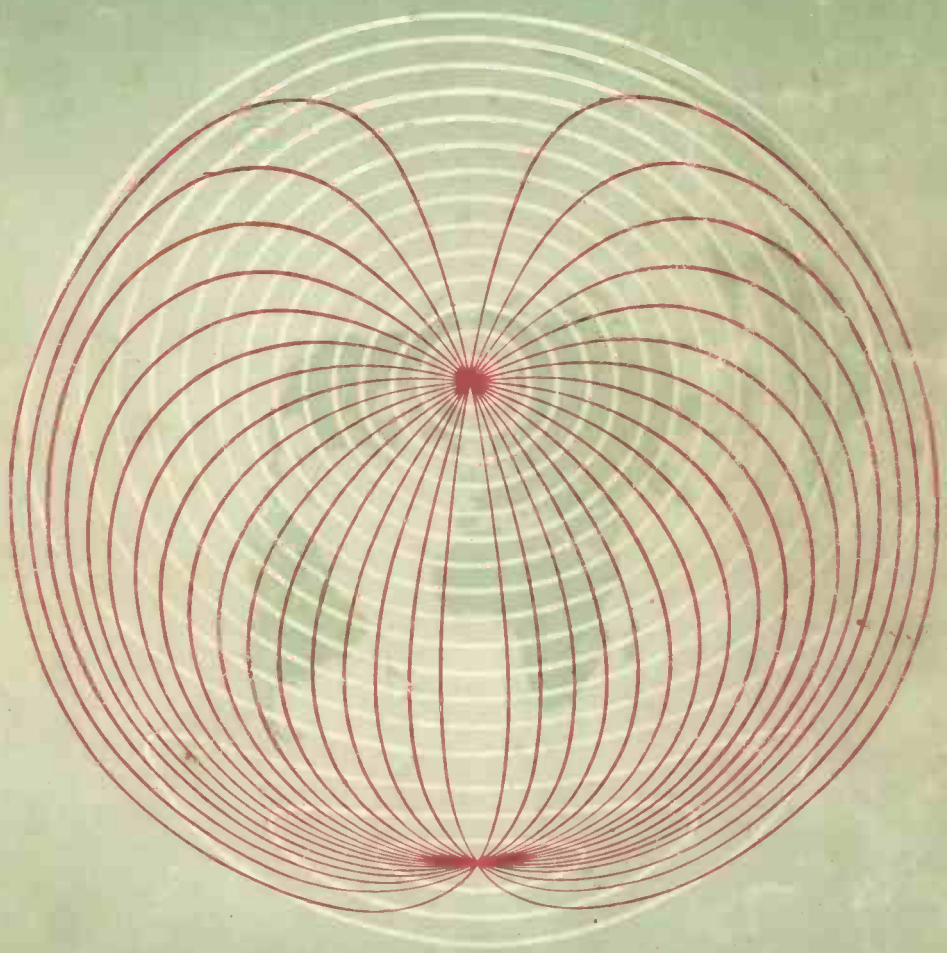
IMPROVING FM UNIT

Wireless World

SEPTEMBER 1953 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

Wireless World

RADIO, TELEVISION AND ELECTRONICS

43rd YEAR OF PUBLICATION

Managing Editor : HUGH S. POCOCK, M.I.E.E.
Editor : H. F. SMITH

SEPTEMBER 1953

In This Issue

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Wireless World

SEPTEMBER 1953 VOL. LIX No. 9

Two Bites at a Cherry

IN last month's *Wireless World* we suggested (with some diffidence and with all due deference to the recently published findings of the Television Advisory Committee) that it might be a good thing to abandon all idea of using Band 3 (174-216 Mc/s) for television in this country. The band is at present largely occupied by other services and it is doubtful whether it could be entirely cleared. We argued that, sooner or later, television was bound to go to the higher frequencies; why not pass to them at once, and avoid making two bites at a cherry? The existence of a handful of stations operating in Band 3, and giving much less than nation-wide coverage, would be a grave embarrassment to producers and distributors of receivers. To pass direct to Band 4 (470-585 Mc/s) seemed to us to be much more orderly, economic and, in the long run, likely to lead to more rapid development of the art.

We have been surprised by the amount of support given to a suggestion put forward so tentatively. One of the strongest arguments put before us is that competitive television, in the proper sense of the term, cannot come into being without a large number of competing stations—a larger number than could be accommodated in Band 3, even if the whole of it could be freed. And the chances of freeing it seem rather remote. According to a statement in Parliament by the Assistant Postmaster-General, there are at present some 1,680 fixed and mobile stations at the lower end of the band, while aeronautical navigational aids occupy the upper end from 200 to 216 Mc/s. Other services within the band, including P.O. telephone links, B.B.C. outside-broadcast links and 75 short-term experimental stations, could be rather more easily moved, though time would be needed for changes. The Asst. P.M.G. has, indeed, spoken of clearing the band gradually "over a period of years."

This statement seems to dispel all hopes that effective and worth-while use can be made of Band 3 in the immediate future. It also serves as an answer to a critic of our proposal who urges that the relinquishing of Band 3 would mean intolerable delay in the introduction of an alternative television service. Admittedly, in the preent state of the art the industry is not ready to make mass-production receivers for Bands 4 or 5, but it is well on the way towards being able to do so. Indeed, if the industry has a clear-cut objective on which to concentrate, it is likely to be able to produce sets for the higher frequencies long before Band 3 can be freed.

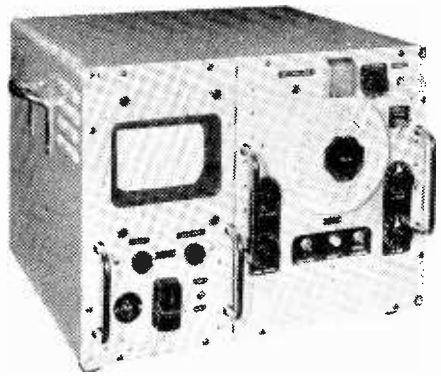
Another indirect argument against making use of the two channels that are at present available in Band 3 was provided by another statement of the Asst. P.M.G. in Parliament. He said that the B.B.C. now believe their plan for virtually complete coverage of the country with a single programme can be completed without going outside the present television Band 1. That, of course, avoids an undesirable complication in receivers designed for use in the immediate future.

Mobile radio, an increasingly important branch of our art, must also be considered. The question of displacing those mobile stations already operating in Band 3 is a thorny one. Instead of doing that, there is much to be said in favour of allocating even more channels in the band to "business radio" and other mobile services.

Perhaps the strongest argument against using Band 3 for television is that it might call for the use of receivers or convertors for three bands. That would be an expensive complication which the viewing public could not be expected to tolerate.

Radio on Parade

THE trend towards television at the forthcoming National Radio Exhibition will be more marked than last year. For the first time, the number of exhibitors of television receivers will exceed those of sound-only sets. The Show, which opens on September 2, will be predominantly of equipment for the home, with sound recorders as runners-up to radio gear proper. Very wisely, however, the organizers are increasing their efforts to show the public that there is more in radio than broadcasting.



SPECIFICATION

Signal-frequency range : 80-220 Mc/s.
Sensitivity : 4 μV. at 80 Mc/s ; 10 μV. at 220 Mc/s for twice the peak amplitude of internal noise.
Scanning ranges : 0-10 Mc/s ; 0-2 Mc/s ; 0-0.4 Mc/s.
Stability : 0.25 Mc/s after the first 15 mins.
Resolution : About 150 kc/s for 10 Mc/s sweep.
30 ,, ,, 2 Mc/s ,,
15 ,, ,, 0.4 Mc/s ,,
Scanning system : Electronic.
Repetition rate : 25 per sec.
Input impedance : 71Ω unbalanced.
Frequency marker signals spaced 2 Mc/s or 10 Mc/s are provided.
Provision is made for the connection of headphones.

Wide-Band V.H.F. Panoramic Receiver

By J. B. LOVELL FOOT, A.M.I.E.E.*

Zero Beat Method of Producing Indicating Pulses

A PANORAMIC receiver provides a visual display on a cathode-ray tube of the signals that are present in a given frequency band. The signals are usually represented by vertical pulses on a base-line representing frequency. The display is produced by automatically swinging the tuning of the receiver over the band of frequency in synchronism with the scanning of the cathode-ray tube. The repetition rate is preferably higher than the persistence of vision so that a picture free from flicker is obtained.

Receivers of this type are often used in the field of radio communication for monitoring radio stations, or for search purposes.

There are so many measurements which can be carried out more quickly on a panoramic display than by other methods, that it is surprising that such a receiver is not more often included in the general equipment of a radio laboratory.

A few of the many possible applications are as follows :—

To facilitate the rapid frequency calibration and testing of oscillators, for example in the production of standard signal generators or of frequency converters for receivers. For this work a panoramic display can be used to show oscillator drift, frequency modulation, harmonic or spurious radiations, sideband radiations or variations of signal amplitude. It can also be used to measure the effectiveness of screening, or for the location and investigation of radio interference.

With the exception of certain specialized equipments, most panoramic displays described in the past have been designed as additional units for use with existing communication receivers. These convert the receiver circuit to that of a double superheterodyne by adding a sweeping oscillator as frequency converter at the input. The output is taken from a suitable point in the receiver (usually after the output from the i.f. amplifier) and is made to deflect the trace of a cathode-ray tube.

Such instruments often suffer serious disadvantages; there is a limitation of the bandwidth that can be scanned, and a wide variation in sensitivity over the band under examination. In addition, the application of the double superheterodyne principle for the receiver system has given rise to spurious responses which confuse the displayed picture.

For a panoramic receiver to be of greatest value it must be free from these defects. It should have a high sensitivity and provide the best resolution compatible with the high rate of frequency scanning (in Mc/s/s). For convenience the scanning range should be adjustable without changing the frequency on which the receiver is centred, and the scanning range should be adjustable down to zero with facilities provided for listening to modulated signals. Signals of known frequency should be made available for comparison purposes at intervals throughout the band.

The photograph at the head of this article shows a commercial form of receiver which was designed with these requirements in mind. Here the double superheterodyne principle has been retained, but unlike the system just described the second local oscillator has been made the sweeping oscillator. Spurious responses have been eliminated, except when the receiver is badly overloaded by strong signals. This

*Research Laboratories, The General Electric Company.

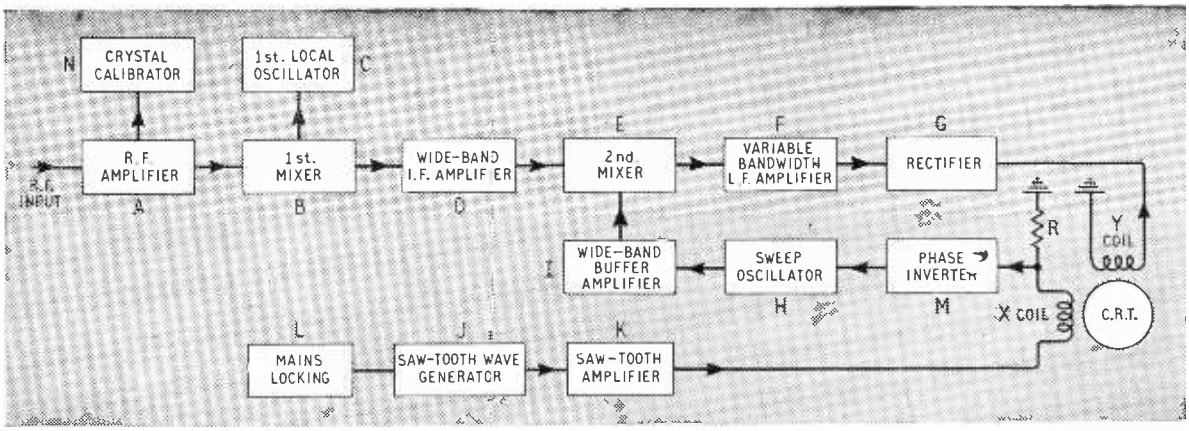


Fig. 1. Block diagram of panoramic receiver.

was done by carefully choosing the frequencies of the various sections to minimize the number and strength of unwanted internally produced signals falling within the r.f. and i.f. bands. Harmonic frequencies of the sweeping oscillator that cannot be entirely avoided are prevented by screening from causing trouble.

Principle of Operation.—Fig. 1 shows a block diagram of the general arrangement. The first local oscillator C determines the mean frequency of operation and the second local oscillator H determines the sweep bandwidth. A received signal in the band under examination is first amplified by a broad-band r.f. amplifier A. This feeds a first mixer B where the signal is converted to an i.f. by mixing with output from C. The signal after amplification in a wide-band i.f. amplifier D is then converted by mixing with the output from the frequency-modulated sweep oscillator H to produce a second i.f. at the second mixer E. This is a swinging frequency from which a narrow band is selected by the amplifier F. The width of the pass band of this amplifier determines the width of the displayed pulse. For obtaining the highest resolution this should be adjustable so that the narrowest width consistent with the rate of frequency scanning can be used.

Turning now to the requirements of the second frequency converter a problem arises in the choice of frequency for the second i.f. amplifier and a sweep oscillator. If the frequency of the second i.f. is high we shall have difficulty in making filters of a sufficiently narrow bandwidth for shaping the pulse. On the other hand, if the frequency is not considerably higher than the maximum bandwidth to be scanned there will be insufficient attenuation outside the pass band of the first i.f. amplifier to prevent second-channel break-through.

This difficulty was avoided by sweeping the second local oscillator frequency through the same band as that covered by the first i.f. amplifier, so that beats of low frequency are provided as the oscillator sweeps across the converted signal frequencies. This produces a zero beat condition for each signal, rising in frequency on both sides. If we now limit the upper and lower beat frequency range by a selection of simple filters included in the i.f. amplifier F we can easily produce a controllable pulse width. The precise shape of this pulse, after rectification at G, will depend on the frequency response of the amplifier as a whole, but will be of the double form shown expanded in Fig. 2(a). A smoothing capacitor after the rectifier combines the double pulse shape to form a single pulse. It is desirable to limit the beats of very low frequency since they give rise to variation of pulse amplitude in successive displays.

The second mixer must not produce a low-frequency output from a signal except when mixing takes place with the sweep oscillator, otherwise any modulated signal within the band under examination would produce a deflection of the cathode-ray tube trace over the whole band. To prevent such an effect a balanced mixer is used. The circuit employed is shown in Fig. 3, and consists of four germanium crystals forming a ring. The signals are applied from the i.f. amplifier to a bandpass circuit which is coupled to the diode ring and no output is produced across the l.f. output terminals in the absence of signal from the sweep oscillator. The sweep oscillator produces a voltage across the diodes which is large compared with any of the signal voltages.

R.F. Amplifier and First Local Oscillator.—A type EF95 valve is employed as an r.f. amplifier; this operates over a frequency band of 80-220 Mc/s.

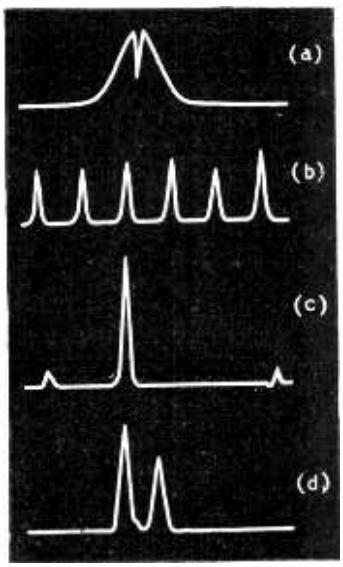


Fig. 2. (a) Expanded pulse, showing dip at zero beat, (b) 10-Mc/s sweep, crystal calibrator markers spaced by 2 Mc/s. (c) 2-Mc/s sweep showing 100μV signal between two marker signals spaced by 2 Mc/s. (d) 400 kc/s sweep, crystal calibrator marker and signal spaced by 50 kc/s.

Tuning is carried out by a ganged variable inductor, which has a spiral scale of about 5ft in length and is calibrated directly in frequency. Three sections of the tuner are associated with the r.f. amplifier and a fourth provides the control for the first local oscillator. The oscillator valve is a type A1714 and operates at a frequency 60 Mc/s higher than the signal-frequency circuits.

The signal and oscillator frequencies are both applied to the grid of an EF95 valve where mixing takes place, and an i.f. in the band 55-65 Mc/s is produced.

Wide-band I.F. Amplifier.—This consists of five stages using type Z77 valves. Tuning is carried out in the valve anode circuits by coils fitted with adjustable brass cores. The amplifier is stagger-tuned to produce a bandwidth of about ± 6 Mc/s. The bandwidth is obtained by tuning alternate coils to the high- and low-frequency ends respectively. The fifth circuit is tuned near the middle of the band.

The Sweep Oscillator.—Scanning could be carried out either mechanically or electrically. A small motor has often been used to vary either L or C of the frequency-determining circuit of the oscillator. This is a particularly useful method when a very high ratio of frequency change to mean frequency is required. In the present case the ability to change the scanning range without appreciable change of centre frequency is important. As the centre frequency is 60 Mc/s, the percentage change of frequency is not very great, and the required range of ± 5 Mc/s can be obtained electrically without great difficulty. The circuit employed is the phase-shift oscillator shown in Fig. 4. This consists of an amplifier and three cathode followers arranged in a closed ring. The cathode followers feed into capacitive loads, formed mainly by the valve interelectrode capacities shown dotted in the diagram. Oscillation occurs at the frequency at which there is a total phase shift around the ring of 360 degrees, provided that the gain is greater than unity. Variation of the voltage applied to the grids of the cathode followers changes the g_m of the valves, and a phase shift occurs. Since the total phase change must equal 360 deg, a change of frequency takes place to restore the required condition.

Output is taken from the first cathode follower in the ring sequence at a very low level, and drives a wide-band "buffer" amplifier (I in Fig. 1) for feeding to the mixer. This amplifies the signal to the required level and prevents frequency-pulling by strong signals near the zero beat condition. The relationship between oscillator frequency and voltage applied to the grids of the cathode followers in the oscillator is not quite linear, but this is corrected as described later.

Low-frequency Amplifier and Rectifier.—This amplifier is fed from the second mixer and consists of three stages employing type Z77 valves. A gain control is provided between the first and second stages. The bandwidth is controlled in three steps by a switch mechanically coupled to the sweep range switch, so that the narrowest band is selected for the narrowest sweep. Three widths are provided, the widest being the normal amplifier bandwidth and the other two are produced by the inclusion of RC filters between the second and third valves.

A transformer with a push-pull output couples the amplifier to a pair of diodes where the output is formed into a pulse for deflecting the cathode-ray tube. A capacitor is introduced across the output of the diodes for removing higher frequency components and the dip at zero beat, thus providing a pulse of smoother appearance on the display.

C.R.T. and "X" Deflection Circuits.—It was decided, for reasons of circuit simplicity, to employ a magnetically deflected c.r.t. This also has other minor advantages compared with the corresponding electrostatic tube. A 6in screen was considered to be the most suitable size, as this leads to a portable instrument

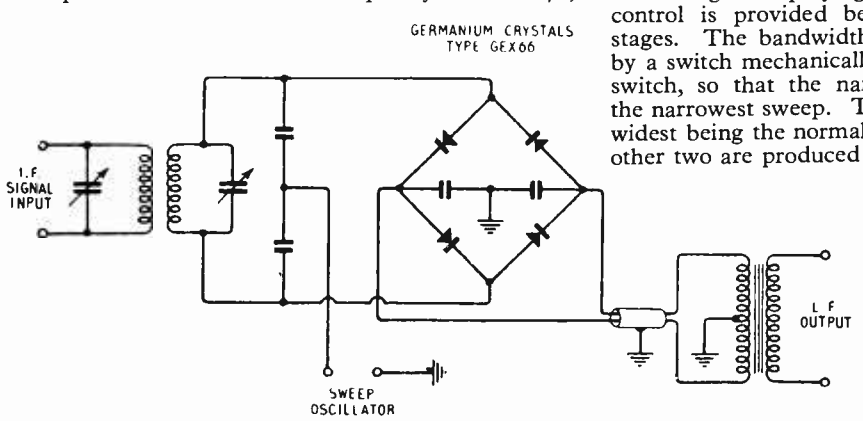
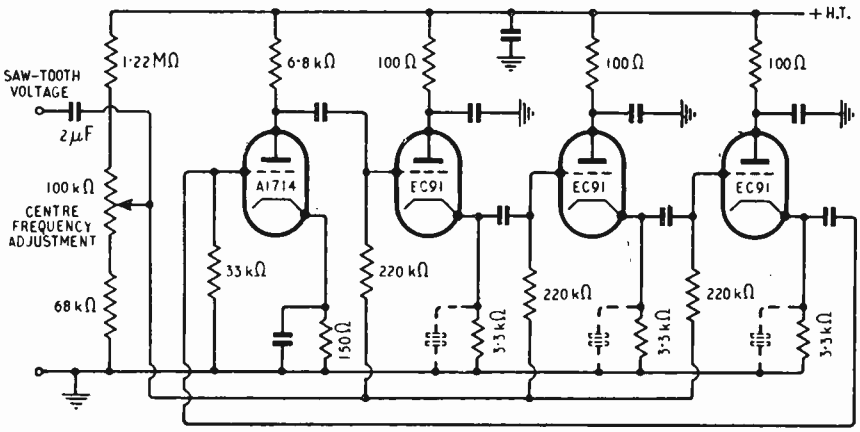


Fig. 3. Circuit diagram of balanced second mixer circuit.

Fig. 4. Circuit diagram of frequency-modulated oscillator.



and still provides a trace that can be viewed by the operator at a convenient distance. A saw-toothed waveform generator, J in Fig. 1, driving an amplifier K, produces the current for deflecting the base line of the c.r.t. and for controlling the frequency of the sweep oscillator. This operates at a repetition rate of 25 per sec., which is the lowest frequency that can be used without introducing appreciable flicker, and is locked by a circuit L to alternate cycles of the a.c. mains. Locking prevents instability of the viewed pulse due to beats between the saw-tooth generator and any stray magnetic field from mains transformers.

The c.r.t. trace is blacked out during the flyback period by a pulse of voltage produced from the amplifier. The voltage for controlling the sweep oscillator is provided by the p.d. across a resistance R connected in series with the "X" deflection coil. This gives accurate synchronization and makes the linearity of the trace independent of changes in the saw-toothed waveform. The frequency linearity of the trace has been improved as follows: The saw-toothed voltage waveform for the control of the sweep oscillator is changed in phase by 180 deg. by means of a negative-feedback amplifier M. The waveform is then shaped by the coupling circuit which has a suitable time constant, so that a shape roughly compensating for oscillator non-linearity is obtained. This voltage is fed to the sweep oscillator, instead of the original voltage.

Crystal Calibrator.—A crystal calibrator N is built into the equipment. This provides a spectrum of harmonics over the entire signal frequency range. The spacing of the harmonic frequencies is equal to the crystal frequency and is useful when,

(a) setting the mean frequency of the sweep oscillator.
(b) checking the frequency calibrations of the first local oscillator.
(c) marker signals of known frequency are required on the display.
(d) adjusting the receiver to give a "flat" frequency output response over the band under examination.

Normally a 2-Mc/s crystal is used to provide marker signals, but by operation of a push-button switch, markers spaced by 10 Mc/s are provided. This allows the positive identification of the 2-Mc/s spaced signals which are multiples of 10 Mc/s.

Because the crystal harmonics are injected into the first tuned circuit of the receiver, these give an immediate indication of the overall sensitivity of the set and of the uniformity of gain over the band under examination. This latter can be adjusted by an r.f. trimmer controlled from the front panel.

The level of the signals produced by the crystal oscillator is too low to produce appreciable radiation when the receiver is connected to an aerial.

General Construction.—The equipment is constructed in three parts: the receiver, the c.r.t. display unit and the power unit. The power unit is mounted on the baseplate of a carrying case, and the receiver and c.r.t. sections, which slide into the case on guide rails, are secured by screw on the front panels. A detachable cover to protect the controls is fitted over the front of the set. Interconnection between the sections is by plugs and sockets.

The power supply required is a.c., 50-60 c/s, and a series voltage-regulator valve maintains a constant h.t. voltage on the receiver. A small fan ventilates the containing case.

Additional Facilities.—As an alternative to the panoramic display, the receiver can be used for listening to modulated signals and a telephone jack provides the connection for this purpose. The changeover is effected by setting the sweep oscillator range to zero on the bandspread control, and switching out the filter in the l.f. amplifier. If the receiver tuning is then set in a slightly "off tune" condition a second i.f. of, say, 30 kc/s will be produced in the l.f. amplifier, and normal detection takes place in the rectifier. For the identification of signals picked up while scanning over a wide band, it is convenient to reduce the scanning range to zero, keeping the signal in the middle of the c.r.t. trace with the tuner, and finally to listen to the modulation. This operation can be carried out in a few seconds without losing the signal.

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Cormack, A., "Wide-range Variable Frequency Oscillator," *Wireless Engineer*, September, 1951.

Crompton, E. W., "A V.H.F. Multi-band Panoramic Receiver," *Electronic Engineering*, November, 1952.

British Patent Application No. 19487/51.

ELECTRICAL CONTACT PROBLEMS

THE making, maintenance and breaking of circuits carrying current is of such fundamental importance that people concerned with electricity must early acquire a rule-of-thumb working knowledge of materials suitable for switch contacts, and the conditions which influence arcing and cause deterioration of the contact surfaces. An extensive literature has accumulated on the subject, mostly dealing with specialized applications, which makes it difficult for the designer to find reliable basic principles.

To remedy this state of affairs, Prof. F. Llewellyn Jones has prepared a report* which presents a critical review of rival theories, establishes a coherent picture of basic principles, and suggests directions in which research might most profitably be extended.

The pamphlet, which will be invaluable to the specialist, contains much of interest for a general reader. For instance, it is surprising to learn that in the microscopic bridges conducting current between the salient irregularities of the contact surface, temperatures are so high that it is the *boiling* point which determines the suitability of a contact metal. They all melt locally, and, due to the Thomson† effect and the reversal of temperature gradient across the bridge, the highest temperature is biased away from the centre. When the bridge is ruptured more material usually adheres to the cathode contact, and photographs of this typical "pip and crater" wear, as well as photomicrographs of actual molten bridges are included.

Not all damage results during the "break" and at the instant before "make," when the contacts are about 2×10^{-8}cm apart, the electrostatic forces of attraction, when the potential difference is only 1 volt, may exceed the yield stress of the material and pull off particles. There is also an electron discharge before contact, which impinges on the anode contact and can cause pitting as well as a rise in temperature relative to the cathode contact.

Theoretical as well as experimental evidence is produced in support of these and other interesting views of contact phenomena. The report concludes with a 79-item bibliography and a good index.

* Radio Research Special Report No. 24, "Fundamental Processes of Electrical Contact Phenomena," published by Her Majesty's Stationery Office, price 3s.

† E.M.F. due to a temperature gradient in a metal; conversely, heating or cooling, depending on direction of current, relative to temperature gradient.

C.C.I.R. London Meeting

FOR the first time a Plenary Assembly of the C.C.I.R. (Comité Consultatif International des Radiocommunications) will be meeting in London in September. There will be over 300 participants, representing about 50 countries, at this seventh plenary assembly, which will be opened by the Postmaster General at Church House, Westminster, on September 3rd and is scheduled to close on October 7th. The last meeting was in Geneva in 1951. The proceedings of the meetings will be conducted in English and simultaneous translations in French, Spanish and Russian will be available to delegates.

Entrusted with "the study of technical radio questions and operating questions, the solution of which depends principally on considerations of a technical radio character," the C.C.I.R. meets biannually to consider the reports and recommendations presented by the national study groups appointed by each of the member nations.

Before summarizing the matters to be discussed at the assembly we should, perhaps, state the general principles governing membership of the C.C.I.R. which is one of the permanent organizations of the International Telecommunications Union; others being the International Frequency Registration Board, International Telegraph Consultative Committee (C.C.I.T.) and the International Telephone Consultative Committee (C.C.I.F.). Administrations of any of the 80 or so members of the I.T.U. have the right to be members of the International consultative committees, and, upon request, "recognized private operating agencies" which are defined as companies operating a telecommunication installation. Scientific or manufacturing organizations engaged in the study of telecommunications problems or in the design of telecommunications equipment may be admitted to participate in certain meetings. So far as this country is concerned the Post Office is the co-ordinating body for the official delegation which will include representatives of the Services, B.B.C., D.S.I.R., R.I.C. and the British Joint Communications Electronics Board. In addition, however, representatives of Cable and Wireless, International Marine Radio Co., Marconi International, Redifon and Siemens will be participating in their own right. The complete U.K. delegation will total about 50 and will be lead by H. Faulkner, deputy engineer-in-chief at the Post Office. The deputy leader is H. Stanesby (P.O. staff engineer).

The business of the assembly can be epitomized by the phrase "to secure the maximum economy and efficiency in the use of the spectrum." Some idea of the diversity of subjects to be covered will be gained from the following list of fourteen study groups with, in brackets, the names of the chairmen of the U.K. groups:—

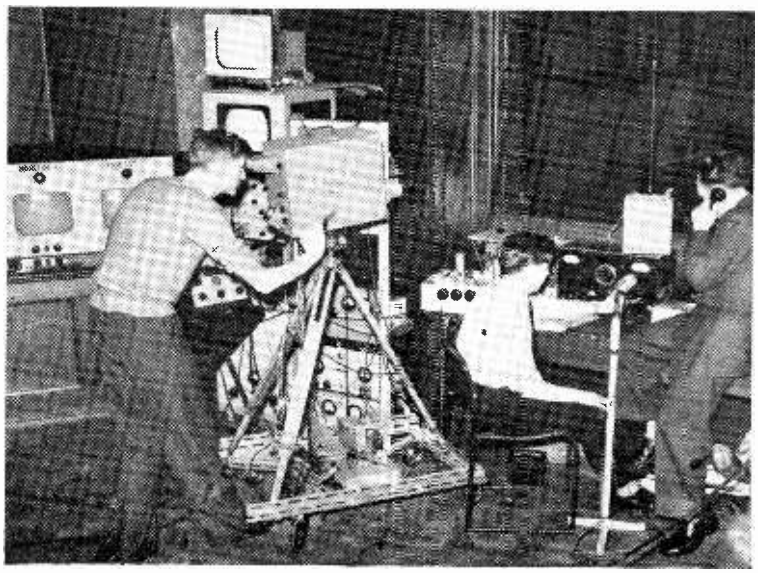
1. Transmitters (A. Cook, P.O.).
2. Receivers (W. J. Bray, P.O.).
3. Complete radio systems (J. A. Smale, C. & W.).
4. Ground-wave propagation.
5. Tropospheric propagation.
6. Ionospheric propagation.

(Dr. R. L. Smith-Rose, D.S.I.R.).

7. Radio time signals and standard frequencies (H. B. Law, P.O.).
8. International monitoring (C. W. Sowton, P.O.).
9. General technical questions (H. Stanesby, P.O.).
10. Broadcasting (E. L. E. Pawley, B.B.C.).
11. Television (H. Faulkner, P.O.).
12. Tropical broadcasting (P. Adorian, Redifon.).
13. Operational questions.
14. Vocabulary (H. T. Mitchell, P.O.).

Groups similar to these in each of the member countries submit their reports to Geneva and a co-ordinated summary of them will be presented at the London meeting by the international chairman of the appropriate group. The text of each of the national reports is available in full and some 300 contributions will have been circulated to delegates before the opening of the assembly.

We hope to be able to deal with the findings and recommendations of the assembly in a future issue.



AMATEUR TELEVISION

HOME constructed equipment provided the pictures which were "piped" to various receivers around the Institution of Electronics exhibition at Manchester. The temporary studio contained a 405-line camera, a flying-spot scanner, two monitor screens, a vision transmitter and a large-screen front projection receiver. A signal generator acted as the sound transmitter and its output was combined with the vision signal in a bridge network. Here the camera is shown televising through an open window interviews with men working on a new extension to the College of Technology, with the sound coming by way of a Marconi walkie-talkie. The demonstration was organized by the local branch of the Television Society, and the equipment was provided by Ian McWhirter, who is also a well-known member of the British Amateur Television Club. The call sign of his amateur station is G3ETI.

20th National

Radio Exhibition

Introduction to the Show : Classified Guide to the Principal Exhibits

ON September 2nd at 11 o'clock the 20th British National Radio Exhibition (Earls Court, London), organized by the Radio Industry Council, will be opened to the public. The previous day will be a pre-view for specially invited guests. Admission to the Show, which will be open daily (except Sunday) from 11 a.m. to 10 p.m. until September 12th, is 2s 6d (children under 16, 1s).

The available floor space appears from the plan given on another page to be more fully occupied than in previous years, all the space not allocated to stand-holders having been utilized by the R.I.C. for the staging of displays and demonstrations of electronic gear. Of the 112 exhibitors (four more than last year), 40 are manufacturers of broadcast and television receivers. There are, in fact, two more exhibitors of television than sound sets.

PLACE : Earls Court, London, S.W.5

DATE : September 2nd to 12th

TIME : 11 a.m. to 10 p.m.

ADMISSION : 2s 6d (Children 1s)

Once again we have prepared our pre-view of the Show in the form of classified lists in graphical form, but with one important difference. Hitherto, there were several separate tables each embracing an associated group of items, and while they certainly enabled all the makers of any particular product to be found quite readily, it was not so easy to extract from these tables everything that each exhibitor manufactured.

We think this small defect has been overcome by the use of the single tabulated list which has been compiled for this year's pre-view. It enables the majority of the products shown by any one firm, or the names of all the firms making any particular product, to be extracted from the table merely by running a finger along or down the appropriate column.

Exhibitors are listed in alphabetical order under their trade names or the abbreviated names of the firm, as appropriate, and also numerically by stand numbers. These lists together with the plan will enable any exhibitor to be quickly located in the exhibition.

While we would like to have included every item shown in the exhibition limitation of space necessitated the omission of a few items, of which only one or two examples are shown. A case in point is the very specialized air-sea rescue beacons shown by Vidor-Burndept and by Ultra. Both are miniature lightweight radio beacons for attachment to an airman's life-saving jacket and both provide also for radio-telephone communication. In this section also would have been included radar air-field approach equipment made by Ekco.

Coil winders find no place in our table, as again one firm only shows them (Avo), and they are also specialists in testing equipment which is included.

Scientific, industrial and medical equipment is another omission, but it would have had three entries only, Dynatron for counters, Ediswan for electro-medical apparatus and K.B. for a hearing aid.

In addition to the commercial exhibits listed in the tables and those already referred to, there are a number of radio *users* who have taken stands. Two of the largest displays will be staged by the Army and the R.A.F., and will together show the operation and maintenance of radio equipment in the Services and the training of radio personnel. One of the main objectives of the Army display is the recruitment of radio specialists into the Army Emergency Reserves of the Royal Corps of Signals and the Royal Electrical and Mechanical Engineers. The B.B.C. has a stand and is again co-operating with the R.I.C. in the provision of a television studio.

Some stands will be devoted by the holders exclusively to information centres, among them the Association of Radio Battery Manufacturers, British Iron and Steel Federation, British Railways, Bowmakers (industrial bankers) and the Electrical Trades Union. Others, like the four banks, are providing services for exhibitors and visitors.

In collaboration with Philips Electrical, Ltd., who employ several blind workers, the United Appeal for the Blind is providing a demonstration of blind workers assembling radio components.

As far as is practicable each of the ten displays of electronic equipment staged by the Radio Industry Council will be devoted to a specific application of electronics.

On the stand devoted to electronics in the air, E. K. Cole will be displaying airfield radar approach equipment, and Ultra Electric the air-sea rescue radio beacon "Sarah," which was described in our August issue. Electronics at sea is represented by a display of Cossor and Kelvin-Hughes marine and harbour radar gear, Kelvin-Hughes echo-sounder and a crystal-controlled clock coder for m.f. marine radio beacons provided by Trinity House.

Industrial applications of electronics as diverse as watch-timing and seed-sorting are provided in another display.

Electronic business equipment, including a card sorter handling 650 cards a minute provided by International Business Machines, Ltd., and desk facsimile equipment by Creed, are grouped on another stand. Examples of the application of electronics in medicine include Leland Instruments auscultoscope for the observation of the functioning of the heart and lungs.

An analogue computor by E.M.I. Engineering

Development, a model of the radio telescope being constructed for installation at the Jodrell Bank Research Station, radio-controlled models operating on 465 Mc/s provided by the International Radio-Controlled Models Society, a large scale model of a guided missile and examples of sub-miniature component assemblies (Ministry of Supply) are among other electronic exhibits.

The central feature of the Hall will be a radio-controlled clock which will be governed by pulses received by radio from the Post Office station at Rugby. This is being installed by the Telephone Manufacturing Company.

The Television Avenue, giving visitors an opportunity of comparing side-by-side forty sets in operation, will again be a feature of the Show.

In view of the controversy on adaptors for standard television receivers, the display of a 400-Mc/s adaptor on the Television Society's stand is of considerable interest. The Society will also be exhibiting its 405-line transmitter which, when installed at the Norwood Technical College, will operate on 427 Mc/s vision and 423.5 Mc/s sound.

It will be recollected that for the first time last year projection receivers were installed at each side of the stage in the B.B.C. television studio to enable the audience to see the picture being transmitted as well as the whole action on the stage. This year a cinema-size screen measuring 21ft × 16ft will be mounted over the proscenium in the studio so that every member of the audience of nearly 1,000 may see clearly the transmitted picture. The equipment will be installed by Cinema-Television. For the benefit of front-row occupants, smaller screens will be installed in the wings as last year.

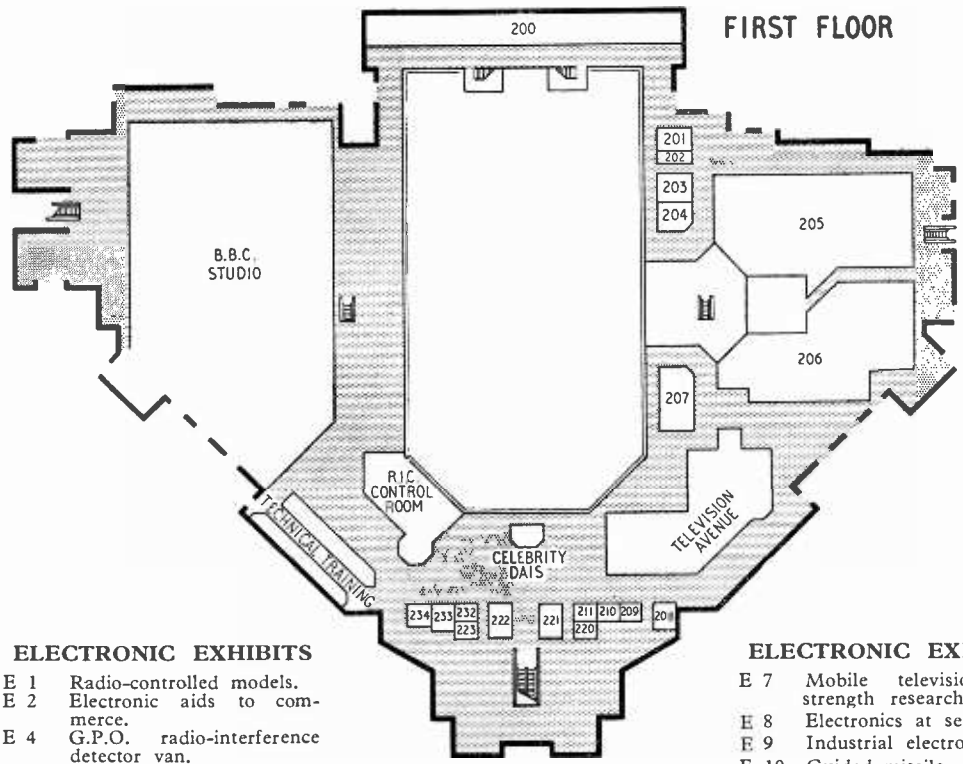
The Technical Training display, which was an innovation last year, is being enlarged. Five colleges and the B.B.C. Engineering Training Establishment are participating in the provision of the "how it works" models and displays. An information section is being included and a leaflet will be available outlining the opportunities and type of work offered by the various sections of the radio industry.

As in previous years the television programme feeding the receivers on the stands and those in the television avenue will be distributed at r.f. on Channel 4 to avoid the possibility of interference caused by the direct pick-up of the Alexandra Palace transmission. Each outlet will feed only one receiver at a signal level of 1 mV ± 3 db into 70 ohms unbalanced. Programmes for distribution throughout the exhibition via the R.I.C. control room on the first floor may be obtained by direct pick-up of the Alexandra Palace transmission, from the film scanner in the control room, from the small studio which forms part of the control room, from a camera covering the celebrity dais, and, of course, from the B.B.C. studio on the first floor of the exhibition.

ALPHABETICAL LIST OF EXHIBITORS AND GUIDE TO THE STANDS

Name	Stand
A.R.B.M.	99
Acos (Cosmocord)	234
Aerialite	79
Air Ministry	205
Alba (Balcombe)	101
Allan Radio	85
Ambassador	5
Antiference	53
Argosy Radiovision	3
Avo (Automatic Coil Winder)	15
B.B.C.	200
Baird	59
Bakers "Selhurst"	14 (D2*)
Belling-Lee	102
Bernards (Publishers)	232
Boosey & Hawkes	209
Bowmaker	210
Brimar (S.T.C.)	9
British Iron and Steel Federation	12
British Radio and Television	25
British Railways	2
Brown Brothers	70
Bulgin	1
Bush	74 and 97
Champion	71
Collaro	35 (D6)
Cossor	90 (D13)
Decca	48 (D26 and 27)
Defiant (Co-op Wholesale Soc.)	6 (D28)
Domain	13
Dubilier	98
Dynatron	112
E.M.I.	93 and 104 (D24)
E.T.U.	202
Econasign	20
Ediswan	51 (D8)
Ekco (E. K. Cole)	100 (D14)
Electrical and Radio Trading	86
Electric Audio Reproducers	22
Elpreq (Electronic Precision Equipment)	222
English Electric	52
Ever Ready	30
Ferguson	57 (D3 and 4)
Ferranti	49 (D25)
G.E.C.	89 (D9)
Garrard	103
Goodmans	37
H.M.V. (Gramophone Co.)	92 (D10)
Hobday Brothers	96
Hunt	88
Imhof	211
Invicta	47
J. B. Cabinets	27
J. G. Publications	24
K.B.	32
Kerry's	38
Linguaphone	19
Lloyds Bank	84
Lugton	204
McMichael	34
Marconiphone	58 (D23)
Masteradio	46
Midland Bank	39
Mullard	91 (D7 and 11)
Multicore	111 (D16)
Murphy	31 (D1)
National Provincial Bank	23
Pamphonic	108
Peto Scott	77 (D5)
Petter	223
Philco	50
Philips	33 (D21)
Pilot	56
Plessey	113 (D19)
Portogram	36
Practical Wireless and *Practical Television*	87
Prowse, Keith	114
Pye	76 (D29)
R.G.D.	94
Reflectograph	208
Regentone	60
Roberts	11
Rola-Celestion	8
S.T.C.	81
Simon	95
Slingsby	62
Sobell	55
The Star	221
Stella	72
T.C.C.	107 (D12)
Taylor	105
Telequipment	28
Telerection	7
Television Society	220
Thompson, Diamond and Butcher	78
Trix	16
Truchord (Reproducers Electronic)	233
Truvox	106 (D17)
Ultra	73
United Appeal for the Blind	201
Valradio	207
Vidor-Burndept	75 (D18)
War Office	206
Waveforms	26
Westinghouse	54
Westminster Bank	10
White-Ibbotson	4
Whiteley	109 (D15)
Wireless and Electrical Trader	63
Wireless World and *Wireless Engineer*	45
Wolsey	61
Wright & Weaire	110

* Demonstration rooms and offices are prefixed with "D". A number of manufacturers have demonstration rooms on their main stands.

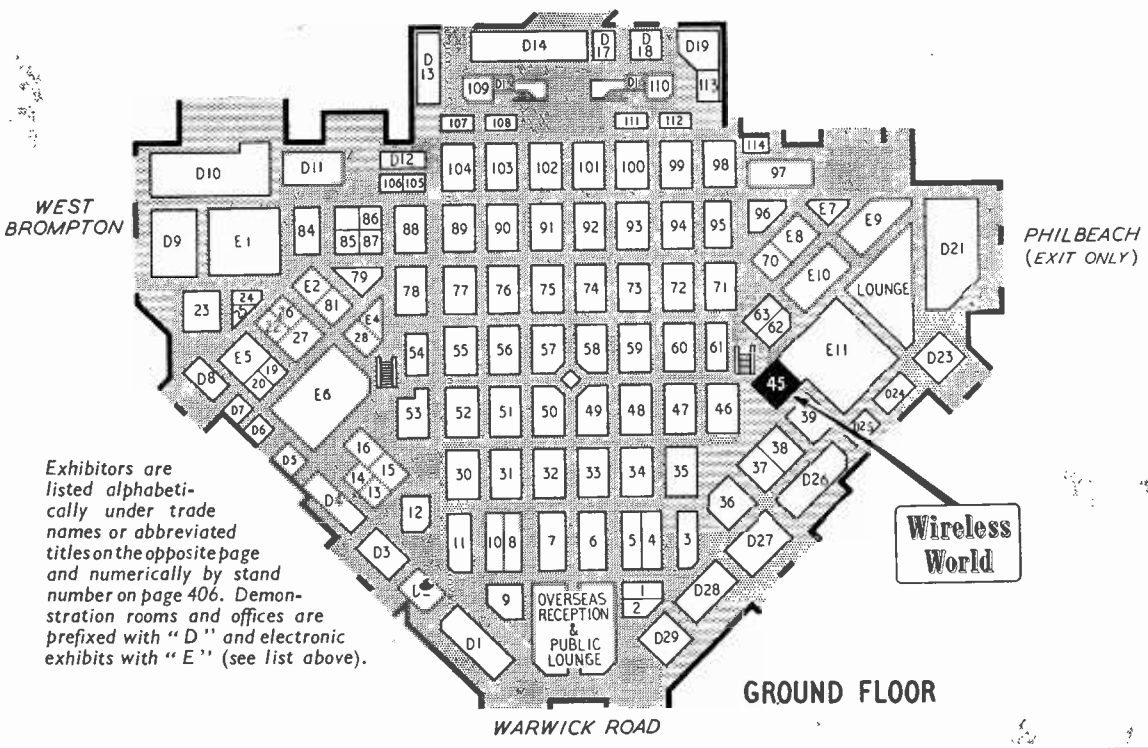


ELECTRONIC EXHIBITS

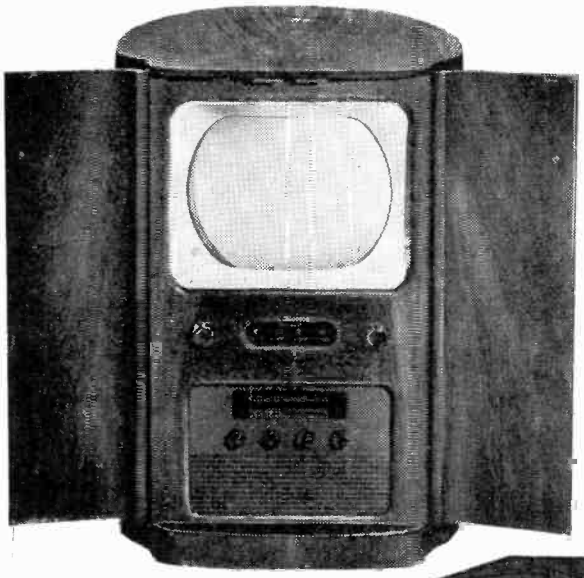
E 1 Radio-controlled models.
E 2 Electronic aids to commerce.
E 4 G.P.O. radio-interference detector van.
E 5 Electronics in medicine.
E 6 Aeronautical electronics.

ELECTRONIC EXHIBITS

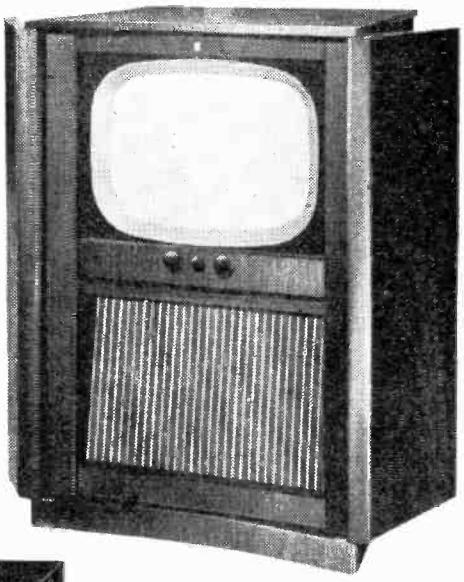
E 7 Mobile television field-strength research unit.
E 8 Electronics at sea.
E 9 Industrial electronics
E 10 Guided missile.
E 11 Electronics "in control."



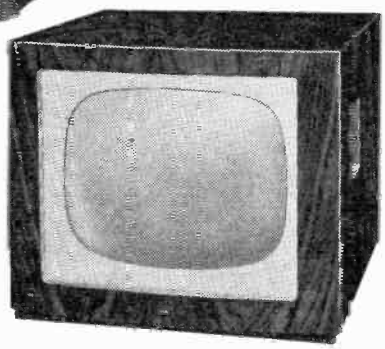
Exhibitors are listed alphabetically under trade names or abbreviated titles on the opposite page and numerically by stand number on page 406. Demonstration rooms and offices are prefixed with "D" and electronic exhibits with "E" (see list above).



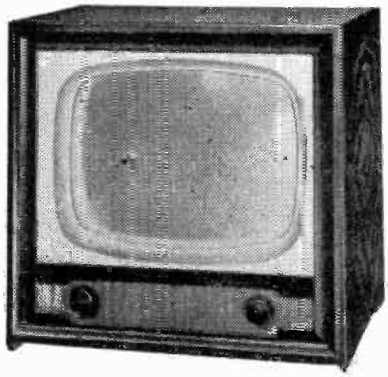
Ambassador TV10CR radio/television receiver.



