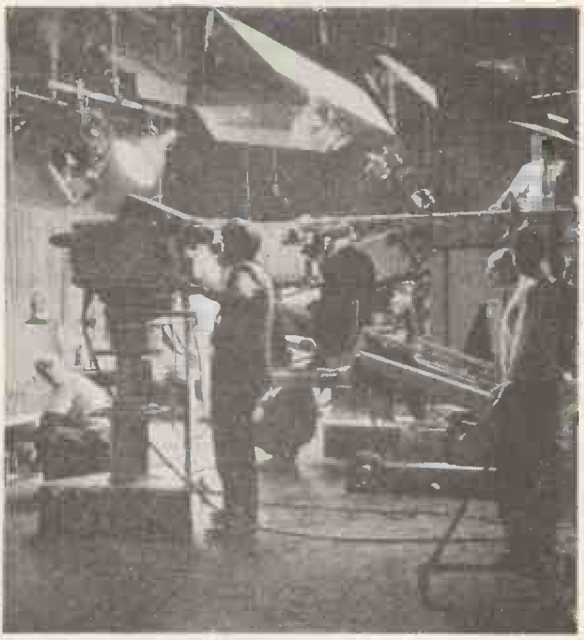

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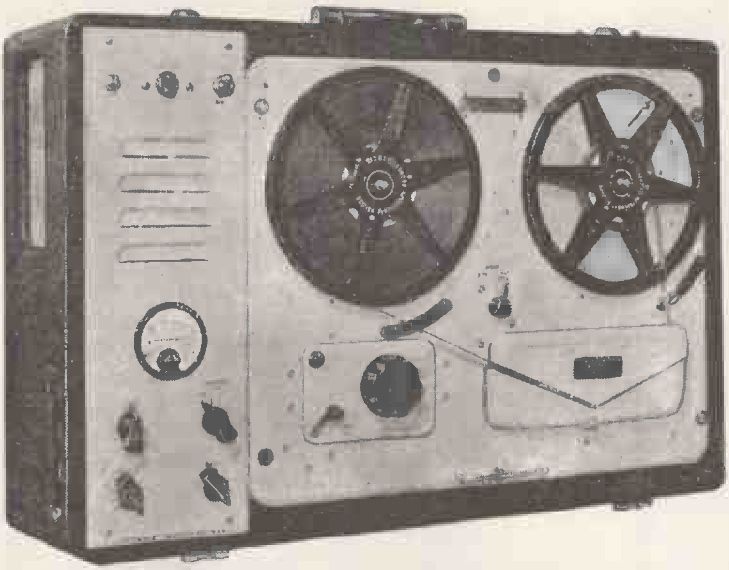

★ The total hum and noise at $7\frac{1}{2}$ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.
★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate 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%. Suppressed for use with Tape Recorder. **PRICE £18 0 0.**

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

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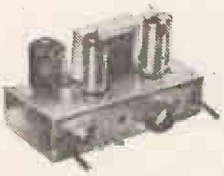

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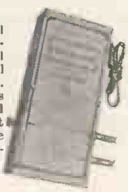
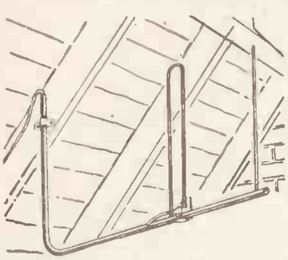
BAND III PRE-AMP



In difficult areas it will be necessary to increase the signal level and this is the ideal unit for this purpose. It is A.C. mains operated and is fitted with input and output coax. plugs. Price £4, post and packing 3/6.

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/-

T.R.F. CONVERTER

New this month is a converter for T.R.F. Set Viewmaster-Electronic Engineering, etc. Small mods. to the TV are necessary as this must be turned into a superhet to stop re-radiating. Price complete with two valves £6/10/- assembled—ready Oct./W.W.

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- Superhet circuit with A.V.C.
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EB34	6/6	U71	8/6	6CB6	12/6	7193	6/6
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ECH35	13/6	VP23	7/-	6C6	6/6	78	7/6
EF36	6/-	VR55	7/6	6D6	7/3	807	6/6
EF39	9/6	VR65	2/6	6F5	7/3	84	8/6
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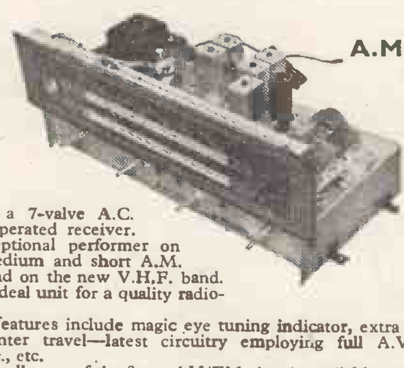
EL50	12/6	V872	4/-	6G6G	5/-	954	4/6
H63	7/6	XH1.5	4/6	6H6	3/6	9004	7/6
HL23DD	8/-	XP1.5	4/6	6J5	6/6	12SK7G	8/-
HL4	8/6	X73M	9/6	6J7	6/6	12SH7	6/-
HL13	10/6	Y63	9/-	6K6	6/6	12SR7	8/-
KT63	7/6	ILD5	5/6	6K7	6/9	12Y4	9/-
KT66	9/-	1S5	9/-	6K8	9/6	1625	8/6
KT72	12/6	IT4	8/-	6L6G	9/-	210LF	3/-
KT81	8/6	IV	10/6	6N7	7/-	215SG	6/6
KTW62	8/6	2A6	2/-	6Q7	9/6	230XP	6/6
KTW63	8/6	2X2	8/-	6SA7	8/-	35L6	9/6
KTW73	8/6	37	7/6	6SK7	6/-	35Z4	8/6
KTW74	8/6	3A4	7/-	6SL7	7/6		
KTZ41	6/-	3D6	5/-	6Z4	5/-		
LD210	3/6	4D1	3/-	6X5	7/6		

A.M.—F.M.



This is a 7-valve A.C. mains operated receiver. An exceptional performer on long, medium and short A.M. bands and on the new V.H.F. band. It is an ideal unit for a quality radiogram.

Special features include magic eye tuning indicator, extra long scale and pointer travel—latest circuitry employing full A.V.C. feed-back, etc., etc.

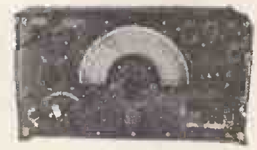
Undoubtedly one of the finest AM/FM chassis available today. Chassis size 17¼in. × 6½in. × 7½in. Price £23/17/6, carriage, packing and insurance 20/- extra.

THIS MONTH'S SNIP

THE WOLSEY 4-VALVE SUPERHET

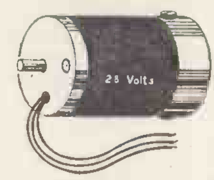
This excellent little all mains receiver employs standard circuitry and is ideal as a second receiver for bedroom, kitchen, etc. It is a broadcast band set and will receive all stations with only a few feet of aerial. Complete, ready to work in modern-looking oak cabinet—limited quantity offered this month at £6/15/-, plus 5/- carriage and insurance. Overall size approximately 11½in. × 7in. × 8in.

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/-.

MINIATURE MOTOR



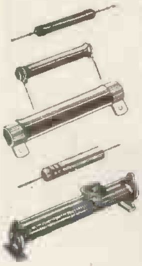
Size only 2¼in. long by 1½in. diameter. American made—laminated poles and armature—intended for 28 volt. Price 10/6, post 2/-.

F.M. TUNER

This tuner is based upon the very successful circuit in the booklet published by Data Publications. We have made up models at all branches and will be glad to demonstrate. Cost of all parts including valves, prepared metal chassis, wound coils and stove enamelled scale, slow motion drive, pointer, tuning knob, in fact everything needed to make the complete unit, is £6/12/6. Data is included free with the parts or is available separately price 2/-.

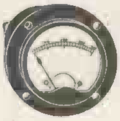
THIS IS ON OFFER AT APPROX. HALF COST TO MAKE

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.



RESISTORS

High stability types from ½-watt to 2-watt. Wire wound vitreous covered wire ended up to 20-watt. High powered types up to 150-watt mostly clip-in. Insulated and non-insulated carbon types preferred valves. High and low powered variable types. Big stocks available—send details of your requirements.



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 supplied	35/-
0-2.5 kV D.C. external multiplier supplied	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/-
0-250 mA.	25/-
0-500 mA.	25/-

INDUSTRIAL OVERHEAD HEATER

This overhead heater warms only the area within its radiant rays, and so effects a considerable saving of fuel. Its benefits are felt immediately, there is no warming-up period. It is essentially a personal type of heater, having controls within easy reach of the operative. The controls give four variations of heat and "Off." At maximum heat the unit consumes 1 kW.

The Infray Major is of particular use:—

(a) In large rooms, warehouses, lofts, machine shops, etc., where the cost of heating the whole room to a comfortable level would be too great.

(b) In rooms which in the main have to be kept cool, e.g., food storage chambers, beer cellars, etc.

(c) In any situation where local heating is required quickly.

Price is £7/10/-, carriage paid.

ELECTRIC BLANKET WIRE

Waterproof P.V.C. covered, so blanket washable. 16½ ohms per foot—1/6 per yard. 14 yards, ideal for average blanket, £1 post free.

NEW THIS SEASON

UNI-TV

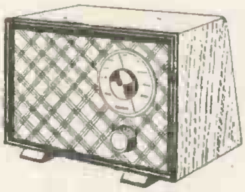
Undoubtedly the most up-to-date televisor for the home constructor. You can build all or only part and the set when finished will be equal to a factory made equivalent. What other constructor T.V. has all these features?

- Made up units if required
- All miniature valves
- Metal rectifier
- No expensive transformers
- 13-channel circuitry
- Multi-vibrator time bases
- Ferrox cube, E.H.T. and scan coils
- 34/38 m/c. I.F.
- Suitable for any modern 12, 14, or 17in. tube
- Modern contemporary cabinet if required.

The building cost (less tube) is only £29/10/- plus 10/- carriage and insurance. All parts guaranteed twelve months. Full information and data free with parts or available separately price 3/6.

THE "SKYSEARCHER"

An all mains set for 19/6. This is a 2-valve plus-metal rectifier set useful as an educational set for beginners, also makes a fine second set for the bedroom, workshop, etc. All parts, less cabinet, chassis and speaker, 19/6. Post and insurance 2/6. Data free with parts or available separately 1/6.



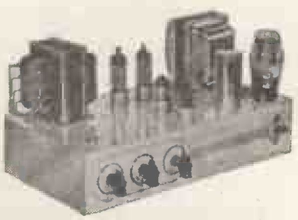
THE "REALITE"

This is a complete flourescent fitting, stove enamelled white, with starter and ballast all ready to install. Price 29/6, plus 4/6 carriage and packing. 40-watt tube 10/-, no extra for packing, if ordered with fitting.

BABY ALARM

Unlike most baby alarms, this not only enables you to hear baby but also talk to him. Price complete with one microphone and 100ft. twin flex £6/19/6, carriage 3/6. Additional microphone 19/6.

THE MULLARD 510 AMPLIFIER



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.

CROYDON BRANCH OPENING

We have taken the Lease of 266, London Road, Croydon and hope to open this month.

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.

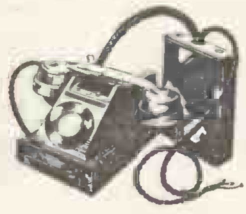
CONNECTING WIRE

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.

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.

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.S.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 26
Transmitter T1154/B.D.J.N.	R.F. unit 25
Fifty-eight walkie-talkie	R.F. unit 27
Frequency meter B.C. 221.	Wireless set No. 19
	Demobbed valves

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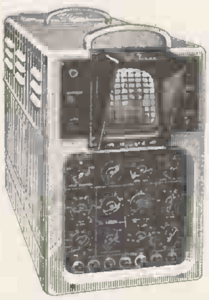
from the new Mullard catalogue

Transistor Tester

L264

The Mullard Transistor Tester has been developed to provide a rapid means of checking general characteristics and ascertaining if a transistor has been damaged in circuit. Facilities for measuring the important parameters, α^1, base-collector short-circuit current gain, as well as $I_{co}{}^1$ and the collector turnover voltage are provided. Although designed as a simple testing unit, it has an accuracy of ±5%.