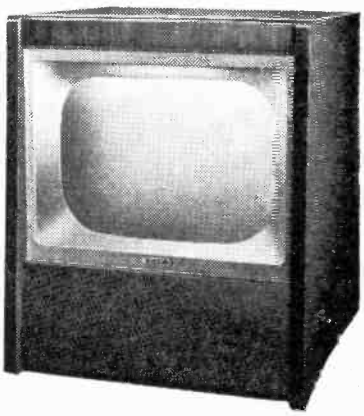
Ferranti Model 17K3 receiver.



A 17-in rectangular tube is used in the Stella ST8,317U receiver.



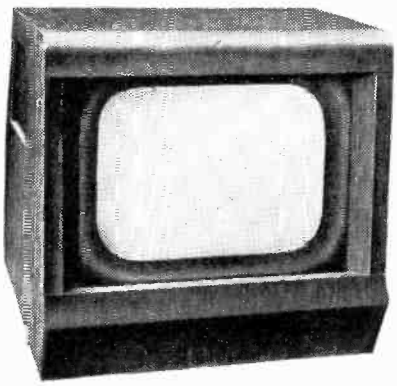
Argosy Model T2 television set with 17-in tube.

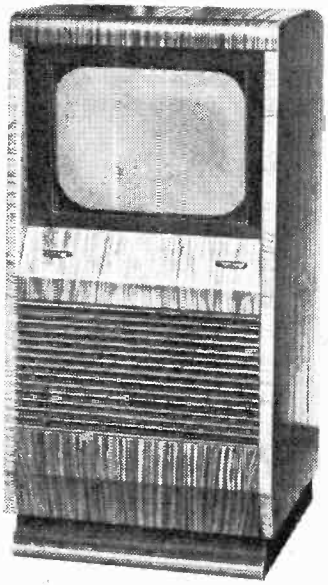


Ekco Model T207 table television set.

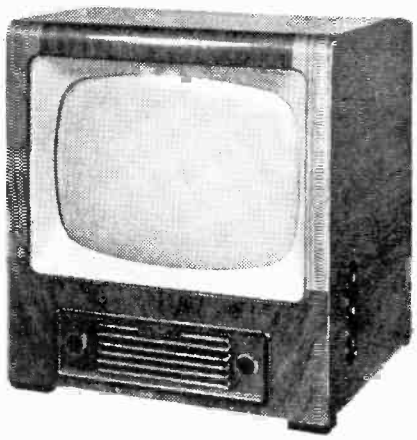
Below : Bush 17-in television receiver Model TV36.

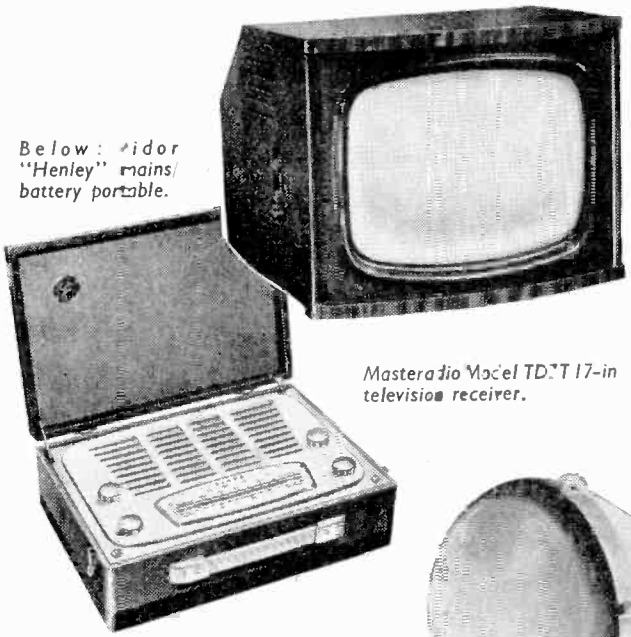
Below : Invicta Model 120 receiver.





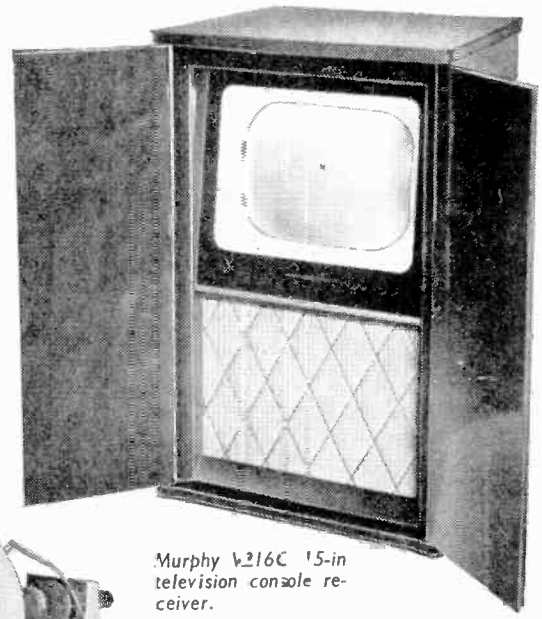
Pye television console receiver (V4C) with 14-in tube.



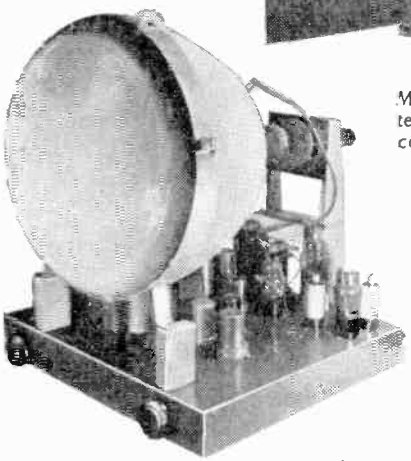


Below: Vidor "Henley" mains/battery portable.

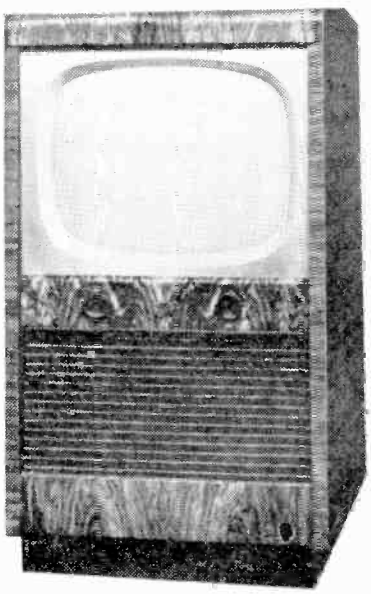
Masteradio Model TD.T 17-in television receiver.



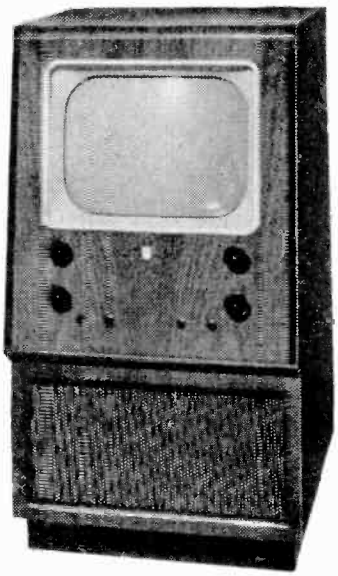
Murphy V.216C 15-in television console receiver.



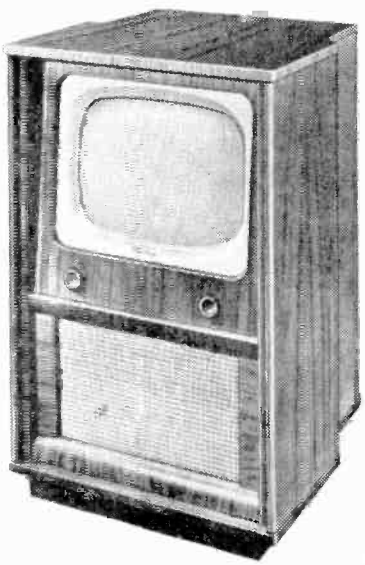
Constructors television set with 15-in tube (Elpreq).



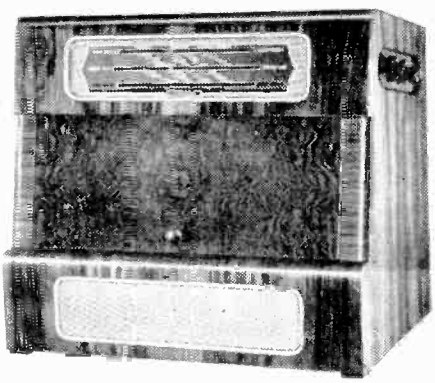
Model CV87 17-in television console (Pilot).



Philips Model 1,437U console receiver.

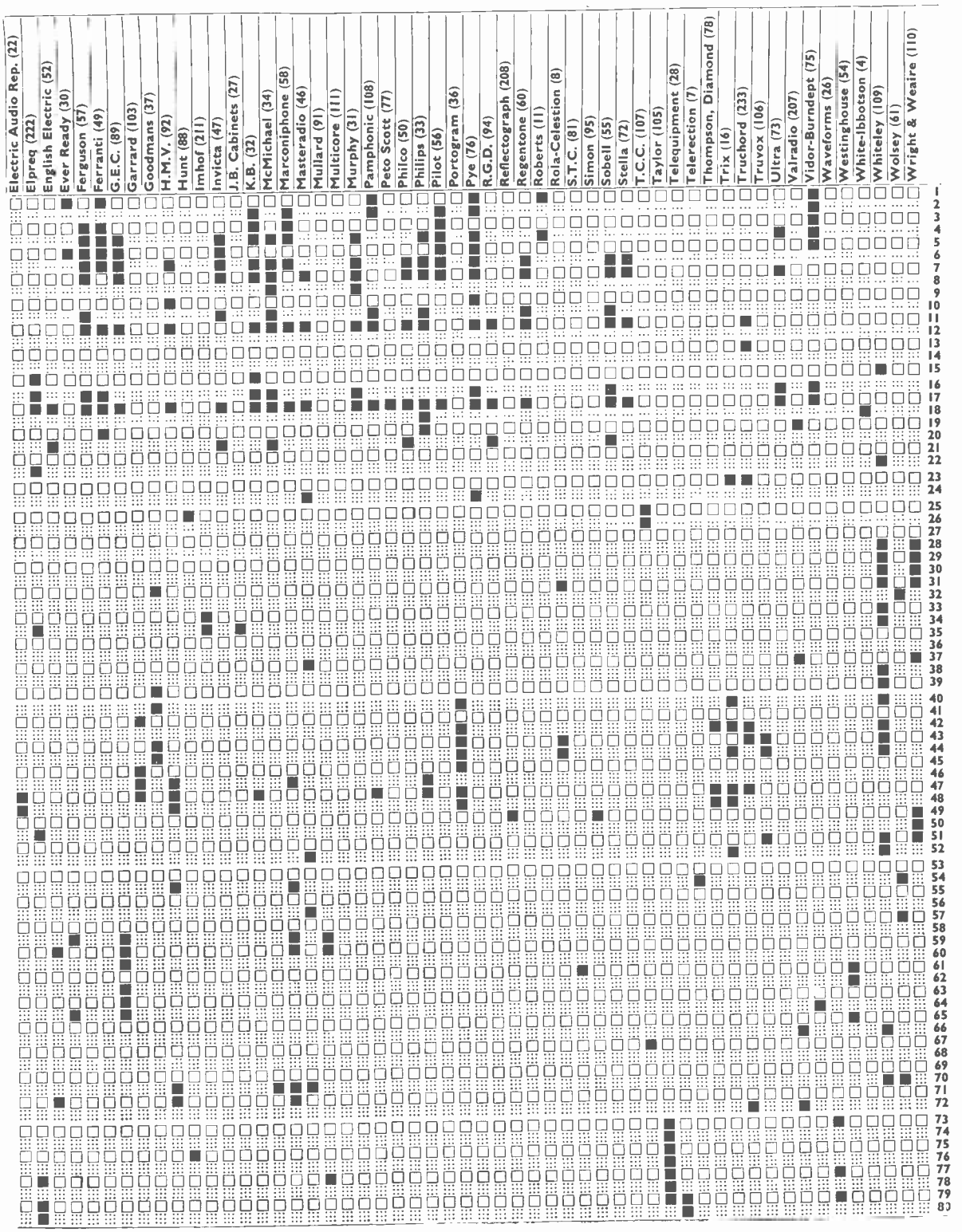


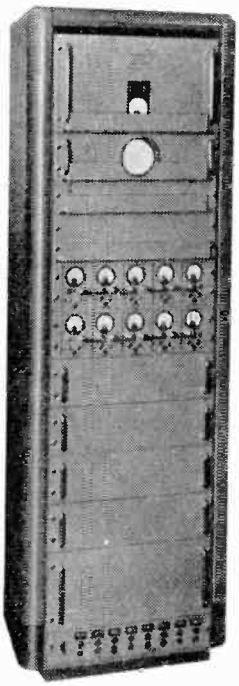
Above: Model 1,712C 17-in television console (Peto Scott). Left: "Sky Queen" portable made by Ever-Ready. Right: Cossor Model 508 receiver.



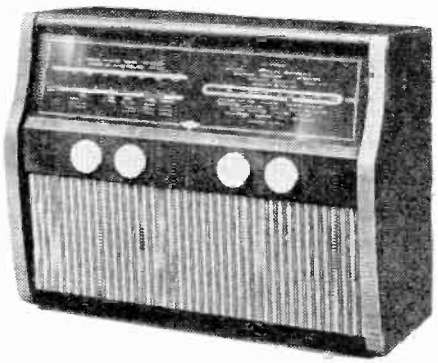
	PRODUCT		FIRM	Acos (234)	Aerialite (79)	Alba (101)	Allan Radio (85)	Ambassador (5)	Antiference (53)	Argosy (3)	Avo (15)	Baird (59)	Bakers "Selhurst" (14)	Belling-Lee (102)	Boosey & Hawkes (209)	Brimar (9)	Bulgin (1)	Bush (74)	Champion (71)	Collaro (35)	Cossor (90)	Decca (48)	Defiant (6)	Domain (13)	Dubilier (98)	Dynatron (112)	E.M.I. (104)	Ediswan (51)	Ekco (100)
SOUND RECEIVERS	Portable, battery		1																									
	Portable, A.C.		2																									
	Portable, A.C./D.C.		3																									
	Portable, mains/battery		4																									
	Table, battery		5																									
	Table, A.C.		6																									
	Table, A.C./D.C.		7																									
	Console		8																									
	Radiogram, portable		9																									
	Radiogram, table		10																									
	Radiogram, console		11																									
	F.M. receivers		12																									
	Radio feeder units		13																									
	Chassis		14																									
	Kits		15																									
TELEVISION RECEIVERS	Direct-viewing 12in and under		16																									
	Direct-viewing over 12in		17																									
	Projection, back		18																									
	Projection, forward		19																									
	Television-broadcast		20																									
	Chassis		21																									
	Kits		22																									
SPECIAL-PURPOSE SETS	Schools		23																									
	Car		24																									
COMPONENTS	Capacitors, fixed		25																									
	Trimmers		26																									
	Reistors, fixed and variable		27																									
	Switches		28																									
	Coils, R.F.		29																									
	Transformers, mains		30																									
	Transformers, audio		31																									
	Plugs, sockets, connectors		32																									
	Chassis fittings, valveholders		33																									
	Cabinets, chassis and stands		34																									
	Dials, drives, knobs		35																									
	Thermal cut-outs and fuses		36																									
	Vibrators		37																									
	Television scanning components		38																									
	TV focus and ion-trap magnets		39																									
SOUND REPRODUCING EQUIPMENT	Microphones		40																									
	Pickups		41																									
	Amplifiers		42																									
	Loudspeakers, Domestic		43																									
	Loudspeakers, P.A.		44																									
	Gramophone motors		45																									
	Record changers		46																									
	Record players		47																									
	Electric gramophones		48																									
	Magnetic recorders		49																									
	Magnetic tape and wire		50																									
	Magnetic recording components		51																									
	Intercom. sets		52																									
ACCESSORIES	Aerials, Broadcast		53																									
	Aerials, Television		54																									
	Aerials, Anti-interference		55																									
	Aerials, Car		56																									
	Aerial accessories		57																									
	Valves		58																									
	C.R. tubes		59																									
	Photocells		60																									
	Metal rectifiers		61																									
	Crystal diodes		62																									
	Transistors		63																									
	Batteries		64																									
	Battery chargers		65																									
	Power units and eliminators		66																									
	Interference suppressors		67																									
	Wire and cable		68																									
	R.F. cable		69																									
	Television pre-amplifiers		70																									
	Television optical accessories		71																									
	Television tuners		72																									
TEST AND MEASURING GEAR	Single-range pointer meters		73																									
	Multi-range meters		74																									
	Bridges and accessories		75																									
	Valve voltmeters		76																									
	Test sets		77																									
	Signal sources		78																									
	Television signal sources		79																									
	Oscilloscopes		80																									

CLASSIFIED GUIDE TO THE PRINCIPAL EXHIBITS



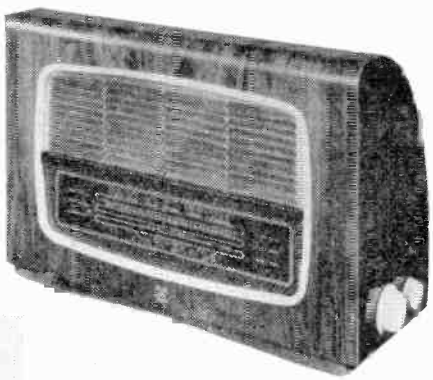


Telequipment "Monoscope" signal generator.

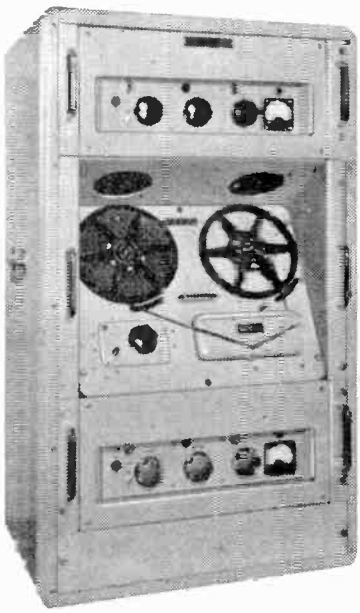


Kolster-Brandes 10-waveband receiver, Model KR40T.

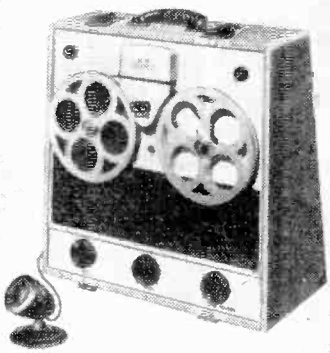
Sobell table receiver, Model 513.



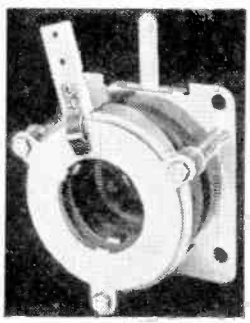
Regentone Model A133 table receiver.



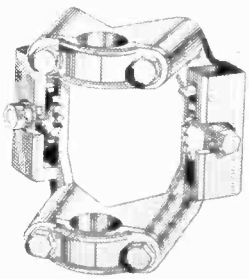
Wright & Weaire tape recorder



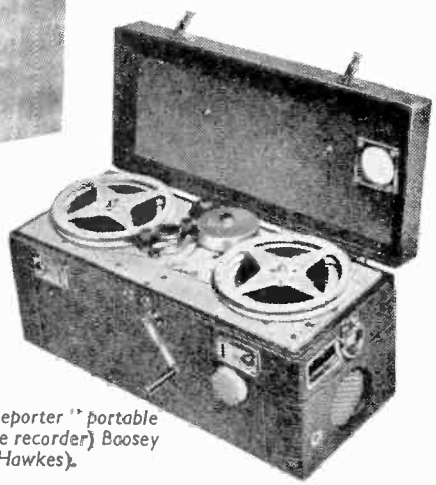
New "Soundmaster" tape recorder (Baird), and (right) Reflectograph transportable tape recorder.



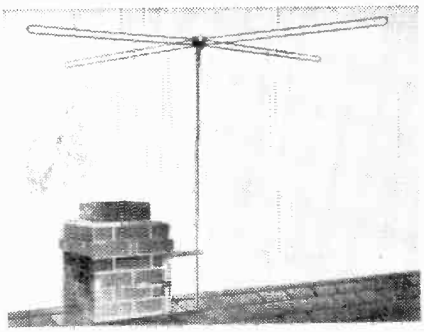
Left: Permanent-magnet focusing unit (Goodmans).



Right: Ratchet bracket for fixing television aerials. (Belling-Lee).

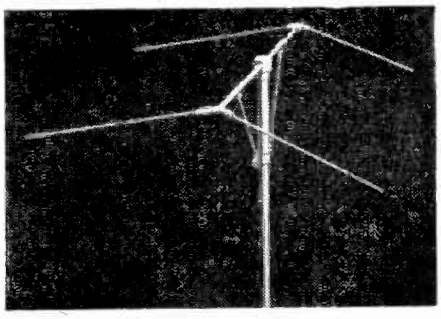


"Reporter" portable tape recorder) Boosey & Hawkes).

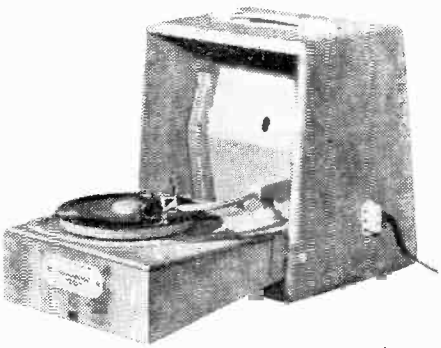


Left : New "Dublex" horizontal television aerial (Aerialite).

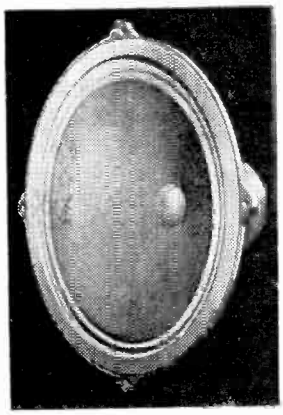
Right : Horizontal "Paravex" television aerial, made by Telerection.



Champion "Rev-ler" a.c. transportable record player.

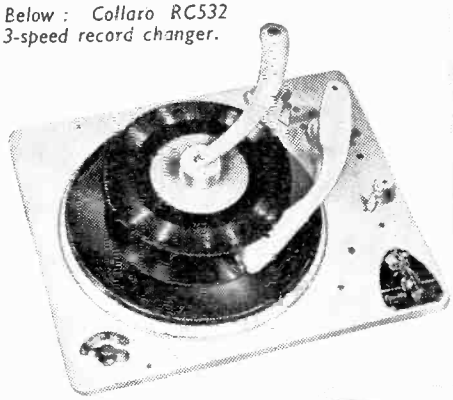


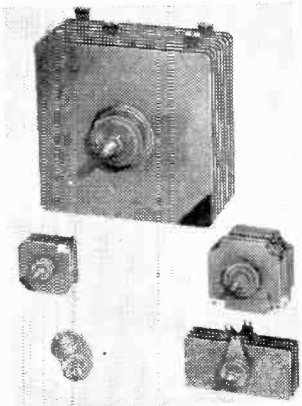
H.M.V. Portable radio gramophone, Model 1,507.



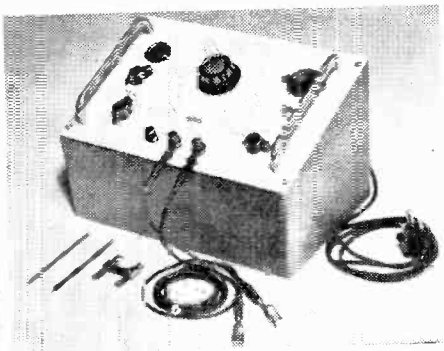
Whiteley Electrical cambric-cone loudspeaker.

Below : Collaro RC532 3-speed record changer.



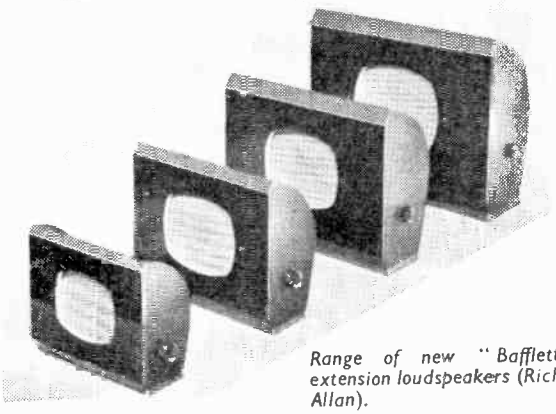


Selection of Westinghouse rectifiers.

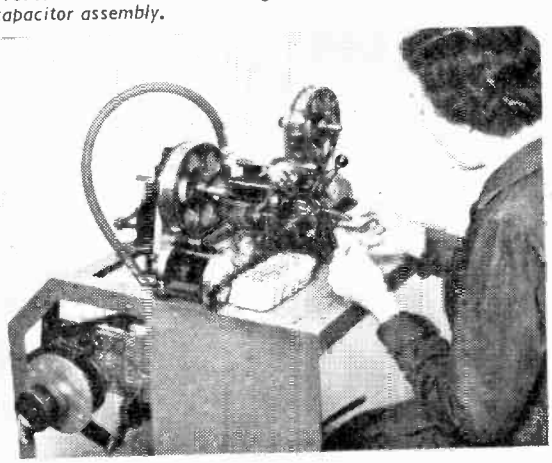


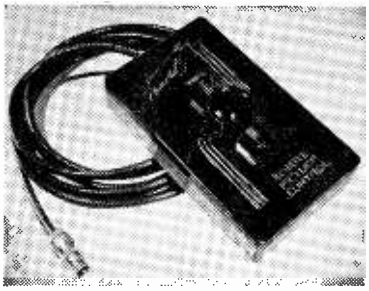
Capacitance analyser and resistance bridge (Hunt).

T.C.C. automatic mica-stacking machine used in transmitter capacitor assembly.



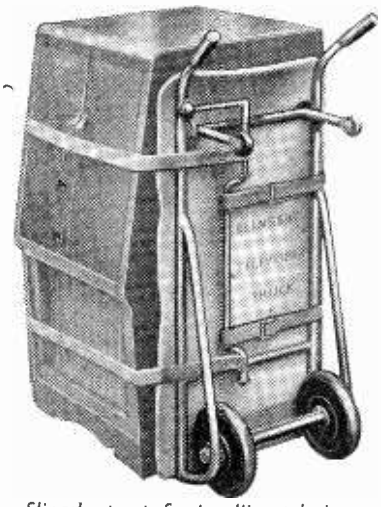
Range of new "Bafflettes" extension loudspeakers (Richard-Allan).





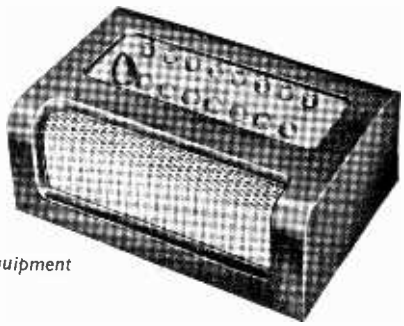
Remote picture control unit (Truchord).

Metal-case capacitors for tropical conditions (Dubilier Type 5,200).



Slingsby truck for handling television receivers.

Garrard Model RC90 automatic record changer with extra spindles.



Right : Six-way inter-communication equipment (Trix Intervox).

NUMERICAL LIST OF STANDHOLDERS

1 **A. F. Bulgin & Co. Ltd.**, Bye-Pass Road, Barking, Essex.
2 **British Railways**, Railway Executive, 222, Marylebone Road, London, N.W.1.
3 **Argosy Radiovision Ltd.**, Argosy Works, Hertford Road, Barking, Essex.
4 **White-Ibbotson Ltd.**, 205, Station Road, Harrow, Middlesex.
5 **Ambassador Radio**, Princess Works, Brighouse, Yorks.
6 **Co-operative Wholesale Society Ltd.** [Defiant], 99, Leman Street, London, E.1.
7 **Telerection Ltd.**, Antenna Works, St. Pauls, Cheltenham, Glos.
8 **Rola Celestion Ltd.**, Ferry Works, Summer Road, Thames Ditton, Surrey.
9 **Standard Telephones & Cables Ltd.** [Brimar], Footscray, Sidcup, Kent.
10 **Westminster Bank Ltd.**, 51, Threadneedle Street, London, E.C.2.
11 **Robert's Radio Co., Ltd.**, Creek Road, East Molesey, Surrey.
12 **British Iron and Steel Federation**, Steel House, Tothill Street, London, S.W.1.
13 **Domain Products Ltd.**, Domain Works, Barnaby Street, London, N.W.1.
14 **Bakers "Selhurst" Radio**, 24, Dingwall Road, Croydon, Surrey.
15 **Automatic Coil Winder & Electrical Equipment Co. Ltd.**, [Avo], Winder House, Douglas Street, London, S.W.1.
16 **Trix Electrical Co. Ltd.**, 1/5, Maple Place, Tottenham Court Road, London, W.1.
19 **Linguaphone Institute Ltd.**, 207/209, Regent Street, London, W.1.
20 **Econasign Co. Ltd.**, 92, Victoria Street, London, S.W.1.
22 **Electric Audio Reproducers Ltd.**, 17, Little St. Leonards, Mortlake, London, S.W.14.
23 **National Provincial Bank Ltd.**, 15, Bishopsgate, London, E.C.2.
24 **J. G. Publications Ltd.**, 56A, Rochester Row, London, S.W.1.
25 **"British Radio and Television,"** 92, Fleet Street, London, E.C.4.
26 **Waveforms Ltd.**, Radar Works, Truro Road, London, N.22.
27 **J.B. Manufacturing Co. (Cabinets) Ltd.**, 86, Palmerston Road, Walthamstow, London, E.17.
28 **Telequipment Ltd.**, 1319A, High Road, Whetstone, London, N.20.
30 **Ever Ready Co. (G.B.) Ltd.**, Hercules Place, Holloway, London, N.7.
31 **Murphy Radio Ltd.**, Welwyn Garden City, Herts.
32 **Kolster-Brandes Ltd.**, Footscray, Sidcup, Kent.
33 **Philips Electrical Ltd.**, Century House, Shaftesbury Avenue London, W.C.2.
34 **McMichael Radio Ltd.**, 190, Strand, London, W.C.2.
35 **Collaro Ltd.**, Ripple Works, Bye-Pass Road, Barking, Essex.
36 **Portogram Radio Electrical Industries Ltd.**, Preil Works, St. Rule Street, London, S.W.8.
37 **Goodmans Industries Ltd.**, Axiom Works, Wembley, Middlesex.
38 **Kerry's (Gt. Britain) Ltd.**, Warton Road, Stratford, London, E.15.
39 **Midland Bank Ltd.**, Poultry, London, E.C.2.
45 **Iliffe & Sons Ltd.**, [*Wireless World*], Dorset House, Stamford Street, London, S.E.1.
46 **Masteradio Ltd.**, 10/20, Fitzroy Place, London N.W.1.
47 **Invicta Radio Ltd.**, Parkhurst Road, Holloway, London, N.7.
48 **Decca Record Co. Ltd.**, 1/3, Brixton Road, London, S.W.9.
49 **Ferranti Ltd.**, Hollinwood, Lancs.
50 **Philco (Overseas) Ltd.**, Romford Road, Chigwell, Essex.
51 **Edison Swan Electric Co. Ltd.**, 155, Charing Cross Road, London, W.C.2.
52 **English Electric Co. Ltd.**, Queens House, Kingsway, London, W.C.2.
53 **Antiference Ltd.**, 67, Bryanston Street, London, W.1.
54 **Westinghouse Brake and Signal Co. Ltd.**, 82, York Way, Kings Cross, London, N.1.
55 **Sobell Industries Ltd.**, Langley Park, Slough, Bucks.
56 **Pilot Radio Ltd.**, 31/37, Park Royal Road, London, N.W.10.
57 **Ferguson Radio Corporation Ltd.**, 105, Judd Street, London, W.C.1.
58 **Marconiphone Co. Ltd.**, Hayes, Middlesex.
59 **Baird Television Ltd.**, Lancelot Road, Wembley, Middlesex.
60 **Regentone Radio and Television Ltd.**, Eastern Avenue West, Mawneys, Romford, Essex.
61 **Wolsey Television Ltd.**, 43 45, Knights Hill, West Norwood, London, S.E.27.
62 **H. C. Slingsby Ltd.**, 89/97, Kingsway, London, W.C.2.
63 **Trader Publishing Co. Ltd.**, [*Wireless and Electrical Trader*], Dorset House, Stamford Street, London, S.E.1.
70 **Brown Brothers Ltd.**, Great Eastern Street, London, E.C.2.
71 **Champion Electric Corporation**, Champion Works, Newhaven, Sussex.
72 **Stella Radio and Television Co. Ltd.**, Oxford House, 9/15, Oxford Street, London, W.1.
73 **Ultra Electric Ltd.**, Western Avenue, Acton, London, W.3.
74 **Bush Radio Ltd.**, Power Road, Chiswick, London, W.4.
75 **Vidor Ltd.**, West Street, Erith, Kent.
76 **Pye Limited**, Radio Works, Cambridge.
77 **Peto Scott Electrical Instruments Ltd.**, Addlestone Road, Weybridge, Surrey.
78 **Thomson, Diamond and Butcher Ltd.**, 34 Farringdon Road, London, E.C.1.
79 **Aerialite Ltd.**, Castle Works, Stalybridge, Cheshire.
81 **Standard Telephones and Cables Ltd.**, Connaught House, Aldwych, London, W.C.2.
84 **Lloyds Bank Ltd.**, 71, Lombard Street, London, E.C.3.
85 **Richard Allan Radio Ltd.**, Taylor Street, Batley, Yorks.
86 **Odhams Press Ltd.** [*Electrical and Radio Training*], 96, Long Acre, London, W.C.2.
87 **Geo. Newnes Ltd.**, Tower House, Southampton Street, London, W.C.2.
88 **A. H. Hunt (Capacitors) Ltd.**, Bendon Valley, Garratt Lane, Wandsworth, London, S.W.18.
89 **General Electric Co. Ltd.**, Magnet House, Kingsway, London, W.C.2.
90 **A. C. Cossor Ltd.**, Cossor House, Highbury Grove, London, N.5.
91 **Mullard Ltd.**, Century House, Shaftesbury Avenue, London, W.C.2.
92 **Gramophone Co. Ltd.** [H.M.V.], Hayes, Middlesex.
93 **E.M.I. Sales and Service Ltd.**, Hayes, Middlesex.
94 **Radio Gramophone Development Co. Ltd.**, Eastern Avenue West, Mawneys, Romford, Essex.
95 **Simon Sound Service Ltd.**, 48, George Street, Portman Square, London, W.1.
96 **Hobday Brothers Ltd.**, 21/27, Great Eastern Street, London, E.C.2.
97 **Bush Radio Ltd.**, Power Road, Chiswick, London, W.4.
98 **Dubilier Condenser Co. (1925) Ltd.**, Ducon Works, Victoria Road, North Acton, London, W.3.
99 **Association of Radio Battery Manufacturers**, 41, Gordon Square, London, W.C.1.
100 **E. K. Cole Ltd.**, Ekco Works, Southend-on-Sea, Essex.
101 **A. J. Balcombe Ltd.** [Alba], 52, Tabernacle Street, London, E.C.2.
102 **Belling & Lee Ltd.**, Cambridge Arterial Road, Enfield, Middlesex.
103 **Garrard Engineering and Manufacturing Co. Ltd.**, Newcastle Street, Swindon, Wilts.
104 **E.M.I. Sales and Service Ltd.**, Hayes, Middlesex.
105 **Taylor Electrical Instruments Ltd.**, 419, Montrose Avenue, Slough, Bucks.
106 **Truvox Ltd.**, Exhibition Grounds, Wembley, Middlesex.
107 **Telegraph Condenser Co. Ltd.**, Wales Farm Road, North Acton, London, W.3.
108 **Pamphonic Sales Ltd.**, 400, Holloway Road, London, N.7.
109 **Whiteley Electrical Radio Co. Ltd.**, Victoria Street, Mansfield, Notts.
110 **Wright and Weaire Ltd.**, 138, Sloane Street, London, S.W.1.
111 **Multicore Solders Ltd.**, Maylands Avenue, Hemel Hempstead, Herts.
112 **Dynatron Radio Ltd.**, "The Firs," Castle Hill Maidenhead, Berks.
113 **Plessey Co. Ltd.**, Vicarage Lane, Ilford, Essex.
114 **Keith Prowse & Co. Ltd.**, 159, New Bond Street London, W.1.
200 **B.B.C.**, Broadcasting House, London, W.1.
201 **United Appeal for the Blind**, 204/6, Great Portland Street, London, W.1.
202 **Electrical Trades Union**, Hayes Court, West Common Road, Bromley, Kent.
204 **Lugton & Co. Ltd.**, 209/212, Tottenham Court Road, London, W.1.
205 **Air Ministry**, Whitehall Gardens, London, S.W.1.
206 **War Office**, Whitehall, London, S.W.1.
207 **Valradio Ltd.**, New Chapel Road, Feltham, Middlesex.
208 **Rudman, Darlington (Electronics) Ltd.** [Reflectograph], Lichfield Road, Wednesfield, Staffs.
209 **Boosey and Hawkes Ltd.**, Electronics Division, Deansbrook Road, Edgware, Middlesex.
210 **Bowmaker Ltd.**, Lansdowne, Bournemouth, Hants.
211 **Alfred Imhof Ltd.**, 112/116, New Oxford Street, London, W.C.1.
220 **Television Society**, 164, Shaftesbury Avenue, London, W.C.2.
221 **"The Star,"** 12/22, Bouverie Street, London, E.C.4.
222 **Electronic Precision Equipment Ltd.** [Elpreq], High Street, Wealdstone, Middlesex.
223 **Petter Radio and Electrical Supplies**, 201/207, Forest Road, Walthamstow, London, E.17.
232 **Bernards (Publishers) Ltd.**, The Grampians, Western Gate, London, W.6.
233 **Reproducers (Electronic) Ltd.**, [Truchord] 82, Great Portland Street, London, W.1.
234 **Cosmocord Ltd.** [Acos], 700, Great Cambridge Road, Enfield, Middlesex.

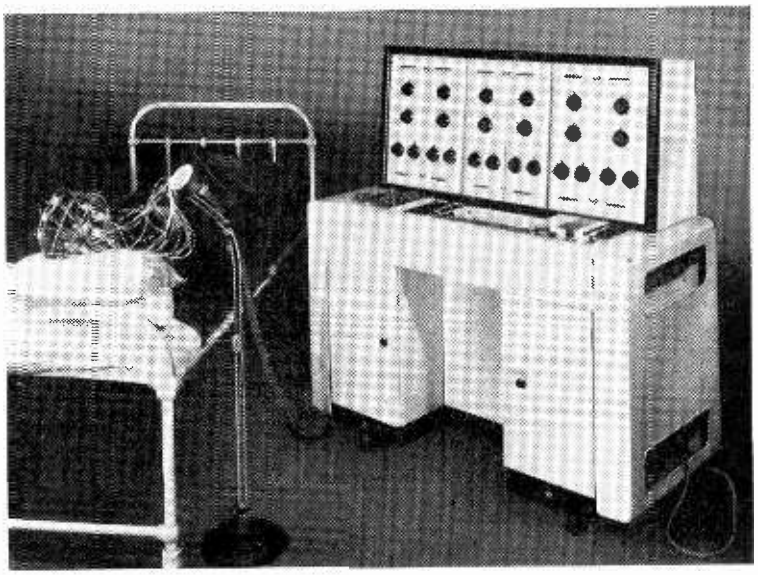
Electronics in Medicine

Apparatus on Show at Manchester

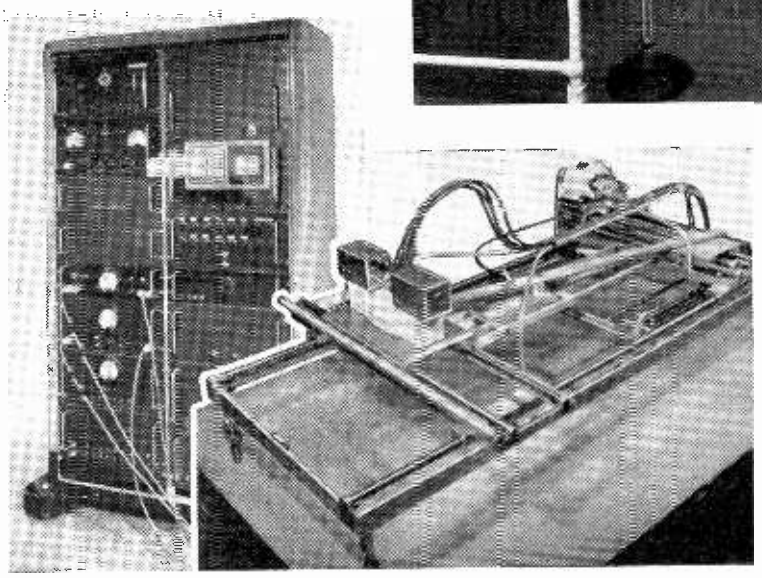
"IF electronic engineers were acquainted with those problems confronting the medical profession which require their specialized knowledge, perhaps more of them would be attracted to the service of medicine." This observation was made about three years ago by a prominent member of Guy's Hospital Medical School. Since then, there have been signs that engineers are becoming more and more aware of the ways in which they can be of use to the medical world. The fact that their interest is growing is largely due to the efforts of the small band of technicians who spend their lives making specialized electro-medical apparatus in various hospitals around the country. Most of these technicians are men with a strong sense of vocation. They prefer working in the cause of medical science, for somewhat less pay than they could get in industry, simply because it gives them more personal satisfaction than making, say, guided missiles. Now they are beginning to organize themselves and make their presence felt in various ways.

A recent event which gave some prominence to their work was the Eighth Annual Exhibition of Electronic Devices, organized by the north-western branch of the Institution of Electronics at the Manchester College of Technology. The "Research" section of the exhibition was largely dominated by the stands of various hospitals and medical schools, and quite a number of firms were showing examples of commercial electro-medical apparatus. In addition, over a third of the lectures given during the course of the exhibition were on electro-medical subjects. This being the dominant theme, it was appropriate that the proceedings should have been opened by Sir Geoffrey Jefferson, C.B.E., F.R.S., who is professor of neuro-surgery at Manchester University.

Although electronic techniques are used in both diagnostic and therapeutic work, there is perhaps more scope in the diagnostic field because of the wide range of different phenomena in the human body that can be detected or measured. The most common instruments here are probably the electro-cardiograph, for amplifying and recording heart potentials, the electro-encephalograph, for brain



Six-channel Marconi electro-encephalograph, notable for being entirely operated from the mains and having very well-regulated power supplies.



Television-type images of the distribution of radioactive material in patients are given by this apparatus developed by the University of London Institute of Cancer Research. On the right is the scintillation-counter scanning head mounted on a pantograph and on the left the associated electronic equipment.

potentials, and the electro-myograph, for muscle potentials. After this the apparatus becomes more specialized. The auscultoscope, for example, is an amplifying stethoscope for examining heart and lung sounds. The phonoelectrocardioscope amplifies heart sounds at the same time as recording the heart potentials, while the cardiotachometer measures the heart rate in beats per minute. Other instruments measure the rate of flow of blood and the amount of oxygen in it, and one called the sphygmograph registers pulse waves in the veins and arteries.

On the therapeutic side, the diathermy apparatus, or r.f. heater, is probably the best-known type of instrument. Nowadays it is quite often used by surgeons for making incisions and cauterizing wounds. Then there are stimulators. Most of these are devices for applying electrical waveforms directly to the body, but some generate flashes of light for visual stimulation and others sound pulses for aural stimulation. One stimulator made by Lorenz in Germany is used for giving artificial respiration by applying electrical impulses to the stomach muscles to produce a rhythmic contraction of the stomach wall. A new type of treatment which seems to be developing very rapidly is ultrasonic therapy, although most of the work seems to be confined to the Continent at the moment.

At one time radioactive substances were only used for therapeutic purposes, but they are now coming into the diagnostic field and bringing with them various electronic devices for detecting and measuring the radioactivity. In diagnosing cancer of the thyroid gland, for example, a dose of radioactive iodine is given to the patient; the iodine is selectively absorbed by the thyroid tissue and any cancer, and the resulting concentration of radioactivity gives an indication of whether a cancer is there or not and how big it is.

Ionization chambers and Geiger-Muller tubes are often used for detecting the radioactivity, but a much more sensitive instrument now coming into use is the scintillation counter. In this the radioactive particles impinge on a phosphor and produce flashes of light, which are detected by a photo-multiplier tube. The output of pulses from the tube is then fed into an electronic counter, or rate-of-count meter, which indicates the strength of the radioactivity. One of these devices was shown at Manchester by Isotope Developments.

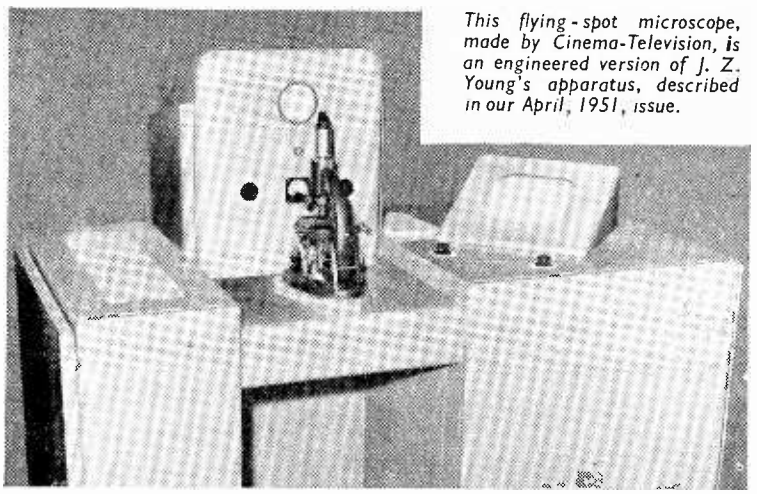
Unfortunately, the photo-multiplier tube introduces a certain amount of noise, which could lead to errors in the pulse counting. A way of overcoming this is to have two photo-multipliers "looking" at the phosphor and arrange their electronic circuitry so that only coincident pulses are counted. Any pulses coming separately from either tube are obviously noise and are therefore not counted.

One scintillation counter working on this principle was shown at the exhibition by the University of Leeds. Another one was part of an extremely interesting apparatus, built by the University of London Institute of Cancer Research, which displays an image of the distribution of radioactive material in a patient's body on the screen of a cathode-ray tube. The patient is scanned mechanically by the scintillation counter, which moves backwards and forwards across him on a kind of large pantograph. Pulses from the counter are fed to an electrostatic storage tube (E.M.I. type VCRX350) and arranged to modulate its "writing" beam, which scans the target of the tube in synchronism with the mechanical scanning of the patient.

In this way a charge pattern is slowly built up on the target of the tube corresponding to the distribution of radioactive material in the patient's body. When a complete charge pattern has been formed, the "reading" beam scans the target at something like normal television speed, and the output signal is fed to the c.r.t. display to produce a corresponding visual pattern on the screen. The image formed in the storage tube can be "read" and displayed for about an hour before it fades away. One of the great advantages of the television type of display is that the contrast of the image can be altered electronically as required—a feature which was also to be seen in the flying-spot microscope shown by Cinema-Television.

A characteristic feature of the biological amplifiers used in medical work is that they usually have a differential input stage, consisting of a pair of valves with a common cathode load. The object of this circuit is to get rid of any interference picked up from the patient, which it does because the interference signal is usually in the same phase as both input grids and so cancels out at the anodes. To make the circuit give a high rejection ratio, however, the two valves have to be carefully matched so that they give exactly the same amplification, and this is not always easy to do. A new circuit, shown by the University of Manchester, overcomes this difficulty by using only one triode valve, and connecting the two input leads, each through a cathode follower, to its grid and cathode. With this arrangement the ratio of wanted signal to interference signal at the input is increased over a thousand times at the output, and the interference signal can be hundreds of times greater than the wanted one before it has any appreciable effect.

Lewisham Hospital showed an apparatus for amplifying and recording the heart sounds of unborn babies—the purpose being to detect any changes in the heart rate indicating physical distress. The signals are displayed visually and a meter indicates their repetition rate.



This flying-spot microscope, made by Cinema-Television, is an engineered version of J. Z. Young's apparatus, described in our April, 1951, issue.

Portable Magnetic Recorder

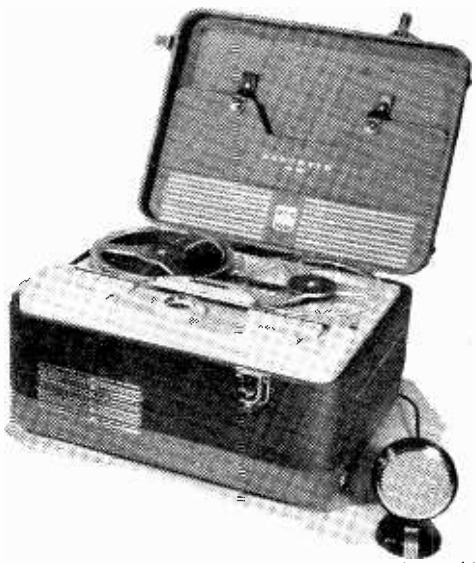
Interesting Mechanical Details in the Grundig, Type 700L

BEFORE its introduction to the British market the Grundig tape recorder was already well established on the Continent. It is a well-tried design, and one which bristles with ingenuity of detail. Its compact and neat exterior suggest easy portability, but on closer acquaintance this impression is modified by the discovery that it weighs 35lb. No doubt pressure has been brought to bear on those responsible for the design of the "innards" to reduce this figure, but no compromise with performance has been made which involves any reduction in the mass and inertia of moving parts, which, in the present state of the art, is necessary for steady tape speed and freedom from "wow."

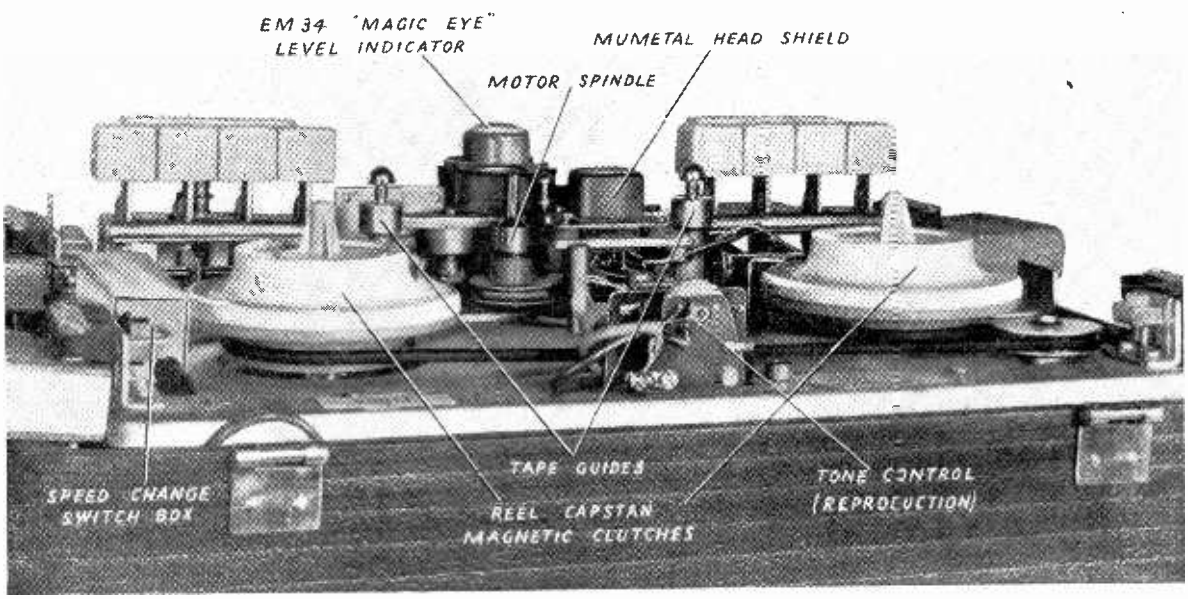
The machine accommodates tape reels up to 7in diameter (1,200ft) and records on half the tape width. Alternative speeds of $7\frac{1}{2}$ and $3\frac{3}{4}$in/sec are available, giving total playing times of 1 and 2 hours per reel, respectively. The usual facilities for fast forward and reverse winding are provided, and there is an intermittent stop switch in addition to the normal cancelling stop switch. All functions are selected by push-buttons with mechanical interlocks.

The microphone supplied with the machine is of the condenser type. A plastic film, gold-sputtered on its outer surface, is stretched in physical contact with a rigid back plate which is perforated with a large number of small holes. The variation of capacitance results from the depression, under the influence of the sound pressure, of the numerous elements of the film covering the holes. The polarizing voltage is low, and is in fact derived from a potential divider across the h.t. supply, yet the sensitivity appears to be remarkably high.

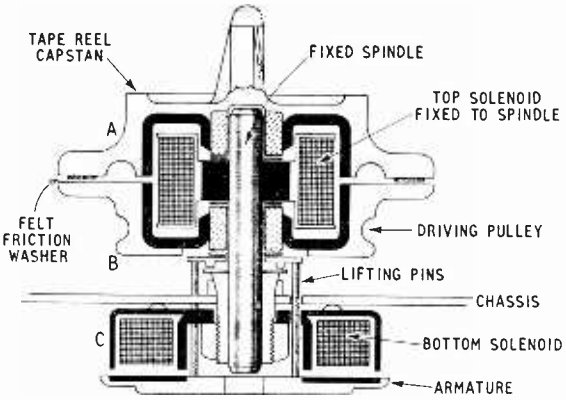
Performance.—A good test for tape speed constancy is to record the B.B.C. 1,000-c/s tuning note (not the



Dimensions of the carrying case when closed are 16in x 12in x 8in.



Top panel with cover removed, showing magnetic clutches for transmitting the drive to the reel capstans.



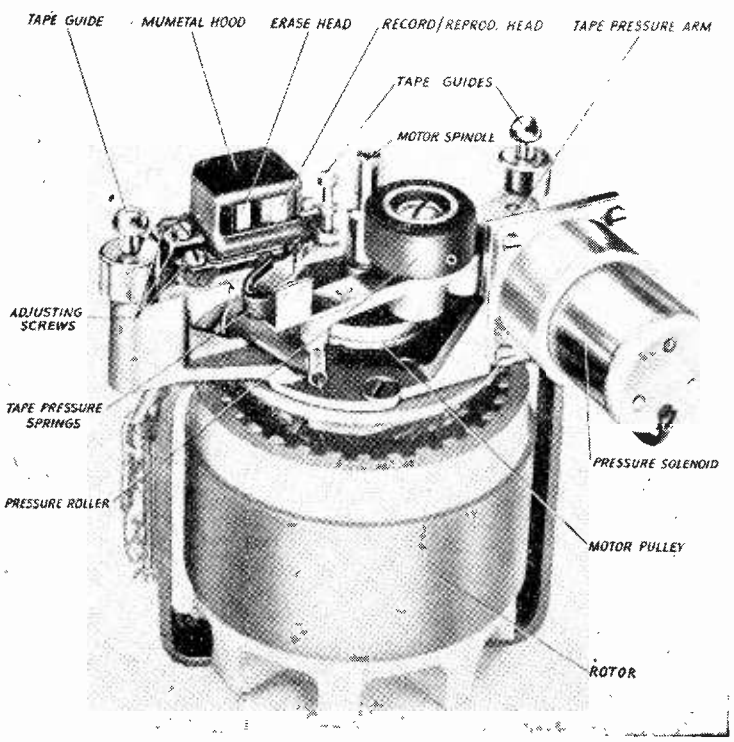
Arrangement of solenoids in the magnetic clutches.

Third Programme 440 c/s) at 3¾in/sec and replay it at 7½in/sec. The Grundig passes this test easily; no trace of fluctuation is perceptible to the ear.

The hum level in low—the makers claim 40 db below maximum signal level on the tape—but it is wise to record always at as high a level as possible as slight hum may otherwise obtrude if an external loudspeaker with a good bass response is used instead of the small-diameter internal loudspeaker.

Basically the quality of reproduction is excellent, and is limited by the reproducing amplifier and loudspeaker rather than by the qualities of the recording heads, the tape and the tape transport mechanism.

The large single driving motor, which is of the split-phase induction type, can be switched to give two speeds of rotation. The outer cage revolves round a central stator.



Those who care to take the trouble to reproduce the tape through an amplifier of greater power-handling capacity and a high-grade loudspeaker will not be disappointed. Particularly impressive is the performance at 3¾in/sec, and for all but the highest quality musical programmes it seems rather a waste of tape to use the 7½in/sec speed. A response up to at least 10 kc/s was confirmed, at 7½in/sec, by using a calibrated test tape.

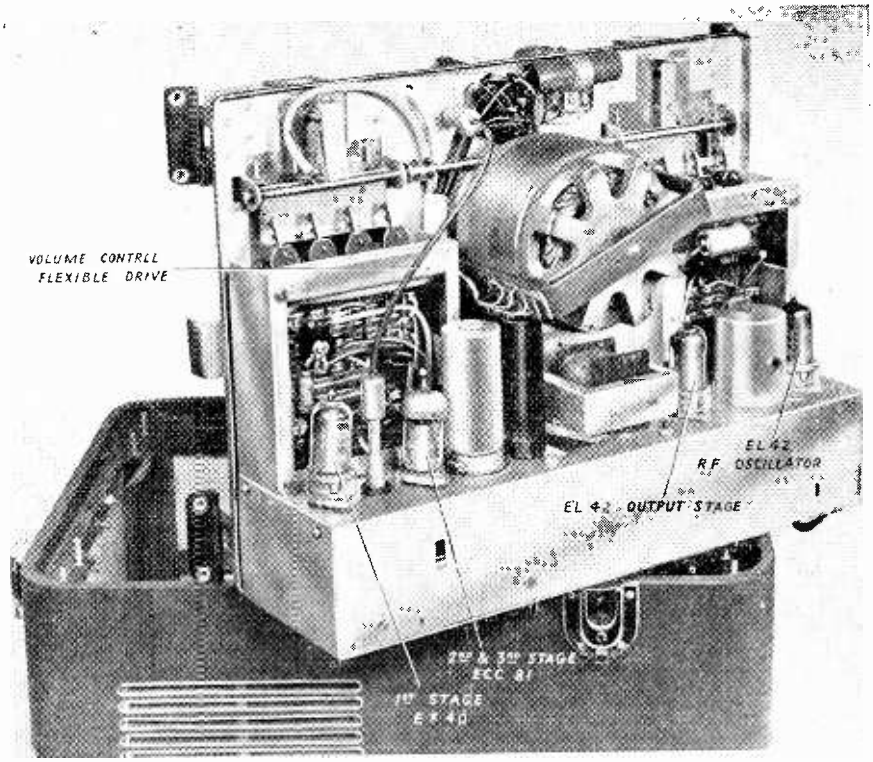
Tape handling involves no more than dropping the leading edge into a slot, and no mishandling of the controls could be devised to make the tape spill or misbehave itself in any way.

Mechanical Design.—A large single motor drives the tape transport mechanism. It is of the split-phase induction type and is remarkable for the fact that the outer body of the motor rotates. The field coils are wound in slots in what would normally be regarded as the armature. Change of speed is effected by switching these windings so that only alternate segments are energized at the higher speed. One advantage of this arrangement is that speed can be changed while running without the risk of wearing flats on idler wheels, as is the case in purely mechanical speed-change mechanisms. The motor speeds are of the order of 900 and 450 r.p.m., with capstan diameter of about 5/32in. The tape makes only a line contact with the capstan and the drive is effected virtually on the back of the tape via the rubber pinch roller, which overlaps the edges of the tape and picks up the drive direct from the capstan. Both the pinch roller and the pressure pads for holding the tape in contact with the erase and record/reproduce heads are mounted in a bar which is pulled forward by a solenoid in the h.t. circuit, and is operative only when recording or reproducing.

Control of the supply and take-up tape reels is effected by magnetic clutches which are energized, in the appropriate sequence, by switches associated with the push-button controls. Loose pulleys (B), driven by a round plastic belt at a speed in excess of the fastest reel speed required, are carried on spindles fixed vertically on the chassis. The reel capstans (A) also rotate freely on the spindles. Inside A and B is a fixed solenoid winding, mounted on the vertical spindle. The winding is shrouded by annular cores pressed into A and B. When energized this solenoid pulls A and B hard together and provides maximum friction for fast forward or reverse winding according to whether the right- or left-hand capstan is clamped.

When starting to record or reproduce tape the bottom solenoid only of the right-hand take-up capstan is energized, and its armature plate, to which three pins are fixed, lifts B until it is supporting A together with the empty reel. The pressure between A and B, due to the weight of the reel, is small, but so also is the torque required to tension the tape at the minimum spool diameter. As the spool fills its

weight increases, and so does the friction in the clutch. Thus practically constant tape tension is assured whatever the state of the reel. During running, overspill from the supply tape is prevented by light friction from an internal spring in the bearing of the capstan. When the "Stop" button is pressed, both bottom solenoids are energized, and contrary tension is provided by the normal friction of both clutches while the motor is slowing to a stop.



Underside of chassis. Valves are readily accessible, and the amplifier sub-assemblies can be reached, as seen at each side of the driving motor, by removing coverplates.

Circuit. — The main record/reproduce amplifier consists of four stages: an EF40 low-noise pentode (in later models an EF86) is followed by a twin-triode ECC81 and an EL42 output pentode. The EF40 is underrun to reduce residual hum, and the heater is fed from a separate winding and earthed via a "humdinger." Feedback through RC circuits is used to give pre-emphasis on all recordings of 10 db over the range of frequencies from 1 to 10 kc/s. On play back the normal equalization is effected by other RC feedback networks giving 22 to 25 db rise at 50 c/s referred to 4 kc/s and a further rise of 3 to 5 db between 4 and 10 kc/s. At the lower of the two tape speeds an additional cathode bypass capacitor in the first half of the ECC81 is used to lift the response 10 db over the range 500 c/s to 6 kc/s.

Input sockets are provided for the condenser microphone, for recording from radio or gramophone pickup and for recording telephone conversations by inductive pick-up from a coil attached to the outside of the instrument. Other types of high-impedance microphone, and a diode connection from a radio receiver can also be used with the second input socket. High- and low-impedance output connections are also provided for monitoring with headphones or connection to an external amplifier, and for feeding an external loudspeaker.

The bias oscillator is an EL42 and its frequency (approximately 50 kc/s) is adjusted by means of a dust core. It feeds the high-impedance record/reproduce head through a capacitance from the tuned winding; current for the low-impedance erase head is supplied from a third winding coupled to the oscillator coils. A "humbucking" coil is fitted in series with the record/reproduce head.

A type EM34 "magic eye" is used as a volume level indicator. It is fed through a small half-wave rectifier and a suitable time-constant circuit from the output of the second half of the ECC81 double triode. The h.t. supply is derived from a full-wave bridge metal rectifier.

In conclusion, a special word of commendation must be reserved for the service manual which has been prepared for the use of dealers. This is one of the clearest and most detailed works of its kind which has so far come our way, and is in keeping with the thoroughness with which the rest of the design has been carried out.

NEW LONDON TELEVISION STATION

WILL the new London television transmitter at Crystal Palace be much the same as the last high-power one built at Wenvoe, or something entirely different in design? The B.B.C. itself is not yet prepared to say, but one of its engineers has publicly given his own personal opinion on what form it may possibly take.

Speaking recently at Manchester, C. Buckle, the engineer in charge of Holme Moss, said he thought the Crystal Palace station would represent a completely new approach to television transmitter design. It would probably have a self-supporting mast, after the style of the Eiffel Tower, and a dual arrangement of two vision transmitters and two sound transmitters. At the top of the mast would be eight sets of dipoles stacked one above the other, the upper four being fed from one combined vision and sound output and the lower four from the other. Each vision transmitter would have an output power of 75kW, making a total of 150kW, and with an aerial gain of about 8 this would give an effective radiated power of 1,200kW

If one transmitter broke down the other would continue radiating the programme, and there would be a switching arrangement to enable either sound transmitter to be combined with either vision transmitter. The new station, concluded Mr. Buckle, would be a culmination of all that had been worked for since 1936 when the television service began.

WORLD OF WIRELESS

Co-ordinating Radar Research • E.B.U. Receiving Station • Television News • Radio Courses

Radar Research

WITH the object of integrating more closely all radar research and to ensure a more rapid interchange of technical information, the two research establishments at Malvern are to be amalgamated. From September 1st the Telecommunications Research Establishment and the Radar Research and Development Establishment will cease to exist as separate entities and will in future be known as the Radar Research Establishment. W. J. Richards will be the director of the new organization (see "Personalities"). In announcing this change the Minister of Supply stated that the combined organization would be working for all three Services.

Components in Sweden

AN EIGHTH of the radio industry's total exports last year went to Scandinavia and to foster this interest in British radio equipment some 20 manufacturers will be participating in an exhibition of radio and electronic components, valves and test gear which is being organized in Stockholm by the British Radio and Electronic Component Manufacturers' Federation.

The exhibition will be held at the Kungshallen, Kungsgatan, where a similar exhibition was held in 1948, from 10.0-6.30 on September 25th, 26th, 28th and 29th.

New Receiving Station

SOME MONTHS AGO we reported the decision of the European Broadcasting Union to build a new receiving and measuring station in Belgium for monitoring the broadcasting bands and for research work on radio propagation, especially on its bearing on the effective utilization of the spectrum.

The new station, known as Jurbise-Masnuy, was opened on July 22nd by M. Georges Conus, president of the E.B.U. and director of the Swiss Broadcasting Corporation, in the presence of representatives of the member organizations and of the Union, including General Sir Ian Jacob, director-general of the B.B.C. and founder-president of the E.B.U. During the opening ceremony, the Belgian Minister of Communications recalled the reasons for selecting south-west Belgium for the station, as it is the broadcasting "centre of gravity" of Europe.

A description of the new station by the chief engineer of the E.B.U. appears on page 422.

RADIO-TELEPHONE equipment is being installed in some of the 4,000 German passenger-carrying Post Office buses enabling passengers to be called by telephone subscribers. This photograph was taken at the German Communications and Transport Exhibition, being held in Munich.

Modern P.A. Installation

PORTABLE v.h.f. radio telephones were used by technicians when adjusting the levels of individual loudspeakers in the new p.a. system, designed and installed by G.E.C., at the Glasgow Central Station.

Existing loudspeakers on the platforms have been retained, but for the circulating area and the booking-halls a Goodmans "Concentric" diffuser type of unit, modified for this particular application in collaboration with G.E.C. Research Laboratories, has been adopted.

Normally the installation is fed by two 120-watt amplifiers, but in the event of failure of one amplifier the other can be switched with automatic re-matching to carry both loads in parallel. A dummy load is also connected across the faulty amplifier in readiness for service testing.

One of the most interesting features of the new installation is the use of alternative equalizing circuits designed to give the maximum intelligibility and naturalness with male or female voices when operating at unnaturally high levels.

Television Plans

EQUIPMENT for the five medium-power television stations (Northern Ireland, Plymouth, Isle of Wight, Aberdeen and Pontop Pike) has now been ordered by the B.B.C. and construction of all five stations will start as soon as possible.

It is planned to provide temporary stations at Plymouth, Isle of Wight and Aberdeen within the next 18 months as has been done at the other two stations. The Brighton booster station will close down when the temporary station is brought into service at Rowridge, Isle of Wight.

It may not generally be known that a booster station was installed in the Isle of Man by a private concern in time for the Coronation, but has since been taken out of service. As stated in our summary of the T.A.C. Report, the B.B.C. plans to provide a station on the Island working in Channel 4.

Educational Opportunities

WITH the opening of the scholastic year in September a large number of colleges and institutes are offering special part-time radio and allied courses in addition to the recognized full-time courses in telecommunications. Complete syllabuses and regulations covering courses in telecommunications, radio and television servicing and for the radio amateurs' examination is issued at 2s by the Department of Technology of the City & Guilds of London Institute. Prospectuses covering both full-time and part-time courses have also been received from the Northern Polytechnic, London, N.7, and the S.E. London Technical College, London, S.E.4 The Polytechnic, London, W.1, has issued a prospectus of evening courses in telecommunications approved for the award of the Ordinary and Higher National Certificates.

Before referring to some of the special courses brought to our notice, we should mention the "Bulletin of Special Courses in Higher Technology" issued by the London and Home Counties Regional Advisory Council for Higher

Technological Education, Tavistock Square, London, W.C.1, price 1s 6d.

A course of eight lectures on crystal valves and transistors will be given at the Borough Polytechnic, London, S.E.1, on Tuesdays, commencing October 20th (fee 30s). Twenty-four lectures on communication networks will be given at the S.E. London Technical College, Lewisham, S.E.4, on Fridays from October 23rd (fee 30s).

Classes for the Radio Amateurs' Examination are being held at the Wembley Evening Institute, Copland School, High Road, Wembley, on Mondays (fee 10s per annum); Ilford Literary Institute, Cranbrook Road, Ilford, Essex, on Wednesdays (fee 10s), and the Brentford Evening Institute on Wednesdays.

OUR AUTHORS

J. de Gruchy, who writes on the protection of meters in this issue, is a measurements engineer and was responsible for radio test gear design for Everett Edgcumbe & Co. for many years. Before and during the last war he was a teacher at the Borough Polytechnic, London, and also taught at the Telecommunications Research Establishment. He was at one time engaged on air-to-ground telemetering and upon the development of the British pulsed altimeter. He is now head of the Instrument Department of the Electrical Apparatus Co., of St. Albans, Herts. Mr. de Gruchy was an original member of the Radio Trades Examination Board.

J. Treeby Dickinson, who, in an article in this issue, describes the new E.B.U. receiving station in Belgium, studied electro-communications at the Imperial College of Science and Technology and in 1927 joined the Telegraph Construction and Maintenance Co., Ltd. He transferred from submarine cables to radio, and from 1929 was engaged on receiver development in several of the European companies of the International Standard Electric Corporation. In 1937 he joined the Engineering Division of the B.B.C., to which he returned after war service in the R.A.F.V.R., latterly as assistant chief engineer of No. 26 (Signals) Group. He was seconded by the B.B.C. in 1950 to the European Broadcasting Union, as chief engineer.

V. J. Tyler, contributor of the article in this issue on a simple distortion meter, joined Marconi's W.T. Co. in 1935 and worked on transmitter development until 1941 when he joined the R.A.F. He rejoined Marconi's in 1946 for work on marine transmitters and remote control systems and is now engaged on the development of broadcasting transmitters.

PERSONALITIES

W. J. Richards, C.B.E., chief superintendent of the Telecommunications Research Establishment, Malvern, since 1946, has been appointed director of the new Radar Research Establishment, Malvern, which, as stated elsewhere, will embrace the existing establishments—T.R.E. and R.R.D.E. He joined the Royal Aircraft Establishment at Farnborough in 1925 and during the war was Deputy Director of Scientific Research (Armament) at the Ministry of Aircraft Production.

W. E. Miller, M.A.(Cantab.), editor of our contemporary *Wireless and Electrical Trader* since 1945 and president of the British Institution of Radio Engineers, has been elected to the Freedom and Livery of the Worshipful Company of Musicians.

A. E. Lawson, who was at one time London manager of the Edison Bell Co. and has been television manager for the Gramophone Co. since April, 1949, has been appointed assistant sales manager for H.M.V. radio, television and gramophones. During the last war he was associated with the development of inter-Service radar and was Deputy Assistant Director of Ordnance Services in charge of the radar branch at the War Office. Mr. Lawson succeeds A. E. Newland, who has been appointed to an executive position in the E.M.I. International Department in Dublin.

F. W. J. Grinter, who began his career as a sea-going radio officer with the Marconi Marine Company in 1927 and has been in charge of the Grimsby depot for the past year, will be the new manager at Hull in succession to J. R. Thomson, who is retiring. He will also remain responsible for Grimsby pending the appointment of a new manager.

On the retirement of **F. M. Dimmock,** O.B.E., head of the Equipment Department of the B.B.C., in October after 28 years' service with the Corporation, **E. C. Drewe,** M.I.E.E., who has been assistant head of the Research Department since September, 1950, will succeed him. **A. B. Howe,** A.M.I.E.E., research consultant, will be the new assistant head of the Research Department.

A. J. Brunker, B.Sc. (Eng.), A.M.I.E.E., who joined E. K. Cole, Ltd., in 1947 from the Ministry of Supply where he was Deputy Director, Radio Production, has now been appointed a director and general manager of Ekco Electronics, Ltd., the recently formed subsidiary of E. K. Cole, Ltd. He is general export manager of the parent company, and before the formation of the new company was also responsible for commercial activities of the Electronics Division.

C. R. Bates, A.M.I.E.E., has given up his practice as an industrial-electronic consultant in order to specialize in electronic welding-controls. He has been appointed a director of Bates & Bates, Ltd., 73, Ashville Avenue, Birmingham, 34, a company manufacturing synchronous controls to his designs and patents.

T. D. Humphreys, M.Brit.I.R.E., has been appointed general manager of Reproducers and Amplifiers, Ltd. He has been in the radio industry for the past 20 years, including a long period with Cossor's and more recently with Radar Components, Ltd., where he was general manager.

O. E. Trivett, A.M.I.E.E., M.Brit.I.R.E., who joined Aerialite, Ltd., as personal assistant to the managing director in 1950, has been appointed a director of the Company.

John Beard, previously communications controller, has been appointed communications manager of Aer Lingus. He is responsible for all matters relating to the development of airborne radio equipment, electronic flight instruments and public address systems, and the administration of the communications organization of Aer Lingus.

IN BRIEF

Broadcast Receiving Licences in the U.K. at the end of June totalled 12,964,065, including 2,415,305 for television and 191,433 for sets fitted in cars. Television licences increased by 98,705 during the month.

Harwell Electronics Course. The seventh specialized course on the design, use and maintenance of electronic instruments used in nuclear physics, radio chemistry and work with radioisotopes will take place at the Isotope School, Atomic Energy Research Establishment, Harwell, from September 28th to October 2nd. Applications for participation are invited from physicists and electronic engineers holding a degree or equivalent qualification. Application forms for the course, for which the fee is 12 guineas, can be obtained from the Electronics Division, A.E.R.E., Harwell, near Didcot, Berks.

Amateur Show.—The seventh annual Amateur Radio Show to be organized by the Radio Society of Great Britain will be opened at the Royal Hotel, Woburn Place, London, W.C.1, at noon on November 25th by Rene Klein (G8NK), a founder member of the Society in 1913. The exhibition will remain open daily from 11.0 to 9.0 until November 28th.

Marine Radio.—Concurrently with the Earls Court Radio Show the 19th Engineering Marine and Welding Exhibition will be held at Olympia, London (September 3rd-17th), at which a number of radio manufacturers, including B.T.H., Cossor, Decca, English Electric, G.E.C., Mullard and Redifon are exhibiting.

German Radio Show.—F.M. vies with TV at the *pièce de résistance* at the second post-war German Radio Show, which is being held in Dusseldorf from August 29th to September 6th. There are about 90 F.M. stations in operation in Western Germany and it is estimated that there are some four million f.m. receivers or adaptors already in use.

Royal Society Research Appointment.—B. J. Robinson, B.Sc., of Sydney University, has been appointed a Rutherford Memorial Scholar, by the Royal Society, to carry out ionospheric research at the Cavendish Laboratory, Cambridge.

Amateur Television Transmission over a distance of 30 miles using a peak-white power of only 2 watts on 436 Mc/s was achieved by R. L. Royle (G20J/T), of Great Canfield, near Dunmow, Essex, on August 1st. The transmitter, pulse

generator, camera, etc., were home-constructed. The receiver at Abbots Langley, Herts, which was operated by L. V. Dent (G3GDR) was locked perfectly by the line and frame sync pulses and the pictures were clearly identified.

B.S.R.A.—The Manchester centre of the British Sound Recording Association opens the session's meetings with a lecture on "Tape Recording with Special Reference to Stereophonic Techniques," by J. S. Holiday, at 7.30 on September 21st at the Engineers' Club, Albert Square, Manchester. G. A. Briggs (Wharfedale) will give a demonstration-lecture on loudspeakers at a meeting of the south-west centre of the Association at 7.45 on September 10th at Callard's Café, Torquay.

Brit.I.R.E.—The first meeting of the new session of the British Institution of Radio Engineers (London Section) will be held at 6.30 on September 30th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, when D. A. Bell, M.A., B.Sc., Ph.D., will speak on "The Impact of Communication Theory on Television."

E.P.T.A.—There will be a general meeting of the Electro-Physiological Technologists' Association at the Burden Neurological Institute, Stoke Lane, Stapleton, Bristol, at 10.30 on September 19th. There will be papers and demonstrations at this meeting at which non-members may attend. Details are obtainable from G. Johnson, Hurstwood Park Hospital, Haywards Heath, Sussex.

I.P.R.E.—A north-west section of the Institute of Practical Radio Engineers was recently inaugurated in Manchester with an initial membership of 82. Details of lectures, which will commence in September, are obtainable from the secretary, H. Budworth, 466, Holden Road, Leigh, Lancs.

I.E.E. Students.—The new officers of the I.E.E. London Students' Section Committee are: chairman, M. H. Alder (S.T.C.); vice-chairman, R. Thomas (Sperry); hon. sec., M. C. Cubitt (Pye).

Institute of Physics.—The 33rd Annual Report of the Institute records that the membership at the end of 1952 was 4,347, an increase of 267 on the previous year. The Electronics Group has a membership of 314.

Telecraft, Ltd., ask us to say that an obvious error in the position of the masthead mounting, as illustrated in their advertisement on p. 33 of this issue, was not detected until the page had gone to press.

PUBLICATIONS

Weekly Publication is to be resumed by our trade contemporary *Wireless & Electrical Trader* (with its first show issue on August 29th) after more than 12 years' fortnightly publication. Originally published as a monthly in 1923, it started weekly publication in 1925 and continued as such until May, 1941, when prevailing conditions forced it to become a fortnightly. A feature of the journal, which is exclusively for *bona fide* members of the trade, is the service data sheets on commercial receivers published with each issue.

A Buyers' Guide listing alphabetically over 3,750 British products, with the names of the manufacturers and Canadian suppliers, is included in the CABMA Register, 1953, recently published jointly by Kelly's Directories, Ltd., and our publishers for the Canadian Association of British Manufacturers and Agencies. The 800-page volume, which also lists proprietary names and trade marks and gives a complete English-French glossary of the headings used in the Buyers' Guide, costs 42s.

Standards Yearbook.—The 1953 edition of the British Standards Yearbook includes brief details of some 2,000 specifications current at the end of March. It also gives a brief outline of the work being undertaken by each of the Industrial Committees. In the case of the telecommunications industry it includes "microwave measuring instruments," "performance of radio receivers," "definitions of the electrical characteristics of receivers" and the revision of a number of existing Standards. The Yearbook is obtainable from the British Standards Institution, 24, Victoria Street, London, S.W.1, price 12s 6d.

Plastics Industry.—The 23rd edition of the "British Plastics Yearbook"—first published in 1931—includes in its nine sections classified lists of manufacturers of plastic materials, products and equipment, proprietary names and a review of important plastics patents issued in the past year. The 562-page Yearbook is published by Iliffe & Sons Ltd., price 30s.

"Wire and Radio Communications" is the new title of our New York contemporary *Telegraph and Telephone Age*, which has been in circulation since 1883. The change, say the editors, has been dictated by the fundamental change in the field of world-wide communications.

BUSINESS NOTES

Nigerian Posts and Telegraphs Department has ordered from Marconi's equipment for an extensive network of v.h.f. multi-channel radio stations to link the telephone systems of many towns and provide additional channels on existing overhead wire routes. The network (forming roughly a triangle) provides twin-path v.h.f. interconnections between Ibadan (which is already linked by radio with Lagos), Enugu and Minna.

Ekco Electronics, Ltd., Southend-on-Sea, Essex, has been formed as a subsidiary of E. K. Cole, Ltd., to handle the production, marketing, installation and maintenance of electronic and nucleonic equipment previously handled by the company's Electronics Division.

Plessey-Amplion Agreement.—The arrangement whereby Ediswan acted as distributors for Plessey components having terminated, Amplion (1932), Ltd., have been appointed distributors to the wholesale and retail trade for the sale of Plessey radio and television components.

Electric Audio Reproducers, Ltd., of 17, Little St. Leonards, Mortlake, S.W.14 (Tel.: Prospect 4466), has been formed to manufacture the Microgram portable electric gramophones previously made by Collaro, Ltd. The new company will incorporate Phono Disc, Ltd., and will market the record-playing equipment previously manufactured by Phono Disc. The managing director of E.A.R. is Leonard Stone, who has resigned the general managership of the Trix Electrical Co., Ltd., with which he has been associated since 1943.

Marconi's are to supply a 5-kW vision transmitter, 3-kW sound transmitter, with combining unit and ancillary studio and O.B. equipment for Canada's fourth television station which is being built in Vancouver, B.C. When the 525-line station opens towards the end of the year it will have a temporary aerial which eventually will be replaced by a 12-stack array increasing the effective radiated power to approximately 100 kW.

Naval R/T Equipment, worth approximately $278,000, has been ordered by the U.S. Naval Purchasing Office from Pye, Ltd.

A Magnetizer of ring magnets and small power magnets has been produced by Advance Components, Ltd., of Back Road, Shernhall Street, Walthamstow, E.17. The Advance magnetizer, Type K1, has a power consumption of only 30 watts.

Blick Time Recorders, Ltd., announce the introduction of a new vacuum impregnator by their subsidiary Blickvac, of 505, Lordship Lane, London, S.E.22, which also provides an impregnation service.

Sky-masts, of Beadon Road, London, W.6, have marketed a new 45-ft patent mast for erection on roofs and in inaccessible places. It is available with a rotatable array.

Savage Transformers, Ltd., are this year celebrating their Silver Jubilee.

NEW ADDRESSES

British Standards Institution moved into its new premises at 2, Park Street, London, W.1 (Tel.: Mayfair 9000), on August 17th.

Dynatron Radio, Ltd., have moved their main office and service department from the works at Ray Lea Road, Maidenhead to "The Firs," Castle Hill, Maidenhead, Berks. (Tel.: Maidenhead 3811.)

Rees Mace Marine, Ltd., have opened depots at 26, Coed Celyn Road, Derwen Fawr, Swansea, and 187, Snargate Street, Dover.

Exeter Branch Office of B.I. Callender's Cables, Ltd., is now at 40, Whipton Village Road, Whipton, Exeter. (Tel.: Exeter 67308.)

LETTERS TO THE EDITOR

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

Through Unofficial Channels

HAVING suffered an abnormal spate of "sporadic E" this year, the repeated statements by the B.B.C. that "nothing can be done" tend to wear a little thin.

Following interference from automatic morse at terrific strength recently, I hung on till I got the call-sign during an "idling" period and then wrote to the station concerned. I was somewhat agreeably surprised to receive the accompanying letter in reply. Thus one of the sources of trouble has been removed—without international intervention!

I assume from their letter that the Swedish station had had no "official" notification of the signals, and I wonder how many other signals that cause trouble are also third harmonics which could receive similar attention.

Reading, Berks. R. C. HORSNELL.

Letter from the Engineer-in-Chief, Varbergs radio station, Grimeton, Sweden, to Mr. Horsnell.

WE thank you for your letter of July 22nd, 1953, telling us that the 3rd harmonic of our transmitter SDQ5 (13,832.5 kc/s) interfered with the B.B.C. television programme on 41.5 Mc/s (channel 1) on July 18th at 14.15-14.45 B.S.T. According to our log SDQ5 had on this occasion a c.w. telegraphy transmission directed to east Asia.

We very much regret this interference, and beg to inform you that we are now taking measures in order to suppress the 3rd harmonic.

It is very unusual that we have complaints regarding interference of harmonics from our transmitters, and we find it remarkable that such a high frequency as 41.49 Mc/s can interfere with your transmitters at the comparatively great distance from our transmitter.

However, we are very grateful to you for your message, and will very much appreciate further reports regarding our transmissions.

Re-defining "Electronics"

ELECTRONICS; the study and application of submolecular phenommena as elements of control (?)

Farnborough, Hants. R. A. FAIRTHORNE.

"ELECTRONICS" having been branded as an esoteric term, everyone is entitled to his own definition. Mine I share with the lay public, and it covers a very wide field—"anything electrical which I do not understand."

Support for this view is coming in from quite unexpected quarters and in the preface to a recently published textbook on the principles of electronics we read: "The first five chapters are devoted to the basic facts and theory underlying electronic work. Some of the concepts here may be a little difficult of comprehension, *but this is inherent in the nature of the subject and need not deter the reader from proceeding.*" The italics are mine.

Hindhead, Surrey. HENRY MORGAN.

Commercial Television: Industry's Attitude

WHAT is the matter with the British TV manufacturers? Don't they realize that the reason why people buy TV is to see the programmes and that with better programmes and greater alternatives available, more people will buy TV? Why are they so frightened to openly support an additional television system in competition with the B.B.C.

I see from *The Daily Telegraph* of Wednesday, July 8th, referring to the first report of the Television Advisory Committee 1952, that there is one manufacturer who feels that the present position is "highly unsatisfactory" and is fighting for more frequencies for TV. Now is the time for all manufacturers who value their future business and stability of the industry to come in in support.

Imhof's, Ltd., London, W.C.1. A. GODFREY IMHOF.

"Stereoscopic Television"

I WAS most interested in the suggestion by R. A. Fairthorne (August issue) that transmissions of stereoscopic television could be viewed without any apparatus. However, an investigation of the visual problems involved suggests that the system would not be very satisfactory.

Assuming an average screen size of 12in, an interpupillary distance of 60 millimetres, and a viewing distance of 3 metres, the relative convergence necessary for clear viewing would be approximately 7 prism dioptres.* A survey has shown that the average positive fusion reserve for healthy young adults, wearing their proper refractive corrections, is between 10 and 14 prism dioptres. It is accepted that for comfort a visual effort should not employ more than one-third of the available reserve. In this case rather more than one-half is required, and discomfort would ensue after protracted viewing. GEORGE E. WEAVER.

Stourbridge, Worcs.

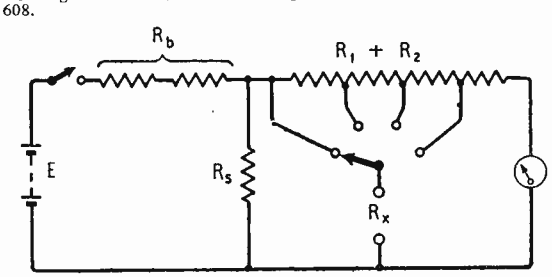
* The prism dioptre is an optical unit defined as the strength of a prism that causes a deviation of 1 cm at a distance of 1 metre. In practice it works out to be roughly equal to a degre.—ED.

The Ohmmeter

IN dealing with the shunt form of ohmmeter in the July issue, W. Tusting stated that by shunting the meter the lower ranges can be extended indefinitely, but at the expense of the simple one-pole switching applicable to the basic shunt type. This objection does not hold if a single-valued low-resistance shunt is used on the battery side of R_x, as shown here. R_s is made equal to the mid-scale value of R_x on the lowest range; i.e., with the range switch connecting R_x directly across R_s. In order to make the same scale fit all ranges, R_b ought to be sufficiently large for the connecting of R_x on the lowest range not to affect the battery current significantly; at the same time it must pass sufficient current to set up across R_s the full-scale millivoltage input of the meter with R_1+R_2 in series. Therefore the more sensitive the meter the wider the range of resistance measurable.

A four-range ohmmeter of this type to the writer's design* was produced by the Cambridge Instrument Co., Ltd., as an accessory to their "Unipivot" galvanometer, and covers 0.001 to 1,000 ohms, being particularly useful

* M. G. Scroggie, Patent No. 407,341. "A Multi-Range Direct-Reading Ohmmeter," *Wireless Engineer*, November, 1933, pp. 606-608.



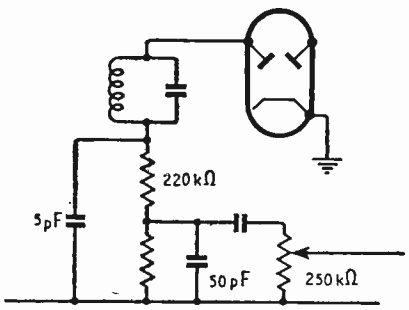
for testing switch contacts and low resistance transformer and tuning coil windings.

An incidental advantage of this type of ohmmeter is that variations in e.m.f. and resistance of the battery do not require separate compensation, a preliminary full-scale setting by adjustment of R_b being all that is needed.

Bromley, Kent. M. G. SCROGGIE.

Broadcast Transmitter Distortion

I HAVE been most interested in the correspondence on the quality of B.B.C. transmissions. Since the matter was raised some two or three months ago, and it was stated that the transmissions were liable to be modulated practically 100 per cent, particularly on high notes, I have realized that my own demodulation circuit might well be responsible for much of the distortion from which I was a frequent sufferer. High soprano voices in a choir were particular offenders in loud passages, and I concluded therefore that a poor a.c./d.c. load ratio, caused by unsuitable r.f. filter component values, was the likeliest cause of the trouble. I therefore altered my diode circuit, formerly all too conventional, to the following:—



This has proved completely satisfactory, so that personally I now have little, if any, criticism to make of the quality transmitted. I *estimate* that this circuit produces a ratio of at least 95 per cent at the highest frequency likely to be transmitted at a high modulation level. What figure to give to this frequency is difficult to say, hence my use of the word "estimate." One might reckon that only fundamental tones are likely to be fully modulated, but some instruments such as the oboe have harmonics stronger than the fundamental. Because of this consideration I am unable to understand Ian Leslie's statement that his a.c./d.c. load ratio is 98.9 per cent, and I would feel happier in accepting his conclusions if he would either publish the values used in his circuit or state the highest frequency used in his calculations.

Salisbury, Wilts. J. D. HERRING.

"Reactivating the Dry Cell"

I HAVE been reactivating dry cells for about two years and, as my method is somewhat different from that described in your August issue, it may be of interest.

Many of the batteries I have experimented with have been in very bad shape, with internal resistances so high that initial currents of 0.1 ampere would be impossible, about 20-30 volts per cell being required to drive such currents, and at such voltages the battery disintegrates.

My method is to apply 2 volts per cell and leave on until the charging current has settled to a steady value for a few minutes. This steady value is considerably in excess of the normal discharge currents—about 0.5 A for a 3-cell flat battery, 1.25 A for a U2, and 2 A for a twin-cell cycle-lamp battery. The time required varies from about half an hour for a partially discharged cell in good condition to many hours for a cell in such bad condition that the initial current is less than 10 mA. Many of these badly discharged cells refuse to respond, but the chance is about equal and when successful they compare quite favourably with other reactivated cells in terms of renewed life.

The same treatment with 2.5 V per cell proves to be destructive, as also does the application of 2 V for about an hour after current reaches peak value. A cell accepting a large current should be removed immediately if the current begins to fall, as this indicates "cooking," but a cell accepting only a few millamps may be very erratic for hours and should be persevered with until there appears to be no hope of the current reaching a higher value.

Voltages below 1.8 per cell give very little reactivation.

A relative of mine without an electric supply has an all-dry portable, the batteries of which used to last about 3 months. Her present h.t. battery, reactivated four times, is 13 months old; the l.t. battery (a bell cell), once reactivated, is 8 months old. The 90-V h.t. battery, last treated 3 weeks ago, showed (after a 12-hour period to settle from reactivating) 87 volts on a 10-mA load. The reconditioning of both these batteries is mainly guess-work because for the h.t. battery I have a supply limited to 80 mA and for the bell cell my limit is 5 A, neither currents being peak for the particular sizes of cell. However, cycle lamp and torch batteries on my l.t. charger capable of up to 5 A have been reactivated many times before cells punctured.

Barkingside, Essex. E. HURRAN.

Technical Qualifications

THE letter from "J. S. A." (your August issue) on the lack of appreciation of the City & Guilds full technological certificate is unfortunately all too often justified. As one of the moderators for these examinations I can testify to the high standard required and as one responsible for the training of staff, and therefore having an interest in their future progress, I can confirm that successful candidates in the City & Guilds examinations have proved excellent material.

It is difficult to see what more can be done to educate employers in the value of these certificates except through the personal efforts of people like "J. S. A." It is possible that the recognition now being accorded to the important class of technician in the electrical industry will help to establish the status of these examinations.

"J. S. A." may feel that his letter has not been in vain if I say that at least one public corporation has for some time recognized the value of the full technological certificate. The B.B.C. specifies it as one of the qualifications for promotion to the higher ranks of its engineering division. K. R. STURLEY.

B.B.C. Engineering Training Department.

Your correspondent "J. S. A." (August issue) is presumably unaware of the conditions of enrolment on the Technical and Scientific Register of the Ministry of Labour. It is these conditions which limit a man's possible employment rather than the view of the radio industry as a whole since, as he has pointed out, such employers as have given him an interview have been agreeably surprised at the high standards required for his City and Guilds Technological Certificate.

Recruitment of radio engineers through the Ministry of Labour is governed by the conditions laid down by the Technical and Scientific Register (Electrical Engineering Section) where the conditions for enrolment are dependent on holding a university degree or membership of a particular professional institution.

The meeting of these requirements involves a 5-year study of electrical engineering, and thus the full technological certificate in telecommunication engineering is not taken into consideration in determining eligibility for enrolment on the Register.

"PERSONNEL MANAGER."

Valves for Microwaves

1.—*Mainly on the Magnetron*

By "CATHODE RAY"

SCOTLAND and the north of England depend for their daily television on radio links working at frequencies around 4,000 Mc/s. And this is only one of the present-day uses of frequencies above about 1,000 Mc/s, commonly called microwaves. Radar, for instance. Most of you probably know that ordinary valves are no good at all at these frequencies, and that weird types such as klystrons and magnetrons are used, but you may be rather vague about how these special types work. They have been described from time to time, especially just after the War, but to the younger readers at least that might as well have been in the days of William the Conqueror for all the notice they were able to take of it at the time; and in any case these descriptions are rather scattered, and either refrain from getting down to the basic principles or explain them too learnedly to be understood. So what I propose to do this month is to review the main types of microwave valve.

First of all, though, a brief reminder of why special types are needed. There are several reasons; but mainly two. The first is transit time. In the ordinary types of valve, electrons are released from the cathode and attracted across a short space to the anode by the positive voltage maintained there. The flow is usually controlled by one or more grids encountered on the way. Imagine that a negative voltage is suddenly applied to the control grid, sufficient to cut off the flow of electrons—and hence the anode current—completely. At the instant this happens a large number of electrons are actually in transit between cathode and anode. So there is inevitably a sort of "amber phase" while the traffic is getting clear of the crossing. During it, the signal at the grid is not completely effective in stopping the arrivals at the anode. Moreover—and we shall look into this later on—the crowds of electrons departing from the grid in both directions, although not actually in contact with it, are equivalent to a temporary conducting path from the grid, damping the source of the signal. Thanks to the agility of the electron traffic and the narrowness of the crossing, this phase is only of the order of a thousand-millionth of a second—little enough to be negligible in comparison with each cycle at ordinary broadcasting frequencies. At television frequencies it is not negligible, but is insufficient to upset the working of the valve completely. The result of raising the signal frequency to thousands of megacycles per second, however, is rather like raising the frequency of the signal lights at a busy crossing to a cycle every few seconds—traffic would be only halfway across in response to the green when they would go red, and a state of chaos would ensue.

The other difficulty at such high frequencies is that the free-space wavelength is only a few centimetres, and half that distance corresponds to a complete reversal of phase. At 4,000 Mc/s, for example, it is only about one and a half inches. So if that happened to be the distance between the grid of a valve and the point where it was connected to the circuit, the result might well be the exact opposite of what was intended! A different aspect of the same thing is the capacitance and inductance of the electrodes and their leads, which tend to make nonsense of conventional valve circuit design. If, in order to avoid this, the dimensions of the valve were made small compared with the wavelength it would be too small to handle appreciable power.

Nevertheless, such is human ingenuity that the design of the ordinary triode has been developed to the extent that it works at well over 3,000 Mc/s. There is actually a type in the current Mullard catalogue, designated the ME1001 and having the very conventional heater rating of 6.3 V, 0.4 A, capable of working down to 8 cm wavelength (3,750 Mc/s). Such valves are called disk-seal triodes, because of the technique mainly responsible for this surprising performance. The construction is shown in Fig. 1. Whereas in ordinary valves the leads to the electrodes each come out through the glass at one point, or perhaps two, here the grid and anode are the central parts of disks which emerge through the glass wall all round, dividing it into three sections. So it was necessary to devise a technique for sealing the metal disks to sections of glass tube. One advantage of this construction is that the grid and anode "leads" are equivalent to a vast number of wire leads in parallel, so their inductance is correspondingly small. Another advantage is that they can be fitted to a coaxial cylinder tuning system, of which they form the end disks. The cathode is an extension of the innermost cylinder or rod. Still another advantage is the large

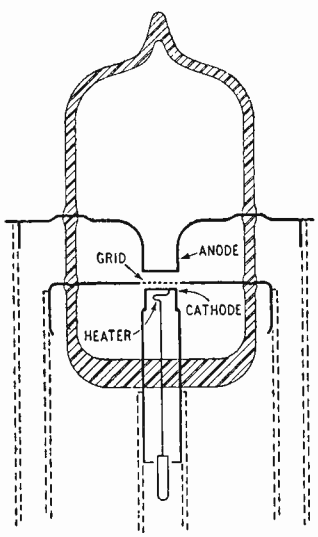


Fig. 1. Section of disk-seal triode, showing how the glass bulb is divided into three sections by the anode and grid disks, and the way in which the electrodes form terminations of the coaxial cylinders (shown dotted) used as tuning circuits. The spacing between the grid and cathode is actually somewhat less than shown here.

amount of cooling that can be brought to bear on what is usually the weakest point when it is concentrated around a wire lead—the glass seal.

As for transit time, that is reduced by phenomenally close spacing; in some types the distance between grid and cathode is literally only the thickness of a sheet of paper. Needless to say, all this precision costs money. And the oscillator power obtainable falls off with frequency, until at 4,000 Mc/s it is difficult to get any at all. At 3,000 Mc/s it is usually about half a watt maximum. This may not sound impressive for a radio transmitter, but it must be remembered that at such short wavelengths the radiation can be concentrated into a narrow beam so that a very little power goes quite a long way.

The idea of using triodes for r.f. amplification at even 1 Mc/s sounds very pre-1925-ish, so it may startle some to learn that this kind of triode can amplify effectively up to thousands of megacycles. An earthed-grid circuit must be used, of course, and Fig. 1 shows how the disk-seal construction makes the grid an extremely effective anode-to-cathode screen, which can easily be continued externally.

That is about as far as what we may call the straightforward approach to microwave valve design has gone so far, and for present requirements it is not far enough. So we come to the main subject: the microwave valves based on entirely different principles, to wit, the magnetron, the klystron, and the travelling-wave tube.

If I were to assure you that anybody who is familiar with ordinary valve electronics can quite quickly and easily learn how these other types work it might be comforting but it wouldn't be true. Although there is nothing really mysterious about them, and their functioning can be explained in terms of basic electrical principles, the particular combinations of those principles will be unfamiliar to many readers. Anybody can keep on throwing a ball up in the air and catching it, and in principle it makes no difference if there are three or four balls, but in practice it is much more difficult than with one ball only. While attention is being concentrated on one the others get the better of us.

Here are four principles I hope I may call well known:

(1) A negative charge is attracted by a positive charge. That is why electrons, which are negative charges, move smartly towards the positively charged anode of a valve.

(2) Charges in motion are an electric current. So the stream of electrons across the empty space in a valve is a current. (Since unfortunately they happen to be called negative, the positive direction of current must be from anode to cathode.)

(3) When a current flows through a magnetic field it experiences a force at right angles to its own direction and to the direction of the field, as shown by the left-hand rule (Fig. 2).

(4) When a charge moves under the force of attraction as in (1), energy is imparted to it by the source of the attraction; but when it moves against a force it imparts energy. This may sound rather highbrow, but it is merely the electrical counterpart of the well-known fact that if a brick is allowed to fall under the attraction of gravity, it acquires energy—enough, perhaps, to crack one's skull—but if it is thrown upwards it parts with its energy of motion and consequently slows down.