Dual Trace Oscilloscope

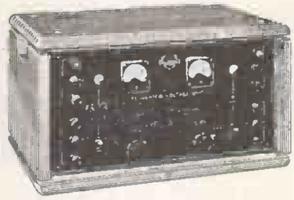
L101/2

This high grade, general purpose instrument incorporates two identical amplifiers with sensitivities of 20mV/cm over a bandwidth of 4 Mc/s. Calibration accuracies are voltage ±5%, and time ±10% by null methods. The time base may be free running or triggered, and sweep speeds are from 0.1 μs/cm to 10 ms/cm.

Television Line Selector

L196

The L.196 enables any normally triggered oscilloscope to give a jitter-free display of one or more lines from a television video signal. It can be used on transmitter and receiver circuits to display depth of modulation, d.c. levels, bandwidth, blanking, synchronizing pulses and for the examination of similar waveforms in detail.



Regulated Voltage Unit

L153

This is a general purpose laboratory unit which provides a stable low impedance d.c. supply which can be continuously varied between 0 and 300V positive and negative at up to 300mA. Two 4 amp a.c. supplies at 6.3V tapped at 4V are also incorporated and an unregulated e.h.t. supply of 1.2kV at 2mA.

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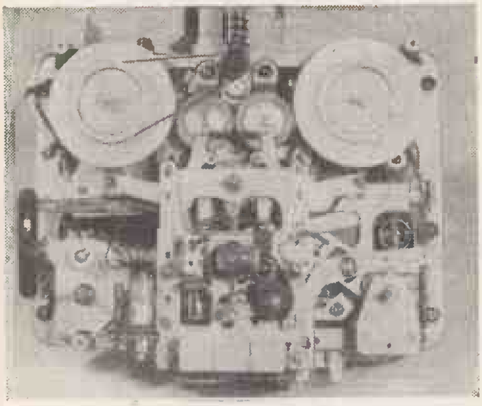

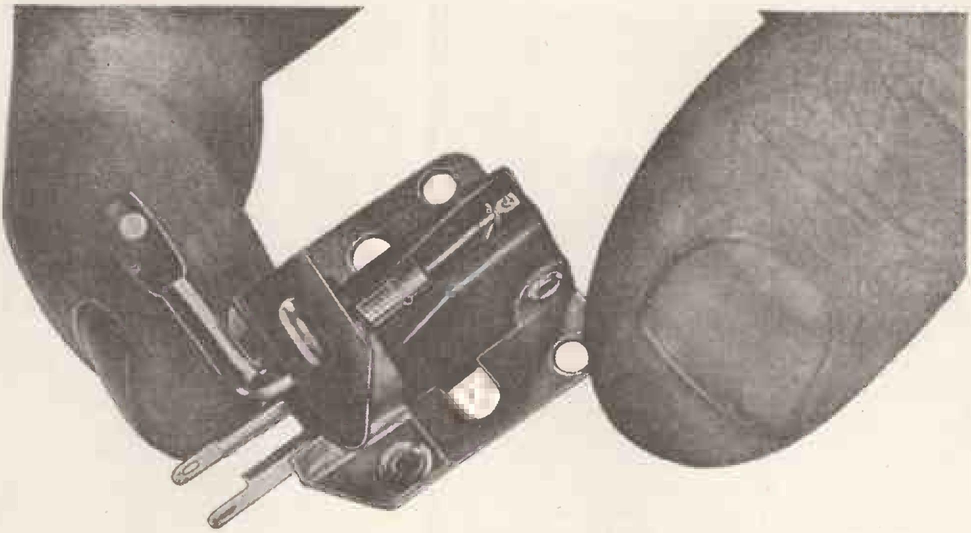

"Put this on record"

The Sonotone Pick-up Cartridge is virtually accepted as a criterion for operation in all climates and is now available in Gt. Britain from Technical Ceramics Ltd.

*

Design engineers and radiogramophone manufacturers are invited to contact Technical Ceramics Ltd. for further information regarding this outstanding product.

Technical Ceramics Limited, Wood Burcote Way, Towcester, Northants

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17" RECTANGULAR T.V. TUBES 14"

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T.V. UNIT CHASSIS

SOUND AND VISION STRIP. 27/6. S/het complete v/strip, 10 valve holders (EF91, etc.), less valves. FREE drawing. Post 2/6.

TIME BASE, 10/6. Containing scanning coil, focus unit, line trans.; etc. FREE drawing Post 3/6.

Power pack and AMPLIFIER, 29/6. Mains E.H.T. 5 kV. 325 v. 250 mA. smoothed H.T. heaters, 6 V. at 5 amp., 4 v. at 5 amp., 4 v. at 5 amp. Centre tapped. Free drawing. Ins., carr., 5/6. S. Output PEN45.

P. PACK AND AMP. 22/6. Output stage 6V6 with O.P. trans., 3 ohms matching. Choke Smoothed H.T. 350 v., 250 mA., 6.3 v. at 5 amp., 22 v. at 3 amp., 6.3 v. at 4 amp., and 4 v. centre tapped. Less valves. Ins. carr., 5/6.

P. PACK AND AMP. 22/6. Output stage PEN45. O.P. trans. Choke. Smoothed H.T. 325 v. at 250 mA., 4 v. at 5 amp., 6.3 v. at 5 amp., 4 v. at 5 amp. Centre tapped. Less valves. Ins., carr., 5/-.

POWER TRANSFORMER, 15/9. 325-0-325 v., 4 v. at 5 amp., 4 v. at 5 amp., 6 v. at 5 amp., 4 v. centre tapped. P. & P. 2/3. As above with 6 v., 6 v. and 22 v. windings, 15/9. P. & P. 2/3.

MAINS TRANSFORMERS, 5/9. 350-0-350 v, 4 + 4 v. htrs.; 200-250 v. prim.; post 2/3.

MAINS TRANS, 3/9. 350-0-350 v. 4 + 12 v. htrs.; 100 250 prim.; post 2/3.

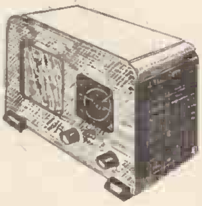
P.M. SPEAKERS 8" 8/9

IDEAL XMAS GIFTS. If fitted in small cabinet. TREAT THE LADY AT HOME Fit one in kitchen or cupboard door, let her follow that T.V. or radio programme. AT THIS PRICE you can have one in every room. Post 1/9.

RADIOS AND R/GRAM. CHASSIS

RADIO CHASSIS, 39/6. 3 w/band and gram. Extra speaker sockets. 5 valves (Int. Octal). Built-in portable aerial optional, 4 knob control. A.C. or Universal. Less valves (see our cheap list). 8in. P.M. Speaker, 7/9, with order. Set of knobs, 2/-. Chassis, 15½in. x 7in. x 9in. (when speaker is fitted). Carr. 4/6.

MIDGET RADIO SUPERHET 79/6



5 valve A.C. s/het, ready to use. Cabinet measures 13½in. x 9½in. x 7½in. Octal valves, COMPLETE IN WALNUT CABINET. Carr. 3/6.

CANDELABRUM 19/9
3 LIGHT FITTING

SPECIAL PURCHASE FREE GIFT OF 3 SHADE BOWLS. Together with flex and lamp-holders. Not normally supplied except as extras. P. & P. 2/9.

OVERLOAD CUT-OUT, 7/9. Mains trip switch variable from 2 to 4 amp. (400 to 800 watts) pre-set at 2.9 amps. (200-250 volts) Mains.

1124 V.H.F. RECEIVER 7/6 less valves, ex-W.D. Owing to these being soiled we are offering them at this very low price. Uses 6 valves. 30.5-40 mc/s. I.F.s 7 mc/s. P. & P. 2/6.

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3 wave band, complete with 2 gang condenser, pair of 465 I.F.s and dial. (Similar drawing FREE). Post 2/3.

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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. Fitted in 2 minutes. Price 10/- inc. instructions.

M & LW (TYPE QRF4) 12/9

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For Mains or Battery Sets

MW (TYPE QFR3) 8/9

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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.

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80 TYPES 20 Mc/s.—27.9 M/Mc/s.
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Also available: 32.5 Mc/s, 36.3 Mc/s., 36.6 Mc/s.
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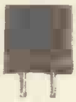

ALL BRAND NEW **7/6** each.

FT241A 200 kc/s. 10/- each.

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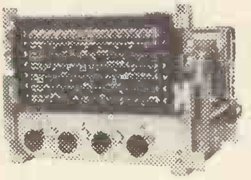
5-VALVE 3-WAVEBAND SUPERHET.



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Negative Feed Back.
Valves 6BE6, 6AT6, 6BW6, 6X4.
Wave change and Gram.
Chassis 11in. × 7½in. × 8½in.

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1A7GT- 1N5GT, 1H5GT, 1A5GT (or 1Q5GT or 3Q5GT)	37/6	Set
10 EF50 (Ex-Brand New Units) 5/- each	45/-	„
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DK96, DF96, DAF96, DL96	32/6	„
6K8G, 6K7G, 6Q7G, 25A6G, 25Z5 (or 25Z6G)	37/6	„
12K8GT, 12K7GT, 12Q7GT, 35Z4GT, 35L6GT (or 50L6GT)	37/6	„
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Comprising the well-known BC625 and BC624A. Units complete with 17 valves types: 2-832, 3-12A6, 3-12SG7, 3-9003, 9002, 6G6G, 12J5GT, 12AH7GT, 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.

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JUNCTION TYPE (Red-Spot) OFFERED AT LESS THAN HALF-PRICE.

Designed for A.F. application up to 800 Kc/s and are suitable for use in amplifiers, Signal Tracers, Local Station Receivers, Radio Control, Oscillators, Transistor Voltmeters, Baby Alarms, Microphone Pre-Amplifiers, etc.

10/- each.

(Tested and complete with Data & Circuits)

N.B. These Transistors may be used in place of Mullard OC71 or similar Transistors.

R.F. TRANSISTORS (BLUE SPOT) 1.6 Mc/s 15/- each.

"TELETRON" PORTABLE TRANSISTOR SUPERHET

We offer all the Components, including 4 Transistors, I.F.T.'s, Trans., 2 Gang miniature Condenser, Ferrite Rod, 3in. P.M. Speaker, V/C and resistors and condensers to build this receiver for £6 10 0
Or as above with Push-Pull Output, 6 Transistors and 6×4 elliptical Speaker £9 0 0
Or with matched pair Mullard OC 72's and latest type high resistance P.P. Elliptical speaker. Output 200 milliwatts, £10/10/-. Call and hear demonstration models working.

TRANSISTOR SIGNAL TRACER

This circuit is designed for Audio, R.F., and I.F. Frequency and is ideal for the Serviceman for checking all types of sets including T.V. Powered by 6-volt dry battery. Miniature in construction.
Complete Kit with 2 Transistors, Components and 'Phones with Circuit.
42/6.

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. × 9in. × 9in. BRAND NEW. 65/-. carr. FREE.

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. free.

PYE 45 Mc/s STRIP TYPE 3583 UNITS

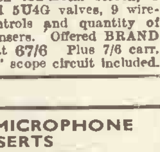
Size 15in. × 8in. × 2in. Complete with 45 Mc/s. Pye Strip, 12 valves, 10 EF50, EB34 and EA50, volume controls, and hosts of Resistors and Condensers. New condition. Modification data supplied.
Price 69/6 Carriage paid.

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.

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.



TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

(100 MILLIWATTS OUTPUT)

Build this Push-Pull Amplifier which is ideal for Crystal or Magnetic Pick-up Amplification, Baby Alarm, Microphone Amplifier, etc. Powered by 6-volt Dry Battery lasting for months.
Complete Kit of Parts including 4 Transistors and all Components with Circuit (less speaker), £4/10/-.

TRANSISTOR SQUARE WAVE GENERATOR

This arrangement comprises an emitter-couples multi-vibrator, and provides a square waveform with excellent transient characteristics. The output provides two basic tones and a large number of harmonics spreading through the A.F. spectrum. Ideal for signal tracing.
Complete Kit with 2 Transistors and Components and Circuit.
25/-.

1355 RECEIVER

Complete with 11 valves 8-SP61 5U4G, VU120. VR92. As specified for inexpensive T.V.
In absolute new condition, 27/6, carr. 5/-

R.F.24 10/- R.F.25 12/6 R.F. 26 25/-
Brand new with valves, carr. 2/6.