In the magnetron all these things are going on at

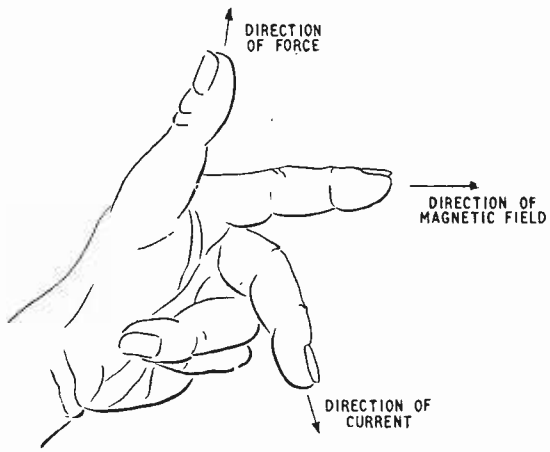


Fig. 2. Left-hand rule for indicating the direction in which a magnetic field exerts a force on an electric current. The direction of the current is reckoned as opposite to the direction in which the electrons constituting the current are moving.

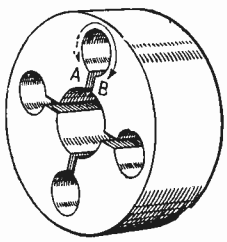


Fig. 3. In the normal mode of oscillation of a resonant cavity in a magnetron, a current flows to and fro between A and B, making them alternately positive and negative.

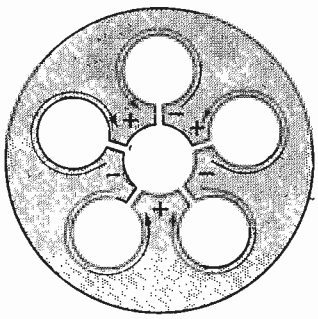


Fig. 4. If there were an odd number of resonant cavities they could not all oscillate in the normal mode, for the reason shown here.

the same time, so it becomes difficult to follow—even when the speed of the action is mentally reduced from, say, 3,000,000,000 cycles per second to about 1. Still, by giving a little thought to the matter one can get at least a rough idea; and it is certainly interesting and wonderful enough to be well worth the attempt.

I am assuming that the workings of ordinary valves and tuning circuits are familiar. If your understanding of tuning circuits has so far been confined to the sorts in which the inductance and capacitance are separate, one being provided by a coil and the other by a system of parallel plates, then it is first necessary to get used to the idea that when in order to make the wavelength very short indeed the number of turns is reduced to one or less and the "plates" are very small and far apart the form of the tuned "circuit" may become quite different, and in general the inductance and capacitance are all mixed up together. A half-wave dipole is an example. For purely tuning purposes, however, it is unsuitable because of the

heavy losses by radiation. In the frequency band we are now considering, one of the best forms of tuning circuit is what is called a resonant cavity. The substitution of sheet for wire is a good idea, because at these high frequencies the current flows mainly near the surface ("skin effect"). An important thing to keep in mind is that a cavity or suchlike generally has several frequencies at which it can resonate, depending on the pattern of current and charge and the associated magnetic and electric fields. A rectangular metal box, for example, could resonate from end to end, or at a higher frequency from side to side or top to bottom. The flow of current to and fro is associated with inductance (because of the magnetic fields set up), and the alternating accumulations of charge piled up are associated with capacitance (because of the electric fields set up); so these kinds of tuning circuit are really the same in principle as the old coil and condenser.

If you were to take a cylindrical block of copper and drill several big holes through it as in Fig. 3, cutting slots from the centre hole to all the others, you would have a multiple tuning circuit or resonator. There are various ways or "modes" of oscillation, each at a different frequency. In one of these, current flows to and fro around the hole as shown by the arrows, causing alternating potentials and electric field that are especially concentrated between the opposite slot faces A and B. The three other outer holes are, of course, identical resonators, and since they are all electrically coupled together it is only necessary to start current in one of them as shown and the whole lot are soon oscillating merrily.

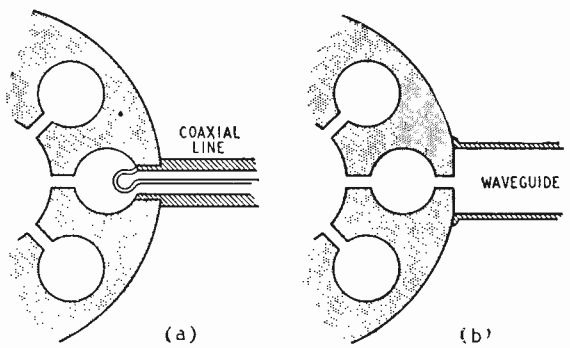


Fig. 5. Two methods of taking off the power developed in a magnetron: (a) by inductive coupling to a coaxial feeder, and (b) by waveguide.

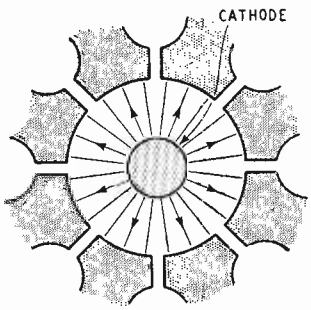


Fig. 6. Directions of electron flow in a magnetron with no magnetic field.

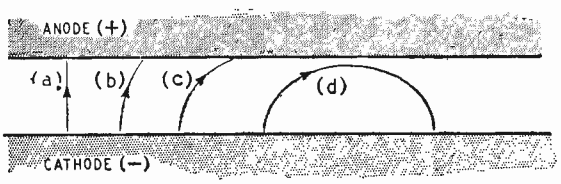


Fig. 7. Here the cylindrical cathode-anode space in Fig. 6 is "rolled out flat" and no divisions are shown between cavity poles. (a) shows the path of an electron with no magnetic field; (b)-(d) with increasing field.

In discussing the evolution of the ordinary triode into the disk-seal type I pointed out that the valve electrodes find themselves unavoidably forming a significant part of the tuning circuits. In the magnetron there is no attempt to make any distinction between valve and tuners; both are completely combined. The anode of the original cavity-resonator magnetron was made exactly as in Fig. 3, except that there were six outer holes, and nowadays there are eight or more. The reason for an even number is that it is necessary if oscillation is to take place in the mode shown. If the number were odd, then one "pole" would have to be both positive and negative at once, which would be awkward for it (Fig. 4). Rather than do that, it would oscillate in some other mode, which would probably be less efficient and at the wrong frequency.

Just as one knows perfectly well that the hero of a thriller is bound to survive, however improbable that may appear from time to time, in the same way you will I am sure be quite confident that before the present story is ended a means will be found for maintaining powerful oscillations in the cylindrical cavities just described. So you will not be worrying about whether or not this is possible, but confidently assuming the possibility will be able with undivided attention to admire the excellent features of this tuning system. It is delightfully simple. (Though in case it looks just too dead easy to manufacture I ought to mention that in order to ensure that all the resonators peak at the same frequency it has to be a real precision job). Then the losses are very low (Q high). This is not only because the current path is entirely through copper and is short and wide, and because there is no other material present where the fields are—not even air—but because radiation is almost completely cancelled out by the symmetry of the system. And this smallness of losses, combined with the unequalled possibilities of cooling, suggests the possibility of exceptional power. It is doubtful, however, whether even the inventors expected power of the order that was soon actually obtained. Instead of fractions of a watt, or even of a kilowatt, the output at 3,000 Mc/s soon leapt up to *thousands of kilowatts*. Admittedly this was peak power under pulse conditions, but even so it seemed as difficult to believe as some of the exploits of the hero of fiction.

You may be wondering how one takes delivery of this power. A usual type of outlet is a ridiculous little coupling "coil" in one of the cavities—a single turn about the size of the curl in a safety pin, leading to a coaxial cable (Fig. 5a). Another scheme is an external slot leading direct into a waveguide (Fig. 5b).

And now, having counted our kilowatts before they are hatched, we can no longer dodge the mental jugglery of visualizing the hatching. The cathode, if you didn't know or haven't already guessed, is situated along the axis of the centre hole. So when the h.t. is applied, and if there were no magnet, the electrons would fly radially off in all directions (as in Fig. 6) to the walls of this hole, which as well as being the anode, incidentally form the poles of the resonators.

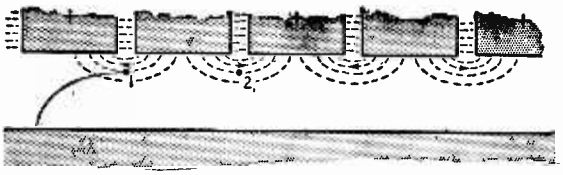
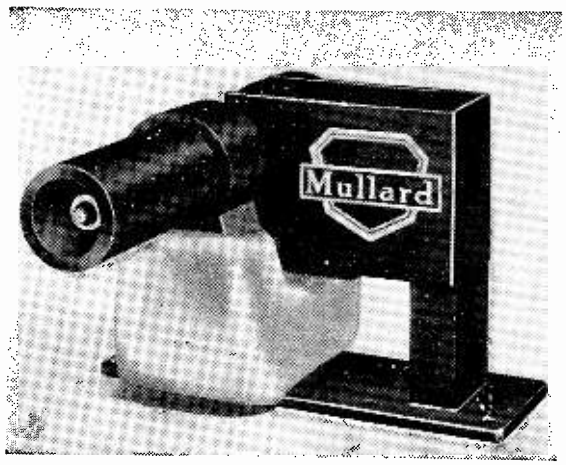


Fig. 8. When alternate oscillatory potentials are superimposed on the high positive potential of the anode as a whole, electrons moving in paths such as Fig. 7(d) interact with the oscillatory fields; those moving against the field, as at position 1, give up some of their energy to the field in being decelerated by it; those moving with the field receive some of its energy and are accelerated thereby.



External appearance of a typical modern magnetron. It works at about 9,400 M/cs and has a power output of 14kW. The light-coloured piece of metal is the magnet.

There is no grid to complicate this simple process. But when we take account of what the magnet does we shall not want to have even a slight unnecessary complication, so to simplify matters still further let us imagine that the radial space between cathode and anode is "unrolled" into a parallel one, as in Fig. 7. Then the natural paths of the electrons are all vertically upward (a), in accordance with our Principle No. 1.

As its name suggests, the magnetron is incomplete without a magnet, and this we now put into position, with its poles at opposite ends of the cylindrical space through which the electrons travel. The direction of the magnetic field is therefore parallel to the cathode, or end to end. This is the direction in which we are looking in Fig. 6, and also in the unrolled version, Fig. 7—down into the paper. Since the electrons are an electric current (Principle No. 2), Principle No. 3 comes into force. Applying the left-hand rule (Fig. 2) and remembering that the direction of the *current* is *downward*, we gather that the electrons will find themselves to be what the Communists would describe as right deviationists. So far we have not gone into details about the actual strength of the force that is now controlling their destiny. It is proportional to the amount of charge carried by the electron (which is an unchangeable constant of nature) and to the strength of the field (as one would expect). It is also proportional to the speed of the electron, and this introduces the most fascinating mathematical complications into the problem. For the speed is not constant but steadily accelerates as it approaches the anode. And it is also accelerating sideways due to the magnetic influence, but the amount of this acceleration is proportional to its velocity. All this may sound bewildering. To anybody familiar with differential equations it is not terribly difficult, and even with ordinary description one should be able to see that the curious paths that electrons actually take are more or less what one would expect.

If the magnetism is relatively weak it is to be expected that the path would be something like the sample shown at (b) in Fig. 7. A somewhat stronger field would cause a greater deviation, as at (c). Remember that by the time the electron is close to the anode it is moving much faster than near the start, so is the more powerfully deflected. And remember too that when you have taken a turning to the right your right is now back in the direction from which you started. So you will not be surprised that when the magnetic field is increased beyond a certain point the electrons miss the anode altogether and find themselves driven back on to the cathode, as at (d).

So much is plain sailing. It is when account is taken of the oscillating potentials of the anode segments or poles, superimposed on the steady positive h.t. voltage, that things become rather tricky. You may think I am cheating by first assuming that oscillation exists before showing how it is maintained, but we all know by experience that when the conditions for maintaining oscillation exist in any valve circuit there is no need to do anything special about starting it; the slightest disturbance, such as switching on the h.t., or even just the arrival of a batch of electrons, shock-excites a resonant circuit into some slight oscillation and it very quickly builds up. So we are entitled to suppose that the cavities are already in a state of oscillation, which if it is in the usual mode results in alternate polarities (above and below + h.t.) as shown in Fig. 8. This is, as it were, an instantaneous snapshot at peak voltage during one half-cycle. In addition to the electric field due to the h.t. there will be a field distribution as shown dotted. The arrows show the directions in which an electron would tend to be urged by it.

Suppose an electron has reached position 1 (compare Fig. 7(d)). It is being impelled by the combined influence of h.t. field and magnetic field *against* the oscillatory (dotted) field. So, bringing on Principle No. 4, we know that it is giving up some of its energy to that field, contributing in its own small way to maintaining the oscillation. And being slowed down thereby it is deflected less forcibly by the magnetic field, and the pull of the h.t. is able to regain some degree of control. If everything is right (h.t. voltage, magnetic field strength, and resonant frequency of the cavities) this electron should find itself near the next gap to the right (position 2) just when the progress of the oscillation cycle has reversed the polarity, making it the same as it was at position 1 half a cycle previously. So it continues to give up energy towards maintaining oscillation and at the same time allowing itself to be drawn nearer the anode, on which it ultimately lands.

Now consider an electron that has been born out of due season, so that unluckily it happens to be around position 2 when the polarity is as shown. It is accelerated by the oscillatory field, drawing off energy therefrom and tending to damp out the oscillation. Its

greater speed enables the magnetic field to gain greater control, dashing it the more violently back to the cathode. Although this electron—and others like it—are technically stigmatized as "unfavourable," they have a chance to redeem their character, as we shall see in a few moments. The foregoing account may make it seem that there are precisely equal chances of electrons helping or hindering oscillation, so that it would inevitably die out, but the situation is saved by the fact that whereas unfavourable electrons are rejected at the first attempt the favourable ones continue in good works for several half-cycles before being finally received into the anode of the blest.

This is, of course, a vastly simplified picture. There are all sorts of subsidiary effects; for instance, electrons that are a little behind the most favourable ones find themselves in a part of the oscillatory field that has a vertical component, which tends to speed them up slightly into the more favourable position. Contrariwise, those just ahead are slowed down. So there is a tendency for all the favourable electrons to move around together, like the spokes of a wheel. Although the individual contributions of the electrons to the oscillatory power are so small, their combined efforts synchronized in this way are responsible for the enormous powers actually obtained, with efficiencies of up to 50 per cent.

If you were a bit incredulous—as you well might have been—when I said that some magnetrons have an output of thousands of kilowatts, you may have performed a rough mental calculation. Whether you did then or not, you can do it now. A certain type has a peak output of 2 megawatts. Even if the efficiency is as much as 50 per cent, that means an input of 4 MW. The h.t. voltage is 40 kV. Then it is easy to work out that the anode current must be 100 amps. Looking up a catalogue of conventional transmitting valves you will see, for example, that a type giving a peak emission of 100 A requires a filament consuming 600 A at 27.5 V, or 16.5 kW, and you may be wondering how such a heater can be got into a space only an inch or two long and a fraction of an inch in diameter, and what happens to the magnetron when it is switched on. The fact is that only quite a small heater is needed in the magnetron, and after it has been running a short time even that can be switched off! The apparent failures, the "unfavourable" electrons, in their fall back on to the cathode dislodge other electrons by secondary emission, which then go up to take their chance with the rest. The more these are the more are emitted, and the number made available in this way is about a thousand-fold greater than the heater alone can provide. So the "unfavourable" electrons are in fact essential to the working of the high-power magnetron.

If you want to know more about these fascinating valves, which incidentally may well have made the difference between defeat and victory in the last war, I can recommend two books: "The Resonant Cavity Magetron," by R. S. H. Boulding (Newnes), and "The Magnetron," by R. Latham, A. H. King and L. Rushforth (Chapman & Hall). As for the klystron and travelling-wave tube, they will have to wait until next month.

NEW POLICE TRANSMITTER

Frequency-modulated 250-watt V.H.F. Radio-telephone

ONE of the most powerful v.h.f. radio telephone transmitters used so far by the police in this country has been supplied by the General Electric Company to the Metropolitan Police for use at their transmitting station at Forest Hill, London.

In this case the requirement was for a single transmitter to give communication with mobile patrols anywhere within a built-up area of some 750 square miles. As the fringe areas are considerable distances from the transmitting station high power was required and this has been provided by the G.E.C. model BRT108, which is capable of supplying an r.f. output of 250 watts on any spot frequency within the band 70 to 100 Mc/s.

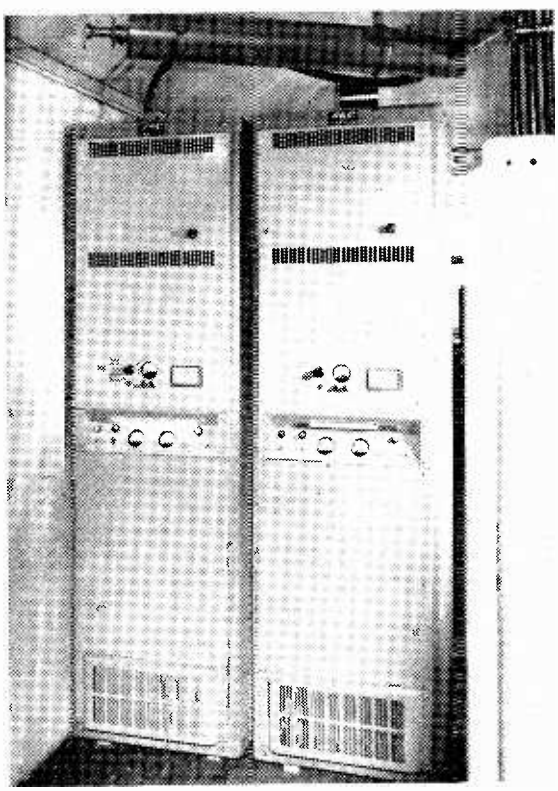
The transmitter, which is crystal stabilized, is in its early stages phase modulated but corrected to give a frequency-modulated output with a deviation of ±12 to 15 kc/s.

As the illustration shows there are actually two BRT108 transmitters installed side by side. One is a standby set kept ready for immediate operation in the event of failure of the other.

The transmitters, which are remotely controlled from the police operations room, consume 1,100 watts each on full power and 280 watts on stand-by.

A 70-ohm co-axial feeder conveys the r.f. output to the aerial at the top of a 100-ft lattice tower and as the site is one of the highest in London (the aerial is some 450 ft above sea level) the high power available ensures a good signal throughout the service area.

Special attention is given to the all-important matter of maintenance. All parts are very accessible and by a system of runners and studied distribution of weight any of the several units can be removed and replaced by one person.



The two BRT108 v.h.f. f-m transmitters supplied by the G.E.C. to the Metropolitan Police Force.

International Monitoring

Receiving Station of the European Broadcasting Union

By J. TREEBY DICKINSON*

THE European Broadcasting Union was founded in February, 1950, at a meeting of representatives of Western European broadcasting organizations and its present membership includes the broadcasting organizations of 23 countries in the European Broadcasting Area, with 11 broadcasting organizations in other parts of the world as associate members. Its objects are: to facilitate and co-ordinate the exchange of information on all aspects of broadcasting; to undertake research work of general interest; and to put forward the common viewpoint of its members at international conferences.

The activities of the E.B.U. are divided between two establishments, one at Geneva, which deals with cultural and legal matters, and the other, called the Technical Centre, at Brussels. The building that houses the Technical Centre was originally constructed for the offices and receiving station of the International Broadcasting Union (the predecessor of the E.B.U.), in what was then an almost rural district on the outskirts of the city. As a result of steady development over the last two decades and particularly since the war, the Centre is now in the middle of a busy suburb, and the level of electrical interference is such that the location is no longer suitable for a receiving station. It was, therefore, decided in October, 1951, to build a new receiving station on a technically more suitable site.

The search for a site was not an easy one. In addition to the obvious requirement of low noise level, which suggested a site remote from roads, railways, power lines and transmitting stations, it was necessary to stipulate reasonable communications and services. It was necessary, also, to be reasonably sure that the noise level would remain low. This was particularly difficult as there is no law in Belgium corresponding to the British town and country planning regulations, and there could be no certainty that a factory using radio-frequency heating or making and testing electro-medical apparatus might not be built on an adjoining site. Finally it was decided that the safest solution would be to seek a site as close as possible to a long-distance radiotelegraph receiving station then being built by the Belgian Department of Telegraphs and Telephones at Jurbise, near Mons. This would solve the problems of communications and power supply, and the E.B.U. should profit by anything the Administration did to protect its own station from man-made interference. The Union was actually able to lease about six acres of the Administration's own site, with wayleave to erect additional aerials on the rest of the Administration's ground.

The new building, which was officially opened as the Jurbise-Masnuy receiving station on July 22nd, is a one-storeyed building of about 80 feet by 40 feet with underground accommodation for the frequency standards, stores, batteries and the central-heating plant.

The Technical Equipment

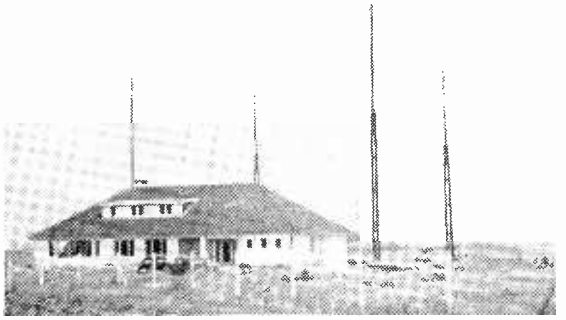
Before discussing the technical equipment it is perhaps appropriate to mention some of the functions which the station has to perform. These may be divided roughly into (a) routine operations and (b) special studies. The former include a regular and continuous watch on all the broadcasting bands. The information so obtained is used, in conjunction with data obtained at the receiving stations operated by member organizations, in the compilation of the periodical reports on conditions in the bands. These reports are prepared primarily for the benefit of the members of the E.B.U. by the Technical Secretariat which remains in the original offices in Brussels.

These routine operations are carried out in three of the five receiving cubicles, each measuring approximately 16 feet by 8 feet 6 inches in size, which are provided in the new building. In these cubicles have been installed receivers designed and constructed by the Technical Centre. The first cubicle is devoted to v.h.f. reception, the second to h.f. and the third to the long- and medium-wave broadcasting bands. The fourth cubicle is normally held in reserve and the fifth is used for the special studies undertaken at the request of individual members, or as contributions to the study programmes of the several Working Parties set up by the Technical Committee of the E.B.U.

Normally receivers are required to stay tuned to a given transmission for a considerable time, but at this station they are required to stay tuned to a transmission only long enough to identify it, measure its frequency and assess the standard of reception. The shorter the time taken to deal with one station the better. The electrical requirements are therefore a high and variable selectivity, low receiver noise and, particularly, the minimum of spurious responses. The mechanical requirements include extremely robust and easily operated tuning arrangements and easily read tuning scales.

The arrangement adopted for the layout of the receivers might be considered as a compromise between the vertical rack arrangement and the so-called

*European Broadcasting Union.



The new E.B.U. receiving centre at Jurbise-Masnuy, near Mons, Belgium.

"console." The main units of the receivers and the frequency-measuring sets are mounted on the upper parts of racks, with the power-supply units beneath, and in front of these are mounted wide sloping desks on which are the controls and the interpolation devices for frequency measuring. Provision has been made for magnetic-tape recording as an aid to identification, and it is planned to provide in due course a cathode-ray display of received signals over more or less narrow bands of frequencies.

As mentioned earlier, the frequency standards are installed in an underground compartment which is thermostatically maintained at a uniform temperature. There are two standards, one basically a "Telefunken" instrument of pre-war design, obtained from the U.I.R. and extensively modernized. The quartz crystal frequency of 500 kc/s is fed to a doubling stage before the multi-vibrator, from which outputs spaced at 100, 10 and 1 kc/s, and, of course, at 1,000 kc/s, are distributed. The frequency is normally constant within 3 or 4 parts in 10^8. The other standard is of American manufacture.

Frequency Measurement

The method adopted for frequency measurement is fundamentally one of the classical methods, and the only novelty introduced is its adaptation to rapid operation. To minimize the risk of operators' errors, which can be quite serious towards the end of a period of duty, as many operations as possible have been made automatic and, among other devices, a simple arrangement has been incorporated to give an immediate indication of the sense of the frequency difference between the signal to be measured and the locally generated oscillation.

The receiver having been tuned accurately to the signal to be measured, a signal is injected into the r.f. amplifier of the receiver. The injected r.f. signal is selected so that the heterodyne frequency produced in the receiver output is a fairly low audio frequency, the local signal having the lower frequency. Next a locally generated audio frequency is injected into the a.f. chain of the receiver and adjusted to zero-beat with the first heterodyne tone. The reading of the a.f. oscillator then gives the amount to be added to the whole number of kc/s to obtain the frequency of the signal being measured. The accuracy of this method depends upon the accuracy of the frequency of the injected radio frequency signal and upon that of the audio-frequency oscillator. The injected frequency is checked at each observation by reference to the multi-vibrator output and the a.f. oscillator is accurate to within one or two cycles per second. Measurements made by this method in the ordinary course of routine operations have an accuracy of four or five parts in 10^7.

This method of frequency measuring is generally used but when, as often happens, the signal frequency is within a few cycles of a known integral number of kilocycles per second, the output of the 1-kc/s multi-vibrator is injected into the r.f. amplifier of the receiver and the beats are counted against a chronometer. The sense of the difference is determined by introducing a phase-change in the feed to the multi-vibrator, which has the effect of changing the local frequency in a known sense. Work is at present going forward on a scheme to extend the application of this method by utilizing electronic counting.

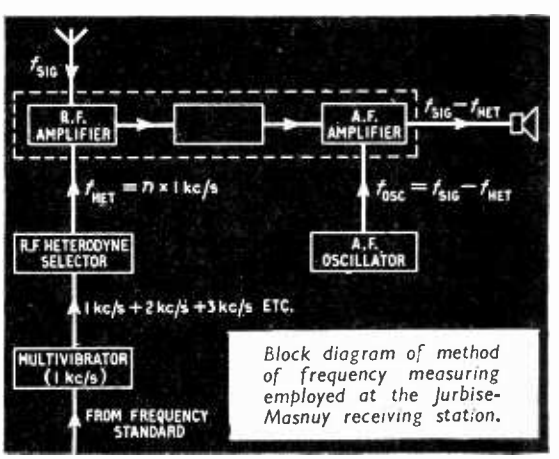
The Aerials

For long and medium waves, inverted "L" aerials are used as they are effective for both ground and sky waves. For h.f. broadcasting, elevated horizontal dipoles have been found most satisfactory. Two sets have been erected at right-angles, giving approximately E-W and N-S directivity.

For v.h.f. a rigid horizontal dipole is used. It is slung, complete with its rotation motor, immediately above the v.h.f. receiving cubicle. It can be readily lowered and for measuring v.h.f. field-strengths the dipole elements are removed and a signal from a standard-signal generator injected into the matching unit to obtain the same signal at the receiver.

It is planned to erect in due course a direction-finding aerial for use on h.f. and medium waves, mainly as a means of facilitating reception of individual stations in crowded channels. In the meantime, large rotating frame aerials are being used.

Three h.f. feeders, buried coaxial for the first 100 yards and thereafter overhead open wires, join the E.B.U. building to that of the Belgian R.T.T. station. These enable any of the aerials of the point-to-point station, which are mainly rhombics, to be connected to the E.B.U.'s receiving station. The same feeders can also be used to make the Union's standard frequencies available to the R.T.T. station.



Block diagram of method of frequency measuring employed at the Jurbise-Masnuy receiving station.

PORTABLE ALUMINIUM MAST

200-ft Lightweight Structure for Experimental Use

DURING the early stages of planning a micro-wave relay chain, it is often necessary to try out several likely sites at each relay point before finally deciding on the most suitable one. This generally involves erecting a mast and testing aerials at various heights.

The design of the mast and the materials from which it is made can therefore be quite important and should be such that the minimum effort is required to erect and dismantle it.

A sectional mast intended to meet these requirements has been constructed from a special lightweight alloy known as Noral 51SWP. It is an aluminium-silicon-magnesium alloy having a typical tensile proof stress of 18 tons/sq in.

As an example, a 200-ft mast made of Noral 51SWP complete with steel head, base plates and wire ropes, but excluding anchorage pickets, weighs just over 1½ tons. With the pickets in position it is possible to erect such a mast in an eight-hour working day with a team of six men.

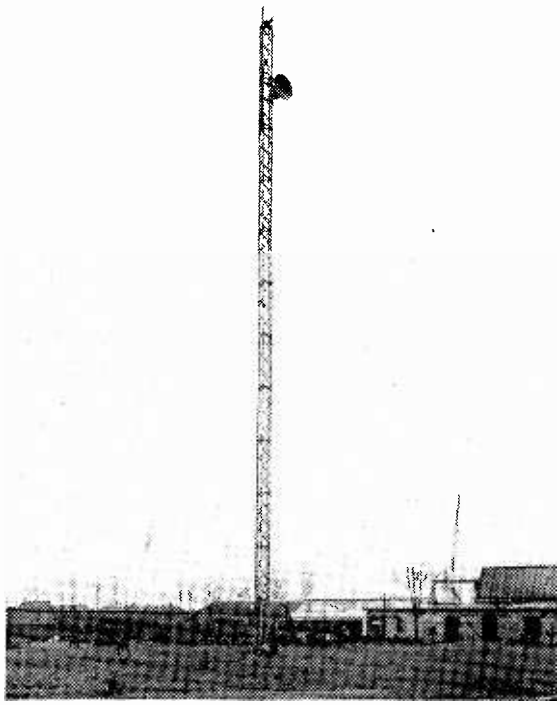
The mast, which is prefabricated, is triangular in section and is of lattice construction. It is built up from a number of sections each 8 ft 4 in long and weighing 110 lb. These are easily handled by two men working on the mast with the aid of a suitable erecting pole. One can be seen at the top of the mast in the illustration and, like the mast itself, is made of lightweight alloy.

Sections of the mast are bolted together by high-tensile steel bolts and these and the few other steel parts used are galvanized as a protection against the weather.

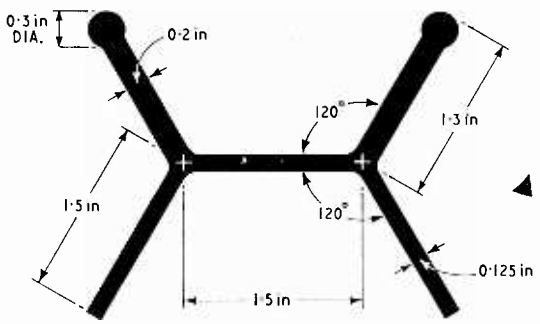
The main longitudinal members of the mast are shaped as shown in the drawing and this particular cross-section is said to enable equipment and aerials to be raised easily up the mast for testing at the various desired levels. The use of aluminium alloy simplifies the production of extruded sections of this kind.

Another advantage of aluminium for outdoor structures is its inherent resistance to weather conditions without the help of protective paint, an important feature in a mast which is frequently being assembled and dismantled since paint would have a very short useful life.

The mast illustrated was built by Painter Brothers to the design of British Insulated Callender's Construction Company, from Noral 51SWP supplied by the Northern Aluminium Company.



Part of a 200-ft experimental portable mast made of lightweight aluminium alloy to facilitate transport and erection.



Cross-section of one of the main longitudinal uprights made from extruded aluminium alloy.

Book on Communication Theory

IN September last year a Symposium entitled "Applications of Communication Theory" was held at the I.E.E., and in our November issue we reviewed some of the more practical topics which emerged from the proceedings. Now, the complete set of papers and the discussions which followed them have been published in book form under the title of "Communication Theory" by Butterworths Scientific Publications.

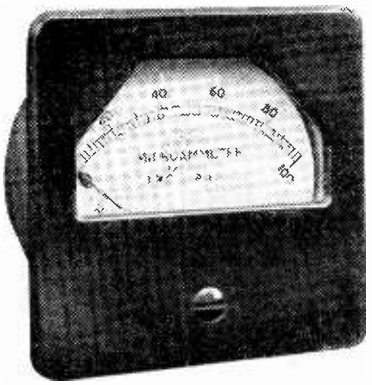
The papers have been arranged under five main headings: transmission systems and coding; transmission in the presence of noise and signal discrimination; characteristics of transmission channels; applications of the theory in television; and transmission and analysis of speech. Other papers not falling into these groups are on information generators, hearing, the statistical structure of language, semantic information, and the application of information theory to optics. In addition there is a very useful summary of the whole field of communication theory by Dr. D. Gabor and an opening address by Professor Willis Jackson, who organized the Symposium.

The book is very well produced and for those interested in this field of study is well worth the price of 65s.

Meter Overload Protection

Use of Metal Rectifiers as a Safeguard for Delicate Instruments

By J. de GRUCHY*



Typical example of a rectifier protected microammeter.

THE wide use of microammeters in the field of communications and electronic engineering has produced a need for a protective system to safeguard these delicate instruments.

In case anyone challenges the use of the word "delicate," they should check the power consumption of representative moving-coil movements. They will find that instrument users of twenty years ago were well satisfied with a 1-mA, 100-ohm movement, i.e., 100 microwatts for full-scale deflection. Nowadays, circumstances sometimes compel the rejection of a 1,000-ohm 50-μA movement (which requires only 2.5 microwatts for full-scale deflection) on the grounds that its resistance is too high. Although modern magnets have made some improvement, it is nothing like the forty times change in power sensitivity noted above. The user of this 50-μA instrument will expect the pointer to move off zero when a half microamp flows through its 1,000-ohm coil (i.e., a 1-% deflection) and when this current ceases to flow he will expect the control spring to bring the pointer smartly back to zero against the frictional torque, despite the fact that the power involved in its excursion is a quarter of a milli-microwatt.

Users could do much towards making the microammeter a less vulnerable instrument by studying their circuit conditions and specifying the maximum resistance that the circuit will permit.

A high resistance winding has more ampere turns, and hence a larger working force for a given current; this permits the use of relatively strong control springs which will return the pointer more accurately to its zero without external assistance. Furthermore, the high resistance will help to limit any fault current that may appear in the circuit and thus provide a measure of protection on its own account.

It is unfortunately true that there are many applications where the permissible circuit resistance for the microammeter is in excess of the maximum value that is commercially available. In the meter the limit is set by the dimensions of the magnet gap, the angular deflection of the coil and the diameter of the wire. The first two are settled by conventional design, whilst the wire diameter is fixed by the skill of the operator in the factory.

It is a relatively simple matter to magnify an instrument pivot by optical means, so that the operator who is polishing the 0.001-in radius at its tip, thinks that he or she is dealing with the business end of a 6-in wire nail. It is not so easy to persuade the operator winding 50-s.w.g. enamelled wire (d = 0.001 in) that it is 22 s.w.g., particularly when it comes to removing the enamel and soldering the connection.

These factors lead to the adoption of 2,000 to 2,500 turns of 50 s.w.g. as the highest resistance generally available, the resistance being of the order of 3,000 ohms.

Whilst there would be a real advantage in employing 52 s.w.g. (d = 0.00006 in) in order to reduce the weight of the copper winding, the difficulty in handling this fine wire restricts its use to the more specialized type of instruments.

The characteristics of a number of commercial instruments using a "Ticonal" magnet and a 0.625-in tunnel are shown in Table 1.

This table shows that it is possible to provide the normal torque at any current sensitivity down to 100 μA with an increasing volt drop as the current sensitivity is increased, until at 100 μA full-scale deflection, the volt drop on the movement is 350 millivolts.

When a full-scale deflection with less than 100 μA

* Electrical Apparatus Co.

TABLE I

Current for Full Scale Deflection	Turns	Res. (ohms)	Torque (mg. cm. for 100°)	Millivolts at F.S.D.	Microwatts at F.S.D.
2 mA	120	9	80	18	36
1 ,, ...	240	36	80	36	36
100 μA	2,400	3,500	80	350	35
100 ,, ...	1,200	1,000	40	100	10
50 ,, ...	2,400	3,500	40	175	8.75
50 ,, ...	1,200	1,000	20	50	2.5
25 ,, ...	2,400	3,500	20	87.5	2.2

is required some torque must be sacrificed and it is here that the case for a high resistance coil becomes apparent.

The microammeter is delicate, therefore, because of its lightweight construction, made necessary by the limited torque available, and also by reason of the fine wire winding on the moving coil. Protection of a microammeter then requires, first, mechanical protection against damage to the movement and, secondly, protection of the fine wire coil from thermal overload.

It will be understood that a fine wire fuse, such as the Wollaston wire fuse described by F. R. W. Strafford (W.W., Feb., 1953, page 90) will be scarcely suitable for the present purpose since reference to Fig. 1 of that article shows that a 600-times overload on our 50-μA instrument takes some five seconds to clear the fault, and although the winding may be protected from thermal damage, the pointer will, in all probability, be found at some quite unexpected angle relative to the coil former.

In order that we may assess the relative merits of different overload protection methods, it becomes necessary to define overload capacity. As far as the writer is aware, no one has yet put forward a definition of overload capacity of a moving coil instrument, and he is well aware that the following definition, while quite practical in its application, may not at first be readily acceptable.

It should be stressed, therefore, that the mechanical overload factor described here is not to be taken as the maximum overload that the movement will withstand. It is a figure of comparison only, and the safe overload factor will be of the order of one-half of the values quoted below.

It is as well at this juncture to consider the effect of an overload on a moving-coil instrument. There is first of all the side thrust on the pivots when the coil and pointer are arrested. There is a danger, if the end play is excessive, that the pivot tip may strike the edge of the jewel cup, but beyond this the writer has yet to find a damaged pivot due to simple overload.

Bending of the pointer as the result of an overload will almost certainly upset the balance of the instrument, and it then becomes necessary to re-balance and re-calibrate the instrument before it can be used as a measuring tool. There is also a risk on heavy overloads that the control spring will fly out and be caught up on any nearby obstruction. Spring guards on the spring anchors will help to reduce this risk.

Lastly, under thermal overload, the insulation between turns or between layers may be damaged, and short-circuited turns or layers will cause the instrument to read low.

Mechanical Overload Tests

For the tests described below, the "mechanical overload factor" is taken as the reciprocal of the ratio of the full-scale current to that current which, when applied suddenly in a forward direction to the moving coil (standing previously with the pointer in line with a side zero mark) causes the pointer so to bend on impact with the top stop that upon the removal of the current (with the scale plate in a horizontal plane), the pointer comes to rest 1 % of the full-scale deflection away from the zero mark. Tests on three representative microammeters showed that they exhibited mechanical overload factors of 140, 150 and 225 respectively, as defined above.

These values may be somewhat higher than the reader might have expected. Little information has been published on this subject, although makers, particularly those in the multi-range meter field, have been actively engaged for many years in making their products as rugged as possible.

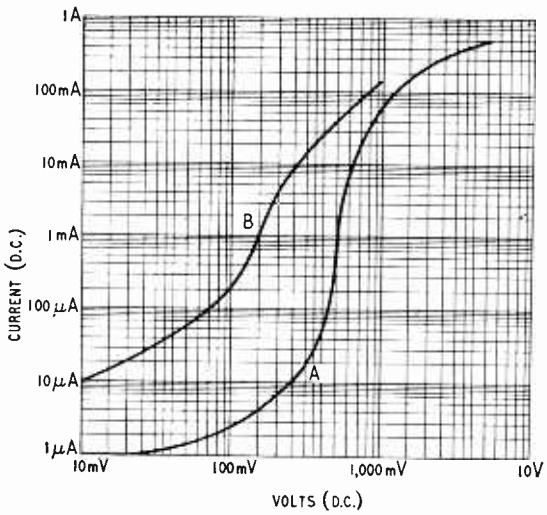


Fig. 1. D.C. voltage/current relationship for metal rectifiers. Curve A, selenium type H9; curve B, copper oxide type 1.1.1.BNS.

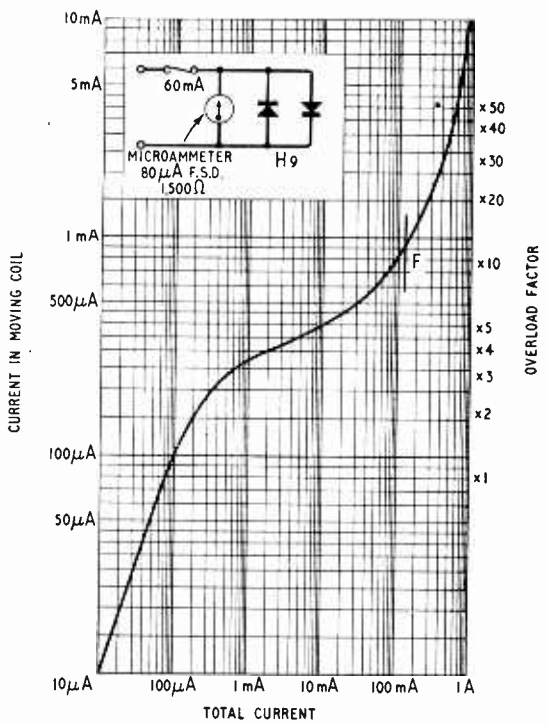


Fig. 2. Test curve of microammeter with rectifiers and fuse for overload protection.

The movements used for these tests have a generous magnet and are more than critically damped. In addition, the resilient pointer-stops are set to support the pointer just below the spade. Whilst a short knife-edged pointer can be made to exhibit similar characteristics, some difficulty is experienced to protecting a pointer with a long knife edge, such as is needed to cover the multitude of scales that are sometimes seen on multi-range instruments.

In the ideal case, the movement would withstand a mechanical overload equal to its maximum thermal overload. The thermal overload capacity is controlled by the surface area of the coil former and the proximity of cooling mass. For a 3½-in instrument, the safe thermal dissipation will be of the order of 500 milliwatts. Taking 10 microwatts as the consumption of our microammeter, this represents a thermal overload of 50,000 times, or a current overload of $\sqrt{500{,}000} = 220$ times.

Even when we have provided this measure of protection, it will be seen that it requires 22 volts only to overload a 100-μA 1,000-Ω microammeter.

Since voltage of at least ten times this value might be encountered, it becomes necessary to provide an auxiliary safeguard. Such a device should also have the property of reducing the maximum overload under any circumstance to a figure well within the capabilities of the instrument movement.

To give complete protection, therefore, a non-linear resistance is connected across the moving coil so that it has negligible shunting effect whilst the pointer is on the scale, but its decrease of resistance with applied voltage allows it to shunt an increasing proportion of the current when the pointer has exceeded a full-scale deflection.

This non-linear resistance has the effect of shunting the movement during overload, and this shunt also serves to pass the current due to the self-generated voltage caused by the movement of the coil. This secondary effect increases the braking torque, and thus softens the impact of pointer on the stop.

The choice of the non-linear resistance will lie between a copper oxide or selenium rectifier disc, and it is necessary to employ discs facing in each direction, to protect the movement against both a forward and a reverse current overload.

The characteristics of a 1.1.1.b.n.s. copper oxide and an H9 selenium rectifier are shown in Fig. 1. Where the full-scale volt drop exceeds 50 millivolts, the copper oxide rectifier is scarcely suitable, on account of the large value of the shunt current at full-scale deflection. Under these circumstances the selenium disc is to be preferred. On the other hand, for the protection of milli-voltmeters having a volt drop of less than 50 millivolts at full scale, the copper oxide rectifier would give a greater measure of protection.

Since these rectifier discs exhibit a negative coefficient of resistance with temperature, a coefficient which may approach 1 % per degree C at small current densities, it is imperative that the current shunted at full-scale deflection shall be a small proportion of the total. With a full-scale deflection with 150 millivolts and a typical H9 rectifier passing 3.5 μA at this voltage, the effect of a 10 ° C change in temperature will give rise to a 0.35-μA increase of current in the rectifier, or a reduction of full-scale deflection current of less than 1 % on a 50-μA instrument.

It is only in the case of microammeters that this shunt error will be observed. When the full-scale deflection is 1 mA or more, the millivolt drop at full scale will be so small that from Fig. 1 it will be seen that the shunt current can be ignored.

In addition to the protection of the moving coil which is given by the rectifier shunt, we now need protection for the rectifier itself. This can be obtained conveniently by means of a 60-mA fuse (the continuous rating of the H9 rectifier is 75 mA) and a double fuse holder carrying a spare fuse can be fitted to the back of the instrument case.

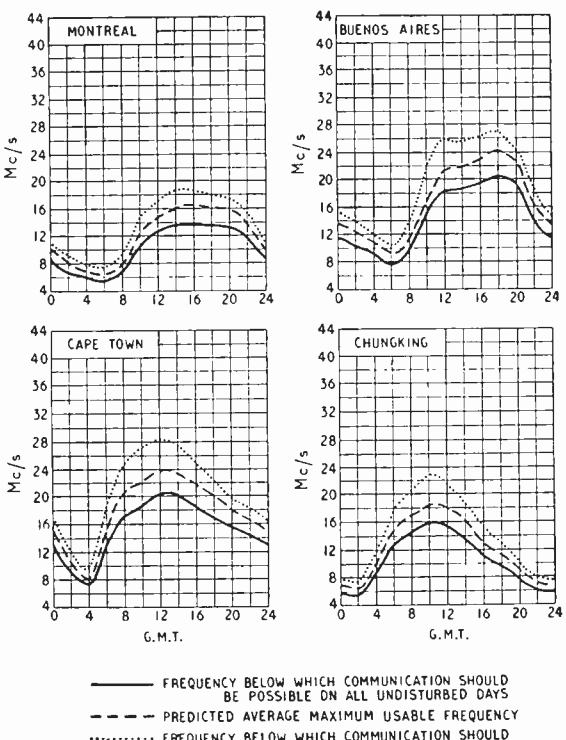
Perusal of the test results in Fig 2, which were taken with the fuse short circuited, show that the rectifier and instrument combination could withstand, for a short period, an overload representing 10,000 times full-scale current of the instrument. The fuse, if connected, would have opened the circuit at about point F in Fig. 2, where the total current in the circuit was 120 mA, representing a 10 times overload on the movement. As explained above, such an overload would do no harm to the movement, and the cost of carelessness will be only the price of a new fuse.

Short-wave Conditions

Predictions for September

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

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



Improving the

SINCE the publication of the original articles on the f.m. feeder unit in the September and October 1952 and February, 1953 issues, the authors have continued work on the design and have succeeded in improving the performance in a number of respects. The chief feature of the improved design is a new frequency-changer circuit which, though simpler than the original gives better oscillator stability. Another feature is a pre-set potentiometer which is included in the discriminator circuit and greatly facilitates adjustment of the unit for minimum response to a.m. signals. The complete circuit of the revised unit is given in Fig. 1 in which, where possible, components have been given the same numbers as in the original circuit in the September issue but do not necessarily have the same values. This circuit as drawn is suitable for use with an EF91 (or equivalent) as r.f. amplifier but the new design is equally suited for use with an EF95 in this position ; the EF95 will, however, require the screen potential divider shown in the original circuit and in Fig. 2.

The essential features of the new frequency changer circuit are shown in Fig. 3. Signals from the anode of the r.f. valve are injected into the cathode circuit of the oscillator via the series inductor L_3. This particular form of signal injection into the frequency changer was adopted because, as shown below, it readily permits an improvement in frequency stability. This inductor L_3 together with the anode capacitance of V_1 and C_{10} constitute a π-section matching network and the value of C_{10} is chosen to give maximum voltage transfer to the low cathode input impedance of V_2. L_3 is effectively tuned by the anode capacitance of V_1 and C_{10} in series and its inductance is chosen to give resonance at the centre of the tuning range. Winding details for L_3 are given in the accompanying table. Best results are obtained with a low value of capacitance across the input to the π-section network and, to keep this capacitance low, the anode load resistor R_5 for the r.f. stage is connected to the output side of the network. C_5 is a d.c. blocking component and its capacitance is not critical provided its reactance is small at the frequency handled.

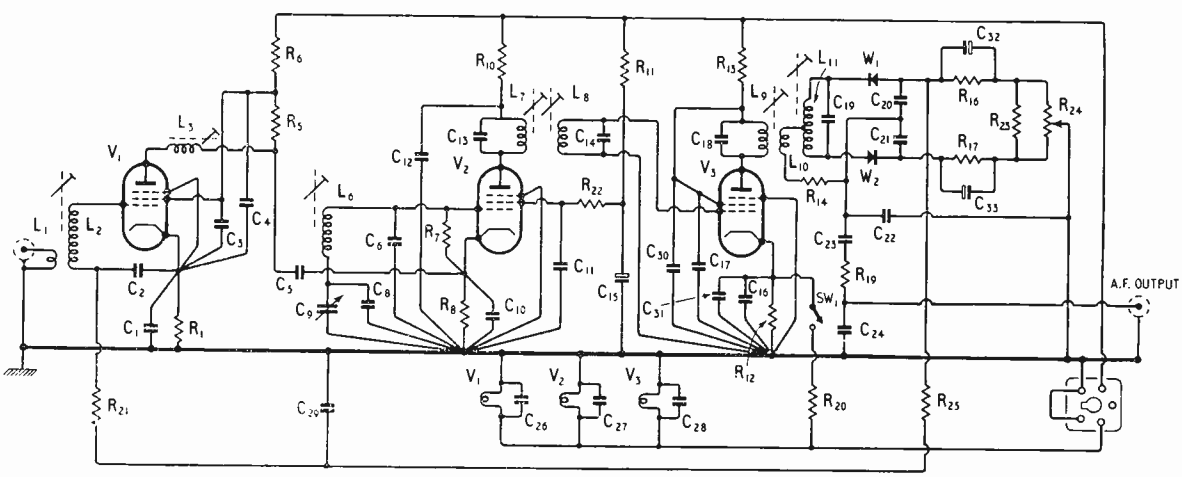
Because of the presence of the π-section network, the cathode circuit of the oscillator is effectively inductive over a small frequency range below the resonant frequency of the π-section network, and is effectively capacitative above it. As the cathode-coupled Colpitt's oscillator requires a capacitative cathode circuit, the oscillator must work above the signal frequency. This is a departure from the original circuit in which the oscillator operates below the signal frequency. The necessary increase in oscillator frequency is obtained by reducing the number of turns on the tuning inductor L_6, winding details for which are also given in the table. It might be thought that oscillation would be difficult to maintain with such a large value (15 pF) of cathode capacitance, C_{10}, but in fact the effective capacitance is appreciably less than the physical value because of the presence of L_3 and V_1 output capacitance.