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

GARRARD 3-SPEED MIXER AUTO-CHANGER Model RC110

A.C. 200/250. List price £14/13/-. Brand New. **£7/19/6** P. & P. 3/6.

B.S.R. 4-SPEED RECORD CHANGERS

Very latest type 4 speed with HGP37 crystal turnover pick-up. Plays mixed records. Brand new and guaranteed. £8/15/-. Carriage 3/6.

MINIATURE TRANSMITTING STRIP "TYPE 81"

Size 7¼in. × 6in. × 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.

MINIATURE I.F. STRIP TYPE "373" 9-72 MEG.

Brand new miniature I.F. Strip size 10½in. × 2½in. × 3in. high. Valve line-up: 2-EF92; 3-EF91 and EB91. With circuit.
With valves, 45/- (less valves 8/- Post free.)
This I.F. Strip is part of above equipment.

CLYNE RADIO LTD.

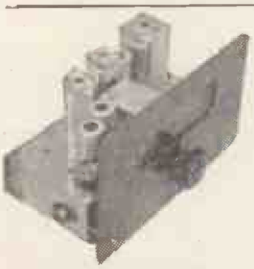
18, TOTTENHAM COURT ROAD, LONDON, W.1

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

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. × 2½in. 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.

ACOS TYPE 7 Crystal Microphone. Inserts. Brand New, 7/6 each, post free.



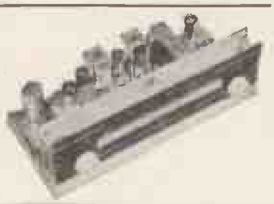
THE JASON F.M. TUNER

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 m/cs., 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. & P. Fringe area kit £7/15/-, plus P. & P.

F.M. POWER PACK KIT. We can now supply complete kit for power pack suitable for the above F.M. tuner 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 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 × 7½ × 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!

INTRODUCING THE NEW T.S.L. F.M. TUNER UNIT.

This compact unit with built-in power supplies has been designed by craftsmen to standards which will satisfy the most critical enthusiast. Brief specifications: Valve line-up: ECC85, 2-EF89, EABC80, 6X4 and EM80. Overall size: 10½in. W. × 5¾in. H. × 6½in. D. Dial size: 10½in. × 5¼in. Attractive plastic dial in Black and Gold with easy-to-read calibration. Controls: Switch. OFF FM & GRAM. and tuning. Pre-set gain control at rear of chassis. Connections: Co-Axial output socket, 300 ohm aerial input socket and pick-up input socket on rear of chassis. Price £17/10/-, plus 5/- P. & P.

THE DULCI F.M. TUNER. Incorporates own power supply, suitable for use with any amplifier, Valve line-up: ECC85, two EF89, EABC80, 6X4 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.

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.

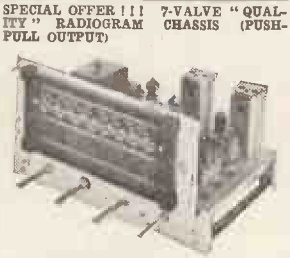
COIL PACKS. Manufacturers' Surplus, Miniature size, only 2⅛in. × 2⅜in. × 1½in. deep Iron-cored. For L., M. and S.W. with gram. position. Switch has 2-inch spindle. Absolutely brand new, complete with circuit. Price only 27/6, plus 1/6 P. & P. A snip!

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.

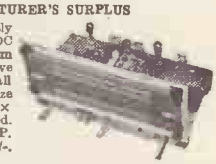
SPECIAL OFFER!!! 7-VALVE "QUALITY" RADIOGRAM CHASSIS (PUSH-PULL OUTPUT)



Limited quantity only of this fine Chassis Specification: Valve line-up: X79 W77, 2 DH77, 2 N78 and U78. 3 wavebands: Short 19-50 Metres, Medium 200-550 Metres, Long 800-2,000 Metres Size (overall) 12in. L. × 7in. D. × 7in. H. Dial size: 9in. × 4½in., in Gold, Red and Green lettering on Black background. Logging Scale. Manual wide-range tone control. Output approx. 7 watts. Output impedance to match 3 ohm. Provision for Gram pick-up. We are pleased to be able to offer this most attractive Chassis at ONLY £11/19/6, plus 5/- 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 11½ × 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/-.

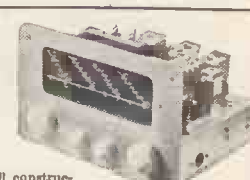


THE COLLARO HIGH FIDELITY TAPE TRANSCRIPTOR

A new Collaro product designed on Transcription quality principles, for live recording from F.M. broadcasts etc., and for the reproduction of all types of tapes. More refinements than incorporated in other Tape Decks.

● 3 speed ● Four heads ● Twin track (bottom and top tracks recorded or played back without removing tape) ● Instantly reversible ● Constant tape tension device ● Fully mechanical ● Low wow and flutter content—less than .1 of 1% ● Many other outstanding features. Dimensions: Unit plate width—14¾in. Unit plate depth 11¾in. Depth from upper surface of mouting board 4½in. Height from upper surface of mounting board 1½in. Price Standard Cream Polystyrene cover plate with maroon controls £20, plus 3/6 p. and p. Special Clear polystyrene cover plate, but sprayed gold on the outside. Maroon controls, £20/10/-, plus 3/6 p. and p.
The Transcriptor is also available as under. Complete with Dulci Co., pre-amplifier wired to transcriptor £13/13/- extra. This unit is now ready for use with amplifiers developing sufficient power e.g. Leak, etc.
Also available with pre-amplifier plus power pack £17/10/-. With these two fitments the unit is ready for use with any amplifier.
Both pre-amp. and power supply are wired within the area of the unit plate.
We can also supply the special Dulci Hi-Fidelity amplifier if required, for use with the transcriptor with pre-amp. and power supply already wired. Price £9/9/-, plus 2/6, postage and packing.
Leatherette covered attractive portable carrying case is expected to be available to accommodate the above complete equipment, by the time this advertisement appears. Price 79/6, plus 3/6 p. and p. Suitable 7in. × 4in. Elliptical speaker 21/6. All leading makes of recording tape and microphones are suitable for the above, and can be supplied is desired. H.P. TERMS AVAILABLE. London's largest selection of tape recording equipment!

AM/FM KIT



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.

DULCI H4T AM/FM TUNER

This unit has been designed for Quality Reproduction and built to the highest technical standards. Contains own power supplies. Brief specification: Four wavebands: VHF 87-101 mc/s. Short, 16-50 metres, Medium, 187-540 metres. Long, 1,000-2,000 metres. Intermediate Frequencies: 10.7 mc/s and 470 Kc/s. Full A.G.C. on all A.M. Bands and amplitude limitation on F.M. Band. Three controls: ON/OFF, Volume, Tuning, and Wave-change. Valve line-up: ECC85, ECH81, EF89, EABC80, EM80 and EZ80. Attractive dial in Black with Red, Green and Gold lettering, size 11½in. × 5¾in. Chassis size: (overall) 12in. W. × 7¾in. H. × 8¾in. D. A low impedance of 47K ohm. output makes matching to amplifier non-critical. Weight: 12 lbs. Price £20/17/-, plus 5/- P. & P.

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 £24/6/- cash—or H.P. terms.

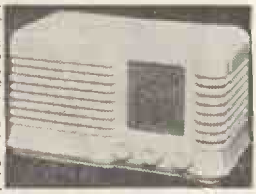
THE R.C.3/4 WATT AMPLIFIER KIT

Compare the advantages!

Treble bass. AND middle controls! For crystal or magnetic pick-up! A.C. Mains 200/250 v. Valve line-up, 6V6GT, 6SG7, metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 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.

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 as supplied. Valve line-up: 2 6SG7, 6 X5GT and 6 V6GT. Chassis ready drilled. Cabinet size, 10½in. × 10in. wide. Maximum depth at base 6in. 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 microamp	D.C. 2in.	M.C.	R.P.	50/-
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/-
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
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/-
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/-
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/-

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.

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.

No. 17 Mk. II TRANSMITTER/RECEIVER. Built into a strong wooden cabinet 15in. × 14in. × 9in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. 44-61 m/cs. (5-7 metres). Uses standard 120 v. H.T. and 2 v. L.T. batteries. Complete with instructions 45/- each plus 7/6 post and packing.

24 VOLT ROTARY CONVERTER. Input 24 v. D.C. Output 200/250 v. A.C. 100 watts. Complete in black steel box 18½in. × 11½in. × 8in. Weight approx. 30lbs. Completely smoothed incorporates Sodium Lamp transformer. Brand new 92/6.

HEADPHONES Low resistance. Brand new Ex W.D. type CLR. 7/6 per pair, plus 1/6 p. & p. High resistance, 4,000 ohms brand new lightweight 15/- per pair plus 1/6 p. & p.

TRANSISTORS! MULLARD TYPE O.C71. Available ex stock at new list price of 24/- each, post free.

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

VIDEO AND SYNC. GENERATOR. We have a very limited quantity only, of these units by well known instrument manufacturer. They are not brand new but in good condition, and all have minor faults. They are complete in black crackle metal carrying case with handle, and measure overall 13in. × 8in. × 5½in. Wt. 15½lbs. Valve line-up is either 7-6SN7GT or 7-12AU7. Units are offered less these valves, but a set of seven required can be supplied at the special inclusive price of 42/- per set. It is a useful unit for producing Modulated bar type pattern, sync. pulses and sound modulation, independently or simultaneously, on all 5 B.B.C. channels for servicing or setting up T.V. receivers. Sound modulation at 1,000 cycles. Incorporates Oscillator unit containing 3 type 954 valves (supplied), 3 polystyrene Acorn holders, 10-10/70 of Philips concentric trimmers, 1-2 pole 5 way rotary switch, 2-½in. polystyrene coil formers, several useful resistors and capacitors. Rectifier DRM1B (supplied). The whole unit was originally made to sell at over £40. Our price is £5/10/- only, plus 5/- p. and p.

N.B.—From the above unit we have a number of spare sets of carrying case complete with plain front panel, carrying handle and drilled chassis, already punched for miniature valves. Measurements as above. A very useful case for any instrument, remote control transmitter, etc., etc. Price only 15/-, plus 2/6 p. and p.

HEAVY DUTY CONSTANT VOLTAGE TRANSFORMER. Input: Variable from 110 to 250 volts OUTPUT: 110 and 230 v. at 1.2 kVA. Contained in grey metal case with carrying handle. Overall size: 10in. W. × 8in. D. × 12in. H. Weight 1 qtr. 19 lb. Brand new! £8/10/-. plus 7/6 carriage and packing.

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 L.T.

THE R.C. 2 AMP. BATTERY CHARGER KIT. Our new 2 amp. charger kit is now available. Includes handsome well-ventilated black stove-enamelled steel box, size 7½in. × 3½in. × 3½in. Fully shrouded first quality transformer, brand new G.E.C. rectifier. Mains fuse, etc., for charging 6 or 12 v. batteries at 2 amp. Absolutely complete kit with full practical and theoretical instructions. Price 33/6, plus 2/6 P. & P. Can be supplied assembled and tested at 41/6, plus P. & P. Heavy duty crocodile clips suitable for car battery lugs, optional extra at 1/6 per pair.

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 13in. × 7in. × 5½in. Wt. 22 lb. Few only at £4/19/6, plus 3/6 p. and p.

MAINS TRANSFORMER SPECIAL! Primary: 10-0-200-220-240 v. Secondary windings: 375-200-0-200-375 v. at 250 mA. Double wound 230 v. at 6 amp. 6.3 v. at 3 amp., 6.3 v. at 3 amp. 8 v. at 0.25 amp. Unshrouded, fully impregnated drop-through type. 50/-. plus 1/6 p.p.

FOUR-SPEED CHANGERS! The new B.S.R. 4-speed auto-changer in attractive cream and gold finish, now available from stock at £9/15/- only, plus 3/6 p. and p. H.P. terms available.

B.S.R. MONARCH. The very popular 3-speed mixer auto-changer. Complete with turn-over crystal pick-up. Complete in original manufacturer's cartons, fully guaranteed. Price only £7/5/0, 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 styli, 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 manufacturers cartons. £8/19/6 only; plus 3/6 p. and p. H.P. terms available.

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. Purchase 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!

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!

MAINS TRANSFORMER BARGAINS. Limited quantities. Manufacturers' Surplus 350-0-350, 80 mA., 6.3 v. 3 a., 5 v. 2 a. Half shrouded, dropthrough, 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.

GARRARD RC.110 ! ! ! 3-speed mixer auto-changer unit with G.C.2 t/o crystal head. Cream and brown finish. Brand new in sealed manufacturer's cartons with fitting and operating instructions. £7/19/6 plus 5/- p. and p.

RECORD PLAYER CABINETS—to suit all types of single record and auto-changer units. Priced from 45/-. Send stamp for fully illustrated list.

Another Cabinet Bargain! Special purchase of walnut trolley-type cabinets originally intended for use in projection T.V. Easily recognised as being of leading High Quality manufacturer's stock. 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.

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/s. 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 Trans., 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. **69/6** Carr. 3/9.

SELENIUM RECTIFIERS

L.T. Types		6/12 v. 6 a.	19/9
2/6 v. ½ a.h.w.	1/9	6/12 v. 10 a.	25/9
6/12 v. ½ a.h.w.	2/9	**H.T. Type H.W.**	
F.W. Bridge Types		120 v. 40 mA.	3/9
6/12 v. 1 a.	5/9	250 v. 50 mA.	5/9
6/12 v. 2 a.	8/9	250 v. 80 mA.	7/9
6/12 v. 3 a.	12/9	250 v. 150 mA.	9/9
6/12 v. 4 a.	14/9	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.

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	
88µF 450 v.	1/9	8 mfd. 600 v.	2/11
8 mfd. 500 v.	2/6	16 mfd. 350 v.	1/11
16µF 350 v.	2/3	16µF 450 v.	2/9
16µF 450 v.	2/9	16 mfd. 500 v.	3/9
16µF 500 v.	3/9	32µF 350 v.	2/11
32µF 350 v.	3/9	32 mfd. 450 v.	4/9
32 mfd. 500 v.	5/9	100 mfd. 450 v.	4/9
8-16µF 500 v.	4/11	8-8µF 450 v.	2/9
25µF 25 v.	1/3	8-16µF 450 v.	2/11
50µF 12 v.	1/3	16-16µF 450 v.	3/11
50 mfd. 25 v.	1/9	32-32µF 350 v.	4/9
50µF 50 v.	1/9	32-32µF 450 v.	5/9
100 mfd. 12 v.	1/9	60-100 mfd. 350 v.	6/11
100 mfd. 25 v.	2/3	64-120 mfd. 350 v.	7/6
6,000 mfd. 6 v.	3/11	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.

EX GOVT. METAL BLOCK PAPER CONDENSERS

2 mfd. 500 v.	1/9	8 mfd. 500 v.	4/11
4 mfd. 500 v.	2/3	10 mfd. 500 v.	5/9
4 mfd. 1,000 v.	3/9	8-8 mfd. 500 v.	5/11
4 mfd. 1,500 v.	5/9		
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; VS110 1/11; MU14 7/9; KT44 4/9; 6J5 3/9; 6V6G, 5Y3G, 5U4G, 5/9; 6K7G, 2/11; 6X4 5/9.

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.

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

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 cabinet illustrated above or walnut veneered type. 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, or veneered walnut.

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

120-0-120 v. 40 mA.	5/9
300-0-300 v. 150 mA., 4 v. 3 a.	9/9
250-0-250 v. 80 mA., 6.3 v. 3 a., 6.3 v. 1 a. Potted 4½-3½-3in.	11/9
460 v. 200 mA., 6.3 v. 5 a.	22/9

0-16-18-20 v. 35 a., 79/6. Carriage 7/6 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. 230-0-230 v. 60 mA., 6.3 v. 2.5 a. Midget, 2½ × 3 × 2½in. approx., 11/9. Post 2/9.

EX GOVT. SMOOTHING CHOKES

250 mA., 5 H., 50 ohms	12/9
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., 5 H., 100 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 .0005 mfd., 4/9. 8-8 mfd., 450 v. Electrolytics (midget) in lots of six, 1/6 ea.

MAINS ENERGISED SPEAKERS R.A. 2-3 ohms. 8in. Field 600 ohms., 10/9.

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.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 250, 300, 330, 400, 470, 500, 1,000 pfd. (.001µF), .002 mfd. (2,000 pfd.). .005 mfd., .01 mfd. All at 6d. each, 3/9 doz. one type.

VIBRATORS. Oak 2 v. 7 pin. synchronous, 7/9.

T.V. CABINETS. For 15, 16 or 17in. tube. Table model with doors, 79/6, carr. 7/6.

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. 4a., c.t., 5v. 3a.	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	
12 v. 1 a.	7/9	24 v. 1.5 a.	17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 16/9; 0-3.5-9-17 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.

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 5 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

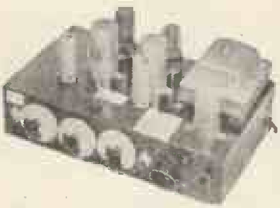
R.S.C. A6 ULTRA LINEAR 30 WATT AMPLIFIER

NEW 1956 DESIGN. HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. Tone Control Pre-amp stages are incorporated. 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** with extra input. **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 with 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 terms with amplifiers.

EXPORT ENQUIRIES INVITED

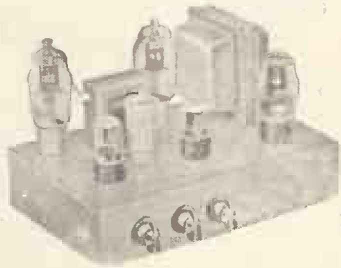


R.S.C. TA1 HIGH QUALITY TAPE DECK AMPLIFIER

FOR ALL DECKS WITH HIGH IMPEDANCE RECORD/PLAYBACK AND ERASE HEADS. Such as Lane, Truvox, etc., or matched to low impedance erase heads as fitted latest COLLARO TAPE TRANSCRIPTOR. 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. Facilities for recordings at 15in., 7½in. or 3¾in. per second. Automatic eqnalisation 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.

11 GNS. Ready for use. Carr. 7/6.

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.** 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. **TERMS ON ASSEMBLED UNITS** with extra input as mentioned above. **DEPOSIT 25/6** and nine monthly payments of 22/4.

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 £7/19/6, plus 3/6 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, £6/19/6.

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.

QUALITY AMPLIFIERS. 3-4 watt, specially designed for use with BSR or Garrard changers. 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 × 4in. 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.

PLESSEY DUAL CONCENTRIC 12 in. 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.

ROTARY CONVERTERS. 200 watts. Input 12 v. D.C. Output 230 v. 50 c/cs. A.C. Only 7 gns. Carr. 7/6.

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.

SUPERHET FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F., and double Diode Second Detector. Delayed A.V.C. Ae./Grid F/C Coupling is by bottom end Condenser Coupling giving freedom from alignment troubles when Ae. of varying lengths and capacity are used. Both Frequency Changers and I.F. valves are A.V.C. controlled from the very low distortion Double Diodes so arranged that very high Percentage modulation of the Transmitter can be handled without distortion. The Feed for the delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W., Ch., and Vol. Output will load most Amplifiers requiring 500 M.V. input depending on Ae. location. Only 250 v. 15 mA. H.T., and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-point wiring diagrams and instructions, 2/6.

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.

HERE IS "SOUND REALITY"

Stern's "fidelity" Tape Recorder

UNDOUBTEDLY THE BEST VALUE YET OFFERED

IMMEDIATELY AVAILABLE TO MAIL ORDER CUSTOMERS

- Extension speaker sockets are provided
- Has dual input channels for mixing
- Monitoring provided for
- Will play the new pre-recorded tapes
- Provides 2 hours playing time at 3¾in. or 1 hour at 7½in. per second.
- Case contains concealed pocket to accommodate Mike, Mains Lead and spare reel of Tape.

GUARANTEED FOR 12 MTHS. (B.V.A. VALVES 90 DAYS)

SEND S.A.E. FOR ILLUSTRATED AND DESCRIPTIVE LEAFLETS

HOME CONSTRUCTORS ! ! YOU CAN BUILD THE COMPLETE RECORDER FOR £40/-/-

TERMS: £10 Deposit and 9 months of £3/13/4, or £20 Deposit and 12 months of £1/17/1.

The Truvox **TAPE DECK** and the **Quality Amplifier** are supplied tested and ready for use, and the actual assembly of the Tape Recorder is extremely simple, involving only a few connections. Step-by-step connection chart is supplied for this purpose.

If you have your own Cabinet WE WILL SUPPLY: The **TRUVOX TAPE DECK**, the **TAPE AMPLIFIER, MATCHED SPEAKER**, and 1,200ft. of E.M.I. TAPE for £33/10/- plus £1/10/- carr. and ins., £1 of which is refunded on return of case.

TERMS: £8/8/- Deposit and 9 months of £3/1/4, or £16/15/- Deposit and 12 months of £1/11/1.

PRICE COMPLETE READY FOR USE £43

TERMS: £11 Deposit and 9 months of £3/18/3, or £21/10/- Deposit and 12 months of £1/19/10. Carr. and ins. is £1/10/- extra, but we return £1 on return of packing case.

The following items form complete Recorder. Plus attractive Carrying Case.

THE TRUVOX MODEL TR7U TAPE DECK

3 Shaded-Pole motors. Drop-in Tape Loading. Push Button Control. Separate Push Button Brake. Fast forward and fast reverse. Silent drive eliminating Wow and Flutter. Half Track working and 2 speeds, 3¾in. and 7½in. per sec. Positive Azimuth Adjustment. Overall size only 14¼ x 12¾in. Available for £23/2/-.

THE MODEL T.R.I./F. AMPLIFIER

Has been expressly designed to meet the requirements of enthusiasts for fidelity reproduction, and in particular to CORRECTLY operate the above TRUVOX DECK. It is supplied complete with a matched Elliptical 3 ohm P.M. Speaker, it incorporates an efficient Tone Control arrangement and has a Magic Eye Indicator (Operative on Record). A Co-axial Socket is also incorporated for MONITORING on Record, and this can also be used to feed an external amplifier. The Amplifier can also be used for high quality reproduction of gramophone records direct from a gram unit. Available for £14/14/-.

ACOS CRYSTAL MICROPHONE, MODEL MIC.33.1 Price £2/10/-.

1,200 ft. REEL OF SCOTCH BOY or E.M.I. MAGNETIC RECORDING TAPE. Price £1/15/-.

Modernise your old Radiogram WITH THE LATEST

3 or 4 SPEED AUTOCHANGER and a modern AM or AM/FM RADIOGRAM CHASSIS available at REDUCED PRICES. (H.P. Terms available.) A good varied selection is available . . . SEND S.A.E. for full DETAILS.

TWO REALLY GENUINE PRICE REDUCTIONS

A BULK PURCHASE ENABLES US TO OFFER these RECEIVER CHASSIS at SUCH LOW PRICES. Each is BRAND NEW and FULLY GUARANTEED.

MODEL AW3-7

A 7-valve 3-waveband superhet chassis having a Push-Pull stage for approximately 6 watts output. PRICE **£12-19-6**

H.P. TERMS: Deposit £6/9/9 and 8 monthly payments of 18/9.

MODEL B3

A 5-valve 3-waveband Superhet employing Negative Feedback over entire Audio Stages and having a single valve type 6BW6 output for approximately 4 watts. PRICE **£11-11-0**

H.P. TERMS: Deposit £5/15/6 and 7 monthly payments of 19/4.

THESE CHASSIS HAVE "GRAM" POSITION and are IDEAL REPLACEMENT CHASSIS FOR THAT "OLD RADIOGRAM"—Send S.A.E. for complete details.

NEW ! ! A COMBINED AM and FM RADIOGRAM CHASSIS of EXCEPTIONAL HIGH QUALITY and VERY PLEASING APPEARANCE. PRICE IS ONLY £21/10/-. SEND S.A.E. for full details.

THE ARMSTRONG FC48

A high-quality replacement Radio or Radiogram Chassis having provision for an FM Feeder Unit and incorporating separate BASS and TREBLE CONTROLS. PRICE ASSEMBLED and READY FOR USE **£25/2/0**

TERMS: £6/6/- Deposit and 9 months of £2/5/- or £12/11/- Deposit and 12 months of £1/3/3.