The stability of an oscillator is dependent on a number of factors but the principal cause of frequency drift in v.h.f. oscillators is variation in valve capacitances ; such drift is very obvious, of course, in the period immediately after switching on when the valve is warming up. In the original oscillator circuit the valve is connected directly across the LC circuit and is thus tightly coupled to it. This gives good amplitude

NEW COIL SPECIFICATION TABLE.

Circuit position	Circuit reference	Winding details
r.f. anode coil	L_3.	8 turns 26 s.w.g. enamelled copper wire occupying a length of 0.5½in approximately.
oscillator coil	L_6	3 turns 26 s.w g. enamelled copper wire occupying a length of 0.3½in approximately.
Formers: Aladdin type PP5892 or PPF 16055. Dust-iron cores : Aladdin type PP5804 or Neosid 901.		

Fig. 1. Complete circuit diagram of the modified F.M. Feeder Unit. Circuit numbers are the same as in the original, but their values may be different (See list of components).



F.M. Feeder Unit

Modifications Giving Better Oscillator Stability and Simpler Adjustment of Discriminator

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

of oscillation and efficient frequency conversion but is not the condition for maximum stability of oscillation frequency. The latter is achieved by coupling the valve very loosely to the LC circuit but if the degree of coupling is reduced below a certain value it is impossible to maintain oscillation. Best stability is thus obtained by using a coupling slightly greater than the minimum value necessary to secure oscillation; this entails a slight loss in conversion efficiency.

Alternatively, stability can be improved by using a tuned circuit of lower L/C value. For a given resonance frequency this implies increased capacitance which tends to "swamp" any variations in valve capacitance. This also entails a loss in conversion efficiency. Increased oscillator stability has been obtained in the new frequency-changer circuit by a combination of both methods, i.e., by use of a larger capacitance across the valve and by reduced coupling to the LC circuit.

Experiments on the f.m. feeder unit showed that if the capacitance across L_6 is made up of two equal capacitors in series, a valve connected across one of them gives adequate oscillation amplitude and good conversion efficiency. In such a circuit, a change in valve capacitance gives one quarter the change in oscillation frequency which is obtained when the valve is directly connected across the same inductor. Thus by tapping the valve down the tuned circuit in this manner, the oscillator stability has been quadrupled. The factor of improvement actually realised with this circuit is such that tuning drift is negligible after the initial warming-up period.

The capacitance in parallel with L_6, i.e., the effective tuning capacitance is made up of four sources namely C_6, C_8, C_9 and the input capacitance of V_2. The latter capacitance varies from valve to valve but an average value for this particular circuit is 8 pF. These four capacitances must satisfy the following:

1. They must tune L_6 to the required frequency.
2. They must give the correct frequency coverage (98.2—110.7 Mc/s) as C_9 is rotated from maximum to minimum. (oscillator coverage).
3. They must be such that the valve is effectively tapped half-way down the resonant circuit.

If L_6 is fixed, these three conditions determine precisely the capacitances of C_6, C_8 and C_9. If L_6 is decreased, the capacitances must be increased to meet these conditions and it is advantageous to make L_6 as small as is consistent with the maintenance of oscillation, because the large capacitance required across the valve ensures high stability. Oscillation is possible with L_6 consisting of a single turn only but a larger inductance is advisable.

It will be noticed that there is no oscillator grid capacitor (such as C_7 in the original circuit); this capacitor is not necessary because the lower end of L_6 is not directly earthed but includes C_8 and C_9 in parallel, these functioning as a grid capacitor.

It was pointed out in an earlier article that the values of R_{15} and R_{18} (Fig. 1 in the Sept., 1952 article) should be chosen to give minimum output when the

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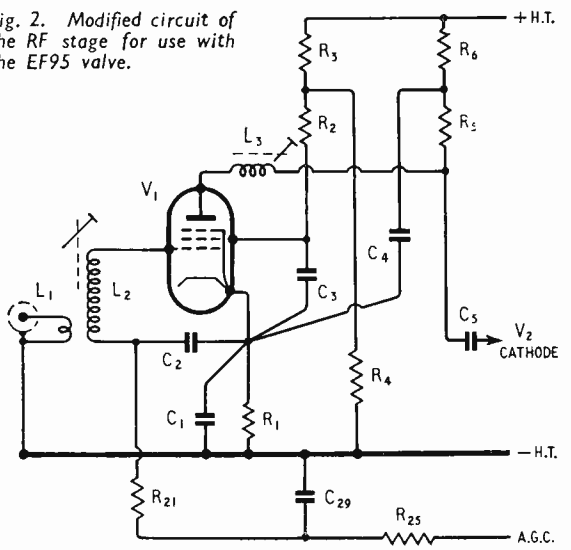
Fig. 2. Modified circuit of the RF stage for use with the EF95 valve.



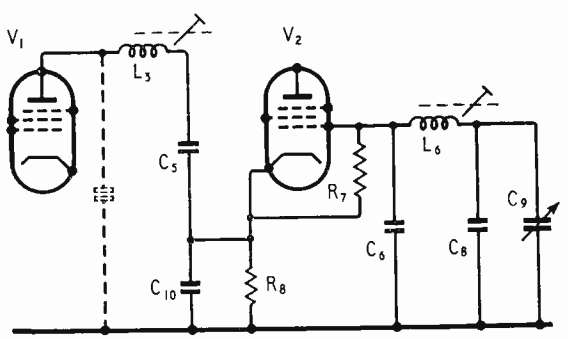


Fig. 3. Essential features of the new frequency changer circuit. Only components necessary for its understanding are included.

unit is tuned to an a.m. transmission, the value of $R_{15}+R_{18}$ remaining at 2.5 kΩ. This adjustment is desirable to obtain the maximum degree of amplitude limiting. The discriminator circuit has been revised to facilitate this adjustment; the four resistor R_{14} to R_{18} constituting the discriminator load are now arranged in a different order, R_{16} and R_{17} being next to the crystals and being shunted respectively by C_{32} and C_{33}. This re-arrangement was made to give R_{15} and R_{18} a common earth connection; these resistors can thus be replaced by the potentiometer R_{24} which has its slider earthed. As a 2.5-kΩ potentiometer may be difficult to obtain, a 5-kΩ component (with the shaft allotted for screw-driver operation) is used and is shunted by a fixed 4.7-kΩ resistor R_{23} to give an effective resistance of approximately 2.5 kΩ. The potentiometer can be mounted on the rear flange of the chassis close to the discriminator components. It should be adjusted to give minimum a.f. output when the unit is tuned to an a.m. signal such as the transmission from Wrotham on 93.8 Mc/s or the output of an a.m. signal generator. It may be found that the potentiometer setting required for minimum output varies slightly with the amplitude of the signal input to the unit. The reason is that the difference between the forward resistances of the two crystals does not, in general, remain constant when these resistances are reduced by the application of larger signals to the crystals.

Because of the inclusion of R_{23} and R_{24} the a.g.c. line is no longer effectively decoupled to earth by the electrolytic capacitor C_{25}, as in the original model, and the additional components R_{25} C_{29} are introduced to filter any audio signals from the a.g.c. line. To avoid congestion around the input side of the r.f. valveholder, these components are included in the a.g.c. line before it enters the screened input compartment of the r.f. valve.

The changes introduced do not affect the method of lining up the i.f. transformers described in previous issues if the slider of R_{24} is set to the mid position. The adjustment of amplitude limiting can be carried out afterwards, following which the r.f. and oscillator circuits should be adjusted as follows:

If V_2 does not oscillate at all, or if it oscillates only when the tuning capacitor is near minimum capacitance, this is probably due to the inductor L_3 being too low and the dust-iron core should be screwed fully in. When oscillation is satisfactory, the oscillator inductance should be adjusted to give the correct frequency coverage. First set C_9 at maximum and adjust L_6 to receive an input to the unit at 87.5 Mc/s. Now set C_9 to minimum and find the frequency to which the unit is tuned. If this is considerably above 100 Mc/s, C_8 should be increased and if it is considerably below 100 Mc/s C_8 should be decreased. If C_8 needs alteration, L_6 must again be adjusted at the low-frequency end of the band. L_1 and L_3 can now be adjusted to give maximum sensitivity at the centre of the 87.5-100 Mc/s band. If the Wrotham a.m. transmission is receivable this will serve as a carrier on which to carry out the adjustment; otherwise the adjustment can be made on the output of a signal generator set to 94 Mc/s. It will be found that adjustment of L_3 affects the oscillator frequency slightly and, as L_3 is varied, the tuning control should be rocked so as to keep the unit accurately tuned.

Ideally it should not be necessary to advance the slugs of L_1, L_3 and L_6 into the centre of the windings in order to line them up. A dust-iron slug in such a position with respect to a winding usually lowers the Q of the inductor at frequencies of the order of 100 Mc/s and better results can be obtained if one end of the slug just enters the winding.

A number of enquiries have been received about the use of an f.m. feeder unit with an audio amplifier which includes a mains unit of which the 6.3-volt winding has an earthed centre tap. In general it is preferable to modify the feeder unit for use with an l.t. supply of this type rather than to transfer the earth connection to one side of the 6.3-volt winding in the amplifier (which might lead to hum). The feeder unit can be adapted by bringing out both sides of all the heaters to connections on the supply socket. Both sides of the heaters should be decoupled to earth by 0.001-μF miniature ceramic capacitors mounted on or very close to the valveholders. A number of such amplifiers supply 400 volts h.t.; this should be reduced to not more than 250 volts for the unit by a series resistor of 4.7-kΩ decoupled to earth on the unit side by an electrolytic capacitor of 450 volts rating and, say 16 μF capacitance. The resistor must be of at least 5 watts rating and will get hot in use. It should not therefore be mounted underneath the f.m. unit for it may cause tuning drift by warming up the oscillator components.

LIST OF COMPONENTS

Resistors.

R_1	180 Ω	R_{14}	47 Ω
R_2	270 Ω	R_{16}	6.8 kΩ*
R_3	22 kΩ	R_{17}	6.8 kΩ*
R_4	47 kΩ 1 W.	R_{19}	47 kΩ
R_5	10 kΩ 1 W.	R_{20}	470 Ω
R_6	4.7 kΩ	R_{21}	10 kΩ
R_7	33 kΩ	R_{22}	330 Ω
R_8	1.8 kΩ	R_{23}	4.7 kΩ
R_{10}	1 kΩ	R_{24}	5 kΩ pre-set potentiometer.
R_{11}	4.7 kΩ		
R_{12}	180 Ω	R_{25}	1 MΩ
R_{13}	1 kΩ		

* Close tolerance.
All resistors 1/4W unless otherwise stated.

Capacitors.

C_1	0.001 μF miniature ceramic.	C_{17}	0.01 μF 350 V.
		C_{18}	10 pF*
C_2	0.001 μF miniature ceramic.	C_{19}	35 pF*
		C_{20}	300 pF
C_3	0.001 μF miniature ceramic.	C_{21}	300 pF
		C_{22}	300 pF
C_4	0.001 μF miniature ceramic.	C_{23}	0.01 μF 350 V
		C_{24}	0.001 μF
C_5	0.001 μF miniature ceramic.	C_{26}	0.001 μF miniature ceramic.
C_6	15 pF*	C_{27}	0.001 μF miniature ceramic.
C_8	15 pF*		
C_9	15 pF max. airspaced variable.	C_{28}	0.001 μF miniature ceramic.
C_{10}	15 pF.	C_{29}	0.1 μF
C_{11}	0.001 μF miniature ceramic.	C_{30}	0.001 μF miniature ceramic.
C_{12}	0.001 μF miniature ceramic.	C_{31}	0.001 μF miniature ceramic.
C_{13}	10 pF*	C_{32}	25 μF 25 V electrolytic.
C_{14}	10 pF*		
C_{15}	4 μF electrolytic.	C_{33}	25 μF 25 V electrolytic.
C_{16}	0.01 μF 350 V.		

* Close tolerance.

Valves.

V_1	EF91, 6AM6, Z77, 8D3, 6F12 EF95, or 6AK5.	V_2, V_3	EF91, 6AM6, Z77, 8D3 or 6F12.

Simple Distortion Meter

Provision for Qualitative Inspection of Distortion Products

By V. J. TYLER, B.Sc., A.M.I.E.E. *

DISTORTION factor, or total percentage harmonic distortion, is a common indication of the quality of an amplifier, since it is an easy quantity to measure. It is not the best indication, for reasons explained later. However, when used in conjunction with an oscilloscope, a distortion-factor meter can be a powerful and subtle tool for analyzing circuit behaviour. When distortion products are purged of the last traces of fundamental, and presented at high level for visual inspection, their complicated nature and great variety are revealed. At the same time it becomes clear that meter readings of percentage distortion may mean anything or nothing, according to the type of distortion present. An accurate meter may therefore be an unnecessary luxury for many measurements. More often, all that is needed is a simple instrument capable of presenting distortion products in a form suitable for oscilloscopic presentation, and, less importantly, to give a reasonably accurate idea of their level on a meter for rough comparison purposes.

A "double-T" bridge-type filter is used for removing the fundamental-frequency component of the waveform to be analyzed. With two of the resistive elements variable as shown in Fig. 1, the fundamental can be absolutely removed. When the bridge is nearly balanced, the changes in output caused by adjusting the two controls are in quadrature phase relationship. Consequently, the controls do not react upon each other, and the bridge can be balanced in two or three moves. The advantages of the double-T bridge for removing the fundamental are, firstly, that it is more compact than most types normally used, and, secondly, that it can be used at very low frequencies without massive inductors. The disadvantage is that different harmonics are differently attenuated and phase-shifted by the bridge, but this is avoided in the present circuit by adding an equalizer after the bridge.

Fig. 2 shows the attenuation characteristics of a plain bridge, A, and with the addition of an equalizer, B. Since the insertion loss of the equalizer at harmonic frequencies is about 15 db, a switch is provided to cut it out where maximum sensitivity is more important than truthful presentation.

The frequency range of the bridge and equalizer

* Marconi Wireless Telegraph Company.

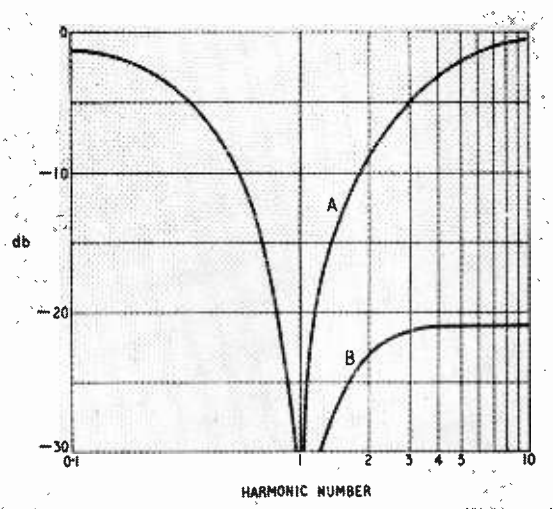


Fig. 2. Response of simple double-T bridge (A), and with the addition of an equalizing circuit (B)

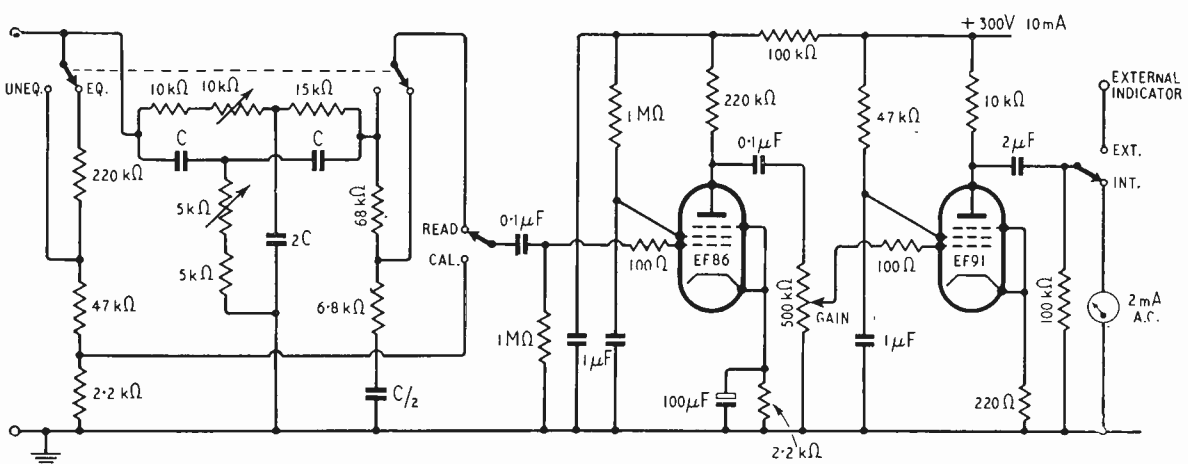


Fig. 1. Circuit diagram of filter-amplifier for removing the fundamental frequency. At 1 kc/s, c = 0.01μF.

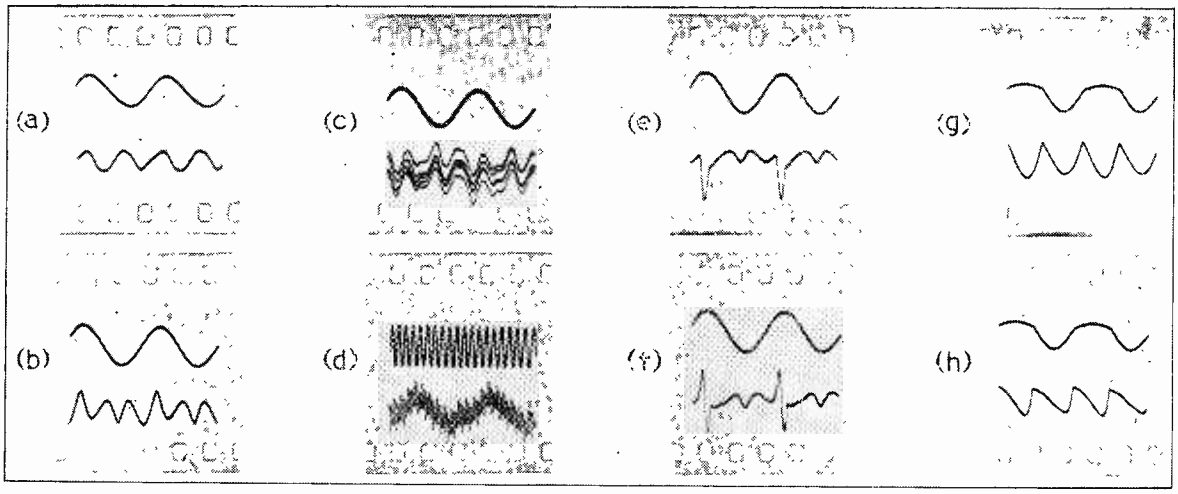


Fig. 3. Oscillograms of typical distortion displays, described in text

network is a matter of choice. If the fixed 15-kΩ resistor is replaced by another 10 or 20 kΩ variable, ganged to the one already shown, smooth "tuning" over a 2:1 frequency range is possible. The four capacitors can then be switched to give overlapping ranges, keeping them always in the ratio shown. The centre frequency of each range is inversely proportional to the value of C, which is about 0.01 μF for 1 kc/s. In the writer's experience, however, only four spot frequencies are necessary to obtain distortion characteristics for an average amplifier, say, 20 c/s, 100 c/s, 1 kc/s and 5 kc/s. These can easily be obtained by switching capacitors, leaving the resistor arrangement as shown in Fig. 1. Components of ±5 per cent tolerance should be used for the bridge and equalizer.

The distortion products leave the bridge at a level of the order of a millivolt, and are amplified by the straightforward amplifier shown. Since only the distortion is amplified, reasonable further distortion in this amplifier is of second-order importance, and no unusual precautions are needed in respect of linearity. The design shown gives about 70 db gain over the range 16 c/s-16 kc/s, but the characteristics may be altered to suit individual cases. The harmonics are measured by diverting the current output of the final pentode through a 2-mA rectifier meter, which gives a direct linear reading of distortion percentage. The meter indicates the average value instead of the more usual r.m.s. value, but there is no point in being academic over so equivocal a quantity as percentage distortion, and in actual practice the average value is little more or less meaningful than the r.m.s. value. The amplifier output can be switched through to an external terminal for oscilloscope use, or for connection to an external r.m.s. indicator if the craving for an r.m.s. value proves irresistible.

A calibration signal is obtained from a potentiometer connected across the source, components for this being of ±2 per cent tolerance. This gives a signal which is the equivalent of 10 per cent distortion, and the amplifier gain is adjusted to make this coincide with any convenient scale marking, according to the expected value of the distortion to be measured. The meter can conveniently be scaled 0-50 divisions, either 10 or 50 divisions being used as 10 per cent marks. Alternatively, two separate scales of 0-10 and 0-50 per cent can be used, and the gain control adjusted on calibration to indicate either of the 10 per cent marks. The input to the bridge needs to be between 0.2 and 2.0 V, r.m.s., with the equalizer out, and between 1.0 and 10.0 V, r.m.s., with it in, for full-scale deflection at 10 per cent distortion.

The meter is operated as follows. First turn the gain to zero and connect up the source at the correct input level and frequency. With the switch at READ, turn up the gain to full-scale deflection and balance the bridge, using both controls to obtain minimum meter reading; turn up the gain further if necessary to see the correct null point clearly. Turn down the gain, switch to CAL, and set the gain for the appropriate 10 per cent mark. Switch to READ and read off distortion on the chosen scale. Switch to EXT. and observe the distortion wave form on an oscilloscope before drawing any conclusions from the measured value.

The oscillograms shown in Fig. 3 illustrate the kind of information obtained in this way. In each case the upper trace is the input to, and the lower trace the output from, a distortion meter having the circuit of Fig. 1. Oscillogram (a) shows second-harmonic distortion due to a large current excursion in a single-sided amplifier. The picture is complicated by the fact that, after generation, the harmonic has been shifted in phase by circuit reactances. This can be seen by comparing the phases of the upper and lower traces, and, with distortion of this magnitude (which corresponds to a meter reading of 7 per cent); it can also be deduced from the visible "slant" of the input waveform.

The result of cleaning up this waveform with a simple filter is shown in (b). Most of the second-harmonic has vanished, but about 0.6 per cent (measured) third harmonic remains, which, when amplified, shows a characteristic shape indicating the presence of an iron-cored component in the filter.

Harmonic distortion products may be mixed with hum, which can also be considered as a kind of distortion; this is illustrated in oscillograms (c) and (d). These are of a 500 c/s wave viewed at scan frequencies of 250 c/s and 25 c/s respectively. The first gives an idea of the distortion waveform, the

second of the hum waveform. The mixture gives a distortion meter reading of 0.5 per cent, but it is clear that about 0.3 per cent is hum and 0.2 per cent harmonic distortion.

In the cases considered so far, distortion percentage figures agreeing within about 10 per cent of the measured values were obtained, whether or not the equalizer was used. In the remaining cases, showing distortion of an abrupt kind, considerable differences in these figures can be obtained.

In (e) is shown the effect of slight but sharp limiting on the tip of the positive half-cycle. Clearly the distortion should consist of a narrow negative peak, and is shown as such on the trace below which was taken with the equalizer in circuit. The unequalized trace (f) gives a false picture because of phase-shift effects in the bridge. The meter indicated 1.8 per cent for (e) and only 1.3 per cent for (f), while, for the same waveform, a more conventional instrument of vast dimensions condescended to indicate a true value of 1.9 per cent!

Similarly (g) and (h) show equalized and unequalized distortions corresponding to an input waveform violently limited over each positive half-cycle. This is correctly interpreted in (g) as negative-going "full-wave-rectifier" distortion of 47 per cent, which is about right, while (h) shows a false distortion-waveform with a meter indication of 38 per cent.

The meter as described can be relied upon to read percentage distortion to within about ± 20 per cent of the "correct" value with the equalizer in circuit. There is little point in better accuracy, since harmonic-type distortion is not the only kind present in audio amplification, and percentage harmonic figures are only a rough guide to quality.

The proof of the acoustical pudding is in the hearing, and it is seldom that one listens to pure tone from a loudspeaker. Any amplifier which generates harmonics from pure tone will also generate intermodulation products from speech and music, and any amplifier having a limited upper-frequency response will distort the reproduction of percussive or explosive sounds. Harmonic distortion is a quality which causes speech or music to sound "rough" or even "rattly." Intermodulation products cause musical sounds to appear "edgy" or off key, and can convert a Chopin polonaise into a meaningless jumble of sounds. Poor transient response, usually associated with poor high-frequency response, causes either "woolliness," or a metallic "ringing" colouration, of sounds which otherwise would be sharp and clear.

Intermodulation products can be measured with fairly complicated apparatus, and, provided that the correct frequencies are chosen, their level is a better measure of quality than harmonic distortion. Intermodulation figures are being used increasingly for specification purposes, since it is possible for a poor amplifier to have good harmonic figures over the whole of its frequency range, but not to have low intermodulation products at all frequencies.

As one of many possible instances of this sort of thing, consider an audio power amplifier with an output transformer having an inadequate high-frequency response. At high frequencies the load line may be opened out into an ellipse by the transformer's reactive effect, causing grid-current or anode-bend limiting not present at lower frequencies. The harmonics of such high frequencies. may all be above the cut-off frequency of the transformer, and will not appear at the output terminals of the amplifier. Its measured distortion will therefore be low at all frequencies. But if the amplifier is driven with a mixture of, say, 55 kc/s and 3 kc/s, intermodulation products of 2 kc/s, 1 kc/s and other frequencies will be formed if any distortion is present, and these will pass readily through the transformer.

Poor transient response is best revealed by a square-wave generator and an oscilloscope. High-frequency cut-off shows as a rounding-off of leading edges, usually due to excessive stray capacity at high-impedance parts of the circuit, while attempts to remedy this with added inductance may result in "overshoot," or damped wave-trains following each rise or fall.

These considerations might be taken as indicating that it is hardly worth while measuring harmonic distortion at all, but they are brought up here only as a warning against taking distortion figures too seriously.

There are mathematical formulæ connecting harmonic distortion and intermodulation products, but for the reasons already explained, these do not always agree in practice, and it is better to keep one's harmonic and intermodulation evaluations of quality in separate mental compartments.

The quality assessment of an amplifier therefore requires at least three tests, in addition to the obvious one of listening to it, and the final opinion is seldom more than a subjective synthesis of all the results obtained. The meter described in this article will contribute to this synthesis a pictorial (and therefore memorable) idea of the harmonic distortion, with a reasonably accurate estimate of its relative level.

The cost is reasonable, being two miniature valves, a handful of other components (mostly wire-ended) and ten-milliamps-worth of h.t.

In conclusion, the writer would like to thank G. Ellerby for mathematical verification of the empirical equalizer design.

Packaged Circuits

Standardized Plug-in Units for Electronic Computors

By MICHAEL LORANT

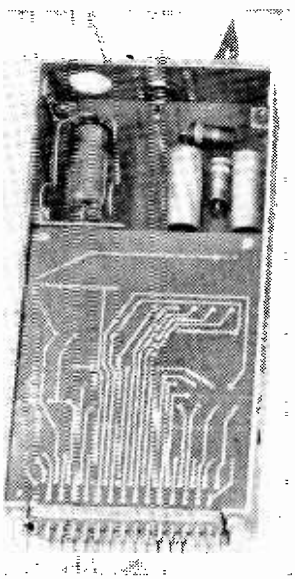
MODERN electronic computors, like other highly complex electronic equipment, must have provision for rapid testing and replacement of components if a high order of satisfactory operating time is to be attained. An electronic computor generally contains tens of thousands of components—valves, germanium diodes, and other parts—and hundreds of thousands of soldered connections. Even momentary failure of a single component or connection may cause incorrect performance and tie up thousands of pounds worth of equipment. However high the quality of components and workmanship, failures will occur at intervals, and the practical value of a complicated and costly computor may well depend largely on the speed with which troubles can be located and corrected.

The U.S. National Bureau of Standards has recently

developed an improved system of standardized plug-in circuitry "packages" for use in the construction of electronic computors. These rapidly replaceable units, if adopted by manufacturers, promise to combine reduced manufacturing and repair costs with improved computor reliability. By the proper interconnection of a sufficient number of the new units, most of the circuitry of large and complex computors can be constructed. The present system is an extension of similar improvements under development by industry.

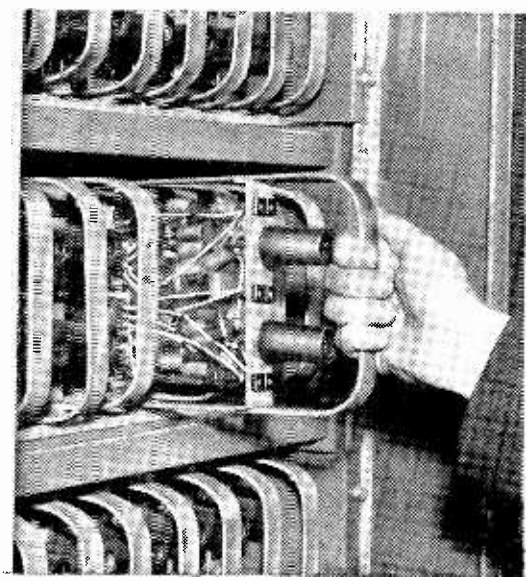
Developed in the Bureau's electronic computors laboratory, the new circuit packages are being incorporated in an advanced computor, designed for special experimental requirements. Each unit has a large number of connections brought out to pins, making it possible to use the unit in many different ways. Test jacks in the tops of the units help to locate defective ones, and as soon as a faulty package is found a new one can be inserted in its place.

A distinctive feature of the Bureau's computor design, both past and present, is the general similarity of most of the circuit stages. Although many hundreds of stages are required, a single basic valve circuit, with minor modifications, is adapted to the great majority of requirements. Thus in the Bureau's SEAC (National Bureau of Standards Eastern Automatic Computor), as well as in the new computor, the same basic circuit serves as a low-impedance pulse generator, as a flip-flop, and for a number of gating functions. This general circuit uniformity invites the use of mass-produced circuit packages.



Left: One of the plug-in units. Underneath the plate carrying the etched circuit are mainly resistors and germanium diodes.

Below: A similar system of plug-in units has been developed by Elliott Brothers (London) for a computor built for the National Research Development Corporation. Here one of the units is being withdrawn from the computor.



The Bureau's package consists of an amplifying valve, a pulse transformer, and a number of germanium diodes. The total number of diodes required per package may be as high as 38. For economy, since not all applications will require as many as this, four slightly altered versions of the new unit are provided, embodying different numbers of diodes. Differences between the four versions are so minor that they do not interfere with mass production.

A second type of package, identical in size to that containing the valve and diodes, houses delay lines for interconnection between stages. Both types are designed for ruggedness, mass production, and quick testing and servicing by easily trained personnel. Etched circuitry and dip-soldering help to make the construction simple and foolproof.

The packages measure approximately 1 inch high by $3\frac{1}{2}$ inches wide by 7 inches deep. Plans for the Bureau's computor call for some 800 packages, plugged into 10 chassis holding 80 packages each. The chassis will be mounted on racks measuring about 7 feet high by 3 feet wide. Each rack holds four chassis. A handle at the end of each package facilitates insertion and withdrawal. Heavy guide pins assure correct insertion and at the same time protect the 60 connecting pins from accidental damage in handling. Many of the components in the package are connected to separate pins and have no connection with other components when the package is unplugged. This has two advantages: it permits flexibility in external connection and also permits testing the unplugged package for faulty components without improvised circuit paths. The test jack at the top of each unit permits easy checking of output signals by means of an oscilloscope.

Defective components within individual packages are quickly located with the aid of a test unit. The package is plugged into the test equipment and a selector switch is rotated to obtain quick checks on the condition of each component. Trouble-free packages are similarly tested periodically as a routine maintenance measure, and components whose characteristics have drifted beyond acceptable tolerances are replaced.

A type 6AN5 miniature valve is used for the transformer-coupled pulse amplifier that forms the heart of each package. The transformer has a 10:1 turns ratio, giving an extremely low output impedance—less than 100 ohms. This results in a high degree of freedom from noise pick-up and permits the use of long signal leads.

Sufficient heat is dissipated in each of the compact packages to make forced-air cooling desirable, particularly since the packages are mounted close together in large numbers. In the new computor, air from suitably located ducts in the sides of the racks is forced into a hole in the side of each package. The incoming air flows first over the temperature sensitive germanium diodes, then over the heat producing valve and resistors, and finally out through a hole in the end of the package.

TRANSISTORS

8.—*Use of Duality in Transistor Circuit Design*

By THOMAS RODDAM

BEFORE proceeding we must look at the dual of a transistor, to see if it really is something familiar. The basic transistor equations have been given in earlier articles. For the grounded base connection we may restate them as follows:

$$v_e = r_{11}\, i_e + v_{12}\, i_c$$
$$v_c = r_{21}\, i_e + r_{22}\, i_c$$
$$= r_{22}\,(i_c + \alpha i_e)$$
where $\alpha = r_{21}/r_{22}$.

Let us now dualize these equations, writing $i_1 = v_e/r$; $i_2 = v_c/r$; $v_1 = i_e/r$ and $v_2 = i_c/r$. Then we have

$$i_1 r = \frac{r_{11}\, v_1}{r} + \frac{r_{12}\, v_2}{r}, \text{ or } i_1 = \frac{r_{11}\, v_1}{r^2} + \frac{r_{12}\, v_2}{r^2}$$

$$i_2 r = r_{22}/r\,(v_1 + \alpha v_2), \text{ or } i_2 = \frac{r_{22}}{r^2}(v_1 + \alpha v_2).$$

The second equation is of the same form as the triode equation:

$i_a = \frac{1}{\rho}(v_a + \mu v_g)$. The dual of a transistor is therefore something like a triode with anode resistance r^2/r_{22} and amplification factor $\mu = \alpha$. The first equation, which in the triode would correspond to the equation for grid current, should, of course, be simply $i_1 = 0$. Provided r_{11} and r_{12} are small enough compared with r, this is approximately true.

This has been rather mathematical: a more practical view of this triode-transistor duality can be obtained from Fig. 1, which shows the valve characteristics and the transistor collector characteristics arranged to accentuate the similarity. The scale change between the two sets of curves is 66 volts ⇄ 10 mA, so that the scale resistance is 6,600 ohms. Since this is a fairly typical value, we can use it to check what happens if r_{11} and r_{12} are not zero, but are, as in the newest transistors, of the order of 100 ohms. The effect of this is to introduce resistances of the order of $(6600)^2/100$ between grid and cathode, and grid and anode, in the true dual triode. This gives us 436,000 ohms as a typical interelectrode leakage resistance, and as the dual triode is of very low μ the performance will hardly be affected.

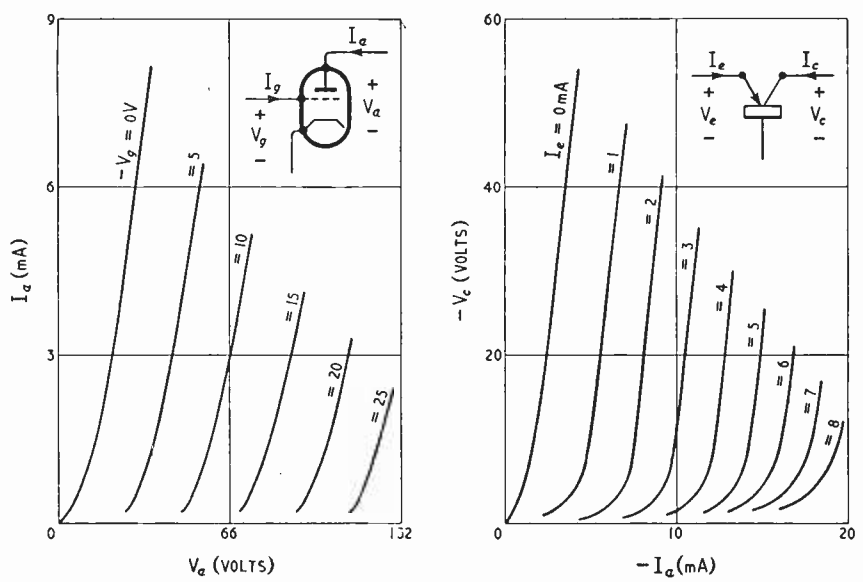
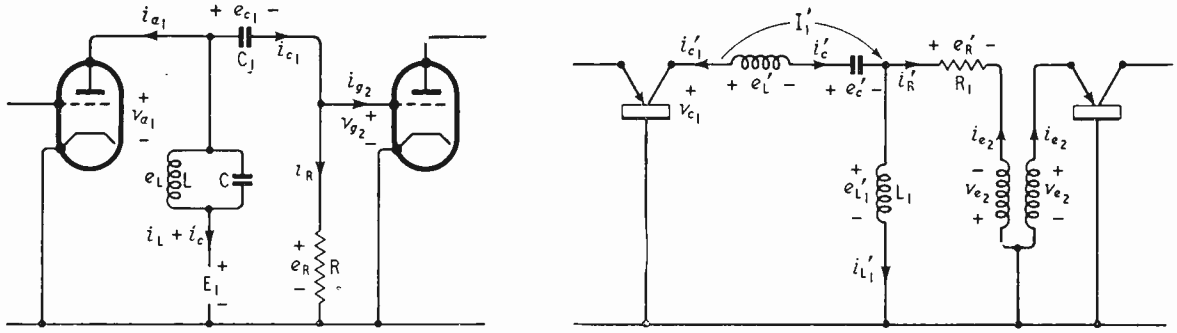


Fig. 1. When transistor currents are compared with valve voltages, and vice versa, the characteristics of a transistor resemble those of a triode.

It should be fairly clear now how we proceed to design a transistor circuit to do a job for which a valve circuit already exists. The valve circuit is taken and converted, element by element, into its dual. Where the phase is important, each valve transforms into a transistor plus an ideal phase-reversing transformer: where phase can be neglected the ideal transformer is omitted. A fully developed example of this kind, with all the Kirchhoff equations, is shown in Fig. 2 on the next page. The anti-resonant load circuit in the anode of the valve becomes a resonant circuit in series with the collector, the low impedance anode battery becomes a current source of infinite impedance, and the coupling capacitor becomes a shunt coupling choke. It is of some interest to note that away from the resonant frequency, at which the circuit operates as an amplifier, the collector load impedance is high. This helps to keep the transistor amplifier stable when the transistor is liable to short-circuit instability.

The circuit shown in Fig. 3 is rather less obvious than the example in Fig. 2. The tuned amplifier is a linear system, converting according to the rules already discussed. The push-pull amplifier works at maximum efficiency in Class B. The valve conditions are well known: the grids are held negative, near to cut-off, so that there is very little anode current.



$$
\begin{aligned}
v_{a_1} - e_L - E_1 &= 0 \\
E_1 + e_L - e_{c_1} - e_R &= 0 \\
v_{g_2} - e_R &= 0 \\
e_L &= e_c \\
i_{a_1} + i_{c_1} + i_L + i_c &= 0 \\
i_{g_2} + i_R - i_{c_1} &= 0
\end{aligned}
\qquad (a)
$$

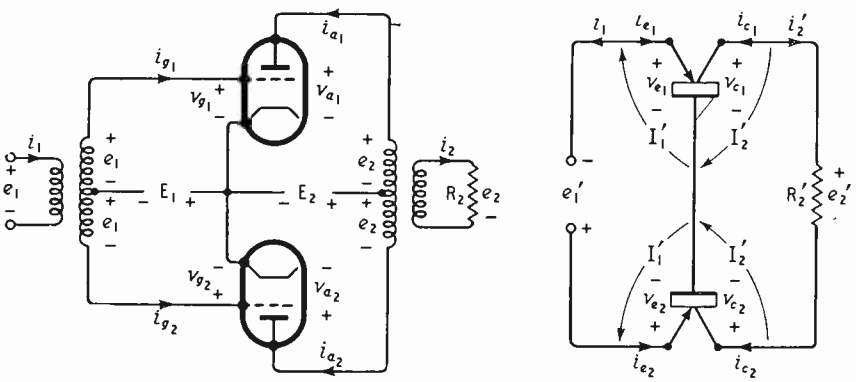
$$
\begin{aligned}
-i_{c_1} - i_c' - I_1 &= 0 \\
I_1 + i_c' - i_{L_1}' - i_R' &= 0 \\
-i_{e_2} - i_R &= 0 \\
i_c' &= i_L' \\
-v_{c_1} + e_{L_1}' + e_c' + e_L' &= 0 \\
-v_{e_2} + e_R' - e_{L_1}' &= 0
\end{aligned}
\qquad (b)
$$

Fig. 2. Tuned valve amplifier stage, and the transistor dual. The parallel tuned circuit becomes a series circuit and the coupling capacitor a chcke. The change of phase is represented by an ideal transformer.

Although the full anode supply voltage then appears across the valves, the dissipation is small and only becomes a limitation when a signal is applied. Transistors can be operated in this way, too, and my own experience suggests that it is the most satisfactory way to use them. For strict duality, however, the collector voltages must be made small and full collector current taken. In the valve circuit a signal caused current to flow in one valve for a half-cycle, while the other valve is completely cut off. During this period, as Class B designers know to their cost, half the output transformer primary is open-circuited.

The transistor circuit is very different. As the upper emitter is driven negative from an emitter bias of, say, 8 mA, the collector voltage swings negative. The lower transistor acts as a short-circuit, because it is being driven from saturation to over-saturation. The two transistors are thus in series with each other in feeding the load, not in parallel like the valves. Ordinary point transistors which give about 20 mW output under Class A conditions will give some hundreds of milliwatts in this circuit.

My own experience has been that this discussion is over-simplified. Using Type 1768 transistors it is possible to get out these large powers, but it does not seem possible to avoid crossover distortion, because the transistor characteristic in the region of saturation is not at all parabolic. The valve designers have produced valves which fit into each other very nicely for Class B working, but the transistor designers are still worrying about the Class A characteristics or the switching properties, and have not much time for the low-distortion problem. More satisfactory performance is obtained by operating at zero emitter bias, corresponding rather closely to the conventional Class B circuit rather than to its dual. This breakdown of the duality method, however, is merely a result of the particular characteristics of the transistor used.



$$
\begin{aligned}
v_{g_1} - e_1 + E_1 &= 0 \\
v_{g_2} + e_1 + E_1 &= 0 \\
v_{a_1} - e_2 - E_2 &= 0 \\
v_{a_2} + e_2 - E_2 &= 0 \\
i_{g_1} - i_{g_2} - i_1 &= 0 \\
i_{a_1} - i_{a_2} + i_2 &= 0
\end{aligned}
\qquad (a)
$$

$$
\begin{aligned}
-i_{e_1} - i_1' + I_1' &= 0 \\
-i_{e_2} + i_1' + I_1' &= 0 \\
-i_{c_1} - i_2' - I_2' &= 0 \\
-i_{c_2} + i_2' - I_2' &= 0 \\
-v_{e_1} + v_{e_2} - e_2' &= 0 \\
-v_{c_1} + v_{c_2} + e_2' &= 0
\end{aligned}
\qquad (b)
$$

Fig. 3. Circuit conditions in a Class B amplifier and the transistor dual.

Other Dual Circuits

Some more conventional dual circuits must be discussed in order to clarify the design process. The single-stage RC amplifier shown in Fig. 4(a) has as its dual the transistor circuit shown in Fig. 4(b). Working through the circuit

from left to right, the series capacitance C, which passes alternating current but blocks direct voltage, has as its dual the shunt inductance L, which allows the maintenance of alternating voltage but short circuits the direct current. R_1, which ideally approaches infinity, allows the bias to reach the grid without absorbing any of the signal. Its dual, R_1', allows the signal to reach the emitter, since the current bias supply is an open circuit, and the ideal value of R_1' is zero. The output battery circuit is similar to the bias circuit, and the two loads, Z_L and Z'_L are duals. I should prefer in this figure to draw Z'_L as a horizontal element with a short-circuit closing the loop, and to add a parallel open-circuit on the right of Fig. 4(a). The voltage gain of the valve circuit can be written in the form

$$\frac{g_m}{\frac{1}{\rho} + \frac{1}{R_2} + \frac{1}{Z_L}}$$

The current gain of the transistor circuit is

$$\frac{r_m}{r_c + R'_2 + R'_L}$$

and the term-by-term duality is quite obvious. Earlier in this article I pointed out that the dual relationship between valve and transistor needed a phase-reversing transformer to make it complete. Fig. 5(a) shows a two-stage RC amplifier, its "false dual" (b), and two true duals. The importance of the true dual forms appears when feedback is applied round the circuit. The feedback may be the positive feedback needed to produce a multivibrator or the negative feedback of an amplifier, but in either case the false dual leads to a reversal of the feedback sign. The rather odd-looking circuit in Fig. 5(c) is of some value if a multistage amplifier using only one battery is required. Fig. 6 shows the two-stage variant of this with the additional resistors R_2 and R_1 needed to provide the collector and emitter voltages. This sort of amplifier circuit will, when elaborated to give more gain and more gain stability, play a very large part in line communications, because the supplies can be fed over the line.

Going back to Fig. 5(a) for a moment, we sometimes allow R_1 and C to provide the necessary bias, and omit the bias battery. Positive peaks on the grid produce grid current and charge the grid side of C negative. In operation C is charged until only very short grid-current pulses are passed to maintain the charge. The working

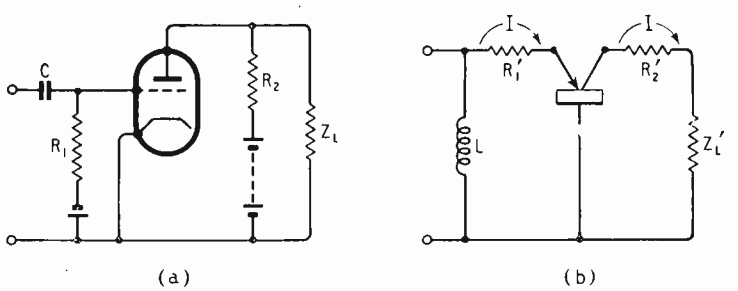


Fig. 4. RC coupled valve amplifier and the transistor dual.

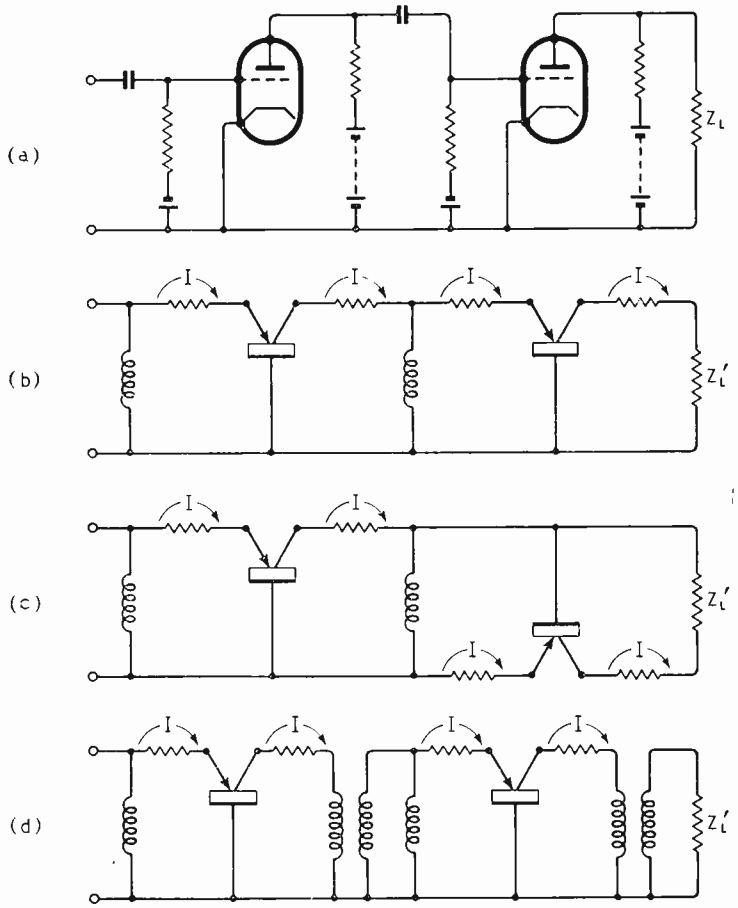


Fig. 5. (a) Two-stage RC valve amplifier, (b) "false" dual, (c) and (d) true transistor duals.

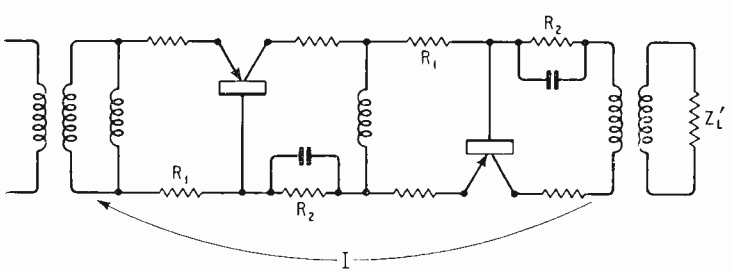


Fig. 6. Two-stage transistor amplifier designed to operate from a single battery supply.

condition is that the time constant CR must be long compared with the frequencies involved. In the transistor circuit the emitter presents a high impedance to negative currents and the negative half-cycles tend to build up a negative current down through L. This is equally properly defined as a positive bias current up through L, and when it is established L is "charged," or "polarized," or . . . there is no word for it, except that by analogy with relays I would say "magnetized." Provided that L is large enough compared with R_1' (L/R_1' large) a steady emitter bias current is produced by L, with short emitter voltage peaks making up the loss. Like its valve counterpart this is not a low-distortion circuit, but it is easily adapted to oscillation applications in which Class C operation is wanted. The inductance L must then produce enough emitter current to keep the transistor collector below voltage cut-off for almost all the cycle, the current in the transistor falling and the voltage rising during an "on" period of less than 180 degrees.