Open Monday to Friday 9 a.m.—6 p.m. Saturday 9 a.m.—1 p.m

STERN RADIO LIMITED

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

LASKY'S RADIO

★ GREATEST TAPE RECORDER BARGAIN EVER OFFERED!

Not a kit, but **THE FAMOUS HIGH FIDELITY "CONCERTONE"** Tape Recorder absolutely ready for use and which will give you the ultimate listening pleasure that comes from high fidelity recording. It is simple, absolutely reliable, rugged, compact, lightweight and easily portable.

Note these few brief details. Two speeds, 7½ and 3¾in./sec. Two half-track heads by Wearite. Power output 3–4 watts. Fast forward time 60 secs., fast rewind 45 secs. Overall size, closed 16½ × 12 × 7in. approx. Gross weight 26lb. approx.

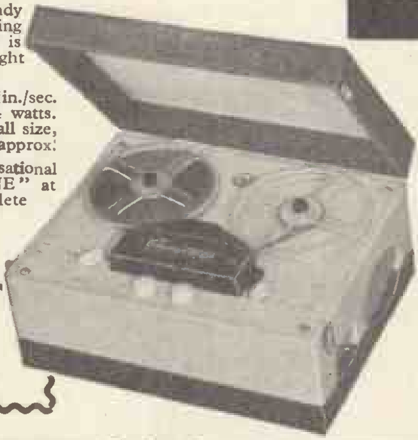
Lasky's are able to offer only a limited number at sensational reduced price. See and hear the "CONCERTONE" at either of our addresses, or order by mail with complete confidence. Guaranteed by us for 12 months.

LISTED AT £50/8/0

LASKY'S PRICE 33 GNS

Complete with 1,200ft. reel or Emitape, take-up pools and microphone.

Carriage and insurance 21/- extra.



SPECIAL OFFER!

GOODMANS 12in. AUDIOM 50 P.M. SPEAKERS

10 watts. Limited number only. Listed at £6/15/-.

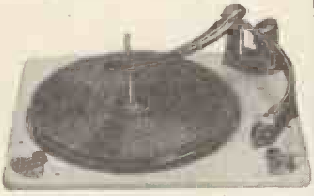
LASKY'S PRICE **97/6** Post free

COLLARO RC54. With Studio O t.o. crystal pick-up. Carr. 5/- **£8.18.6**

COLLARO RC3/554. 3-speed single player with Studio O t.o. crystal p.u. List £9/9. LASKY'S PRICE **£6.10.0** Post free.

3-SPD. MIXER AUTO-CHANGERS

BRAND NEW AND UNUSED, IN MAKER'S CARTONS



GARRARD RC.110, as illus., with t.o. crystal pick-up. Cabinet space required, 14 × 12¼ × 4in. above and 2¾in. below motor board. Cream/brown enamel finish. List £14/13/-. NOW FURTHER REDUCED BY LASKY'S to **£7.19.6**
Carr. 3/6

GARRARD RC.80. Full length arm with two Decca XMS heads. List £20/15/-. LASKY'S PRICE **£13.19.6**
Carr. 5/-

Also available with GC2 t.t. crystal head at same price.

SPECIAL OFFER OF RECORD PLAYER CARRYING CASES.

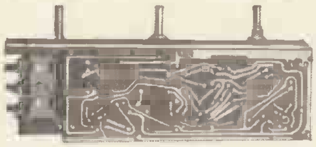
Suitable for almost any auto-changer and with room for amplifier. Attractive maroon/cream finish. Size 16½ × 14½ × 8in. deep. Baseboard size: 14 × 12¼in. Limited number only. Unrepeatable.

LASKY'S PRICE **49/6**
Carr. 2/6

BUILD IT YOURSELF AND SAVE POUNDS!

NEW BATTERY PORTABLE FOR HOME CONSTRUCTION ON PRINTED CIRCUIT

CAN BE BUILT FOR £7.7.0



10 STAR FEATURES make this the finest portable radio ever offered to the home constructor. Peak value for money has been achieved without any sacrifice of quality or design and the handsome case makes it a set you will be proud to own. Would make an ideal Christmas gift!

SIMPLICITY OF CONSTRUCTION. The use of all the latest innovations gives maximum simplicity of construction combined with fine quality performance. In particular, the PRINTED CIRCUIT greatly simplifies construction and completely eliminates the possibility of wiring errors. The veriest novice can build this portable radio easily and quickly and the cost complete, less batteries, is only £7/7/-.

Demonstration models at both our addresses.

SEND FOR CIRCUIT DIAGRAM
with assembly data, all instructions, illustrations and full shopping list. Price 1/6 post free.

- ★ PRINTED CIRCUIT, size 7¼in. × 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 Case.
- ★ Lightweight and Handsome Appearance.
- ★ Every Component available separately.

16" METAL CONE C.R.T. AT ENORMOUS SAVING!

BRAND NEW & PERFECT

Limited number only

Here is your opportunity to convert to pig picture television at a price you can afford. Note especially that these are not "seconds" but perfect tubes without fault, and supplied in original cartons. Brief specification: 6.3 v. heater, ion trap, 14 Kv E.H.T., wide angle 70 deg., standard 38 mm. neck, duodecal base, magnetic focus and deflection. Maximum length 17 11/16in. Gives large 11 × 14⅝in. black and white picture. GUARANTEED BY US FOR 3 MONTHS. Full data, connections and suggested time bases supplied with every tube.

LISTED AT £23.9.10 | LASKY'S PRICE **£8.9.6.**

Carr. and Insur. 22/6 extra.
Masks, Anti-Corona, Bases and Ion Traps available.

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

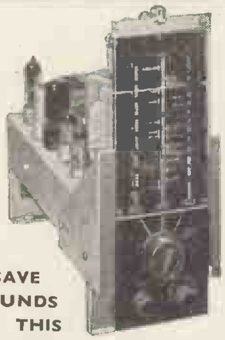
LASKY'S RADIO

20,000 VALVES IN STOCK

Here are a few examples of brand new surplus and imported valves :-

EB91	7/6	EF41	10/6	EY51	12/6
EB41	7/6	EF80	10/6	EC84	11/6
EABC80	10/-	EF85	10/6	EY86	14/6
EAF42	10/-	EF86	12/6	EZ40	8/6
EBC41	10/-	EF89	10/-	EZ80	8/6
ECC85	10/-	6K8	10/6	PCF82	12/6
ECC84	15/-	6V6	8/6	PCC84	12/6
ECC83	9/-	6K7	5/6	PL81	13/6
ECC82	9/-	6Q7	10/6	PL82	10/6
ECC81	9/-	6R7	6/6	PL83	11/6
12AT7	8/6	5Z4	9/6	PY80	10/6
12AU7	8/6	DAF96	10/-	6AT6	7/6
12AX7	9/6	DL96	10/-	6AT7	7/6
ECF82	15/-	DK96	10/-	1S5	7/6
ECH42	11/6	DF96	10/-	3S4	7/6
ECH81	11/6	Set of 4	32/6	1T4	7/6
ECL80	11/6	DM70	9/-	1R5	7/6

Also full stocks of B.V.A. Valves and C.R. Tubes at the new lower list prices.
WRITE FOR COMPLETE 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 13¼ × 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, 11¼ × 4½in. Overall dimensions 14 × 6 × 7in. Valve line-up: 12AH8, 6BA6, 6AT6, 6BW6, 6X4.

LASKY'S PRICE, complete with valves. **£9/19/6**

Carr. 7/6

Table Cabinet for above, complete with ¾in. P.M. speaker, 49/9.

COMPLETE 5-VALVE RADIO CHASSIS

Brand new and unused. A.C./D.C. 200/250 volts. I.F. 465 kc/s. A.V.C., 4 watts output, 3-station pre-set, frame aerial, fully aligned chassis 10 × 5¼in. max. height 5¼in. Completely wired and ready for use, with the addition of a speaker and output transformer. Two controls, volume and station switch. Valves used: 10C1, 10F9 or UF41, 10LD11, 10P14, U404 or UY41.

LASKY'S PRICE **69/6** Less valves. Post 3/6 extra.

With valves £5/19/6

HI-FI ELECTROSTATIC SPEAKERS ('TWEETERS') AT REDUCED PRICES

For high-fidelity sound reproduction. Easy to fit to any radio, TV receiver or amplifier. Full data and circuit diagram supplied.

LSH75. Inherent cap. 800 p.f. For outputs up to 6 watts. Size 3 × 3 × ½in. Reduced from 12/6. NOW 8/-

LSH518. As above, for outputs of 10-12 watts (wide angle sound distribution). Size 7 × 2 × ½in. Reduced from 17/6. NOW 12/6.

LSH100. 7-18 kc/s., 20 dbs., inherent cap. 1,100 p.f For output up to 20 watts. Size 5 × 4 × ½in. Reduced from 21/-. NOW 14/-.

LPH65. Moving coil Tweeter. Imp. 5.5 ohms, freq. range 2,000-2,200, 50 c/s. Four outputs up to 6 watts. 2½in. diameter. Price 39/6

All post free

BUILD A FIRST CLASS TAPE RECORDER AT POUNDS SAVING

Send for details of Lasky's New Portable Tape Recorder Kit, comprising fully fitted Case, Truvox Deck, Amplifier, Elliptical Speaker, 1,200ft. E.M.I. Tape, Plastic Spool and full instructions. Price of the COMPLETE KIT **£35**
Carr. & Pkg. 25/- extra.

LASKY'S RADIO CONSTRUCTOR PARCELS

Each complete with your choice of Cabinet, 12 × 6½ × 5½in. deep, walnut or ivory plastic or wood with walnut veneer.

PARCEL No. 1. Everything to build a 4-valve, 3-wave superhet for 200/250 A.C. mains. Uses 6K8, 6K7, 6Q7, 6V6 valves. CAN BE BUILT FOR **£7.19.6**

PARCEL No. 2. Everything to build a T.R.F. 3-valve set for 200/250 A.C. mains, med. and long wave. Uses 6K7G, 6J7, 6V6 and metal rectifiers. CAN BE BUILT FOR **£5.10.0**

Post 2/6. INSTRUCTION BOOKS 1/- each post free. All components available separately.

MAKE YOUR OWN FERRITE ROD AERIAL.

Ferrite rod, 5in. long, ⅜in. diam., with full directions. Each, 2/6. Post 1/-.

DECCA PICK-UPS

3-speed with T.O. crystal head HI/G, and rest. Brown plastic. Post 2/6. **32/6**

DECCA XMS P.U. HEADS

L.P. and standard, complete with styli. Per pair, Post 3/6. **79/6**
Singly, 42/-. Post extra.

T.O. CRYSTAL CARTRIDGES

B.S.R. complete with two styli. Post free. **18/6**

V.H.F./F.M. TUNERS

All leading makes and types in stock. A few examples :-

THE NEW JASON "ARGONAUT" AM/FM TUNER

A super-sensitive Tuner and Receiver for F.M. and medium waves. Complete parcel containing everything to build the "Argonaut," with power supplies, **£13/19/6** post 3/6.

DATA BOOK 2/- post free.

All components available separately; send for itemised price list.

Chassis Assembly, complete, 57/9. Post 2/6. | I.F. and Coil Set, complete, 78/-. Post 1/6.

JASON F.M. TUNER

Special parcel containing data book, chassis, front panel, dial, drive tuning condenser, full set of coils. I.F.'s, ratio detector, etc.,

DATA BOOK with price list 2/- post free. **68/9**
Post 2/6

Note: this tuner uses 4-6AM6 and 2 crystals and can be built for £6/15/-, plus 3/6 post.

DULCI FM TUNER

Incorporates its own power supply and provides complete F.M. coverage. Operates with most radio receivers and any make of Amplifier. Valve line-up: EABC80 ECC85, two EF89, 6X4 (Rect.), EM80 magic eye indicactor. Dial 10½ × 6in. Overall size 9 × 6 × 5½in. high.
Complete **£17/10/0**
Carr. & Pkg. 7/6.
DULCI AM/FM TUNER £20/17/0

Band III Conversion for All!

FAMOUS MAKE TURRET "TELETUNER"

Complete with 12 Coil Sets. **99/6**

Post 2/6 Knobs 3/6

Covers all Channels, Bands 1 and 3. Valves used: PCC84, R.F. double triode, cascode R.F. amplifier, PCF80, triode pentode f.c. and mixer. I.F. output 33-38 Mc/s. Easily modified to other I.F. outputs. Full instructions and circuit diagram supplied.

BAND III CONVERTERS

BELOW HALF PRICE!

2 valves and metal rectifiers, metal case. Contains power pack for 200-250 v. A.C.
List £8/10/-.
LASKY'S PRICE **79/6**

LARGE RANGE OF TAPE DECKS

Collaro "Tape Transcripter," £20
Truvox 22 gns.
Lane £18/10/-.
Brenell 18 gns.
And all other makes.

BARGAIN VALUE IN SINGLE RECORD PLAYERS

B.S.R. type TU.8 3-speed motor and pick-up with HGP.59 t.o. crystal, complete with two styli.
LASKY'S PRICE **92/6**
Post 3/6.

3-speed motor and turntable without pick-up, 57/6. Post 2/6.

12-CHANNEL TV TUNERS

Famous make. Covers Bands I and III Complete with valves EF80 and ECC81 Ceramic valve holders, finest quality components. Switch and fine tuning. I.F. output 20-25 Mc/s. Freq. coverage 50-87 Mc/s. and 175-215 Mc/s. Full details and circuit diagram supplied.
Reduced to **79/6**
Post 3/6. KNOBS 2/9 extra.

Also another Tuner using PCC84 and PCF80, I.F. output 33-38 Mc/s. Complete with valves and diagram 99/6 Post 3/6.

TELETRON BAND III CONVERTERS

TELETRON CONVERTER COIL SET MK. I For use with TRF and S'het Band I TV sets. Uses two Z719. Circuit diagram alignments, full details supplied. **15/-**
Post 1/6.

MK. I. Complete Kit to build this converter, drilled chassis, condensers, resistances, coils, 2-EF80 valves, etc., with circuit diagram and instructions.
Post 1/6.
Drilled chassis only 3/9. **48/6**

MK.II. Uses latest type valves. Cascode R.F. amp. and triode pentode F.C. PCC84 and PCF80, etc. The COIL SET **17/6**

COMPLETE KIT. Including drilled chassis, valves and diagram.
Post 1/6.
Circuit diagram only 3d. **59/6**

VALRADIO TV TUNERS

Full range, all I.F. freq., series or parallel heaters. **£6**
Post 3/6.

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.

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN

LASKY'S RADIO

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.

Carrying Case, £4/18/-.

Complete equipment with mike and tape, in carrying case, ready for use. 51 Gns.

Full details on request.

LARGE STOCK OF TRANSISTORS

Lowest prices. Fully guaranteed. By Mullard, S.T.C., etc.

SUB-MINIATURE TRANSISTOR TRANSFORMERS, 4 to 1 ratio. Each **4/6**

FILAMENT TRANSFORMERS

All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.

6.3 v. 1.5 amp.	5/11
6.3 v. 2 amp.	7/6
6.3 v. 1 amp.	4/6
0-30 v. 2 amp. tapped voltages	19/6

R1155 RECEIVERS

NOW AVAILABLE ON EASY TERMS

In original wood transit cases.

Brand New	£11 19 6
Secondhand, Grade I	£9 19 6
Ditto, Grade 2	£7 19 6

Carr. 12/6.

Power Pack and Output Stage with 6½in. Speaker £5 5 0

SPECIAL OFFER OF TAPE DECK MOTORS

Anti-clockwise, shaded pole.

Collaro	Garrard	B.T.H.
25/-	26/6	29/6

Post extra.

REMPLOY INSTRUMENT

SOLDERINGIRONS. 200-250v Neon indicator light in handle, 25 watt. **19/3**

3-WATT MIDGET AC/DC AMPLIFIER PUSHPULL. VERY HIGH GAINS.

4 valves: 2 UL41 in push pull 1 UCH42 and 1 UAF42. Input voltage 100/100 AC/DC. Easily converted to 230 volts. Ideal for ships record players tape recorders home record players baby alarms etc. etc. Supplied complete fully assembled with valves. Circuit diagram and details.

REDUCED TO **50/-** Carr. 5/-.

GERMANIUM CRYSTAL DIODES

GEX.00	1/6
GEX.34	3/6
GEX.54 and OA71	5/-
WG4A	3/6
WG4B	4/-
WG5A and B.	5/-
WG6A	5/-

MOVING COIL P.M. SPEAKERS

3in. and 3½in. 19/6

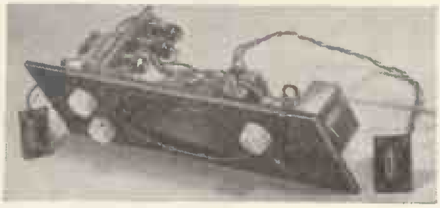
5in.	6½in.	8in.	10in.	12in.
16/6	17/6	25/-	26/6	29/6

6½in. with trans.	21/-
7 × 4in. Elliptical	19/6
10 × 6in. Elliptical	32/6

PORTABLE GRAM AMPLIFIER

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 × 4¼in. 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, 3/554, etc.

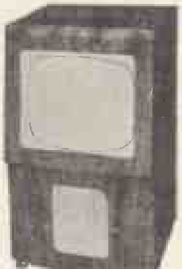
Price, complete with 3 new Osram valves, 7 × 4in. Goodmans elliptical speaker, metal speaker grille, mains lead, and knobs. **£5/9/6** Carr. 5/-



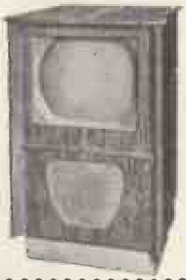
MAGNIFICENT VALUE IN TV CABINETS

THE DE LUXE. Complete with mask, glass, castors, shelf, bearers, C.R.T. neck end protector, back, speaker, fret and baffle board. Finished in beautiful figured medium light or dark walnut veneer, with high polish. Suitable for most home constructor TV Receivers, including the "Viewmaster," "Practical Television," "Tele-King," "Magnaview," "Wireless World," etc. Supplied with cut-out for 14in., 16in. and 17in. C.R. tubes at no extra cost. An allowance of 4/6 will be made if the mask is not required.

Inside dim.: Depth 16½in., width 17¾in., Height 28in. Overall height 32in. Width 18½in. Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.



LASKY'S PRICE **£8/10/-** Carriage 12/6.



THE ROTHESAY. Outstanding contemporary design. Absolutely rigid construction throughout with the finest laminated woods, veneered in walnut, polished light, medium or dark shade. Fitted with gold anodised speaker grille. C.R.T. aperture frame is detachable, supplied to suit any size tube to order. NOTE SIZES:

Outside dim.: 34½in. high, 21⅞in. wide, 21½in. deep. Inside dim.: 18⅞in. wide, 19¼in. deep. Size of top: 22½ × 21⅞in. Thickness ½in.

LASKY'S PRICE **£9/19/6** Carriage 15/-.

WITH FULL-LENGTH DOORS veneered both sides, polished to match the cabinet and mounted with full-length piano hinges. £14/9/6. H.P. Terms arranged for any of above Cabinets.

MAINS TRANSFORMERS

All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.

MBA/3. 350-0-350 v. 80 mA. 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 volts. 19/6.

MBA/7. 250-0-250 v. 80 mA. 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. 19/6.

AT/3. Auto trans. 0-10-120, 200-230-240 v. 100 watts. 19/6.

MT/340. Tapped input 200/250 v. 300-0-300, 100 mA., 5 v. 3 amp., 6.3 v. 1.5 amp. 16/6.

MT/341. Tapped input 250-0-250, 120 mA., 6.3 v. 5 amps., fully shrouded. 27/6.

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 blocking 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, Electro-magnetic	12/6
200 m/a. Smoothing Chokes	10/6

FAMOUS AMPLIFIERS

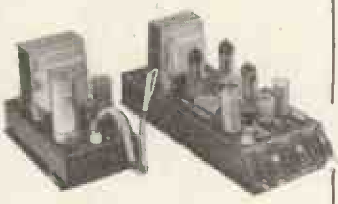
BUILT ON T.C.C. PRINTED CIRCUITS

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 15 GNS. The Book, 3/6.

OSRAM 912. From 19 GNS. The Book, 4/-, post free.

All components available separately, also printed Circuits.



COMPLETE KIT OF PARTS For building the MULLARD 510 Amplifier can be supplied for from 12 GNS. Details on request.

BAND III AERIALS. All types, outdoor or indoor, also Diplexes, Crossover Boxes, Co-axial Plugs, Socket and Cable.

H.P. TERMS AVAILABLE

on certain items. Write stating requirements.

SEND FOR OUR NEW BARGAIN LIST enclosing 3d. in stamps.

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OPEN ALL DAY SATURDAY EARLY CLOSING: THURSDAY.

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There is always a fine selection of equipment at

BENDIX COMMUNICATIONS RECEIVER TYPE RA-10DB

A superb 8-valve 4-band receiver covering 150-400 kc/s, 400-1,100 kc/s., 2-5 Mc/s and 5-10 Mc/s. Valve line up 6SK7 R/F., 6K8 F/C., two 6SK7 L.F. amplifiers, 6E7 Second Det. A.V.C. and A.F. amplifier, 6C5, BFO, 6K6 O.P., 6H6 Sig. limiter diode.

Power supply 28 volts D.C. 2A. to internal motor generator. If desired this can easily be changed to a similar generator with either 6 or 12 volts input. Alternatively the generator may be removed and the space utilised for a converter. *A circuit for A.C. mains conversion is avilable.*

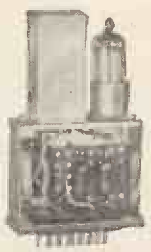
As a BOAT, TRUCK, CARAVAN or CAR RECEIVER it is UNEQUALLED in value; converted to A.C. operation for fixed station it equals receivers selling for over five times the price we ask.

Full technical details, servicing data and circuit are supplied with every receiver.

PRICE **£5 · 10 · 0** *Packing and Carriage 10/-*

I.F. AMPLIFIER UNIT

460 Kc/s with IT4. Brand New and Boxed. Fully Screened in plug-in Box. Size 2½in. × 1in. × 4½in. Price, with circuit, **10/-** ea., plus 1/- p.p.



ABSORPTION WAVEMETER

Easily converted to 2 metres or 70 cm. In Copper-Plated metal case 3½in. × 4½in. × 5½in. with dial calibrated 0-100 and 80 v. Neon tube. Coverage approx. 190-210 Mc/s. New, **6/6** each, post paid.

HEADPHONES

Super sensitive 4,000 ohm Balanced Armature. Brand new and boxed. 17/6, plus 2/6 p.p.

A.P.Q.2 Radar Jamming Unit

Containing 931A Photo Multiplier Cell complete with resistance network and lightproof box. Wide band amplifier 2.6AC7, 1. 6AG7, 2. 388A. This unit is similar to the A.P.Q.9 Jamming Unit shown in the October issue of "Wireless World." Brand new. £5, plus 10/- carr.

EARPHONES

Balanced Armature L/R. New and boxed (single units) 3/6, plus 6d. p.p. **C.H.R. High Resistance.** New and boxed (single units) 3/6, plus 6d. p.p.

TYPE 81 MINIATURE TRANSMITTER STRIP

Complete with valves CV.415 (TT15), CV309 (QV04-7), 2-6AM6, 2-EL.91 and Crystal. Circuit supplied Free with unit. Price £4/10/- post paid.

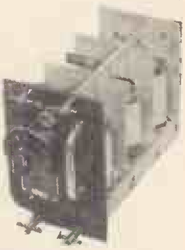
COMMAND TRANSMITTERS

BC-458-A 5.3-7 Mc/s., BC-459-A 7-9.1 Mc/s. Price £2 each. Fully Valved—Less Dynamotors (Not New). Plus 3/- p.p.

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 Output Audio 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.

R.F. UNITS



R.F.24. 20-30 Mc/s. Switched Tuning. Valved. **9/6** each.

R.F.25. 40-50 Mc/s. Switched Tuning. Valved. **9/6** each.

Packing and postage 2/- each.

2-3 mA MEASUREMENT METER

2-3 mA movements in metal case measuring 4¾in. high, 3½in. wide and 5in. deep. **7/6** plus 2/- p.p.