The three triode detector circuits and their duals are shown in Fig. 7. I do not propose to discuss these because the mode of operation should be fairly clear from the general discussion above. The infinite impedance detector (zero impedance detector) needs a very wide band transformer and is thus pretty useless. Another detector and its dual are shown in Fig. 8. This is not a transistor circuit, but is included because in many transistor circuits a simple rectification is needed. For a transistor you must produce rectified, smoothed current.

Duality in Reverse

I do not doubt for a moment that fairly soon the use of duality will be abandoned, except, perhaps, to enable the electronic historians to explain the working of the valve to their transistorized readers. With our present stock of valve circuitry, the duality method provides us with a simple and fairly straightforward way of establishing the transistor circuit configurations which deserve more detailed study. But the title of the Bell System Technical Journal article on this subject should also be a warning: "Duality as a Guide. . . ." You still need to design the circuit.

Acknowledgment. Figs. 1 to 8 are based on Figs. 1, 4, 6, 14, 15, 16, 19, 20 and 21 of "Duality as a Guide in Transistor Circuit Design," by R. L. Wallace, Jr., and G. Raisbeck. *B.S.T.J.*, Vol. 30, April 1951.

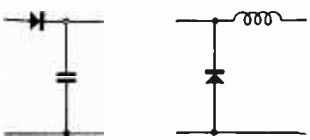


Fig. 8. A dual pair of rectifier circuits.

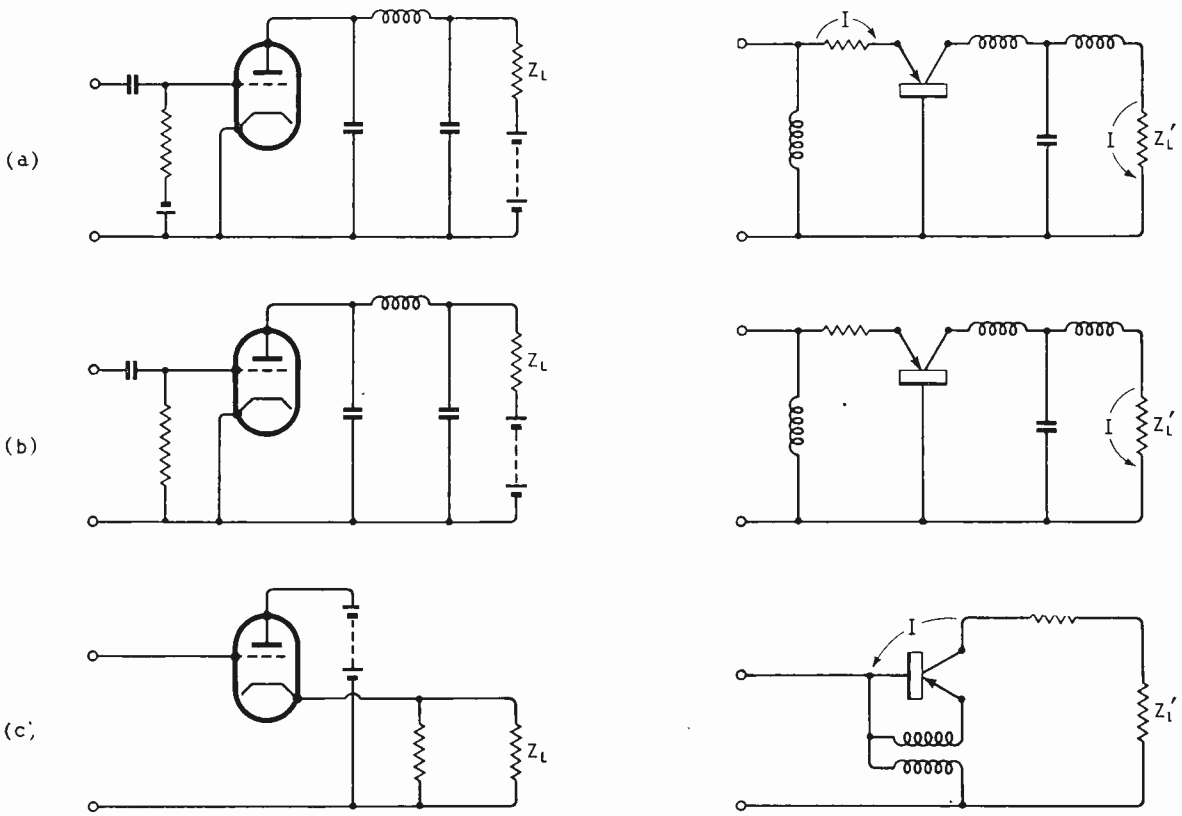


Fig. 7. Typical valve detector circuits and their transistor duals. (a) ancde, (b) leaky grid and (c) negative feedback (infinite impedance).

Simplified Calculations

Working Out Resonant Circuit Constants on the Slide Rule

By FRANCIS OAKES, M.Inst.E.

THE determination of the resonant frequency for a given combination of inductance and capacitance is usually obtained from the formula $f = \frac{1}{2\pi\sqrt{(LC}}$ by a somewhat tedious combination of multiplication, extraction of the square root, and finding of the reciprocal on the slide rule, or by the use of a nomogram and consequent reduction of accuracy. The same is true for the determination of the inductance or capacitance from the other two given parameters.

A rapid calculation is possible with sufficient accuracy for most practical applications by the combination of the square and reciprocal scales of the slide rule, illustrated in Fig. 1.

If, as illustrated above, C (or L) is set on the square scale of the slide opposite 253 on the square scale of the stock (in the left section as shown), then the resonant frequency will be found on the reciprocal scale of the slide, opposite L (or C, if L has been set opposite 253) on the square scale of the stock.

Due to the implicit extraction of the square root, the following rule has to be observed in setting L and C. If the significant digit corresponds to an even power of ten, set in the left section; if to an odd power set in the right section, of the square scale. Thus, 84 pF or 15 μH would be set in the right section, because 8 corresponds to 10^{-11} and 1 to 10^{-5} similarly, 0.01 μF or 15 mH would be set in the left section corresponding to 10^{-8} and 10^{-2} respectively.

An example is illustrated in Fig. 2. Given L = 1.5 μH and C = 84 pF, the resonant frequency is found by setting 1.5 in the left section of the square scale of the slide opposite 253 on the square scale of the stock (left section as always), and reading off the resulting resonant frequency f = 14.2 Mc/s on the reciprocal scale of the slide, opposite 84 in the right section of the square scale on the stock.

If a value of L (or C) is required to resonate with a given C (or L) at a given frequency f, an analogous calculation is performed by setting the given frequency opposite the given C (or L) and reading off the resulting value under "253". The example of Fig. 2 is equally illustrative for this reverse calculation.

As in most other slide-rule calculations, an extension move has to be carried out when the scale on which a setting or reading is sought does not extend far enough. This is illustrated by the following example.

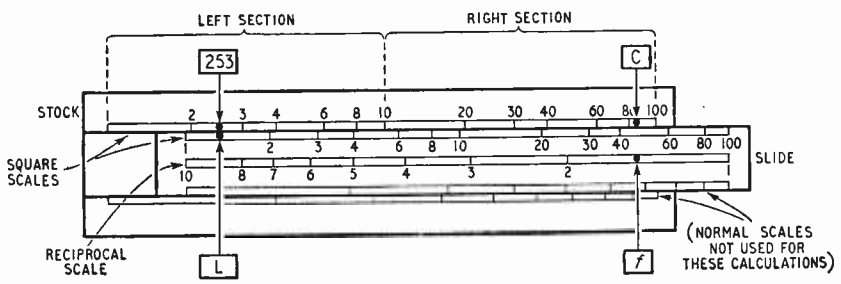


Fig. 1. Slide rule having square and reciprocal scales set for an LC calculation.

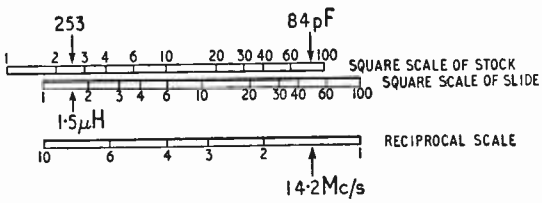
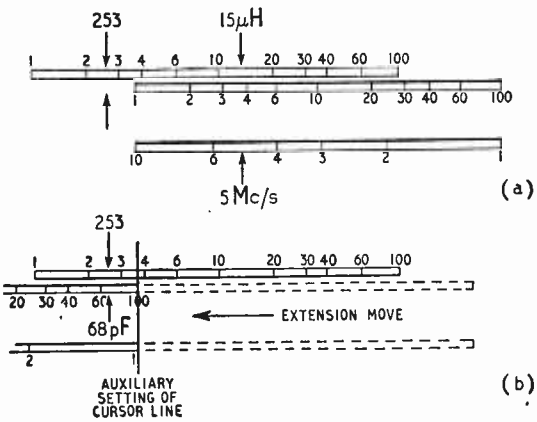


Fig. 2. An example of the setting of the rule for calculating the frequency corresponding to 1.5 μH and 84 pF.



Right: Fig. 3. When the values are such that "253" comes off scale (a), the slide must be pushed through as in (b).

Required the value of C to resonate with L = 15 μH at f = 5 Mc/s. As shown in Fig. 3(a), the scale on the slide does not extend far enough, and a reading opposite 253 cannot be obtained. The cursor is therefore set to the end mark, and the slide pushed right through. The result 68 pF can then be read off as shown in Fig. 3(b). It may be observed that in this particular case, the result could have been obtained without extension move, opposite 253 in the right section of the square scale on the stock, but care must be taken when this procedure is adopted, in order to ensure correct results. Beginners are therefore advised to adhere strictly to the instructions as set out above, until the process is thoroughly understood.

APPENDIX

Proof of this method of calculation is given by the following :—

As illustrated in Fig. 4, f on the reciprocal scale corresponds to $1/f^2$ on the square scale.

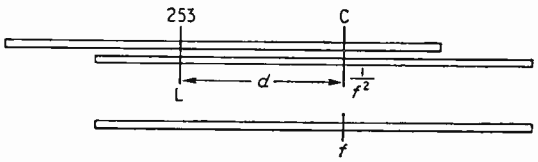


Fig. 4. Diagram used to prove the method.

Bearing in mind that the scales are logarithmic, and that $1/(2\pi)^2 = 0.0253$, the following equations can be obtained from inspection of Fig. 4.

$$\text{Upper scale } d = \log C - \log \frac{1}{(2\pi)^2}$$

$$\text{Lower scale } d = \log \frac{1}{f^2} - \log L$$

$$\therefore \log C - \log \frac{1}{(2\pi)^2} = \log \frac{1}{f^2} - \log L$$

$$\therefore \log C + \log L = \log \frac{1}{(2\pi)^2} + \log \frac{1}{f^2}$$

$$\therefore CL = \frac{1}{(2\pi f)^2}$$

$$\therefore f = \frac{1}{2\pi\sqrt{LC}}$$

Measurement of "Wow" and "Flutter"

CONSIDERABLE diversity exists, both in this country and in the U.S., in the definition and methods of measurement of those undesired variations of frequency in reproduced sound which go under the above descriptive terms.

While it is considered premature to attempt to lay down standards of performance for these factors, a more precise definition of the terms commonly used, and the conditions of physical measurement, is desirable, and the British Standards Institution has issued a memorandum (BS1988 : 1953) which puts forward the views of the Acoustics Industry Standards Committee in this country.

Until further data are available on the subjective effect of different frequency elements in the disturbance, it is proposed that the "unweighted" r.m.s. summation of all components in a band from 1 c/s to 200 c/s, expressed as a percentage of the test frequency of 3 kc/s, shall be accepted. Below 1 c/s peak-to-peak measurements are normally used, and below 0.1 c/s it is proposed that the deviation should be described as "drift," together with other slow deviations of a unidirectional character. "Wow" is used for frequency deviations from 0.1 to 10-20 c/s, which are recognizable as charges of pitch, and "flutter" for deviations occurring at frequencies of 10-20 c/s of more.

The memorandum discusses instruments giving readings of other than r.m.s. values, and gives tentative ratings of performance ranging from "very high" (0.05 per cent) to "poor" (0.5 per cent). It is obtainable from the British Standards Institution, 24 Victoria Street, London, S.W.1, price 1s.

Manufacturers' Literature

Delayed-action Relay, using solenoid and rubber bellows, available with delay times from $\frac{1}{6}$ second to 180 seconds and intended for controlling mains-operated equipment. Description and specification on a leaflet from Electro Methods, Caxton Way, Stevenage, Herts.

Anti-rust Preservative comprising zinc, carbon and rubber latex; is applied as a solution and dries to form a protective coating. Descriptive leaflet from Cowanite (Anti-Corrosive), P.O. Box No. 61, 15 Tithebarn Street, Liverpool, 2.

Portable D.C. Potentiometer with three ranges permitting measurements from 10μV to 1.8 V with an accuracy of 0.05 per cent of the maximum reading on each range. Leaflet from the Doran Instrument Co., Stroud, Glos.

Small Soldering Iron, weighing 3¼oz and 9in long, with a consumption of 25 W on 220/240 V mains. Special mechanical features described in a leaflet from W. T. Henley's Telegraph Works Co., 51-53 Hatton Garden, London, E.C.1.

Surplus Equipment, valves, components and accessories listed in a 1953 mail order catalogue from Duke and Co., 621 Romford Road, Manor Park, London, E.12.

Operating Instructions for the Series 2 magnetic recording Tape Decks, together with amplifier circuit, notes on the choice of operating conditions, and a fault analysis table, are included in "The Manual of the Tape Deck," issued by Wright and Weaire, 138 Sloane Street, London, S.W.1, price 2s 6d.

New Silicone Electrical Varnishes are described in note C11 (Varnish MS994 for coating glass cloth and bonding mica-glass); note C16 (MS997 impregnating varnish with improved heat stability and rapid curing characteristics); and note L20 (Banding resin MS2105, with improved dielectric strength up to 250°C) issued by Midland Silicones, 19 Upper Brook Street, London, W.1.

Comprehensive catalogue of communications receivers, sound recording and reproduction equipment, test gear and a wide range of short-wave components from Webb's Radio, 14 Soho Street, London, W.1. Price 1s.

Ceramic Components; electrical and physical data of the wide range of ceramic parts produced for the radio and electronics industries from United Insulator Co., Oakcroft Road, Tolworth, Surbiton, Surrey.

Constant Voltage Transformers with output maintained within ±1 per cent for input variations up to ±15 per cent. Descriptive leaflet listing types available from Advance Components, Back Road, Shernhall Street, Walthamstow, London, E.17. Also a leaflet on an **Adjustable A.C. Voltage Stabilizer** consisting of a constant voltage transformer with harmonic filter and a variable transformer.

Busbars for Soldering Irons with low-voltage supply from transformer (20 V) and two-pin plugs for irons. Descriptive leaflet from Electrical Remote Control Co., East Industrial Estate, Harlow New Town, Essex.

Silver-zinc Accumulators (1.5 V) ranging from 0.75 Ah cell weighing ¾oz to 80 Ah cell weighing 30oz. Illustrated brochure describing their special features and including discharge characteristics, dimensions and weights of various types made by Venner Accumulators, Kingston By-Pass, New Malden, Surrey.

Control Knobs moulded in walnut and ivory with various inscriptions engraved in gold. Leaflet from Uncles, Bliss and Co., 139 Cherry Orchard Road, East Croydon, Surrey.

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

Magnetic Tape Recorder

WEIGHING 32lb and mounted vertically in a carrying case covered with washable plastic the new Philips Type EL3530 portable magnetic recorder is of the twin-track type, and has a fixed tape speed of 3¾in/sec, giving a playing time of one hour on a 600ft 5in-diameter reel.

There are two heads, one for erasure and the other for recording and playback, and the frequency range claimed is 30-7,000 c/s. A "magic eye" level indicator is provided, and a power output of 2.5W is available for the built-in speaker.

A crystal microphone is supplied with the recorder and there are inputs for radio or pickup and outlets for headphones extension loudspeaker and 200-ohm lines. Accessories available include a telephone pick-up coil (Type EL3970) and a programme indicator (Type EL3979) which can be used for noting and finding particular parts of a recording.

The basic price of the recorder, which is made by Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2, is £77 10s.

Neon Indicating Fusebox

SHOWN in the illustration is a neon indicating fuse carrier which can be used to replace the existing lid of the Belling-Lee twin fusebox, type L1033. The new lid increases the total depth by 5/16in, but no other dimensions are affected.

Two lampholders with resistors are included in the moulding and arranged so that the adjacent lamp gives visual indication when either fuse blows. The neons glow over a voltage range of 180-250 V r.m.s. (a.c.), or 220-250 V d.c. A replacement retaining clip is supplied with the new carrier which ensures that when the box is properly wired the neon lamps are connected for the optimum conditions of working.

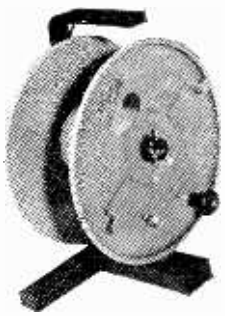
The new indicating fuse carrier, type L732, can be obtained separately or complete with either of the two styles of base part available. One, the L730, is a plain chassis or panel mounting type, the other L731 is the same, but with projecting connections at the back.

The new neon indicating lid only costs 18s, or as a complete twin fuse box (L730), 23s 3d.

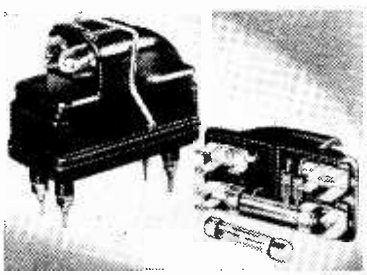
Portable Cable Drum

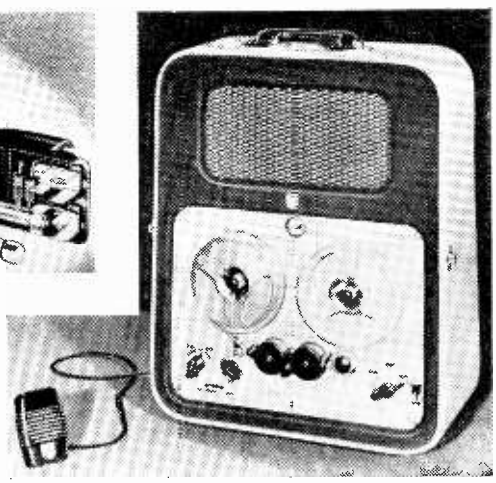
DESIGNED to accommodate at least 50 yards of heavy cable, as used in outdoor public address systems, this drum is light in weight and has a channel steel base combined with a simple carrying handle which should commend it to p.a. operators. A large aperture is provided to pass terminal sockets which are held on the outside by a clip, and the drum is easily detached after withdrawing a retaining pin from the spindle.

The price is £3 15s and the makers are Reosound Engineering and Electrical Company, Sutton Coldfield.



Reosound cable drum for p.a. work.





Belling-Lee neon indicating twin fusebox. The fuse carrier (L732) is shown separately.

Right: Philips type EL3530 twin-track magnetic tape recorder.

RANDOM RADIATIONS

By "DIALLIST"

House and Home

THE TELEVISION position in France to-day is very much like that in our own country a little before the war: people flock to exhibitions and pack demonstration rooms to the point of suffocation; they flatten their noses against the window of any shop displaying TV sets; they read avidly any item about television in the newspapers; they talk about television; they probably dream about it . . . but they don't buy many television receivers! One possible reason is that the average Frenchman has to work a good deal longer than his opposite number in Britain to earn the price of a set; I believe, though, that the main reason why television is not making more rapid progress in France is that it is so essentially a *home* form of entertainment. The Frenchman's house, or flat, or cottage is seldom his home in quite our sense of the word. He goes out, for instance, much more than we do for meals, or for amusement. You may know him intimately for years without being asked to his house. The French must even speak of *le home*, not having a word of their own for it. Once it got under way, television caught on rapidly in this country and in the United States, where the home is so important a part of everyone's life. Is it possible that in France and other Latin countries the process may be reversed? Instead of the home fostering the development of television, television may foster the development of the home—and give them a word for it!

Tubes and Picture Sizes

HOW BIG A PICTURE with an aspect ratio of 4:3 should a c.r. tube of given diameter be able to display? One's often asked the question; and it's not easy to give a definite answer, for so much depends on the curvature near the circumference of the screen; which means how much defocusing and distortion near the corners of the image (or, alternatively, how much masking) can be tolerated. People want bigger and bigger pictures and don't seem to mind a considerable rounding-off of the corners by the mask. Hence manufacturers tend to get the utmost out of any tube in the way of picture size. The ideal from the quality point of view would, I suppose, be to make the corners of the rectangle just touch the circumference of the screen of a reasonably flat-ended tube and to do only a modest amount of rounding off. Given those conditions, it's easy to find the maximum picture size for a circular tube of any diameter. We have a rectangle inscribed in a circle, divided by its diagonal (which is a diameter of the circle) into a couple of right-angled triangles. In these the shorter sides have the ratio 4:3 and recollections of the Pons Asinorum show that the corresponding figure for the third side is 5. Calling the diameter d, we have: width $= \frac{4d}{5}$; height $= \frac{3d}{5}$. This gives 9.6×7.2 inches for the picture on a 12-inch tube, or 11.2×8.4 inches for that on a 14-inch c.r.t. In practice, the corners of the rectangle are usually off the screen altogether, so that for the average domestic set the picture width may be taken as $\frac{5d}{6}$. The figures hold good also for square-ended tubes, which are sized by their diagonal measurements. The picture areas in square inches that are sometimes quoted are a little misleading. For some queer reason "area" has come to mean extreme width multiplied by extreme height and to include the bits of the image covered by the mask—or even off the screen altogether!

Channel-minded

YEARS AGO I made what I still regard as the eminently sensible suggestion that the channels allotted to European stations for "sound" broadcasting should be numbered and the tuning dials of receivers graduated accordingly. Now that people have become used to speaking of Channels 1 to 5 in television Band 1 (and may soon be doing the same with those in other bands), it seems possible that they may grow sufficiently channel-minded to adopt similar divisions of the long-wave and medium-wave broadcast bands. Whatever "plan" is in force, the carrier-frequencies assigned to particular channels don't vary very much. They can't, when you come to think of it, so long as the frequency limit of the bands remains fixed and a 9-kc/s separation between channels is retained. The numbering of channels would save a heap of trouble: it's much easier, for example, to remember that a station

uses, say, channel No. 27 than that its wavelength is so many point something metres or that its carrier-frequency is such and such a number of kilocycles per second. The tuning dials of receivers would look neater with numbers instead of a mass of station names. The latter are seldom correct for long, anyhow. Such is the modern passion for changing the names of towns that if you want to tune in a concert from Pszcrwk, you have to remind yourself that the place was called Dummburg when the dial of your set was made—unless, of course, the set is more than three years old, in which case it will appear as Slonk!

Bands 4 and 5

THE REPORT of the Television Advisory Committee makes it pretty plain that if we are going to provide anything like nation-wide coverage for the B.B.C.'s first and second programmes, *and* for commercial programmes, we shall have to make full use of Bands 4 and 5 (470-960 Mc/s) in the not-far-distant future. What rather surprises me is so many of those with whom one discusses the Report regard these decimetre wavelengths as almost unexplored regions. Mapmakers of the Middle Ages used to show large chunks of land blank except for pictures of ape-men, ogres and fearsome beasts, and for legends such as *HERE BEE HIPPOGRYFFES*. To-day, there are some who seem to look on the Band 4 and Band 5 parts of the frequency spectrum as unknown tracts inhabited by gremlins. Actually, designers have no little experience of even higher frequencies in television, radio-links and in radar. Ten-centimetre radar was in service from 1941 onwards during the war and since 1946 the standard British wavelength for marine radar has been 3 centimetres. In comparison, the wavelengths of Bands 4 and 5 can almost be described as long: 51-64cm for Band 4 and 31-49cm for Band 5. I've heard it suggested that entirely new valves and other components will have to be designed for these bands. That's hardly so, for valves and so on able to cope with far higher frequencies are already in use, though they have not yet been mass-produced here for television reception. U.H.F. television will no doubt have its problems; but I don't think that they'll be all that difficult to solve. To me the nigger in the woodpile is the probable rather high cost of the "all-channel" television receiver of the near future.

UNBIASED

By FREE GRID

"*In the Red*"

THE JACOB'S-COAT SYSTEM used to indicate the values of our resistors is not so old as broadcasting but, of course, a greatly simplified system, using two colours only, has been used for other purposes ever since radio communication officially began on June 2nd, 1896, exactly 57 years before its greatest triumph on June 2nd, 1953. I refer to the use of red to indicate the + terminal of certain electrical instruments; the man who first did this was undoubtedly the inventor of colour coding in electrical and therefore radio circuits.

I have often wondered who he was and why he chose an arrangement which was so contrary to everyday usage, where red denotes deficiency or a negative quantity. To be "in the red" means an overdrawn account, as my bank manager recently reminded me when making the outrageous suggestion that my account should be debited with the cost of the red ink used to keep it. The reason for choosing red to indicate positive could be that this is the colour of the lead oxide paste which is used to fill the grids of the positive plates of an accumulator.

Such an explanation is far too simple, however, and I hope some of you can furnish me with the correct answer; maybe the librarian of the I.E.E. can find the explanation in the archives of the Institution. My own theory is that the universally accepted sign of danger was chosen to indicate the positive pole of a battery or other d.c. generator because, in the far-off pre-electronic days, it was believed that this was the terminal from which the electric current emerged to commence its travels around the external circuit. What more natural than to label the supposedly "hot" terminal or "live wire" with the danger sign.

As for the reason why red is always used for danger, this is, of course, nothing to do with electrical or radio matters; it is due to the unsettling psychological effect this colour has on the male sex as exemplified by the reaction of bulls to a red rag and of men—usually staid and respectable married men—to a passing "Red-head." In the case of Helen of Troy we are told that it was her *face* that launched a thousand ships, but I have always doubted it. As the sailor said to his shipmates who criticized the homely features of his pin-up girl, "Faces ain't everything."

Unsettling effect on the male sex.

Tunes Without Tuning

I AM GLAD to see that one prominent radio manufacturer has marketed an up-to-date push-button set without a tuning dial. It is true that it employs a multi-position switch and so to the literally minded it is not, therefore, really a push-button set, and it is equally true that only four pre-selected stations are available. But it is, at any rate, a beginning and other makers will, I feel sure, soon have something on the market to compete with it.

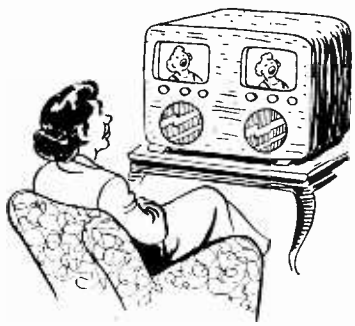
Its most attractive feature, in my opinion, is that it has no tuning dial. I always resented having to pay for something I didn't want in the old days when push-button sets had tuning dials. I have always favoured a set with pre-selection switching because with such a receiver everything "inside the box" (such as circuit coupling) can be arranged to suit the particular frequency which is pre-selected. There need be no compromises such as are unavoidable when a set is designed to have one-knob tuning and at the same time to cover a whole gamut of frequencies. Above all, the complete absence of a tuning dial saves even the most ham-handed of our Harriets from the sin of sideband sibilance.

Things to Come

THIS is the silver jubilee year of the talkies, as anybody who cares to turn up the files of *Wireless World* for 1928 can verify. The cinema moguls are not celebrating it, however. Maybe, they realize that, barring an unexpected invention, their days are numbered.

Broadcasting (owing to the intensive work it caused to be put into the development of the thermionic valve and the moving-coil loudspeaker) fathered the talkies, but television will act as their undertaker, for it can offer real stereoscopic pictures without the necessity of the audience wearing polarized or coloured spectacles. By *real* stereo I mean, of course, *pukka* two-eyed stereo and not merely a half-hearted pseudo-stereo effect which can be obtained by juggling with the shape of the screen.

Technically speaking, real stereo without any other form of stereoscope could be demonstrated to-day on TV by arranging a two-channel vision chain from cameras to c.r.t. screens. At the receiving end we should, of course, require two pictures side by side in the same cabinet, but they would be quite small and the two small c.r. tubes would cost less than one large tube. But everything else, except the power pack, would have to be duplicated. A correspondent in the August issue maintains that only one channel is necessary; if so, my technical education has been sadly neglected.



3D TV.

It will naturally be asked how the two adjacent pictures could be fused into one without special spectacles or some other kind of stereoscope. The answer is that to view stereoscopic pictures in this manner is an art which can be acquired by anybody who cares to take the trouble to do so. It doesn't matter whether you normally wear spectacles or not. There is nothing very new in it; it is, in fact, dealt with in most books on stereoscopic photography. It is rather like learning to ride a bicycle, inasmuch as it seems difficult at first, but eventually becomes second nature. Once acquired, the art is never lost.

It would be quite impossible for cinemas to adopt this system as owing to the large size of the two pictures on the screen, homologous points would be too widely separated for the eyes to achieve correct fusion. If you want to try out the idea, take a few stereo photographs. You don't need any special apparatus. The cheapest form of one-eyed box camera will serve the purpose if used in the manner described in all photographic textbooks and from time to time in journals devoted to photography.

NATURALLY—

he's using the NEW

V.H.F. Pack Set

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★ **Crystal controlled transmitter and receiver with high stability and selectivity**

★ **No tuning—simple to operate—only two controls**

★ **Light—compact—robust**

★ **Unbreakable aerial**

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Now Available

TECHNICAL DATA

Frequency ranges: **L46**, 75—100 Mc/s.
H46, 100—140 Mc/s.
HH46, 140—184 Mc/s.

Weights: with all dry battery power pack for 10 hours' duration, 8½lbs., with accumulator battery and vibrator power pack for 16 hours' duration, 10½ lbs.

Transmitter Power Output: 100 mw.

Receiver Sensitivity: 2-3 μv.

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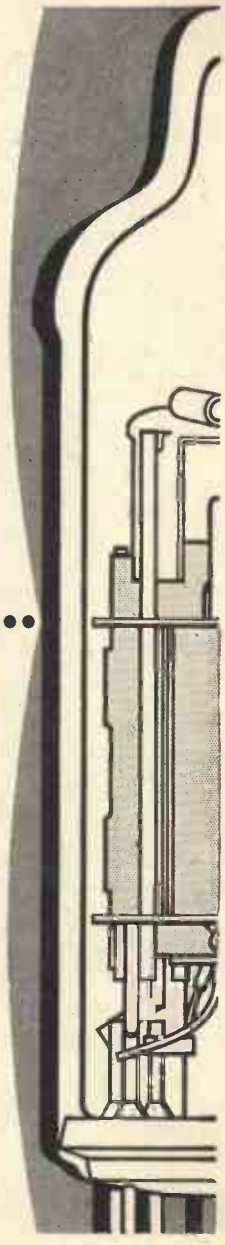
INDIRECTLY-HEATED SUBMINIATURES...



Developed originally for Service applications such as guided missiles and fire control systems, they provide designers with types especially suited to all electronic applications where space is limited, and where shock of impact or high-g vibration is encountered.

The electrical performance of these subminiatures is equal to, and in certain cases even better than, that expected from valves of a much greater size. The EF72 R.F. amplifier, for example, which is suitable for use in the first stage of telecommunications receivers, combines many of the qualities of larger low-noise receiver input valves, with the ability to work at higher frequencies.

Brief technical details of the current range of indirectly-heated valves are given here. Those who require more comprehensive information, including characteristic curves, are invited to apply to the address below.

Type No.	Description	Filament or Heater (V)	Filament or Heater (mA)	$V_a = V_{g2}$ (V)	$-V_{g1}$ (V)	I_a (mA)	I_{g2} (mA)	g_m (mA/V)
EA76	Single diode (5 mm. bulb)	6.3	150	150 (max.)	—	9.0 (max.)	—	—
EC70	U.H.F. triode oscillator	6.3	150	100	2.0	13	—	5.5
EF70	High slope R.F. pentode with short suppressor grid base	6.3	200	100	2.0	3.0	2.5	2.5
EF71	Variable-mu R.F. pentode	6.3	150	100	1.2	7.2	2.2	4.5
EF72	High slope R.F. pentode	6.3	150	100	1.4	7.0	2.2	5.0
EF73	High slope pentode for industrial applications	6.3	200	100	2.0	7.5	2.5	5.25
EY70	Half-wave rectifier	6.3	450	250 (max.)	—	45 (max.)	—	—
DY70	High voltage rectifier (directly heated)	1.25	140	10kV (P.I.V.)	—	2.0 (max.)	—	—

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. . . with safety in the hazardous enterprise of the deep sea trawler is its radio and radar equipment upon which safe navigation depends. Thousands of soldered joints contribute to the efficient functioning of this delicate apparatus. One dry or H.R. joint could mean the breakdown of a circuit, the destruction of the vital link, a perilous voyage.

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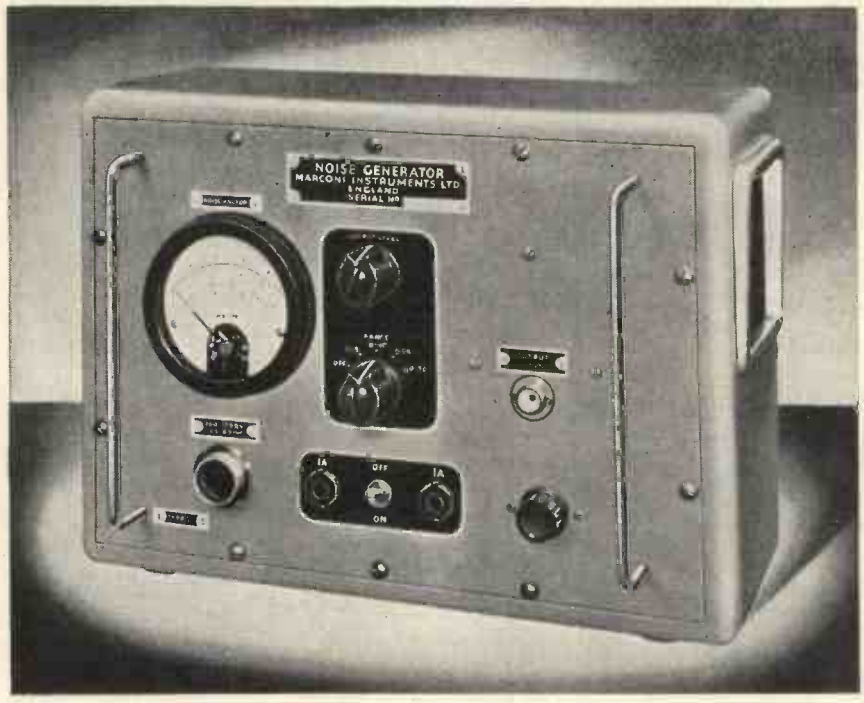
Figure of Merit

MARCONI NOISE GENERATOR TF 987/1

The noise factor (figure of merit) of a receiver is obtained by dividing the signal-to-noise ratio at the input by the signal-to-noise ratio at the output. Using this Marconi Noise Generator, the measurement is made by checking the output level due to internal noise, and then injecting a noise signal to double this level. The meter reading directly gives the noise factor N.



SPECIFICATION

NOISE OUTPUT CALIBRATION: *0-30 in four ranges: 0-5, 0-10, 0-15 and 0-30.*

ACCURACY: *± 0.5 db.*

FREQUENCY RANGE: *100 kc/s to 200 Mc/s.*

POWER SUPPLY: *200-250V, 45-65 c/s.*

DIMENSIONS: *11" × 15½" × 9" over projections.*

WEIGHT: *20 lbs. approx.*

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● Only 1in. high. ● Packed in damp-proof containers. ● Variable iron-dust cores. ● Fitted tags for easy connection ● Low loss Polystyrene formers.

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A spotlight on just one of the range of **OSMOR** *"Q" coils.*

H.F. CHOKE Type Q.C.1.

Frequency coverage 150 kc/s. to 20 m/c Iron-dust core and single-screw fixing Prototype tested and approved by M. G. Scroggie, B.Sc., M.I.E.E. Ideal as anode load in TRF receivers, for decoupling and general purpose. Price 4/-.

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The NEW OSMOR CHASSIS CUTTER

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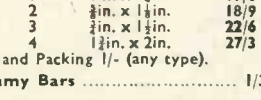


Prov. Pat.

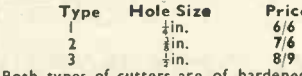
Type	Hole Sizes	Price
1	1in. x 1¼in.	19/6
2	⅞in. x 1⅛in.	18/9
3	¾in. x 1⅛in.	22/6
4	1⅜in. x 2in.	27/3

Post and Packing 1/- (any type).

Tommy Bars ..... 1/3 each

The OSMOR " JIFFY PUNCH "

For cutting smaller holes neatly and quickly with one blow of a light hammer.



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Type	Hole Size	Price
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Both types of cutters are of hardened steel and are for use on **Steel** up to 18 s.w.g., **Brass and Dural** up to 16 s.w.g., **Aluminium and Copper** up to 14 s.w.g.

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Overall size 5¾in. sq., as illustrated. Cream background, 3-colour. Type M1, L.M.S. waves. M2, L. & M. waves. M3, M. & 2/S. waves. Price 3/6 each. Pointer, 1/6. Drum, Drive, Spring and Cord for use with both types of dials, 3/2.

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Sensitive 2 Valve Receiver
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(special coils in cans available)

" PRACTICAL WIRELESS "
3-speed Autogram. Modern 1-valver. A.C. Band-Pass 3. R1155 Converter. Attache case portable. Modern high power Amplifier—2.

Dear Reader,

We can't mention all our products here but shall be glad to receive your enquiries for Chassis, Tuning Condensers, Switches, Volume Controls and all Other Radio Components. If it's top-quality components and a speedy, courteous service you are looking for—try Osmor. We really shall do our best for you.

Keep those small components—resistors, condensers, etc., neatly stored yet visible by using an

OSMOR "JAR-RACK"

(If you're a generous husband you'll buy one or two for your wife's larder, too—she will appreciate somewhere to store her preserves.) Holds any 1 lb. jam jars, with or without lids. Easily removed, cannot fall out. Just the thing for the tidy " HAM " or Radio Dealer.

Type 1 for wall-fixing, 6/9 each, holds 8 jars. (Jars are not supplied but are easily obtained).
Length 24in. enamelled olive green.
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FA300 FA400

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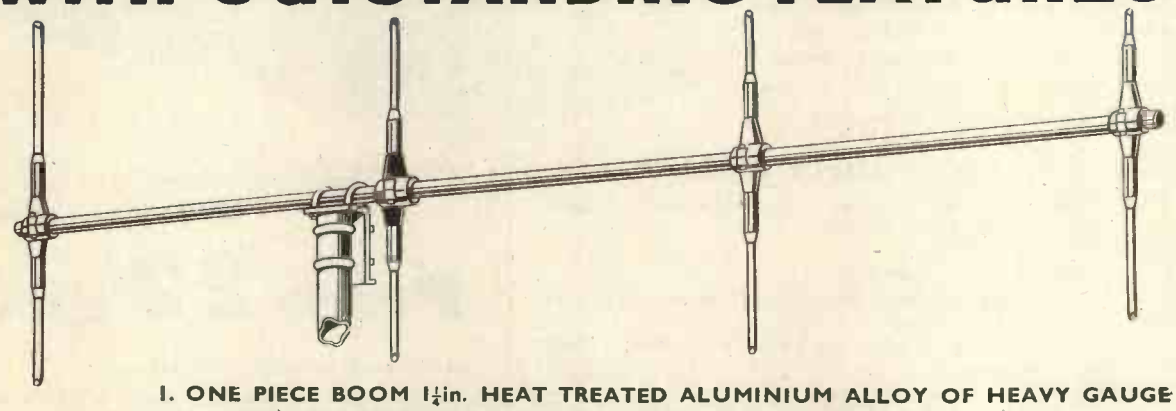
FRINGE AERIALS BY TELECRAFT WITH OUTSTANDING FEATURES



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2. DIPOLE CONNECTION WORKS CONNECTED INSIDE BOOM.
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B

A NEW HIGH PERFORMANCE FREQUENCY CHANGER

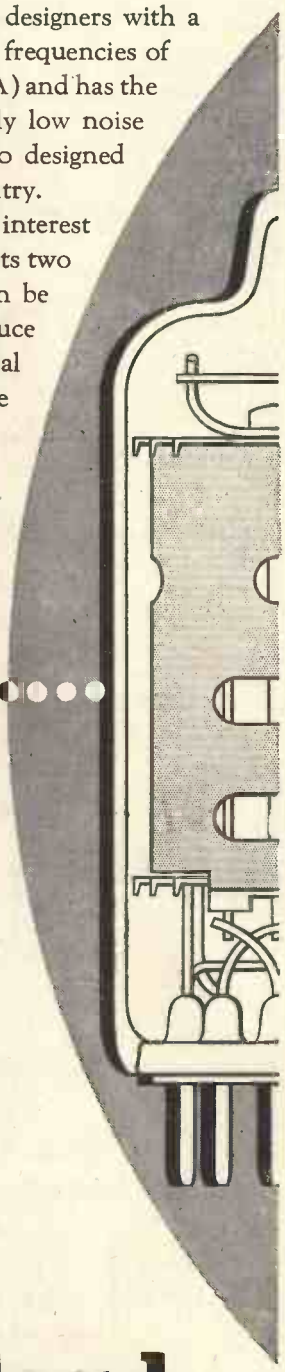
on a Services' Preferred base (B9A)

The new Mullard triode heptode, ECH81, provides equipment designers with a high performance frequency changer that will work efficiently at frequencies of up to 100 Mc/s. It is constructed on a Services' Preferred base (B9A) and has the important advantages of high conversion conductance, extremely low noise factor, and robust construction. Furthermore, the ECH81 is so designed that it enables maximum results to be obtained from existing circuitry.

A special feature of this valve that should prove of particular interest to designers of FM and AM/FM communication receivers is that its two sections may be operated independently. In FM circuits, it can be used as an R.F. or I.F. amplifier, or oscillator and thereby reduce the number of different valve types employed. Brief technical details of the ECH81 are given below. More comprehensive information will gladly be supplied on request.

ACTUAL SIZE

ECH81



PRINCIPAL CHARACTERISTICS

HEATER Suitable for series or parallel operation A.C. or D.C.

Vh	6.3 V
Ih	0.3 A

TYPICAL OPERATING CONDITIONS OF HEPTODE SECTION AS A MIXER

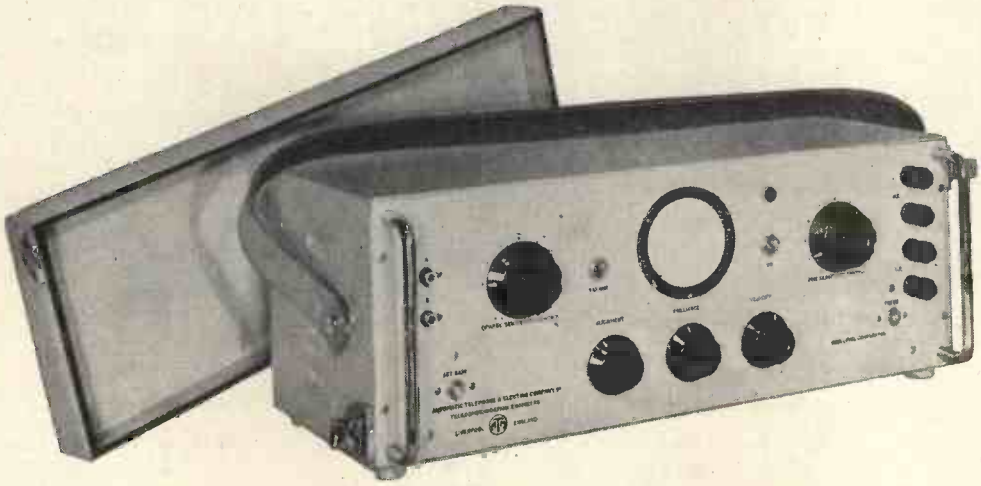
Va=Vb	250 V
Rg2+4	22kΩ
Rg3+gt	47kΩ
Ig3+gt	200 μA
Vgl	−2.0 V
Vg2+4	103 V
Ia	3.25mA
Ig2+4	6.7mA
gc	775 μA/V
ra	1.0M
Vgl for 100:1 reduction in gc. ...	28.5 V

CHARACTERISTICS OF TRIODE SECTION

Vat	100 V
Vgt	0 V
Iat	13.5mA
gm	3.7 mA/V
μ	22

BASE B9A

Mullard



A Precision Tool for Line Transmission Measurements

THIS INSTRUMENT, an electronic voltage comparator, was designed by Automatic Telephone & Electric Company to simplify the routine maintenance testing of line transmission equipment, whilst at the same time ensuring a high standard of reliable and accurate measurement. It is used to measure losses in channelling equipment, amplifier gains, crosstalk and harmonic distortion, and it possesses high sensitivity over a wide frequency range. The development and manufacture of precision measuring apparatus is an important activity of the Company. By the use of such equipment, telephone administrations can ensure that their line transmission and radio circuits function with maximum reliability and economy.

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.

Radio and Transmission Division: STROWGER HOUSE, ARUNDEL STREET, LONDON, W.C.2. Telephone: TEMPLE BAR 9262. Cablegrams: STROWGEREX LONDON. *Manufacturers:* AUTOMATIC TELEPHONE & ELECTRIC CO. LTD., LIVERPOOL AND LONDON. TELEPHONE MANUFACTURING CO. LTD., ST. MARY CRAY, KENT.

AT.8491-BX105

The new

THE MASTER SOUND SYSTEM

MAGNETIC TAPE RECORDER

•

Type PMR/3

"from a pedigree line"

And its SPECIFICATION

The Tape Player itself is of unit construction which enables many special requirements and applications to be met without modification. The following can be provided to order:—

Tape speeds 7½ inches per second, or 3¾ inches per second

Synchronous motor

Remote operation

Automatic braking and reverse drive for cueing purposes

Cassette tape

Rack mounted

TAPE

per second 60-10,000 cycles plus or minus 3 db.

second 70-7,000 cycles plus or minus 3 db.

total harmonic

normal operating

50 db. using

tape.

low level

one input.

K at 1v.

output).

to in-

for ex-

content

230 V.A.

frequencies

order.

high x 18" deep

45 lbs.

PRICES

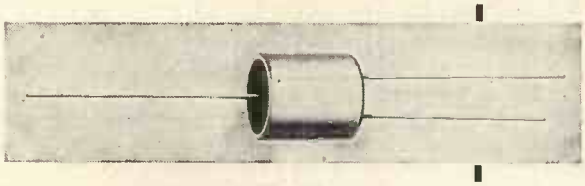
95 GNS. COMPLETE

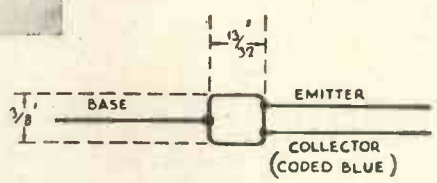
40 GNS. TAPE MECHANISM ONLY

Limited supplies will be available to the public commencing OCT. 1953

M·S·S · RECORDING COMPANY LTD

POYLE CLOSE · COLNBROOK · BUCKINGHAMSHIRE · TELEPHONE · COLNBROOK 284



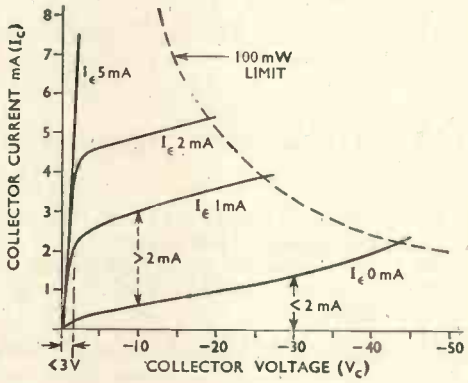


G.E.C.

Germanium Triode GET 1

POINT CONTACT TYPE

now available to all electronic equipment manufacturers



Many progressive designers have made full use of the range of G.E.C. germanium diodes to save power consumption and space. Now the release of the GET 1 — a germanium triode (transistor) of the point contact type — will enable more designers to reap the benefits of this important development in radio and electronic engineering, where the potentialities of the GET 1 are manifold.

For further information write to Osram Valve and Electronics Dept.,

RATING

V_c (collector voltage) for short-circuit stability at V_e=0*	−30 max.	V
V_c (DC)	−50 max.	V
I_c (collector current) DC	15 max.	mA
T_{op} (operating temperature)	35 max.	°C
p_c (collector dissipation)	100 max.	mW

Subject to p_c max. not being exceeded.

*V_e=emitter voltage.

CHARACTERISTICS

I_c (at V_c=−30, I_e (emitter current)=0)	2 max. 1 average	mA mA
V (at I_c=2 mA)	3 max. 1.5 average	V V
I_{gain} (at V_c=−10, I_e range 0–1mA)	2 min. 2.5 average	

GENERAL The GET 1 is hermetically sealed in a metal can, which is insulated from the electrodes. The can may be earthed when necessary.

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

Taylor model 88A multirange universal meter

A portable multirange A.C./D.C. instrument providing wide testing facilities to meet all to-day's requirements. Designed to assure simplicity of operation, accuracy and precision reliability ; many ranges and high sensitivity commend it for testing and experimental work in workshop or laboratory. Supplied complete with leads, crocodile clips and comprehensive instruction manual.

Other Taylor Products include :

SIGNAL GENERATORS, VALVE TESTERS, A.C. BRIDGES, VALVE VOLTMETERS, CIRCUIT ANALYSERS, AUDIO OSCILLATORS, CATHODE RAY OSCILLOGRAPHS, HIGH AND LOW RANGE OHMMETERS, OUTPUT METERS, INSULATION TESTERS, PANEL METERS.

Write for illustrated catalogue of Taylor Test Equipment

The complete range of Taylor Test and Measuring Equipment can be seen at Stand No. 105 at the Earls Court Radio Show.

SENSITIVITY. 20,000 ohms per volt D.C. 2,000 ohms per volt A.C.

METER. Large 5in. sensitive moving coil meter is used, fitted with knife edge pointer and anti-parallax mirror for greater ease in reading.

SCALES. Six scales, clearly marked black on white, cover Voltage, Current, Resistance, Capacity, Inductance and Decibels. Special features are the linear scales for all A.C. ranges.