AN/APN.1 TRANSDUCER

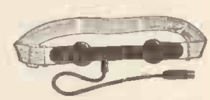
This Unit consists of Magnet, and Coil which is attached to an aluminium diaphragm suspended freely and perforated to prevent air damping. Mounted on a Ceramic cover which sits over the diaphragm is a form of 2-gang capacitor which has a swing from 10-50 pF.

The above unit is used as part of Wobbulator described on page 252 of the June "Wireless World." PRICE **7/6** p.p.

AN/APN.1 RECEIVER UNIT

A sub-chassis 3½ × 6¼ × 2¼in. houses a Receiver tuned to the transmitting frequency. Contains TWO 9004 vlaves. For use in 70 cm. band. Price, post paid, 12/6.

THROAT MICROPHONES



Type TS30. U.S. Manufacture.

Complete with elastic strap. Lead terminating at 2-pin plug PL.291, and socket JJ-048. New and boxed, 3/- each, post paid.

R.C.A. SPEAKER for outside use

20 watt 15 ohm with internal Multitapped transformer in strong metal case measuring 10in. dia. × 5in. deep. Brand new in original packing, £2/10/- plus 7/6 carr.

WIND FINDING ATTACHMENTS

Comprising two small counters. Two Desyn type follower motors (ideal for antenna direction indicators). Size of motors 1¾in. long, 1in. dia. Terminal block 6-way, toggle sw. Housed in metal outer case, fitted with plastic 360-degree dial. Price 8/6, post paid.

BLOCK CONDENSERS

8 mfd. 600 v. W., 5/6 each, post paid. 4 mfd. 400 v. W., 4/- each, post paid.

AMERICAN CLOCKWORK INTERVALOMETER

72-hour jewelled compensated movement. Contacts make for 15 seconds, then open for 45 seconds. Can be easily converted to give variable time delay. Panel mounting 3in. × 3½in. Brand new, 12/6 each. P.P. 1/6.

WAVEMETER TYPE W.1310

Coverage 155 to 230 Mc/s. continuous, complete with Test Prod. Input 230 v. 50 cycles. New condition. £3/10/- plus 7/6 carr.

All these fine offers are on display at →

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. 3 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 50 K. **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 4⅜ × 3 × 1½in., **7/6**.

T.V. Coils, moulded former, iron-cored wound for re-winding purposes only. Ali-can 1⅜ × 1½in., **1/-** each, 2 iron-core Ali-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**.

GARRARD RC/110

3-SPEED AUTOMATIC MIXER CHANGER

Will take 10 records, 7in., 10in. or 12in. Mixed, turnover crystal head, brand new, current model. A.C. mains 200/250 v. (list price £14/10/-).

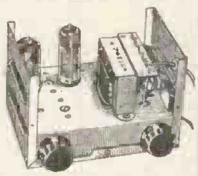
£7 - 19 - 6 P. & P. 3/6.

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. Case 5⅜in. long, 3½in. wide, 4½in. high. Incorporating gain control and band switch.

£3 - 19 - 6 Plus Post & Packing 2/6.



Illustrated with cover removed.

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.

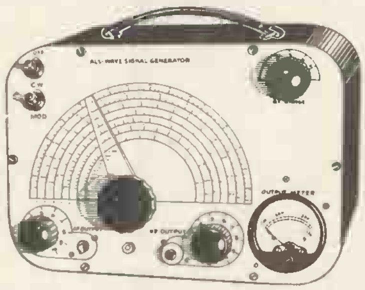
AC/DC MULTI-METER KIT

Comprising 2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-10, 0-100 and 0-500. Milliamps 0-10, 0-100; ohms 0-10,000. Front panel, range switch, wire wound pot (for ohms zero setting), two toggle switches, resistors and meter rectifier. Point-to-Point wiring diagram **1/-**. Free with complete kit.

Complete in case, grey hammer finish. **19/6** P. & P. 1/6.

COMPLETELY BUILT SIGNAL GENERATOR

Coverage 120 Kc/s.-230 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s.-84 Mc/s. Metal case 10in. × 6½in. × 4½in. Size of scale, 6½in. × 3½in. 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated R.F., output continuously variable 100 milli-volts. C.W. and mod. switch, variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%. **£4/19/6**. or **34/-** deposit and 3 monthly payments **25/-**. P. & P. **4/6** extra.

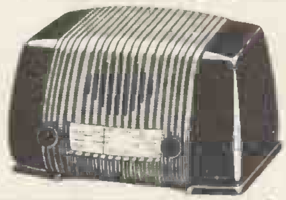


T.R.F. KIT

IN PLASTIC CABINET

3 valve plus metal rectifier, A.C. mains 200-250v. 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. A point-to-point wiring diagram, **1/6**. Free with complete kit.

All parts supplied separately.



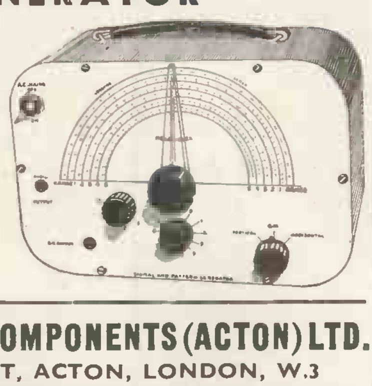
SIGNAL & PATTERN GENERATOR

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/-.



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. Transformers, 9 Kv. using ferrocart core, complete with built-in line and width control. Mounted on small ali-chassis. Overall size 4⅜ × 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. Transformers, 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.

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**.

COLLARO RC54

3-speed automatic changer, current model. Brand new. 10 records mixed. Studio "O" pick-up. A.C. mains, 200-250 v.

£7 - 9 - 6 Plus P. & P. 5/-.

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, 4 × 1½ × 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/-**.

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

RADIO 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. 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.

MODERN ELECTRICS LTD.

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Covent Gdn. 1703.
Cables: Modcharex, London.

Export enquiries invited. *Correspondence in French or English.* *Prompt attention to post orders.*

TAPE RECORDERS

GRUNDIG TK5	46 gns.
GRUNDIG TK8	72 gns.
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4 amps R.F. 2in. F.M.T.C.	5 0
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300 volts A.C. 2½in. F.M.M.I.	25 0
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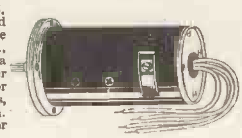

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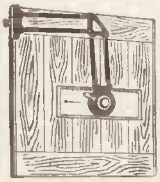

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MARCONI SIGNAL GENERATORS. Brand new, in original transit case, complete with spares, instruction manual and calibration charts. Type TF390G, 4–32 and 50–100 Mc/s. £25.

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MODEL MI-11220. Employs 2 6L6, 4 6J7, and 1 5U4. Output 12 watts at 5–7.5–15–600 ohms. For 190/250 v. A.C. mains. In grey crackled case, 17in. x 11in. x 9in., wt 38lb Brand new and boxed. Price, less valves, £9/19/6. Circuit supplied. Set of new boxed valves, 59/6.

APQ9 TRANSMITTER. Contains 931A electron multiplier (complete with resistor network, etc.), 2 6AC7, 1 6AG7, 2 807, and 2 blower cooled 8012. Lecher Line tuning with rev. counter. Just the job for centimetric band experiments. Brand new, 79/6.

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COMMAND RECEIVERS

Complete with 6 valves: 3 12SK7, 1 12K8, 1 12SR7, and 1 12A6. Size 5in. x 5¼in. x 11½in. deep. In very good condition. Less dynamotor. FREE CIRCUIT WITH EACH SET.

BC455, 6–9 Mc/s, 25/-. BC453, 190–550 Kc/s, 59/6.
BC454, 3–6 Mc/s, 27/6. BCXXX, 1.5–3 Mc/s. 65/-.
NEW, BOXED, BC453 69/6. BCXXX, 75/-.

COMMAND TRANSMITTERS. Complete with 2 1625 (12 v. 807), 1 1626, 1 1629 and Crystal.
BC457. 4–5.3 Mc/s (Xtal 4600 Kc/s), 22/6. New, 29/6.
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METER BARGAINS

RANGE	TYPE	SIZE		PRICE
50 Microamp.	D.C. M/C	2½in.	Flush circ., scaled 0-100	59/6
100 Microamp.	D.C. M/C	2½in.	Flush circ., scaled 0-1,500	39/6
500 Microamp.	D.C. M/C	2in.	Flush square, Weston	27/6
500-0-500 Microamp.	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., 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	10/9

METER RECTIFIERS. Salford Instruments, 1 mA, 8/6; 5 mA, 6/9; S.T.C., 2 mA., as used in E.M.I. Output Meter, 5/6. All are full wave bridge and brand new.

MINIATURE MODEL MOTORS. 2in. long x 1¾in. diam 1/16in. diam. spindle, wt. 5oz. Will work from 6 v. dry battery and are reversible. Has ball bearings. 8/6.

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Indicator chassis	5/-
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8 mFd. paper...	3/-
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EF50's, from ..	2/6
EA50's, NEW..	6d.
EB34's, NEW..	6d.
12H6's, NEW..	6d.
R1155's, Gashed	25/-
Unmarked S.M. Conds. 100 asstd.	2/6

INDICATING UNIT 277. Case size 5¼in. x 7in. x 12in. deep. Contains 1in. C.R. tube type VCR522 (same as that used in G.E.C. "Miniscope"), 4 VR91, 2 VR92, and a host of useful modern components. Fitted with "Focus" and "Brightness" controls, etc. Should convert to useful miniature oscilloscope. All tubes tested. 59/6.

AR77 MAINS TRANSFORMERS. Fully shrouded, drop-through, 3¾in. x 3¼in. Primary 110/125/150/210/240 v. 50–60 c/s. Secs., 325–0–325 v. 100 m/amp., 6.3 v., 3.5 amp., and 5 v. 2 amp. BRAND NEW ex-U.S.A., 29/6.

REPLACEMENT MAINS TRANS., for R C.A. Amplifiers, Pri. 105/115/125 v., 50–60 c/s., Secs., 380–350–0–350–380 v., 170 m/amp. 6.3 v., 3 amp., C.T. and 5 v., 3 amp. 4¼in. x 4¾in. x 4¾in. high. Fully shrouded, 16/6.

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HEAVY DUTY LT TRANSFORMERS. 230 v. A.C. mains input. Secs. 5–0–5 v., 5–0–5 v., and 5–0–5 v., all at 5 amps, each winding. 5, 10, 15, 20, 25, or 30 v. at 5 amps., or other possible combinations. 4½in. x 4½in. x 6in. high. Wt. 12lb. BRAND NEW, 29/6. ANOTHER, 230 v. A.C. mains input, Two separate secondary windings, each 14 v. C.T. 12 amps. 7, 14, 21, or 28 v. at 12 amps., or other possible combinations. Wt. 24lb. Ex-Admiralty. Brand new, 42/6.

G.E.C. 200–250 v. A.C. mains input. 30 v. (tapped at 10 v.) 36 amps output. 5½in. x 6in. x 7in. high. Wt. 24lb., 55/-.

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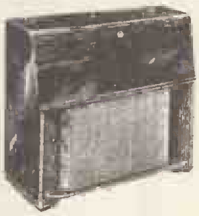

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A well-designed Bureau-type Cabinet in a medium size. Veneered in a highly figured Walnut. Outside dimensions, length 29¾in., depth 16in., height 32in. Sloping control panel on right-hand side approx. 13in. x 10½in. Removable baseboard on right hand side approx. 13½in. x 13in. Large record compartment inside the cabinet, located at the top on left-hand side.

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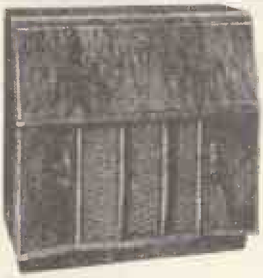

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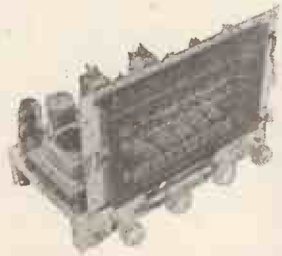

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CAT. NO. CR/AFM49/PP: 9-valve Superhet with F.M./VHF Band (4 wavebands). Push-pull output including 2 loudspeakers. CASH 26 Gns. Or on Credit Terms.