ACCURACY. D.C. mA and D.C. Volts ranges 2 per cent. of F.S.D. ; A.C.V. and A.C.M.A. ranges (except for 5 kV A.C.) 3 per cent. of F.S.D. 5 kV ranges 6 per cent. of F.S.D.

OVERLOAD PROTECTION. Instantaneous overload protection, effective on all ranges, is provided for the meter movement.

BUZZER. Quick continuity tests may be made using the self contained buzzer.

OHMS ADJUSTMENT. An "ohms adjust" control provides compensation for variation of battery voltage. Self contained battery—Ever Ready U.11 cell—is readily accessible from front panel.

Ranges

VOLTS D.C. 0-.1-.25-1-2.5-5-10-25-50-100-250-500-1,000-5,000.
VOLTS A.C. 0-1-2.5-5-10-25-50-100-250-500-1,000-5,000.
MILLIAMPERES D.C. 0-.05-.1-.25-1-2.5-5-10-25-50-100-250-500-1,000.
MILLIAMPERES A.C. 0-.25-1-2.5-5-10-25-50-100-250-500-1,000.
AMPERES D.C. 0-2.5-10.
AMPERES A.C. 0-2.5-10.
RESISTANCE 1 ohm to 5 megohms in 4 ranges.
DECIBELS −20 to +69 in 9 ranges. Zero reference level is 6 mW into 500 ohms.
OUTPUT As A.C. volt ranges, except 5,000 volts, via a condenser.
INDUCTANCE 0.2 to 200 henrys in 2 ranges.*
CAPACITANCE 1,000 pF to 100 μF in 4 ranges.*

* External adaptor, Model 313D, required.

Price £21.10.0

Available on Hire Purchase Terms.

TAYLOR ELECTRICAL INSTRUMENTS LTD

MONTROSE AVENUE · SLOUGH · BUCKS.

Telephone : Slough 21381. Grams ; Taylins, Slough.

Fidelity in tape recording

MODEL PR7 TAPE RECORDER.

The Trusound PR7 tape recorder is an instrument of exceptional performance recording to professional standards, yet at the same time it is compact and simple to operate. Primarily designed as a transportable recorder enabling very high quality recordings to be made "on location" the recorder can be supplied in console form if required and further details of this form of mounting are available on request.

As supplied the PR7 is provided with two input channels with mixing between them. Channel A is for microphone input and channel B for Radio or Gramophone input. If it is desired to use more than one microphone then an external mixer unit may be connected into the channel B input. A power socket is provided on the rear of the recorder for providing the necessary voltages for such a mixer unit. The power socket can also be used for a radio feeder unit if required.

The PR7 tape recorder is a single-speed machine completely free from all forms of "wow" and "flutter" with a tape speed of either 7½in./sec. or 15in./sec., depending on customers requirements, and accommodating reels up to 2,250ft. (2,400ft. with special adaptor). It is also a twin track machine giving economy in tape usage. Twin heads of extremely high efficiency and performance are employed.

The amplifier employs the latest type miniature valves specially designed for high gain audio amplifiers having extremely low noise and hum factors and this in no small way contributes to the excellent signal to noise ratio of the recorder. Independent Treble and Bass controls are incorporated in a negative feedback circuit employed in the amplifier. The incorporation of feedback reduces the distortion of the whole system to less than 1 per cent.

Provision is made to couple the amplifier to an external amplifier system and a 15-ohm. disc cutter head may be driven from the output of the recorder for tape to disc dubbing.

The recorder is supplied fitted with a high quality 15 ohm. 10in. × 6in. elliptical loudspeaker and this loudspeaker can be used for monitoring when recording from gramophone or radio. A headphone socket is provided for monitoring purposes when recordings using a microphone are being made. Headphones can, if desired, be used for all monitoring. Provision is made for using an external speaker having an impedance of 2/3, 5, or 15 ohms.

£72
Carr. & Pkg. extra

MODEL PR7 TAPE DESK.

The PR7 tape desk is a tape mechanism having a performance of the standard required by professional recording studios and broadcasting organisations. Completely free from all forms of "wow" and "flutter" the machine will accommodate spools up to 10½in. in diameter (2,400ft.). It has a tape speed of 7½in./sec. or 15in./sec. dependent on customers requirements and it features simple drop-in, single slot loading, twin track heads, fast forward and fast rewind facilities, super high fidelity head unit giving an attainable top frequency of 10,500 c.p.s. at 7½in./sec. and 18 kc/s. at 15in./sec.

Superbly engineered and powered by three special motors manufactured by a company well known for the high standard of its products, the PR7 gives faultless performance and is a mechanism that will satisfy the most exacting demands of the connoisseur or professional user.

£25
Carr. extra

★ *Further details available on receipt of stamped, addressed envelope.*

AMPLIFIER TYPE P A 12

Conservatively rated at 12 watts output, simple to operate, lightweight, neat and compact, is a brief summary of the Trusound P A 12 Amplifier.

Ideally suited for use in schools and other educational establishments, either as transportable equipment, or for permanent installation; for halls and auditoriums with a capacity of between 300 and 400 people; for clubs and dramatic societies; calling and paging systems; staff location systems etc., the P A 12 fulfils the need for a powerful but compact amplifier which is not only reliable in operation, but also gives an extremely high standard of reproduction.

By virtue of its small physical size, the P A 12 may be used for installations where, by reason of limited space, the use of larger amplifiers of the same power output is precluded. The P A 12 accommodates Microphone and Gramophone/Radio inputs, and provision is made for operating a Radio Feeder unit from the power supply of the amplifier. By the use of a radio feeder and/or a Mixer Unit, the P A 12 may be used as the basis of a complex installation.

A combination of push-pull output and negative feedback account for the extremely high standard of reproduction achieved, and the use of a special pre-amplifier valve gives clean and clear speech reproduction when a microphone is employed. Of special interest is the fact that the P A 12 is entirely suitable for the replay of tape recordings to large audiences.

The attractively finished, clearly engraved control panel, is fitted with a system of coloured signal lamps indicating the particular function of the amplifier. A solidly constructed, well ventilated wooden case, covered in dark brown, hard-wearing rexine, with bronze fittings to match, houses the amplifier.

Complete with Installation, Operation, and Service Data. Fully warranted for 12 months.

£20
Carr. extra

THE MUSICMASTER TAPE DESK.

The Musicmaster tape desk is a moderately priced two-speed mechanism which will record the most difficult music without any trace of "wow" or "flutter" from one end of the reel to the other.

Featuring single slot loading, fast forward and rewind —without any tape handling—twin track high impedance heads, electromagnetic braking from a self-contained supply, the Musicmaster tape desk is well worthy of its name.

Powered by three motors manufactured by a company whose name is always associated with quality, the tape desk is designed for the recording enthusiast having only a limited pocket, but who requires performance unequalled in the price range.

18 GNS.

DESIGNED FOR CRITICS

Trusound Ltd.

BY CRITICAL DESIGNERS

Demonstrations on weekdays by appointment only. Saturdays 9 a.m. — 6 p.m.

OFFICES & SHOWROOM : 196 KINGSLEY ROAD, HOUNSLOW, MIDDX. (HOUnslow 7947) WORKS : TWICKENHAM, MIDDX.

VALVES For SPECIAL PURPOSES

27M1 High Vacuum photo-multiplier

WITH HIGH RESPONSE IN THE VISIBLE REGION

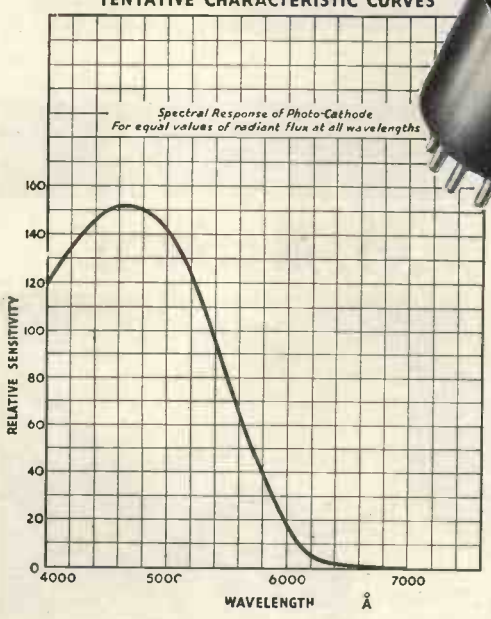
Because of its high sensitivity, low noise level, low dark current and freedom from distortion, the Ediswan Mazda 27M1 may be used for light operated relays, for film scanning, facsimile transmission and in scientific research involving low light levels: and in many applications its small size is an advantage. The 27M1 is capable of multiplying very small currents produced under weak illumination by an average value of one million times when operated at 100 volts per stage.

The resultant output current is a linear function of the exciting illumination under normal operating conditions. Since secondary emission occurs instantaneously, the frequency response is flat up to the frequencies at which transit time becomes a limiting factor.

Muirhead Phototelegraphic Transmitter Type 601-A

A particular application of the 27M1 photo-multiplier is in the Muirhead Phototelegraphic Transmitter, type 601-A where its above-mentioned properties enable a compact and highly efficient instrument to be obtained.

TENTATIVE CHARACTERISTIC CURVES



RATING

Maximum Anode Supply Voltage (volts)	*1,100
Maximum Potential Anode/Secondary cathode K10 (volts)	120
Maximum Anode Current (mA)	1.0
Cathode k1 sensitivity (μA/lumen)	†10

(Vk1=0, all secondary cathodes joined at 100 volts)

* With respect to cathode.

† The sensitivity is on the basis of a lamp colour temperature of 2700°k and a light area of 4 mm x 20 mm

Further details of the 27M1 and other photo-multipliers are available on request.

EDISWAN

MAZDA

WE SHALL BE AT THE RADIO SHOW EARLS COURT SEPT. 2-12

THE EDISON SWAN ELECTRIC CO. LTD., 155 Charing Cross Road, London, W.C.2

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

OPEN TILL 6 P.M. SATURDAYS — TELEPHONES: AMBASSADOR 4033 & PADDINGTON 3377/8

PREMIER RADIO Company

(REGD.) B.H. MORRIS & CO. (RADIO), LTD. EST. 49 YRS.

(Dept. W.W.) 207 · EDGWARE ROAD · LONDON · W2

Terms of Business : Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/-, 1/6 under 40/-, unless otherwise stated.

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-100 cycles. All primaries are screened. All LTs are centre tapped.

SP175B, 175-0-175, 50 mA., 4 v. @ 1 a. 4 v. @ 2-3 a.	25/-
SP250B, 250-0-250, 60 mA., 4 v. @ 1-2 a. 4 v. @ 3-5 a.	25/-
SP300A, 300-0-300, 60 mA., 6.3 v. @ 2.3 a. 5 v. @ 2 a.	25/-
SP300B, 300-0-300, 60 mA., 4 v. @ 2-3 a. 4 v. @ 3-5 a. 4 v. @ 1-2 a.	25/-
SP301B, 300-0-300, 120 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 3-5 a.	28/-
SP350A, 250-0-250, 100 mA., 5 v. @ 2-3 a. 6.3 v. @ 2-3 a.	29/-
SP351, 350-0-350, 150 mA., 4 v. @ 1-2 a. 4 v. @ 2-3 a. 4 v. @ 3-6 a.	36/-
SP352, 350-0-350, 150 mA., 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 2-3 a.	36/-
SP375A, 375-0-375, 250 mA., 6.3 v. @ 2-3 a. 6.3 v. @ 3-5 a. 5 v. @ 2-3 a.	55/-
SP501, 500-0-500, 150 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 2-2 a. 4 v. @ 3-5 a.	47/-
SP501A, 500-0-500, 150 mA., 5 v. @ 2-3 a. 6.3 v. @ 2-3 a. 6.3 v. @ 2-3 a.	50/-
SP425A, 425-0-425, 200 mA., 6.3 v. @ 2-3 a. 6.3 v. @ 3-5 a. 5 v. @ 2-5 a.	67/6

SPECIAL OFFER

DOUBLE WOUND AUTO-TRANSFORMER 250 watts.

Input/Output	Output/Input
100 volts	110 volts
110 ,,	113 ,,
200 ,,	116 ,,
210 ,,	119 ,,
220 ,,	122 ,,
230 ,,	134 ,,
240 ,,	146 ,,
250 ,,	

Price 42/6 Plus 2/6 Pkg., Carr.

With the two windings connected in series a vast number of voltage tappings are available.

PREMIER VARIABLE IMPEDANCE "MATCHMAKER" MO.15 OUTPUT TRANSFORMER

Designed to meet the demand for an efficient variable ratio Output Transformer. 11 ratios from 13 : 1 to 80 : 1 all centre tapped and can be used to match any output valves either single- or push-pull. Class "A" "AB1" "AB2" or "B" to any low impedance speech coil or combination thereof. Primary Inductance 60 henries 15 watts audio 100 mA. Price, 45/-.

WEYMOUTH MINIATURE I.F. TRANSFORMERS

465 Kc/s., iron cored, permeability tuned, 10/6 pair.

WEYMOUTH MINIATURE COIL PACK

Covering Med./Long/Short wave bands. Iron cored coils, gram position on switch. Dimens.: Height, 1¾in. Length, 3¾in. Width 2¾in. Spindle length 2in. Price 19/6.

MINIATURE TUNING CONDENSERS

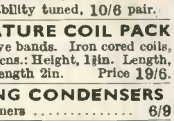
2 gang .0005 mfd. with trimmers 6/9

CHARGER TRANSFORMERS

Input 230 v. A.C. Output 12 v. at 1 amp. Completely shrouded. Price 9/11

BATTERY CHARGERS

200-250 v. A.C. Will charge 6 v. or 12 v. Car Battery at 1 amp. Housed in strong metal casing. Finished in Green hammered enamel. Size : 6in. long, 3¼in. wide, 3¼in. high. Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain ex-Govt. components. Plus 2/6 post and pkg. **39/6**



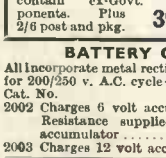
BATTERY CHARGER KITS

All Incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. cycle mains.

Cat. No.

2002 Charges 6 volt accumulator at 1 amp. Resistance supplied to charge 2 v. accumulator £1.2.6

2003 Charges 12 volt accumulator at 1 amp. £1.7.6



H. T. Eliminator *Ex. Govt.*

By famous manufacturer

NEW & UNUSED Input 200/250 v. A.C., Output 120—at 30 mA., housed in strong metal box size 10in. long, 7in. wide, 6¼in. deep.

37/6

Plus 2/- pkg. and carr.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT

All parts to construct an eliminator to give an output of 120 volts at 20 mA., and 2 volts to charge an accumulator. Uses metal rectifier, £2.

"MASTERADIO" VIBRATOR PACK

6 v. input ; 120 v. 60 mA. output ; complete with valve rectifier and leads. 49/6. Plus 5/- pkg., carr.

Famous Set Manufacturer's surplus of

ELECTRIC 'GRAM UNITS

Two-speed, 33⅓ and 78 r.p.m. For playing Standard and L.P. recordings. Complete with Turntable. For use on 200-250 v. A.C. mains. Each unit is in its original manufacturer's carton and is fully guaranteed. Limited quantity only available, at approx. half list price.

£4 · 2 · 6

Plus 2/6 pkg., carr., ins.

SPECIAL OFFER

THE FAMOUS "CHANCERY" HIGH FIDELITY MICROCELL PICK-UP—TYPE GPX *for Standard and Long Playing*

The Chancery Light Weight GP.X Pick-up embodies certain unique features achieving a standard of performance not possible with normal magnetic or crystal pick-ups. The secret of the high standard of performance is in the use of the special microcell crystal cartridge assembly which has an unusually wide frequency response. The sapphire stylus is precision ground and semi-permanent. With two cartridges 1 L.P. and 1 Standard. Price 52/6. *Additional L.P. or Standard Cartridges can be supplied from stock at* 19/6 *each.*

GRAMOPHONE CABINETS—*Portable*

A fortunate purchase of a manufacturer's surplus stock enables us to offer this first grade Portable Cabinet made by a famous manufacturer at the ridiculously low price of Plus 2/6 carr., pkg. **29/6**

Specification :

Substantial Wooden case. Rexine covered, including wooden motor board, already cut to take a gramophone unit. Almost any make of Rim Drive unit can be accommodated. Outside dimensions : Height (when closed) 5½in. ; Length 15½in. ; Depth 13¾in. ; Clearance space under motor board 2¾in. ; Clearance space from motor board to inside lid when closed 2¼in.

AS a special offer for a limited period only the above Gramophone Unit, Pick-up and Cabinet, which will assemble into a complete Portable Electric Gramophone ready to plug-in to your radio or Amplifier, can be supplied at **£7 · 19 · 6**

Plus 5/- Pkg., Carr. & Ins.

ANOTHER SENSATIONAL BUY!

A Three-Speed Automatic Record Changer made by World-famous manufacturer offered at 25 per cent. below the list price.

The Unit designed to play 12in., 10in. and 7in. Records intermixed in any order at 33⅓, 45 or 78 r.p.m. Capacity 10 records.

New reversible dual stylus crystal Pick-up has extended frequency range to 10,000 c.p.s Self-compensated for the L.P. lower frequencies with the Turnover frequency at the correct point.

An essential feature is the simplicity of design. For use on 100/125-200/250 volts 50 cycles A.C. mains.

LIMITED QUANTITY ONLY Plus packing and carriage 5/-. **£11.19.6**

BRAND NEW, guaranteed and in manufacturers orig. carton. LIST PRICE £16.10.0

GARRARD GRAMOPHONE UNITS

£4 · 19 · 6

plus 5/- p.c.

Induction motor 100-250 volt, 50 cycles A.C. only. 78 r.p.m. The GARRARD Induction motor is totally enclosed. Entirely free from radio frequency disturbance, magnetic hum and electrostatic Variable speed. With 12in. Turntable. BRAND NEW!

GARRARD Type 75A. Latest 3-speed Autochange Unit complete with 2 Acos High Fidelity G.P.19 Pick-up Heads. 1 L.P. and 1 Standard. **£14.19.6**

GARRARD Rim Drive 78 r.p.m., complete with magnetic pick-up and turntable .... **£5.19.6.**

COLLARO 3-speed single-gram. unit, complete with head for L.P. and Standard recordings **£8.8.0**

Packing and carriage on each of the above units 2/6.

C.R. TUBES

VCR516

9in. Blue picture, Heater volts 4, Anode 4 Kv., In manufacturer's original carton.

£3.19.6. Plus 5/- pkg., carr., ins.

VCR517C

6½in. picture. This tube is a replacement for the VCR97 and VCR517. Guaranteed full size picture.

Price 35/- Plus 2/6 pkg., carr., ins.

ALL BRAND NEW

A.C.R. I.C.R. TUBES

5½in. screen. 4 volt Heater. This Electrostatic Tube is recommended as eminently suitable for Television, 15/- plus 2/6 Pkg., Carr. and Ins. *Data sheet supplied.*

SUPER QUALITY TELEVISION MAGNIFYING LENS

6in. lens	25/-
10in. lens	£2/10/-
12in. lens	£3/10/-

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Alminium, with four sides.

7×5¼×2in.	4/-
7×3¼×2in.	3/9
9¼×4¼×2in.	4/3
10×8×2¼in.	5/3
12×9×2¼in.	7/-
14×9×2¼in.	7/6
10×9×3in.	7/-
12×10×3in.	7/9
14×10×3in.	7/11
16×10×3in.	8/3
16×8×2¼in.	8/-

ALUMINIUM PANELS 18 s.w.g.

7×6in.	1/3	7×4in.	1/-
9¼×6in.	1/8	9¼×4in.	1/5
10×9in.	2/2	10×7in.	1/11
12×9in.	2/8	12×7in.	2/5
14×9in.	3/2	14×7in.	2/11
16×9in.	3/8	16×7in.	3/5
20×9in.	4/8	20×7in.	4/5
22×9in.	5/2	22×7in.	4/11

LOUDSPEAKERS

ELAC—2¼in. dia., Moving Coil, 15 ohms imped.	15/-
PLESSEY—3in. dia., Moving Coil, 3 ohms imped.	15/-
ELAC—3¼in. dia., Moving Coil 3 ohms imped.	15/-
ELAC 5in. dia., Moving Coil, 3 ohms imped.	14/6
E.M.I.—8in. Elliptical, 15 ohms imped.	27/6
PLESSEY—8in. dia., Moving Coil, 3 ohms imped.	14/6
PLESSEY—10in. dia., Moving Coil, 3 ohms imped.	23/6
GOODMANS—12in. dia., Moving Coil, 15 ohms	£8/8

Plus 5/- packing and carriage.

VITAVOX—K12/20 12in. dia., Moving Coil, 15 ohms imped. £11/11

Plus 5/- packing and carriage.

12" Speakers TAX FREE!

METERS

Large stocks available, a few of which are enumerated below :—

Full Scale Deflection	Scale Length in.	External Dimensions in.	Movement	
25 A	1½	2½ round	R.F. Thermo	7/6
3 A	1½	2½ round	R.F. Thermo	7/6
3.5 A	1½	2½×2½	R.F. Thermo	7/6
4 A	1½	2½×2½	R.F. Thermo	7/6
20 A	1½	2½ round	M/C	8/6
40 A	1½	2½ round	M/C	8/6
1.5 mA	1½	2½ round		12/6
5 mA	2	3½ round		7/6
6 mA	2	3½ round		16/9
50 mA	1½	2½×2½	M/C	7/6
20 V	2	2½×2½	M/C	8/6
40 V	1½	2½×2½	M/C	8/6
1 mA	2	3½ round	M/C	25/-

MOVING COIL METER

A super quality Moving Coil Meter basic movement 2 mA Scale dimension 2¼in. Overall dimensions 2½in. dia. 1¾in. deep. Bakelite Case projecting type. At present scaled 1 amp. R.F. By removing thermo couple, reversing scale and recalibrating the meter, a high grade test instrument with any range above the basic F.S.D. may be built up. Price 4/9

1 mA METER IN PLASTIC CASE

The movement is 1 mA mounted in a case 3¼in. square and 3¼in. high. The scale is 2¾in. long and the dial is 2¼in. diameter. There is ample room in the case for a switch and multipliers. Internal Resistance 100 ohms. Price 27/6

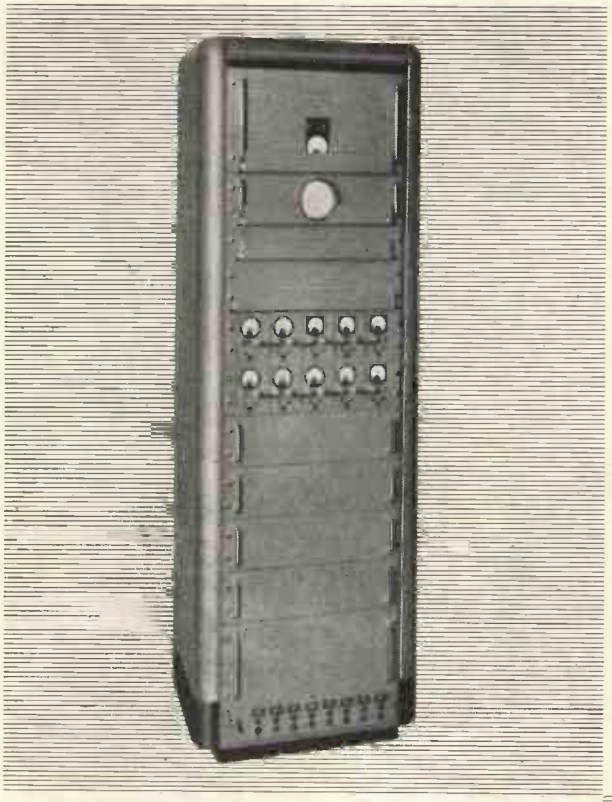
Germanium Crystal Diodes. G.E.C. wire ended. 2/6. 24/- doz.

ACCUMULATORS

By world-famous maker, 2 volt 10 amp. 4/11

C

for all types of T.V. test equipment



TELEQUIPMENT MONOSCOPE SIGNAL GENERATOR

The illustration shows a complete installation for factory T.V. testing. The equipment comprises the Monoscope unit, producing the standard Test Card "C," together with five Vision and five Sound transmitters each crystal controlled.

The Monoscope tube used is completely free from microphony, interference, and other effects usually associated with this type of apparatus.

The equipment is also available for 525 and 625 lines.

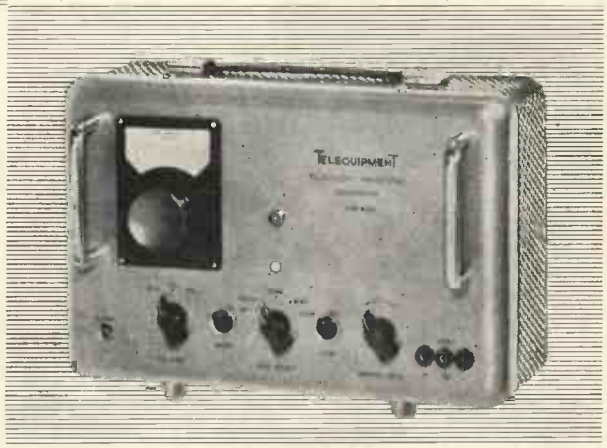
We shall be pleased to quote for variations of this equipment to meet individual requirements.

TELEQUIPMENT WG/4 PATTERN GENERATOR

The WG/4 is a fully portable Pattern Generator designed for the service engineer. Weighing only 15 lbs., it provides a fully interlaced Test Pattern at any frequency in the range 40–70 Mc/s. The pattern gives a complete check of receiver performance and allows all adjustments to be made without reference to a transmitted programme.

The synchronising waveform is identical with that transmitted by the B.B.C.

Also available for 525 and 625 lines.



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STAND No. 28

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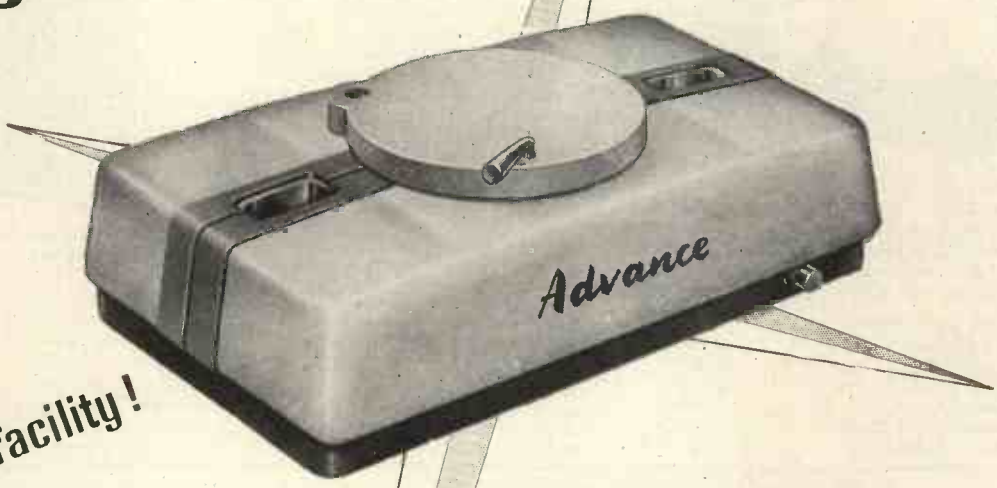
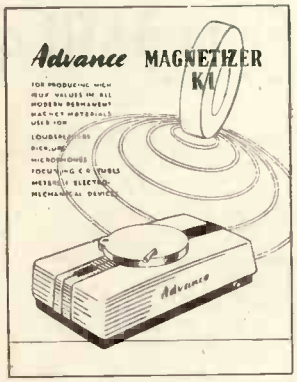
PHONE : HILLSIDE 9044

Specialists in T.V. test equipment

Introducing the *Advance* Magnetizer K.1.



a new facility!



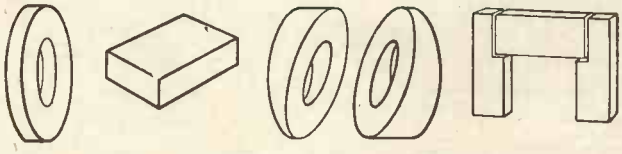
Why no: write today for your copy of Folder S20/W which will tell you more about the Advance Magnetizer K.1 ?

The latest Advance product, the new K.1 Magnetizer, offers outstanding advantages to users of permanent magnets, its small size and low cost being important features.

When magnets are used as component parts of equipment, the importance of magnetizing at the last possible stage of assembly cannot be too strongly emphasized, as the large proportion of rejects due to storage and handling is then eliminated.

The K.1 Magnetizer will process all materials in current use and the simplicity of its operation makes it ideal for use on the production line.

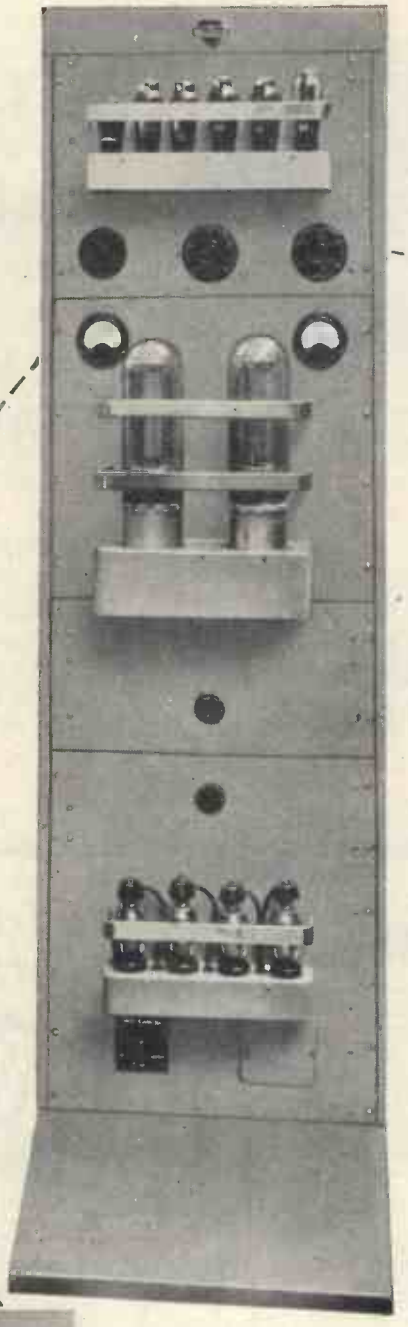
SOME TYPICAL APPLICATIONS



ADVANCE COMPONENTS LIMITED, BACK ROAD. SHERNHALL STREET, WALTHAMSTOW. LONDON. E.17.

Telephone : LARkswood 4366/7/8 *Telegrams : Attenuate Walt, London*

Ultrasonic Power for Industry



L.F. Ultrasonic Generator type E.7590

MULLARD, pioneers in the application of ultrasonic power to industry, now make available the first of a range of h.f. and l.f. ultrasonic generators that provide from 50W — 1kW ultrasonic power at frequencies in the range 15 kc/s to 2 Mc/s.

These equipments are already being successfully applied to such processes as the tinning of aluminium and its alloys, the rapid cleaning of small engineered parts that are either inaccessible or that require delicate treatment, and the dispersion of particles in liquid media.

In addition to these proved applications, high power ultrasonics offers interesting possibilities in research projects where cavitation phenomena or high particle velocities are required.

Research workers and development engineers wishing to investigate the application of ultrasonics to their own particular problems are invited to take advantage of the Mullard advisory service on ultrasonics at the address below.

L.F. Ultrasonic Generator type E.7590

Mullard

SPECIALISED ELECTRONIC EQUIPMENT

Mullard Ltd., Equipment Division, Century House, Shaftesbury Avenue, W.C.2

VALVES, TUBES & CIRCUITS

9. AN EXPERIMENTAL SPOT-WOBBLE CIRCUIT

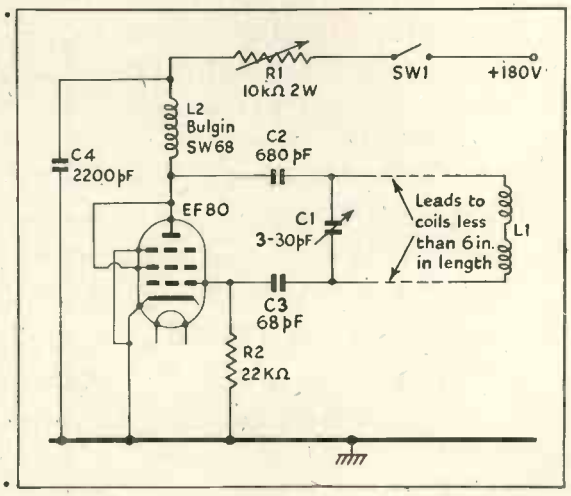
The line structure of a television picture is an unpleasant feature, and is emphasized to the point at which it may become intolerable as the focus becomes sharper. The high horizontal definition achieved by good focus can be retained and at the same time the line structure removed by elongating the spot vertically. The most convenient way of doing this is by deflecting the spot vertically at a frequency which is high compared with the line frequency. This is called "spot wobble".

The best circuit arrangement for producing spot wobble depends upon the picture tube used, its associated components, and the layout of the receiver. A good starting point for experiments in this field is provided by the circuit described below. It should be appreciated, however, that if the interlace is not good, or if the spot is astigmatic, or if there is appreciable deflection defocusing, spot wobble is unlikely to effect any considerable improvement. These points should therefore be looked into before attempting to apply spot wobble.

The diagram shows a simple oscillator in which the spot-wobble deflector coils form part of the oscillatory circuit. An EF80 pentode is employed, connected as a triode, and the total drain on a 180 volt H.T. line is about 12 mA.

The amplitude control R1 is used to adjust the elongation of the spot to the condition in which the lines just merge. The switch SW1 permits the spot wobble to be switched off while the normal focus is being adjusted.

The spot-wobble deflector coils consist of a pair of saddle windings similar to conventional deflector coils. There is, however, no yoke, and the windings are much smaller, each coil consisting of five turns of 0.018″ diameter (26 S.W.G.) enamelled copper wire. These should be wound on a rectangular former 1⅛″ x 1¾″. When removed from the former the flat winding is applied to the tube by folding the longer sides round the neck, i.e., with the 1⅛″ width parallel to the axis of the tube. The two coils are mounted on opposite sides of the tube neck directly behind the normal deflection coils and are connected in series in such a way that their magnetic fields assist each other.



EARLS COURT
STAND
234
FIRST FLOOR

Make a bee-line for and see for yourself:

First of the acos REG'D Hi-g 1 * series of pick-ups & cartridges

A brand new range of inexpensive microphones 2

Acos crystal devices are protected by patents and patent applications in Great Britain and other countries.

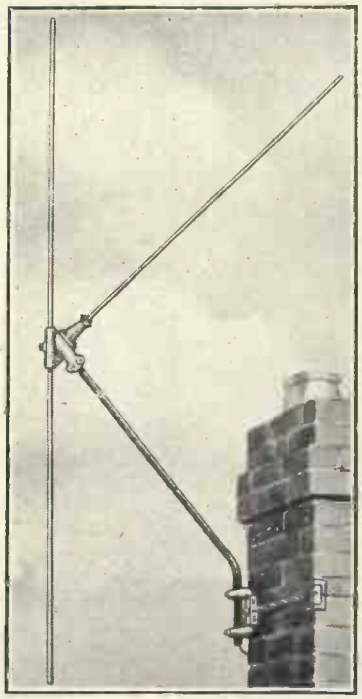
COSMOCORD LIMITED
ENFIELD MIDDLESEX

* Acos "Hi-g" Pick-ups are the first commercially available pick-ups that will track the highest modulation levels capable of being engraved on either standard or long playing records. They thus add an important advance in pick-up design to the already outstanding reproduction qualities associated with Acos crystal products.

. . . always well ahead

THE "BELLING-LEE" PAGE

Mechanical improvements and special features in the design of Belling-Lee Television Aerials to be seen at the Radio Show on Stand No. 102



Something Revolutionary in Television Aerial Design.

Improved Designs

This last year or so has seen great improvements in engineering design of T.V. aerials. When television first started, aerials offered by some of the smaller manufacturers were not much better than different assemblies of standard conduit fittings, but makers who did not improve on that standard, quickly fell by the way.

Designs improved all round, and lately, the improvements have been very real. As manufacturers with enormous sales, " Belling-Lee" could afford to spend large sums on tools to mass produce the ingenious castings which keep their aerials well to the fore, presenting a streamlined appearance and considerably easing the task of erection. A most ingenious reflector casting was released last year, which allowed both the reflector elements and the cross arm to be securely held in true alignment by the tightening of one ¼in. high-tensile bolt.

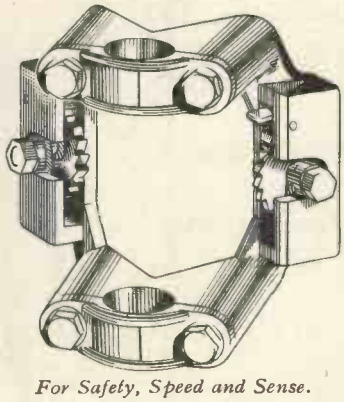
The design is such that the pieces just pull and lock into position, and cannot get out of position afterwards. This one refinement cuts out many minutes of fiddling and is covered by U.K. Patent Nos. 519883 and 677108.

The " Kayrod " Television Aerial

With a performance comparable to that of the well-known " Belling-Lee " Junior " H " series of cranked mast aerials, the " Kayrod," Reg. Design 869286, illustrated top left, has a far higher vision gain than any known aerial in its price range.

The "Kayrod" dispenses with a mast, a lower element serving as the support arm, while ingenious designing has made a cross arm unnecessary. The " Kayrod " is much lighter and easier to erect than most types of television aerials. The " Belling-Lee " ratchet bracket (Reg. Design 869363), is incorporated in the lashing kit, ensuring safe, speedy and sensible chimney fixing, while the insulator is designed to give connections the utmost protection against weather. **PRICES.** Channels 1 and 2, **£4/4/-.** Channels 3, 4 and 5, **£3/19/6.**

The " Belling-Lee " Ratchet Bracket



For Safety, Speed and Sense.

This bracket enables an aerial rigger to spend less time on the roof and to make a better job. We have already made our aerial and mast the easiest to wire and assemble—we cannot do very much to simplify cable runs, except to provide the simplest and most efficient outlet boxes and plugs, but we have now improved bracket and lashing design, to make a sounder, speedier and more efficient streamlined job.

Horizontal Aerials with an Uplift

You can increase the diameter and gauge of the elements to uneconomical figures without gaining much. So we tried to put a "set" in the element so that its "droop" would bring it horizontal. From this thought we uplifted the elements considerably and now all " Belling-Lee " horizontal aerials are instantly recognised by their upswept appearance. They are exceedingly well known around Pontop Pike and Belfast.

Adjustable Mast Head Adaptor

This is invaluable where an aerial is being fitted to a non-standard wooden or metal mast of from 1½in.-2in. diameter. The cross arm fits snugly into its slot and is secured by the standard mast cap which pulls the cross arm into position and assures that it is correctly aligned. Feeder arrangements for both metal and wooden masts are provided for.

Tilting Mast Cap

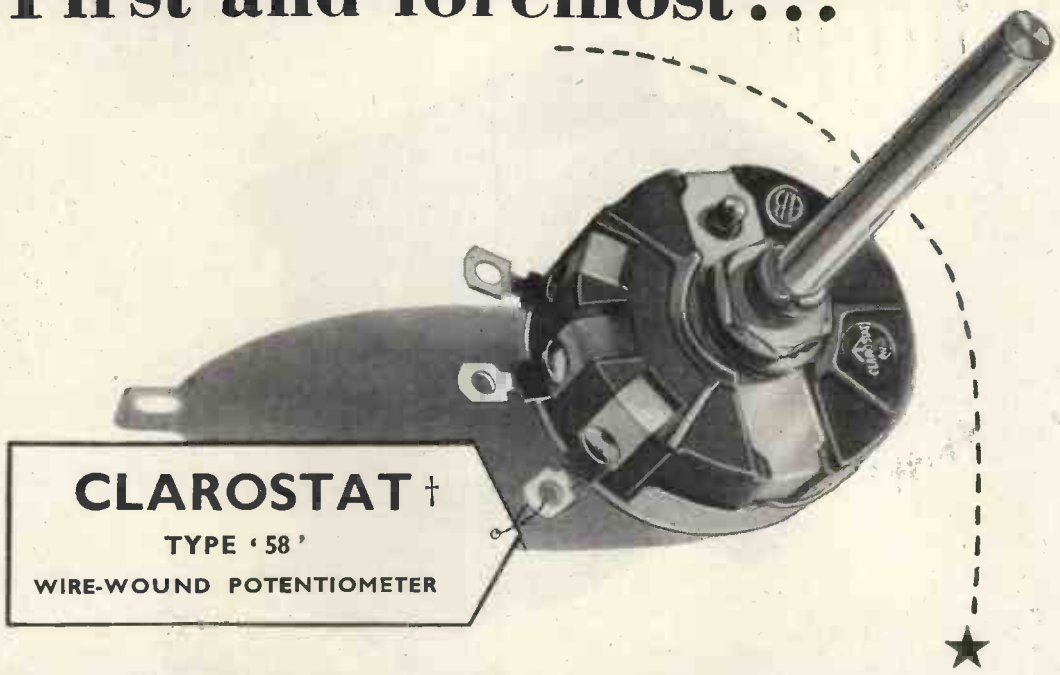
If we felt that there was any general advantage in a tilted aerial we would make them that way. The advantage is the exception rather than the rule, although some people like the look of a tilted aerial.

The " Belling-Lee " tilting mast head adaptor is a beautifully designed job in three castings, calibrated from horizontal to 25°. This adaptor can be used either direct on to a " Belling-Lee " metal mast, or with the adjustable mast head adaptor described above. As a feature of all these castings, true alignment is positive, the parts lock together so that they cannot be out of alignment even through carelessness.

Written 24th July, 1953.

BELLING & LEE LTD
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND

First and foremost...



CLAROSTAT †

TYPE '58'

WIRE-WOUND POTENTIOMETER

We are proud to introduce the CLAROSTAT Type 58 Wire-wound Potentiometer, designed by the world's foremost Potentiometer manufacturers and produced for the first time in this country. The type 58 has many features which will immediately appeal to the discriminating user.

FEATURES

- ★ Rated at 3 watts and available in all values up to 100,000 ohms linear.
- ★ Special windings are available to requirements.
- ★ High Grade Bakelite Casing, of rugged construction. Solder Tags heavily silver-plated and of special design making them completely immovable under all conditions.
- ★ Metal cover firmly keyed into Bakelite Casing, cannot loosen or turn. Connected to fixing bush providing automatic "grounding" of cover.
- ★ Obtainable with single or double pole mains switch.
- ★ Dimensions: Diameter, 1 3/4in. Depth of case without switch, 3/4in.
- ★ Samples and full specifications available on application.

† *Regd. Trade Mark.*

WHOLESALERS

CLAROSTAT TYPE 58 Wire-Wound Potentiometers are supplied individually packed in attractive printed cartons. Delivery is prompt. Write for price list and details of very attractive trade terms.

★

CLAROSTAT

Controls and Resistors

AB METAL PRODUCTS LIMITED.

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Phone: GROsvenor 5206/7

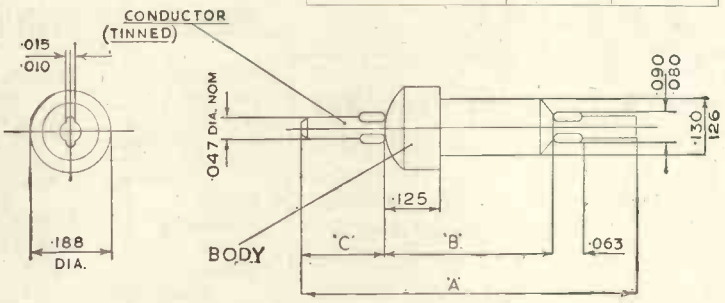
POLYTAGS... lead-through and stand-off insulators

Polytetrafluoroethylene (P.T.F.E.) is an outstanding insulator. It is tough, durable and will not crack or arc. Its dielectric properties are substantially constant over a frequency range of 60 c.p.s. to at least 300 Mc.p.s. and are unaffected by temperature changes between minus 100°C. and plus 288°C. It has zero moisture absorption and is water repellent. It is, therefore, a most suitable material for stand-off and feed-through insulator terminals and has been chosen by Ediswan for this purpose. Ediswan Polytags are available in five types as illustrated below.

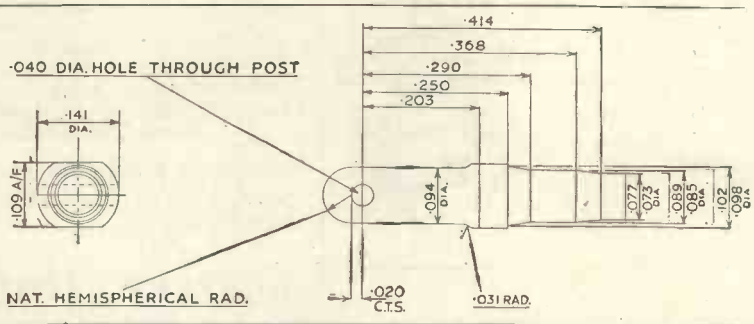
PT 1 & 2. Lead-through

PT 3 & 4. Stand-off

	A	B	C
PT 1	.750	.375	.188
PT 2	.875	.500	.188
PT 3	.563	.375	—
PT 4	.688	.500	—



PT 5. Component mounting



Fixing: Polytags are primarily designed for fixing with a 5 B.A. nut—PT 1—4 or an 8 B.A. nut PT 5. They are self-tapping.

We are equipped to produce components fabricated or moulded in P.T.F.E. to individual specifications and enquiries will be welcomed.

EDISWAN

CLIX

THE EDISON SWAN ELECTRIC CO., LTD.,

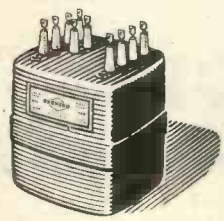
Sales Department P.T.F.E.6, 21 Bruton Street, London, W.1. *Telephone: Mayfair 5543* ER24

Head Office: 155 Charing Cross Road, London, W.C.2. *Member of the A.E.I. Group of Companies*

"In a glass clearly...."

The elements that have conspired to confound man for centuries can now be plotted against—by radar. "Blind" approaches in fog and "dirty weather" are thereby made more safe. And another link is forged in the chain of confidence at sea.

Navigators have faith in their instruments and manufacturers of radar equipment realise their responsibility. They for their part demand from each component the absolute in reliability. Parmeko transformers are often chosen for inclusion in radar equipment for, although their part is small, it is important and for over a quarter of a century Parmeko have proved the strength of their link in the chain of confidence.



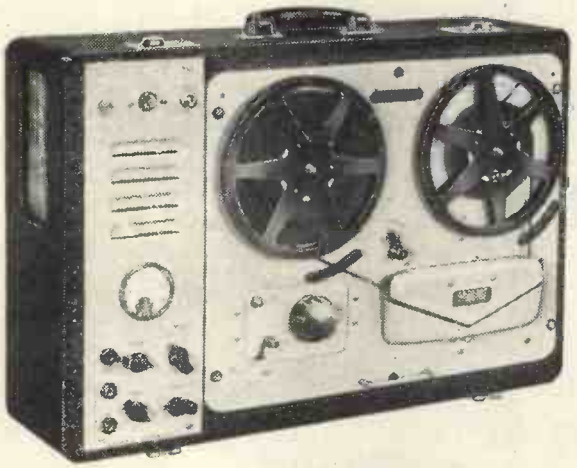
PARMEKO *of* **LEICESTER**

Makers of Transformers for the Electronic and Electrical Industries

*Photograph by kind permission of Decca Radar Ltd.

VORTEXION TAPE RECORDER

FEATURES WORTH NOTING . . . . . .



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

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ The noise level is extremely low and audibly the hum level and Johnson noise of the amplifier and deck are approximately equal. Only 25% of this small amount of hum is given by the amplifier alone.

★ Extremely low distortion and background noise, with a frequency response of 50 c/s.—10 Kc/s., plus or minus 1.5 db. A meter is fitted for the measurement of signal level and bias level.

★ Sufficient power is available for recording on disc, either direct or from the tape, without additional amplifiers.

★ 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.

★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.'s, microphone or radio inputs.

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

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

★ Facilities are provided for using the amplifier alone and using power output or headphones while recording or to drive additional amplifiers.

★ The unit may be left running on record or play back even with 1,750 ft. 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.**

The FOUR CHANNEL ELECTRONIC MIXER

is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording.
It is recommended by a number of tape recorder manufacturers for this purpose.
Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced.
The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.
The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.
An internal screened power pack and selenium rectifier feed the five low noise non-microphonic valves.
Used in many hundreds of large public address installations and recording studios throughout the world.