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Self powered. Six valves with grounded grid RF stage followed by additive mixer using a FCC85 twin triode in sealed permeability tuned unit. Two I.F. stages ensure maximum gain with 6AL5 double diode as ratio detector. Frequency coverage of 85-101 megacycles allows adequate overlap. Very finest quality throughout.

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Complete Unit in Cabinet with Magic-eye tuning. Boxed, 13in. long x 6½in. overall depth x 7½in. high (approx.). Or on Credit Terms.

16½ Gns.

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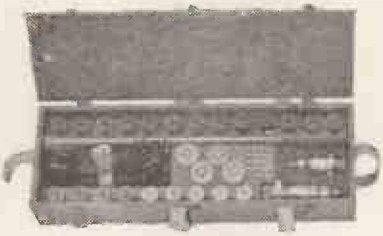

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S.27 HALLICRAFTER. Freq. range: 27–143 Mc/s. A.M./F.M. The only receiver that needs no further description; very good condition, for the very low price of **£35**, carr. and packing 20/-.

COLLINS RADIO RECEIVERS TYPE 46159A. Freq. range: 1500–12,000 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**, carr. 7/6.

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PHOTO-ELECTRIC MULTIPLIER CELLS Type 931A. **£2/10/-**, p.p. 1/–. Also 931A, complete on chassis with multiplier network and 2-832 valveholders, etc., **£3/10/-**, p.p. 2/–.

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BEACON TRANSMITTER RECEIVER RT.37-PPN2. Complete with aerial mast, H-S.30A headset. 9–1.4 v. B7G Min. valves (5-3A5's 3-1S5's, 1-1R5), also 2–2 v. 7 pin Syn. vibrators. Complete in heavy duty haversack, new and unused. **£4/19/6**, carr. 7/6.

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SIZE

3in. in Length 1¼in. dia. 100th H.P. Spindle Length 1 x ¼in. dia.

27 v. input, output 7,000 r.p.m. at 0.63 amp.
12 v. input, output 2,800 r.p.m. at 0.57 amp.
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30 k. W/W N.S.F.	Spindle 1in.	15/-	1/6
250 k. W/W	Colvern	12/-	1/3
250 k. Midget U.S.A.	L/S, dia. ⅝in.	12/-	1/2
½ meg. Linear	Spindle ¼in., dia. 1¼in.	15/-	1/6
600 ohm x 600 ohm	Spindle ¼in.	24/-	2/3

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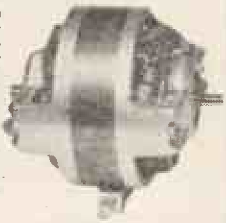

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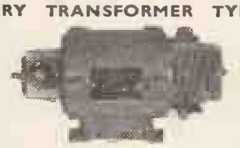

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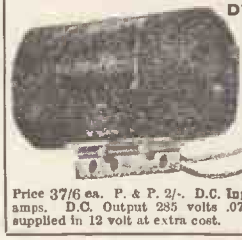

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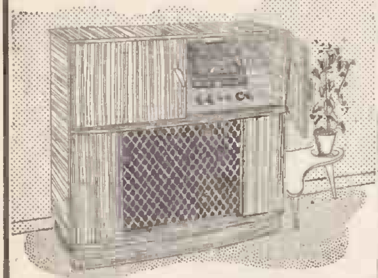

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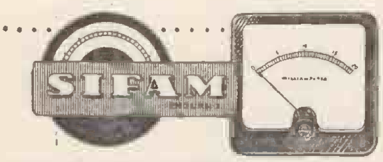

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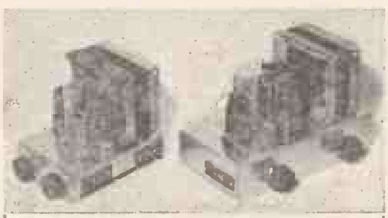

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100Ω w/w pots, 3w, 1in spindle; 2/6.
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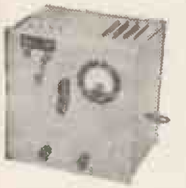

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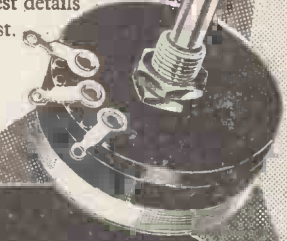

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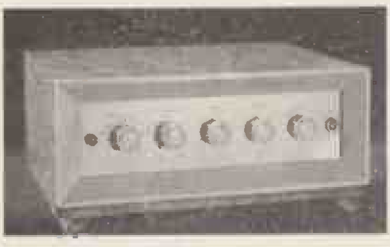

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RADIO T.V. Engineer required, experienced. Permanent job for right man. Genuine Co., 398, Harrow Road, Paddington, W.9. [6369

A WORKS manager is required by a television component firm employing one hundred people.—Apply Gillone Electric, Ltd., Doman Rd., Camberley, Surrey. [6405

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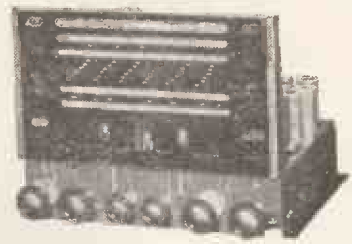

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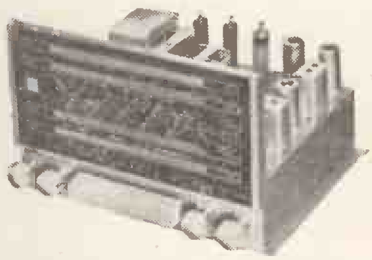

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CRAFTSMAN required for radio and television duties; must be fully experienced in the repair and maintenance of all types of radio and television receivers; present rate of pay 4/5 per hour; N.J.I.C. conditions.—Apply, by letter, to District Manager, Midlands Electricity Board, 42, West Street, Leominster. [6410

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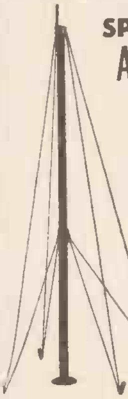

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NATIONAL CHARITABLE ORGANISATION has vacancy for man aged about 50 to take charge of small stores dept. issuing and organising the maintenance of radio sets and other mechanical equipment; ex-Service pensioner preferred; good service conditions, staff canteen.—Write, giving full particulars and stating salary required, to Box 4389. [6416

DESIGN engineer for work on TV aerial development and electronic equipment, good technical background, but specialist knowledge of aerials not essential—must be capable of working accurately with minimum of supervision and producing own ideas.—Applications to General Manager, Wolsey Television, Ltd., Cray Ave., St. Mary Cray, Kent. [6358

ELECTRONIC fitters are required for experimental and development work in the research laboratories of the British Thomson-Houston Co., Ltd., at Rugby.—Candidates should have previous experience in electronic assembly work or servicing, and should apply in writing to the Recruitment Officer, Research Laboratories, B.T-H. Co., Ltd., Rugby. [6267

RADIO and television engineer required by old-established company, must be fully experienced and up to R.T.E.B. standards and hold current driving licence; good salary and bonus; house available for suitable applicant.—Write stating experience and qualifications to: Wycombe Electrical Supplies, Ltd., 51, Oxford St., High Wycombe, Bucks. [6254

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RADIO Engineer required by Trinidad Government Wireless Branch, Works and Hydraulics Department for two years in first instance. Salary scale (including present temporary allowance of £30) equivalent to £780 rising to £1,250 a year. Commencing salary according to qualifications and experience. Gratuity at rate equivalent £100/£150 a year. Outfit allowance £60. Free passages. Liberal leave on full salary. Candidates should be A.M. (Brit.) I.R.E. or possess C. & G. Full Technological Certificate in Telecomms. Engineering. They should have had experience in Wireless Station Management and Organization.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41953/WF. [6385

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A SMALL progressive manufacturer, located in South Bucks, requires the services of a Senior Design Draughtsman with experience of electronic equipment and instrument engineering practice and a Junior Draughtsman.
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APPLY, stating age, education and experience, to Employment Officer, Hoover, Ltd., Perivale, Greenford, Middlesex, or 'phone Perivale 3311, Ext. 147, for further details. [6409

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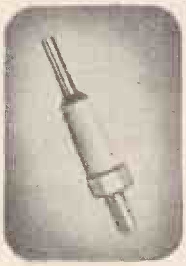

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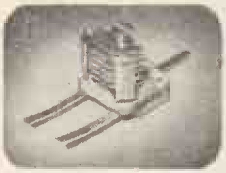

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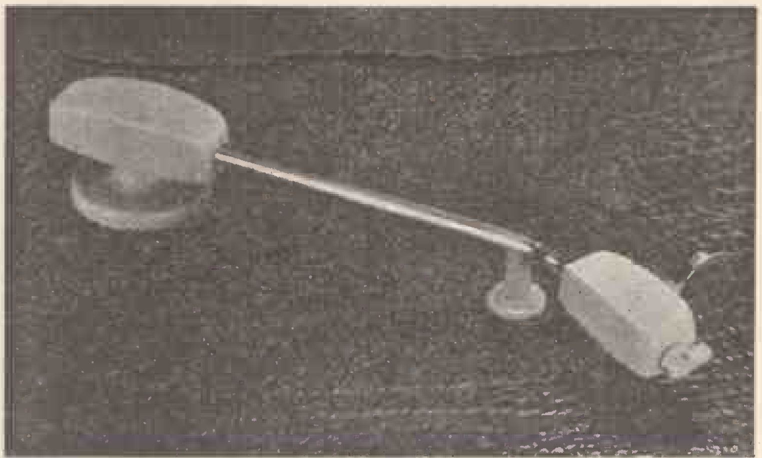

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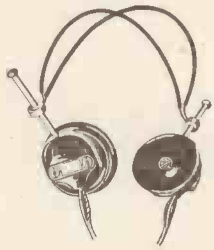

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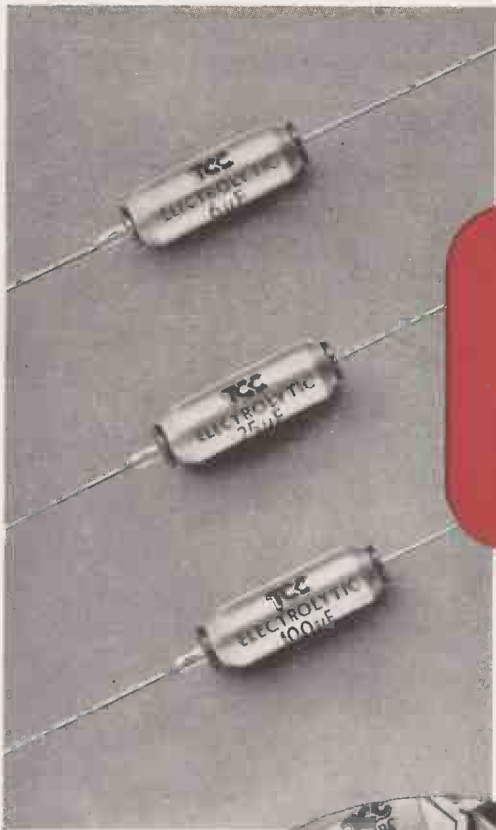

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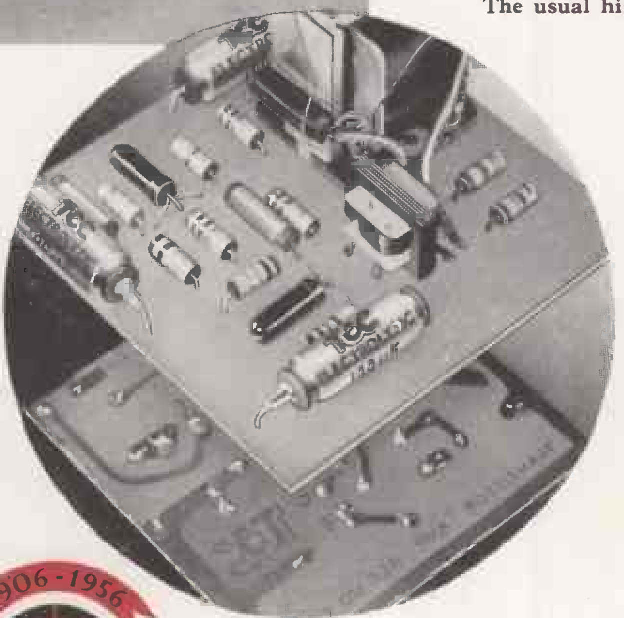

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