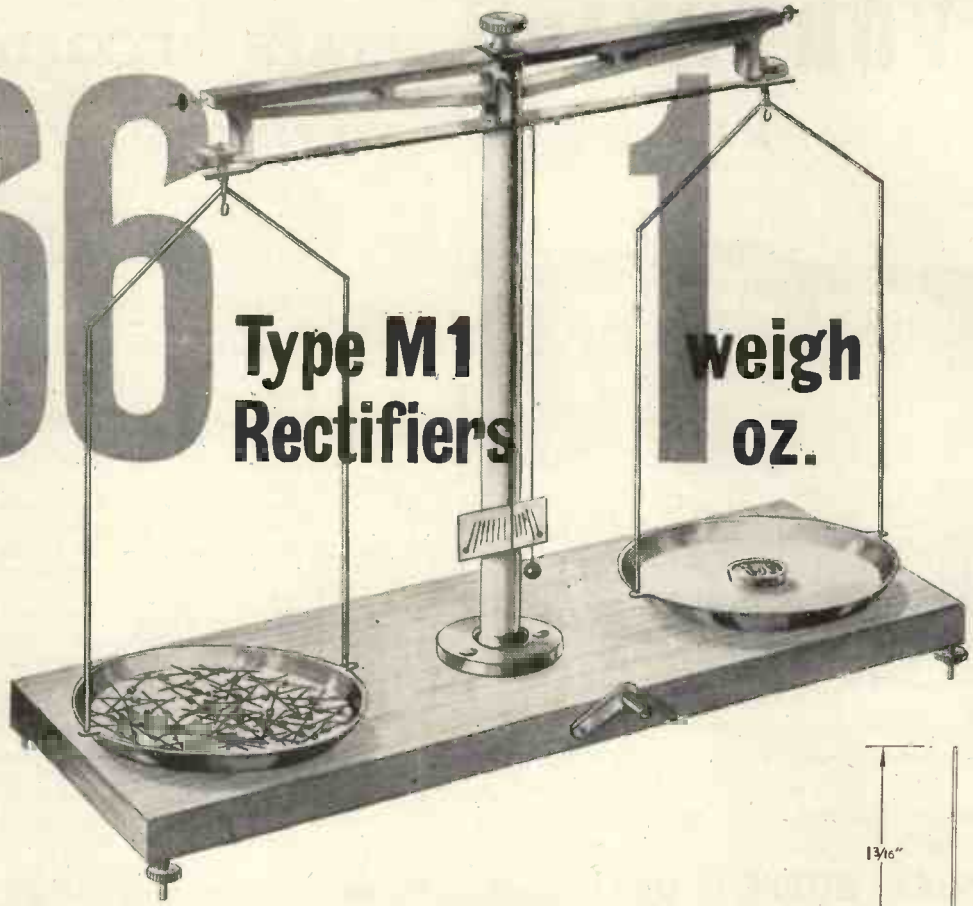
PRICE
£36.15.0

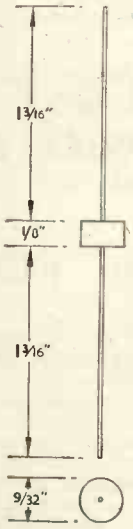
Manufactured by

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

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

66 Type M1 Rectifiers weigh 1 oz.





Inexpensive, featherweight SenTerCel Rectifiers types M-1 and M-3 can be suspended even in light wiring, and in most cases will replace a thermionic rectifier. They measure 9/32" diam. x 1/8" thick . . . and will operate at input levels of 0·5 volt upwards at frequencies up to 5 Mc/s. Less wiring! No valve-holder! No heat!

TYPE M-1

For A.F. 2nd detectors. AGC rectifiers. Muting circuits. Contrast expansion and compression. Level indicators. Modulation depth indicators. Limiters. Automatic frequency control.

Average characteristics :

Self Capacitance	22 pF
Forward resistance at 5 V D.C.	10 kΩ
Reverse resistance at 5 V D.C.	1000 MΩ
Maximum peak inverse voltage	68 V
Minimum A.C. input	0·5 V

TYPE M-3

Has similar characteristics and application with a maximum frequency of 100 kc/s.

Average characteristics :

Self Capacitance	65pF
Forward resistance at 5 V D.C.	1·2 kΩ
Reverse resistance at 5 V D.C.	45 MΩ
Maximum peak inverse voltage	68 V
Minimum A.C. input	0·5 V

SELENIUM
SenTerCel
RECTIFIERS
REGISTERED TRADE MARK

WE SHALL BE AT THE
RADIO SHOW
EARLS COURT
SEPT. 2-12

Standard Telephones and Cables Limited

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

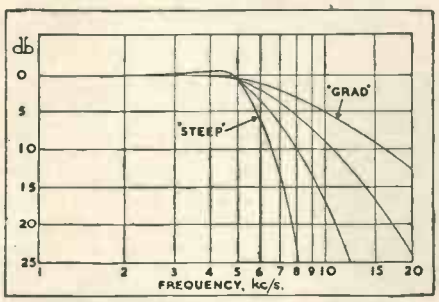
RECTIFIER DIVISION : Warwick Road, Boreham Wood, Hertfordshire

Telephone : Elstree 2401 Telegrams : SenTerCel, Borehamwood

The HIGHEST ATTAINABLE ★ QUALITY of ★ SOUND REPRODUCTION

Representing a unique feedback circuit development, the "Vari-Slope" pre-amplifier gives audibly better reproduction. This advance consists of variable-slope "electronic" low-pass filters operating on negative voltage feedback principles.

No Inductors ("Chokes") are used, and their disadvantages are completely eliminated. The turnover frequencies are 5 kc/s, 7 kc/s and 9 kc/s and the slopes of attenuation are continuously variable over the range 5 db to 50 db per octave.



Frequency amplitude curves for the "TREBLE-3" position (5kc/s turnover). Curves of the same slopes are obtained on the other two positions turning over at 7kc/s and 9kc/s ("—2" and "—1" positions).

The VARI-SLOPE

The filters consist essentially of twin-T resistor-capacity networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include:

(a) Improved transient response characteristics (due to absence of chokes having self-capacitance) and the consequent reduction of "ringing."

(b) Extremely low harmonic and inter-modulation distortion due to negative voltage feedback action.

(c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover. (Both these faults occur in variable-slope choke filters due to the slope control, altering the terminating impedance and the insertion loss.)

(d) No chokes to cause magnetic hum pick-up.

(e) Smaller size, lighter weight, greater uniformity in production.

LIST PRICE IN BRITAIN **12 Gns.**

POINT ONE TL/12

Triple Loop Feedback Amplifier

For laboratory use as a stabilised-gain audio frequency power amplifier. For the highest possible standard of disc recording. For the highest possible quality of reproduction from Pick-up, Radio, Microphone, Film and Magnetic Tape. For use as a driver amplifier in the speech modulator chain of broadcast transmitters. Used with the "Vari-Slope" pre-amplifier and the best available complementary equipment, the TL/12 power amplifier gives to the music-lover a quality of reproduction unsurpassed by any equipment at any price.

27 Gns.

The "Point-One" TL/12 Amplifier is built to a tropical specification and used throughout the world, including:
The British Broadcasting Corporation.
The South African Broadcasting Corporation.
The Swedish Broadcasting Corporation.
The Swiss Broadcasting Corporation
The Italian Broadcasting Corporation.

Write for fully descriptive literature

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

Phone: SHEpherds Bush 1173/4. Telegrams: Sinusoidal, Ealux, London. Cables: Sinusoidal, London.

ELECTRONIC PRECISION EQUIPMENT LTD

ELECTRICAL BARGAINS

In addition to our large range of radio accessories we also carry a good stock of electrical wiring accessories; details of a few of these can be found below:—

T.R.S. CABLES. 250v. CLASS

1/.044 Twin flat	9d.
3/.029 Twin flat	1/-
3/.029 Twin with earth....	1/3
3/.020 3 Core flat.....	1/6
3/.036 Twin flat.....	1/4
3/.036 Twin with earth....	1/7
3/.036 3 Core flat	2/-
7/.029 Twin flat	1/6
7/.029 Twin with earth....	1/11
7/.036 Twin flat.....	2/9
7/.036 Twin with earth....	3/3
7/.064 Twin flat.....	4/9

LEAD COVERED CABLES 250 v. CLASS

	yard
3/.029 3 core.....	2/3
3/.036 3 core.....	2/8
7/.044 twin.....	3/3
3/.036 twin.....	2/-
7/.029 twin.....	2/9
7/.064 twin.....	5/-

WAR EMERGENCY TYPE CABLES 250 v. CLASS

These are P.V.C. or rubber insulated, laid flat then braided with cotton and compounded:

	yard
7/.029 3-core flat.....	2/-
7/.044 twin flat.....	2/-
7/.064 twin flat.....	3/3

MULTICORED FLEXIBLES

All are suitable for mains work as the separate conductors are very well insulated, then they are covered overall either with hard rubber, plastic or waterproof braiding:—

	yard
10 core.....	2/6
7 core.....	2/-
5 core.....	1/-

5 AMP SURFACE SWITCHES —HICRAFT

Oblong Brown Plastic 1-way 1/3 each.
Oblong White Plastic 1-way, 1/3 each.

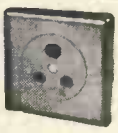
Oblong Brown 2-way..	1/6 each
Oblong White 2-way ..	1/6 „
Round Brown 1-way ..	1/3 „
Round White 1-way ..	1/3 „
Round Brown 2-way ..	1/6 „
Round White 2-way ..	1/6 „

SLIDER RESISTORS

Heavy Duty Type.

Size 7in. × 1¼in. 11 ohms 4.5 amp., 22/-; Size 9in. × 1¼in. 1.2 ohms 15 amp., 15/-; size 13½in. × 1¼in. 3 ohms 10 amp., 15/-.

SOCKETS HICRAFT



Flush type for skirtings, 5 amp. 3-pin shuttered, 1/3 each; ditto with switch, 2/3 each.

CEILING SWITCHES—HICRAFT

With cord and acorn. Brown or White, 1-way, 3/9 each; 2-way, 4/3 each.

LAMP HOLDERS

Bakelite, 1/- each or 10/6 doz.
Bakelite skirted Batten holder, 1/6 or 15/- doz.
Bakelite type threaded for ⅜in. with HO skirt, 1/6.
10 per cent. discount if bought in dozens.

BARGAIN FOR CONSTRUCTORS

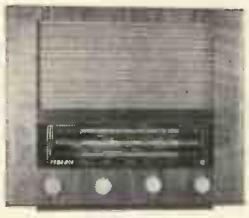
Special this month is the Portable illustrated alongside. We offer a bakelite cabinet with carrying handle, metal chassis, battery housing and two wave band dial, all for 27/6, plus 5/- carr. and insurance. This cabinet and set of parts is ideal for making up either an all dry battery receiver for holidays, picnics, etc., or a battery mains set for everyday use. Constructional details of two suitable circuits using 1.5 v. valves 1R5, etc., will be given free with cabinet assembly, or is available separately price 1/6 post free.

SPECIAL RADIOGRAM OFFER

To those who want an auto radiogram at a low price, we offer the cabinet illustrated alongside complete with Collaro three speed record changer with dual purpose crystal pick up, at a special bargain price of £17/16/8, plus 12/6 carriage and insurance or H.P. terms £6/7/- deposit.

3 colour scale, scale pan, chassis, pulley, driving head, springs, etc., etc., to suit the radiogram and two radio cabinets are available as a parcel at 15/-, plus 1/6 post.

Cabinet separately £7/10/- (or £2/10/- deposit), plus 10/- carriage and insurance.



A Superhet Chassis to fit these two cabinets is now available. L.M. and S. waves, 3 colour scale, A.V.C. Tone control, etc., complete with 8in. P.M. Speaker. Price £9/19/6 or H.P. £3/7/- deposit. Carriage 7/6 extra.

TABLE MODEL RADIO

This very nice-looking cabinet will take the same scale and chassis as the radiogram above, and we are able to offer this at the bargain price of 37/6, plus 3/6 post and insurance.

THE REGINA

T.V. Console Cabinet, undrilled, but cut for 12in. tube, with adjustable platform. This cabinet looks really superior and is ideal for all popular sets—Viewmaster, Tele-King, etc. Price £7/17/6. Carriage 10/- extra.

The table model illustrated is available in fair quantity at £3/17/6, plus 7/6 carriage and insurance, which price includes the armour plate glass and surround.

Mechanical details for this Table Model are available as a parcel: Punched and prepared metal chassis, punched outrigger valve plate with spacers, 12in. Tube Clamping ring, tube rear support brackets, etc. Price 25/-, plus 2/6 post.

"MIDGETRONIC" Radio Cabinet

This pleasing small cabinet is in bakelite and is supplied complete with dial ring, pointer as illustrated but less knobs, also included is metal chassis and hardboard back. Price 15/-, plus 2/6 postage and packing.

To ensure receiving prompt reply, please enclose stamped addressed envelope when writing for additional details.

TRANSFORMER BARGAINS

250 mA. 350-0-350 v., 6.3 v. at 6 amps., 5 v. at 3 amps., 4 v. at 5 amps. 37/6.
200 mA. 425-0-425 v., 6.3 v. at 4 amps., 6.3 v. at 4 amps., 5 v. at 3 amps. 50/-.
150 mA. 300-0-300 v., 7.5-0-7.5 v. at 3 amps., 4 v. at 3 amps. 17/6.
120 mA. 350-0-350 v., 4 v. at 4 amps. C.T., 4 v. at 2 amps. C.T. 42/6.
100 mA. 350-0-350 v., 6.3 v. at 4 amps., 5 v. at 3 amps., fully shrouded upright mounting, 27/6.
100 mA. 250-0-250 v., 6.3 v. at 6 amps., 5 v. at 3 amps., fully shrouded, upright mounting. 27/6.
80 mA. 350-0-350 v., 0-4-6.3 v. at 5 amps., 0-4-5 v. at 2 amps. 19/6.
80 mA. 300-0-300 v., 6.3 v. at 4 amps. C.T., 5 v. at 2 amps. upright mounting. 19/6.
70mA. 235-0-235v., 4 v. at 4 amps., 4 v. at 1 amp., upright mounting. 22/6.
40 mA. 325-0-325 v., 6.3 v. at 3 amps., upright mounting. 15/6.
Please add 1/6 post on each transformer.

FILAMENT TRANSFORMERS

For standard 230 v. mains.

12 v. 1 amp.	8/6
6.3 v. 1.5 amp.	6/6
6.3 v. 2 amp.	8/6
4 v. 2 amp.	7/6
6.3 v. 3 amp.	15/9
6.3 v. 6 amp.	20/-

Plus 1/- postage.

AUTO-TRANS-FORMERS

Input tapped 200-240 v. Output 115 v.

Totally enclosed and screened.

	Price	Carr.
40 watt	16/3	1/6
60 watt	19/6	1/6
100 watt	£1/4/6	1/6
150 watt	£1/11/-	2/-
250 watt	£2/9/-	2/6
500 watt	£4/17/6	2/6

Unscreened.

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

HIGH FIDELITY OUTPUT TRANSFORMERS

20 w. Push-pull, fully shrouded for 3 or 15 ohms operation in the following primary impedances: 10,000 ohms, 8,000 ohms, 6,000 ohms, 4,000 ohms, 30/-, post 1/6.

L.F. CHOKES

50 H	30 mA.	6/6
50 H	20 mA.	6/6
30 H	20 mA.	6/6
20 H	10 mA.	5/6
15 H	80 mA. fully shroud.	15/-
10 H	150 mA. „ „	18/-
10 H	100 mA. „ „	15/-
10 H	75 mA.	4/9
10 H	60 mA.	4/9
5 H	250 mA. fully shroud.	20/6

Please add 1/- post and packing.

MAINS TRANSFORMER

Heavy duty mains transformer with 5 secondaries, suitable for big amplifier, TV, etc. Primary 200-220 v. Secondary 1, 350-0-350 v. at 200-250 mA. S2, 6.3 v. at 5 amp. S3, 4 v. at 3 amp. S4, 4 v. at 3 amp. S5, 5 v. at 3 amp. Half-shrouded drop-through chassis mounting. Price 29/6, plus 2/- postage.

THIS MONTH'S SNIP

This month our snip is possibly of most interest to newcomers to the art—it is all the essential parts for constructing a sensitive multimeter. The kit comprises 2in. moving coil meter, scale (calibrated volts—milli amps—ohms) close tolerance resistors, wire for shunts, terminals and full instructions. Limited quantity only so order at once. Price only 10/- complete.

TRUVOX 12in. P.M. SPEAKER, Type No. BX11. Brand new in original cartons. £3 plus 2/6 postage and insurance.

AMERICAN POWER PACK. Built to operate H.R.O. receiver from British mains. Give 80-100 m/a. smoothed D.C. at 200 volts, also 5 volts and 6.3 volts. Totally enclosed in metal case. An extremely nice unit. Price £2/17/6, plus 5/- postage and insurance.

MOVING COIL METER

0-5 m/a. 2in. flush mounting, Bakelite cased, can easily be made into multi-range test meter. Price 7/6, plus 6d. postage.

HEAVY DUTY SPRINGS

For supporting cathode ray tubes, etc., 4½in., ⅝in. dia. 6d. each, 5/- dozen.

GRAMOPHONE UNIT

BSR 3-speed motor Type MU14 with Chancery pick-up and two crystal heads, one for long playing and one for normal records. £7/7/- plus 3/6 carriage and insurance.

L.P. RECORD PLAYER

Made by Decca. Contains B.S.R. motor and Decca pick-up. Although we offer this at approximately half price it carries same manufacturer's guarantee as if the correct price of £9/9/- were paid. Price £5/5/-, plus 7/6 postage and insurance.

1132 RECEIVER. This is an 11-valve superhet, which covers 100-124 Mc/s. Fitted with extremely nice slow motion drive, tuning meter and both R.F. and L.F. gain controls. Complete and unused. 59/6, plus 7/6 carriage.

COLLARO GRAM MOTOR AND TURNTABLE

TYPE A.C. 47. A centre drive spindle with governor control. 67/6, plus 2/6 carriage

INSTRUMENT TYPE SOLDERING IRON

This is fitted with a double element so that it will not burn whilst idling. Switch in handle brings in additional element whilst soldering. For 200-240 volt working. 12/6, plus 1/6 postage.

PORTABLE CABINET

Has the modern look. Ideal for Tape Recorder or Record Player. Rexine covered. £3 each.

DRY BATTERY REACTIVATOR

If you use a personal portable, this unit will save its cost in a matter of weeks. Mains operated. 35/- each.

T.V. ON THE V.H.F. BANDS

The equipment below—which we offer at only a fraction of its original cost—was built to transmit and receive on the 10 cm. band. It may, therefore, help readers with their experiments on this band in connection with the proposed new T.V. frequencies. All equipment is unused.

MAGNETRONS

Precision made for RADAR type Nos. CV. 186 and CV. 64. Unused, guaranteed. Any not functioning correctly will be replaced. Price £7/10/- Post and insurance 10/-.

MAGNETS FOR MAGNETRONS

These very powerful heavy magnets have many uses, in addition to their original job with a CV.186 or CV.64. Price £1/10/-, plus 2/6 postage.

KLYSTRON-RHUMBATRON

Type number is CV.43 and the device is complete with tuning slug. Price £3 each.

WAVEGUIDE (A)

The section is used for receiving and has a silicon crystal mounted in one arm. Price £1/15/- complete.

WAVEGUIDE (B)

This is for the transmitter output side and is tuneable. Price £1/12/6.

PULSE TRANSFORMER

Oil-filled and highly insulated. Price 12/6 each. Choke to match 22/6.

COMPLETE 10 CM TRANSMITTER RECEIVERS

Type numbers available include TR.3548-TR.3191-TR.3151. All are priced at £15 each, and contain all the above items in addition to blower motor—I.F. unit—suppressor unit, etc.

MILLIBAR BARO-METER, 7/6

The heart of a barometer is a metal bellows which will expand and contract with the varying air pressure. The aircraft altimeter works on the same principle, a series of gears and lever amplifying the expansion and contraction of the bellows and so works the pointer. We can offer the ex-R.A.F. Sensitive Altimeter slightly faulty but containing the essential bellows, gears, wheels, etc., from which a good barometer can be made. Price only 7/6, plus 1/- post.

FULL PICTURE VCR97

We have had a new delivery of this now-famous electrostatic 6in. T.V. tube, these are not the cut-off type, and we guarantee a full picture, 42/6, carriage and insurance 5/-.

SPRING LOADED TERMINAL BLOCK

Fully insulated so is ideal for mains, terminal point fitted on bench of workshop or laboratory. Also suitable for temporary hook ups when testing components, etc., will save its cost the first week of use. Price 3/6.

4in. NAVIGATION COMPASS

Sturdy and reliable. Floating dial, shock mounted in metal case. All cardinal points and degrees marked. Each compass in wooden box. Exceptionally low price. 20/-, plus 2/- postage.

ADJUSTABLE THERMOSTAT

250 v. heavy silver contacts can be adjusted to operate between 70—300 F. These are suitable for aquarium heaters, electric blankets, etc.
1 Amp. Model, 3/6.
2 Amp. Model, 5/6. 5 Amp. Model, 14/6. Post, etc., 6d. extra. Don't be cold this winter, make an Electric Blanket, blueprint 1/6, post free.

Complete kit comprises Hi-craft 40 watt control unit, starter lamp, lamp holders, clips and wiring diagram. Price, less tube, 22/6, plus 1/6 post. Tubes 12/6 each, carr. free, minimum quantity 6.

ELECTRONIC PRECISION EQUIPMENT LTD.

THE VIEWMASTER

ALL COMPONENTS IN STOCK

ANY SINGLE ITEM AVAILABLE SEPARATELY

COILS

All models available including filter chokes. Price (except Alexandra Palace), 28/- per set. Alexandra Palace, 20/- per set. L9 RF choke, 2/-.

CHASSIS

Sound-Vision, 18/6. Power-Pack/Time base, 18/6. Support for S.V. chassis, 6/-.

LASKY'S LINE TRANSFORMER

RF.EHT for line fly back. 6-8Kv, with EY51 heater winding. Suitable for home construction T/V 25/-.

METAL RECTIFIERS

12v. 1a.	6/9
12v. ½a.	3/6
6v. 1a.	3/11
6 & 12v. 4a...	18/6

SENTERCEL RECTIFIERS

RM1	3/10
RM2	4/3
RM3	5/-
RM4	18/-

WESTINGHOUSE RECTIFIERS

All 250 volts input.

14A976 80 m/a	8/6
14A86 250 m/a	20/4
14A100 300 m/a	21/6

W/B & PLESSEY

Line EHT trans.	32/6
Frame trans. ..	23/6
3 Mc/s boost choke	5/9
Width control..	7/6
Scanning coil..	33/3
Main choke ..	15/6
Focus ring	22/6
Heater trans.:	
WB/103	42/-
WB103A ..	52/6
Front and rear C.R.T. supports	21/6

DUOMAG FOCALISER

Low Flux	37/6
Med. Flux	39/6
High Flux	42/-

POSTAGE STAMP TRIMMERS

Paxolin. Up to 100pf. 6d. each. 5/- per doz. Ceramic. Up to 100pf. 9d. each. 7/6 per doz. 350 and 550pf. Ceramic 1/- each. 10/6 per doz.

COIL PACKS

Medium and 2 short wave bands. Price 16/-.

COIL PACKS

Long, medium and short wave bands. 29/6.

METAL RECTIFIERS

WX3 and 6. Ea.	3/9
14D36	12/4
14A86	20/4
14A100	21/6
36EHT45	23/8
36EHT50	26/1
36EHT100 ..	29/6

PLESSEY

Scan coils per pair 25/-
Width Control 6/6

NOW AVAILABLE LARGE SCREEN WIDE ANGLE CONVERSION DETAILS FOR THE VIEWMASTER.

Send 3d. stamp for full data. Fully itemised price list of all Viewmaster components now available.

ALL T.C.C. CONDENSERS

exactly as specified for use in The Viewmaster can now be supplied from stock.

The television set you can build at home from standard parts.

A MODEL FOR EACH FREQUENCY. State station required.

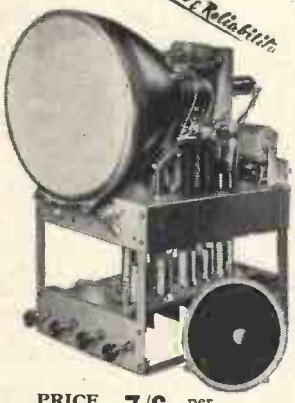
Brilliant high definition black and white picture. Superb reproduction. Uses 9in. or 12in. Cathode Ray Tube. Table or Console Model.

Incorporates all the latest developments.

Television for the home constructor at its finest.

Send to-day for the CONSTRUCTION ENVELOPE, 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions.

Alexandra Palace, Sutton Coldfield, Holme Moss, Kirk o'Shotts, Wenvoe, Pontop Pike, Belfast. State model required.



PRICE Post free **7/6** per copy.

GRAM MOTORS

Rim drive, synchronous. For 200-250v. 50 c.p.s. Many uses. 9/6.

TWO-GANG TUNING CONDENSERS .0005MFD.

No. 1. Miniature. With Perspex dust cover and trimmers. Size: 1½in. x 2in. x 1¾in. ¼in. spindle.
LASKY'S PRICE, 8/6.

No. 2. Midget. With trimmers. Size: 2¼in. x 1⅞in. x 1¾in., ¼in. spindle.
LASKY'S PRICE, 8/6.

No. 3. Midget. Less trimmers. Size: 2in. x 1⅞in. x 1¾in., ¼in. spindle.
LASKY'S PRICE, 6/6.

No. 4. Standard type. Size: 2½in. x 2¾in. x 1¾in., ¼in. spindle.
LASKY'S PRICE, 6/6.

I.F. TRANSFORMERS

465 Kc/s Iron dust cores in cans, midget type. Size: 1in. x 1in. x 2½in. By Plessey. Price 9/6 per pair.
WEARITE TYPE 550. 445-520 Kc/s. 10/- per pair.
WEARITE TYPE 500. 450-470 Kc/s. 10/- per pair.

TWO-WAY TALKIE. Sound powered inter-com. units. Can be set up anywhere, and gives effective communication up to a distance of 500 feet. Units can be purchased to give up to 4-way intercommunication. In metal case, brown crackle finish. Size: 6"×5½"×8". Complete with 5in. P.M. speaker and two U2 batteries.

PRICE:
Master Unit, with 4-station selector switch **37/6**
Sub-stations 27/6
Carriage 2/6 each.

INTERCOM UNITS.

4-station operation. For use on A.C./D.C. mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in attractive plastic cabinet.
Suitable for use as baby alarm.

MASTER UNIT £7/15/-.
Carr. 5/- extra.
Extension Units. Price 21/- each complete. Carriage 2/- each extra.

PORTABLE RADIO CABINETS

Rexine finish. In silver, blue or red. Complete with dial, pointer, knobs, back, speaker fret and 5in. p.m. speaker and handle. Size 13×7×10in. PRICE 37/6 complete. Carriage 5/- extra.
Give second choice of colour when ordering.

MAINS TRANSFORMERS

All 200-250 volts 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. An ideal replacement trans. Price 18/-.
MBA/6. 350-0-350 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. Price 22/6.
MBA/7. 250-0-250 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. Price 18/-.
AT/3. Auto transformer. 0-10-120, 200-230-240 volts 100 watt. Price 17/6.

FILAMENT TRANSFORMERS

6.3 v. 1.5 a., 7/11.
6.3 v. 3 a., 12/6.
Special Transformer. 2 amps., with the following tappings: 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts. Price 17/6.

SMOOTHING CHOKES.

20 mA 40 H	3/11
40 mA 8 H	3/11
40 mA 10 H	4/3
100 mA 10-20 H	7/3
250 mA 10 H	18/6

LIMITED QUANTITY (Frustrated Export). 5 WAVEBAND CHASSIS.

Circuit has RF stage, Magic Eye Tuning Indicator, and many other features. For use on A.C. mains 100-250 volts. Waveband coverage: 11.5 metres to 550 metres. In 5 bands.
Valve line up: 2 EF39; 1 ECH35; 1 EBC33; 1 EL33; 1 5Z4; 1 EM34.
LASKY'S PRICE **£10-19-6**
Complete with valves, less dial. Carriage and packing 15/- extra.

WILL MAKE A SUPER RADIO-GRAM.

CRYSTAL DIODES

Germanium 2/3d. each, post free.

RF25 UNITS. New, with valves. 19/11. Carriage 2/6.

P.M. LOUDSPEAKERS

All less o'trans. new and unused. First quality.

3in. ..	12/11	5in. ..	12/6
6½in. ..	13/6	8in. ..	15/-
10in. ...	32/6		

All 12 inch speakers available free of purchase tax.

OUTPUT TRANSFORMERS

40 mA. Multi ratio	6/11
80 mA. Multi ratio	14/11
80 mA. Pentode	12/6
60 mA. Plessey, 6,000 ohms	5/11
Standard pentode	4/11
Pentode	3/6
Midget Pentode	4/3
Miniature Pentode, 3S4, 1S4	4/6
PX4 Intervalve.....	8/6
5 : 1 Intervalve	5/11

RADIO

ow Road) Ltd.,

DDINGTON, LONDON, W.9

Hospital)

485/487 Harrow Road, Paddington, London, W.10

1979 and 7214. All Departments.

TERMS: Pro Forma, Cash with order, or C.O.D. on post items only. Postage and package on orders value £1—1/- extra, £5—2/- extra, £10—3/6 extra. Over £10 carriage free. All goods fully insured in transit.

ALPHA RADIO SUPPLY CO.

ENAMELLED COPPER WIRE
All 4 oz. Reels.

S.W.G.	Price	S.W.G.	Price
16	1/11	30	3/1
18	2/1	32	3/3
20	2/3	34	3/5
22	2/5	36	3/7
24	2/7	38	3/11
26	2/9	40	4/2
28	2/11	14	1/9

CONDENSERS
8 mfd. 450 v. ... 1/11
16 mfd. 450 v. ... 3/3
32 mfd. 350 v. ... 1/9
8 mfd. 350 v. ... 1/3
16×16 mfd. 450 v. ... 3/–
100 mfd. 25 v. ... 1/9
I.F. Transformers, 465 Kc/s pair ... 6/9
Yaxley, 2-pole change-over ... 1/–
Yaxley, 1-pole 8 way ... 1/6
Yaxley, 4-pole 3 way ... 2/6

WIRE WOUND CONTROLS
5Ω, 200Ω, 2KΩ, 400Ω, 5KΩ, 10KΩ, 15KΩ, 20KΩ, 25KΩ, 50KΩ. All each ... 2/–
Pre-set Types—
Colvern CLR901, 1 KΩ ... 1/9
Polar, 500Ω ... 1/9

EX-GOVERNMENT CONTROLS (CARBON)
500Ω, 600Ω, 10KΩ, 20KΩ, 25KΩ, 50KΩ, 100KΩ, 250KΩ, ½ meg., 1 meg., 2 meg. ... 1/–

REPAIR YOUR OWN SPEAKERS
Cone replacements available as follows :
Rola 8Z and most other 8in. speakers with 1 pole piece ... 5/– ea.
Rola 6Z and most other makes with ⅜in. pole piece ... 4/6 ea.
Philco and R. & A. 8in. ... 5/– ea.
Philco and R. & A. 6in. ... 4/6 ea.
Post and packing on above 1/- each.

SPECIAL PURPOSE VALVES

EF8	6/6	954	2/–
955	4/9	956	3/6
VU111	3/6	VU120A	3/6
6G6G	6/6	CV71	1/–
TT11	6/6	9000	6/3
9001	6/3	9002	6/3
9004	6/3	VR137	5/–
VR116	4/–	2X2	5/6
VU39	8/6	VR53	7/6
VR136	7/–	VR55	7/3
VR56	7/–	VR65	3/9
VR65A	3/6	VR91	6/–
VR66	3/9	CV188	3/9

Wander Plugs. Red only 1½d. each.

MULTICORE SOLDER. Per packet, 6d.
EF50 CERAMIC VALVE HOLDERS with screw Retainer Rings, 10d. each.

BATTERY CHARGERS
Type BC1, 200/250 v. A.C., charge 6 v. 1 amp All enclosed just 2 leads for input and two leads for output, complete with bulldog clips, 35/- each.

COLLARO TAPE DESK MOTORS
Shaded-pole type, clockwise and anti-clockwise, 56/- pair.

SUPPRESSORS
Metal Case Mains Suppressor inserted in Mains Lead will cut out that interference each ... 2/6
Plug Suppressor. Terminal Screw Fitting each ... 1/2
P.K. Self Tapping Screws. No.4. ¼in., doz. ... 3½d.
Copper Plated Tubular Rods 12in. long, each 3d. Will plug into one another to make any length Rod Aerials.
Epicyclic Friction Drive Ratio 8—1, each ... 1/6
Epicyclic Friction Drive with Brass Drum. For use with Steel Dial Drive Wire, each ... 1/9

SCREENED CABLES
Single Type per yard ... 6d.
Twin Core „ „ ... 7d.
Three Core „ „ ... 9d.
Rubber Grommets. Mixed sizes, doz. ... 6d.

METAL RECTIFIERS
12 v. ½ amp., 1/6 ; 2 v. 1 amp., 3/- ; 12 v. 1 amp., 4/9 ; 12 v. 2 amp., 10/6 ; 12 v. 3 amp., 13/6 ; 12 v. 5 amp., 18/6 ; 250 v. 45 m/a., 6/9 ; 300 v. 60 m/a., 7/6 ; 250 v. 75 m/a., 7/6.

LOUDSPEAKERS
PLESSEY, 3in. Round Type for Personnel Portables, 3 ohm ... 12/9
ELAC, 3½in. Square Type 3/09, 3 ohm 13/6
ELAC, 5in. Round Type ... 12/3
LECTRONA, 5in. Latest Type ... 12/3
GOODMAN'S, 6½in. Lightweight, 2 to 3 ohm ... 13/6
TRUVOX, 6½in. Wafer, 1⅛in. deep ... 20/–
PLESSEY, 8in. Lightweight, 2 to 3 ohm ... 15/–
ELAC, 8in. Type 8/37, 2 to 3 ohm ... 15/9
LECTRONA, 8in. ... 14/–
ROLA, 8in. ... 16/6
PLESSEY, 10in. Lightweight, 2 to 3 ohm ... 19/6
ROLA, 10in. 2 to 3 ohm ... 28/6
LECTRONA, 10in. ... 16/6
TRUVOX, 12in. BX11 Lightweight, 2 to 3 ohm ... 57/6
TRUVOX, 12in. Heavy Duty Model, 15 ohm Speech Coil. Model SS9 ... £5/15/–

GRID CAPS
Octal size push-on type, doz. ... 6d.
British screened type ... 3d.

RECEIVER 1132A
Contains EK32, 4 EF39, 6H6, 6J5, 3 SP61, P61, In good condition. Fitted with tuning meter, slow-motion drive and dial. Complete, with Circuit Diagram, 50/- each, carriage, etc., 7/6.

Single Hole Fixing Belling Fuse Holders, Panel Mounting ... 1/–
Paper Block Condensers, 2 mfd. 1,000 v. ... 1/–
Amphenol Valve Holders, Int. Octal ... 6d.
Loctal Paxolin Valve Holders ... 3½d.
Bias Condensers, 25 mfd. 25 v. ... 1/3

RESISTORS, 1 WATT
330Ω, 22Ω, 470KΩ, 10K, 30KΩ, 150KΩ, 56KΩ, 33KΩ, 330KΩ, 1KΩ, 18KΩ, 1.8KΩ, 39Ω, 47KΩ, 2.7KΩ, 150Ω, 68Ω, 39KΩ, 100Ω, 68KΩ, 40KΩ, 680Ω, 220Ω, 12KΩ, 4.7KΩ, 680KΩ, 2.2KΩ, 100KΩ, 15KΩ. All 6d. each.

Intervalve Transformers ... 1/6
Microphone Transformers, 60-1 ratio ... 1/6
VCR139 Tube Base and Screen ... 19/6
Post and packing 1/6.

MAINS TRANSFORMERS


3 - WAY MOUNTING TYPE
MT1
Primary : 200-220-240 v.
Secondaries : 250-0-250 v. 80 mA., 0-4 v. 5 amp. 6.3 v. 4 amp. 0-4-5 v. 2 amp. 17/6 each.
MT2
Primary : 200-220-240 v.
Secondaries : 350-0-350 v. 80 mA., 0-4 v. 5 amp. 6.3 v. 4-amp. 0-4-5 v. 2 amp. 17/6 each.
MT3
Primary : 200-220-240 v. Secondary : 30 v. 2 amps., Taps at 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v., 17/6 each.

AUTO TRANSFORMER
0-10-120-200-230-250 v. 100 watts. 17/6 each.

Crystal Diodes, each ... 1/8
Screened Mic. Cable, yd. ... 6d.

HEADPHONES
High resistance type, pr. ... 10/–
Low resistance type, pr. ... 7/6

VCR138 CHASSIS
An ideal breakdown chassis, contains VCR138 and 12 Mazda valves : SP61, EB34, EA50, etc., 40/- each, carriage 5/6.

INDICATOR LAMPS
Single hole fixing, solid metal construction. Screw ring fixing. Simple bulb replacement system ... 1/9
Spring fixing type. Single hole ... 9d.

SINGLE P.V.C. COVERED WIRE
Various colours : Red, Blue, White, Green, Yellow, etc. 5/6 per 100 yards.

INDICATOR UNIT TYPE 6
Brand new with VCR97 tube, EF50, valves, wire wound col. controls, resistors and condensers, 72/6 carriage 7/6.

INDICATOR UNIT TYPE 233
Complete with VCR97 and 10 Mazda valves, 70/- each. Carriage 7/6.

COLLARO AC37
Gramophone motor, variable speed, manual adjustment. 4-pole shaded-pole type, 100/130 v., 200/250 v., complete with 10in. E.M.I. type turn-table. 46/- each, post 1/6.

INDICATOR UNIT TYPE 255.
Case size 17¾in. x 13in. x 11¼in. All controls to front panel. Contains VCR517C ; 15, VR91 (EF50) ; 2, 6X5G ; 7, VR54 ; 1, EF55.

BRAND NEW. All Complete £8 each, Carriage 7/6.

YAXLEY SWITCH. 4 pole 2 way. 1/9 ea.

TV COIL FORMERS. ⅜in. 9d. ea., ¼in. 7d. ea.

E.H.T. PENCIL RECTIFIERS
K3/25 4/3 ; K3/40 5/6 ea. ; K3/45 6/3 ; K3/50 7/- ; K3/160 17/6.

VIBRATORS. 6 and 12 v. 4-pin U.X. Base Type. 6/6 ea.

BLOCK CONDENSER. 4 mfd 500 v., 1/6 ea.

TOGGLE SWITCHES DPDT 2/9. DPST 2/3.

HYDROMETER. In wooden case. 8/6 ea.

CONDENSER CLIPS. 3d. ea.

J.B. CONDENSERS, etc.
Reaction Condensers, .0001, .0003, .0005, 3/10 ea.
SL8 5-pin wheel drive, 27/6 each.
Full vision drive, 13/- ea.
SL5 RV Drive 26/6 ea.
Cord drives, eyebolts, drums, etc. Send for List.

ENGRAVED KNOBS
1¼in. dia. for ¼in. spindles.
Available cream or walnut, engraved as follows : Focus, Brilliance, Contrast, Brilliance On/Off, Wavechange, On/Off, Tuning, Volume, S.M.L. Gram, Tone, Vol. On/Off, Bass, Treble, Record/Play. All 1/6 ea.
Plain Knobs to match 1/- ea.

ARMOUR-PLATED GLASS
Size 13in. x 10¼in. Rounded corners, 4/- ea.

LINE CORD. .3 amp, 3 core 60Ω per foot, 1/6 yd.

VARNISHED COTTON SLEEVING. 1mm., 1/6 doz. yds.

TAG BOARDS. 2 Tag and earth 2½d. ea.

TAG BOARDS. 4 Tag and earth, 3½d. ea.

TRIMMER. 2 bank 200/200 Pt. 10d. ea.

P.K. SELF TAPPING SCREWS. No. 4 ¼in., 3/6 gross.

44Ω VARIABLE RESISTOR. Suitable for light dimmer or for train sets. 5/- ea.

TERMS : Cash with order or C.O.D. Postage and Packing charges extra, as follows : Orders value 10/- add 9d. ; 20/- add 1/- ; 40/- add 1/6 ; above 40/- 2/-, unless otherwise stated. Minimum C.O.D. fee and postage, 2/3.
Illustrated Catalogue 6d. in stamps.
MAIL ORDER ONLY

5/6 VINCES CHAMBERS, VICTORIA SQUARE, LEEDS. 1

Prices slashed

TEST METER TYPE E.
Ref.: 10S/10613, made by A.V.O.
D.C. Multi-range Meter with 14 test ranges, 2 v., 20 v., 200 v., 1,000 v. D.C. at 1.25 mA or 2.5 mA f.s.d., 20 mA, 100 mA, 200 mA, 2 a., 20 a., 10,000 ohms. Scale marked: 0/40 amps/volts, 0/20 amps/volts, 0/10 amps/volts, 0/5,000 ohms and infinity. Dim.: 4¾ x 3¾ x 1¾in. Tested less battery (U10) 1.5 v.
ASK FOR X/H232 **49/6** Each POST PAID

500 MICROAMP METER REF. ZN2106.
For WS-18 Transmitter.
2in. round, clip mounting case. Res. 500 ohms.
ASK FOR X/E303 **15/-** Each POST PAID

WALNUT-FINISH WOOD RADIO CABINET.
Dim.: Internal 8½ x 15¾ x 7¾in. approx. External 9½ x 17 x 8in. approx.
ASK FOR X/H394 **12/6** Each POST PAID

Or **Cabinet** as above with 3 waveband glass dials, expanded metal L.S. Grill, 3 knobs 1¼in. dia. fluted type.
ASK FOR X/H945 **17/6** Each POST PAID

PLASTIC RADIO CABINET.
Dim.: Internal 11 x 6½ x 4¾in. approx. External 12 x 7¼ x 6¾in. approx.
ASK FOR X/H720 **12/6** Each POST PAID

THROAT MICROPHONE. Ref. ZA.13935.
Pair Electro Magnetic lozenge shaped pieces (7.5 ohms) with strap, lead and jackplug.
ASK FOR X/E14 **3/11** Each POST 6d. EXTRA

THROAT MICROPHONE. Ref. ZA.19374.
Pair Electro Magnetic lozenge shaped pieces (7.5 ohms) with strap, lead and jackplug.
ASK FOR X/H955 **4/11** Each POST 6d. EXTRA

THROAT MICROPHONE.
(U.S.A. made.)
Pair Carbon buttons on mtd. rubber with strap, lead and miniature 2-pin plug.
ASK FOR X/H57 **3/11** Each POST 6d. EXTRA

MICROPHONE. Ref. 10A/14381.
(Flying Helmet Type.)
Electro Magnetic 500 ohms with switch, lead and 2-way socket.
ASK FOR X/E16 **3/11** Each POST 6d. EXTRA

CARBON HANDSET MICROPHONES
No. 8 Ask for X/H480.
No. 4A Ask for X/E13.
With handle switch, lead and 4-way socket.
EITHER UNIT **7/6** Each POST PAID

CARBON POWER MICROPHONE
In Original Carton (made by Tannoy.)
With Transformer and leads. Output 4-5 watts (with loudspeaker and 12 volt Acc. would make a portable P.A. Unit). Power Consumption 2 amps approx.
ASK FOR X/E894 **39/6** Each POST PAID

CARBON POWER MICROPHONE.
And Moving Coil Headphone Assembly. Ref. ZA17604. In Original Carton.
Ex-Tank Corps, with leads and 5-point plug.
ASK FOR X/E18 **15/-** Each POST PAID

HEADPHONES C.H.R.-2.
Pair High Impedance 4,000 ohms, with wire headband and leads.
ASK FOR X/H786 **10/9** Each POST PAID

HEADPHONES D.L.R.-1.
Pair low Impedance 50 ohms with headband, lead, and jackplug.
ASK FOR X/H390 **7/8** Each POST PAID

MORSE PRACTICE BOARD ONLY.
Comprises Key, buzzer, and phone terminals on board 6½ x 6½ x ½in. with battery clamps.
ASK FOR X/E1X **5/6** Each POST 9d. EXTRA

ACCUMULATORS
2 volt 9 a.h. Capacity. "Dry" type, dim.: 4½ x 3½ x 1¼in.
ASK FOR X/H36 **5/11** Each POST 1/- EXTRA

2 volt 14 a.h. Capacity. Wet type dim. : 7 x 2 x 2in.
ASK FOR X/H367 **3/6** Each POST 1/- EXTRA

CONDENSERS.
Mansbridge Metal cased type, dim.: 5½ x 4 x 1¾in. XRN.. Capacity 6 mfd. wkg. Vtg. 2000 volts.
ASK FOR X/H359 **5/6** Each POST 9d. EXTRA

Electrolytic Tubular. Aluminium cased, wxd. cardboard cover. U.S.A. made. **Capacity 32 mfd. wkg. Vtg. 450 v. D.C.** Dim.: Dia. 2in. length 4¼in. with mtg. plate.
ASK FOR X/H852 **1/9** Each POST 6d. EXTRA

Or 3 Condensers (32/450) as above, in original sealed carton.
ASK FOR X/H852X **4/6** Each POST 9d. EXTRA

Electrolytic Tubular. Aluminium case, clip mtg. **Capacity 8-16 mfd. wkg. Vtg. 450 v. D.C.** Dia.: 1⅜ x 2⅜in. Mfg. Surplus.
ASK FOR X/H918 **3/-** Each POST 3d. EXTRA
Clip 4d. extra.

Electrolytic Tubular. Aluminium Case. **Capacity 8 mfd. wkg. Vtg. 450 v. D.C.** Dia.: 1 x 2¼in. Tag Ends. Mfg. Surplus.
ASK FOR X/H598 **1/9** Each POST 3d. EXTRA

Ceramic Tubular. Mfg. Surplus. Capacity PF 1100, 1,000, 504, 200, 180, 150, 120, 120, 82, 68, 56, 39, 33, 15, 12, 8.2, 6.8. Price 6d. each, post 1½d. extra. Dozen Lots 5/- post paid.

Silver Mica. (w) waxed, (p) pitched. Mfg. Surplus. Capacity PF. 5000 (w), 4550 (w), 4000 (w), 432 (w), 432 (p), 350 (p), 135 (p), 47 (w), 20 (w), 10 (w), 8 (w), 5 (w). Price 6d. each, post 1½d. extra. Dozen lots 5/- post paid.

Tubular Paper (pitch covered) 400 v. D.C. wkg. Mfg. Surplus. Capacity mfd. 0.068, 0.039, 0.022, 0.018, 0.015, 0.0082, 0.00068, 0.0056, 0.0039, 0.0027, 0.0022, 0.0018, 0.00082, 0.00068. Price 4d. each, post 1½d. extra. Dozen lots 3/6 post paid.

Tubular Paper (pitch covered) 600 v. D.C. wkg. Capacity mfd. 0.012, 0.0082, 0.0033, 0.00082. Price 6d. each, post 1½d. extra. Dozen lots 5/- post paid.

Volume Controls. Potentiometers, Carbon Track. ¼ meg. (500,000 ohms), long spindle fitted DP/ST Switch and mtg. plate.
ASK FOR X/E189 **3/11** Each POST 3d. EXTRA

With DP Switch ¾in. Spindle, 100,000 ohms. Ref.: 3U/100M PAC X/H415, 500,000 ohms. Ref.: 3U/500M PAC X/H655. Price 3/9 each, post 3d. extra.

With SP Switch 3in. Spindle. 2 meg ohm. Ref.: 187-Z-2169.
ASK FOR X/H427 **3/3** Each POST 3d. EXTRA

Less Switch. 3in. Spindle, ¼ meg. (250,000 ohms).
ASK FOR X/H705 **2/3** Each POST 3d. EXTRA

Preset Types, less switch.
(M) Metal type, (T) Tropicalised. 10,000 ohms, Ref.: 10W/8655 X/H434 (T). 25,000 ohms, Ref.: 10W/9230 X/H433 (T). 100,000 ohms, Ref.: 10W/7457 X/H414 (M). 200,000 ohms, X/H956 (M). 250,000 ohms, Ref.: 10W/9188 X/H431 (T). Price 1/6 each, post 3d. extra.

Short Spindle Types, less switch.
50,000 ohms, Ref.: 10W/8741 ¾in. Sp. X/E924 (T) 100,000 ohms, Ref.: 10W/8777 ¾in. Sp. X/H699(T) 500,000 ohms, Ref.: 10W/7856 ¾in. Sp. X/H700 (T 1 meg. ohm, Ref.: ZA.2809 ¾in. Sp. X/733 (M) Price 1/9 each. Post 3d. extra.

W.W. POTENTIOMETERS.
2 watt by Clarostat U.S.A. 10,000 ohms, Ref.: CMC-63532 Preset.
ASK FOR X/H957 **2/6** Each POST 3d. EXTRA

ROTARY CONVERTER TYPE 195.
Input 24 v. D.C. Output 230 v. 100 W. A.C. 50 c/s. Complete in metal case, dim.: 13 x 11 x 8in. with carrying strap.
ASK FOR X/H914 **£5.19.6** Each CARRIAGE PAID

MALLORY SYNCHRONOUS VIBRAPACK.
Input 21 v. D.C. Output approx. 250 v. D.C. 70 mA unsmoothed, dim.: 5½ x 2¾ x 5in. Unused, but soiled and vibrator contacts stuck due to long storage.
ASK FOR X/E954 **10/-** Each POST PAID

POWER UNIT TYPE 2A, Ref.: 10K/44 for T/R1133.
Input 12 v. D.C. 12 a. Outputs 6 v. D.C. 5 a. 150 v. D.C. 10 mA, 300 v. D.C. 70/240 mA, with starting relay, smoothing, etc. Case dim.: 12½ x 8 x 5½in.
ASK FOR X/H822 **21/-** Each CARRIAGE PAID

POWER UNIT TYPE 104, for T/R1196 Receiver.
Input 12 v. D.C. 12 a. Outputs 230 v. D.C. 65 mA, 6.3 v. D.C. 2.5 a., smoothed, etc., case dim.: 8½ x 4 x 6½in. Wgt. 12lb.
ASK FOR X/H343 **15/-** Each POST PAID

POWER UNIT TYPE 87, for T/R1196 Receiver.
Input 24 v. D.C. 6 a., otherwise as P.U.104.
ASK FOR X/H343A **12/6** Each POST PAID

A UNIVERSAL ELECTRIC MOTOR.
For 200/250 v. A.C. or D.C. Mains. By simple external wiring, full data supplied. New method gives better than 1/6th h.p. Using Ex-R.A.F. Motor Generator, dim.: 11 x 5½ x 5½in.
TYPE 29. ASK FOR X/E880.
TYPE 28. ASK FOR X/E880A.
EITHER UNIT **25/-** CARRIAGE PAID

Or giving slightly less power, ⅛ h.p. Motor Generator Type 30.
ASK FOR X/H488 **19/6** Each CARRIAGE PAID

ROTARY TRANSFORMER TYPE 44, Ref.: 10KB/409.
Input 18 v. D.C. 3.13 a. Output 450 v. D.C. 0.05 a. Spindle extended each end. Dim.: 8½ x 3½ x 3¼in.
ASK FOR X/H845 **12/6** Each POST PAID

STARTER MOTOR TYPE FE-1 CA4750.
Heavy Duty 24 v. D.C. Starter Motor, as used in Aircraft, with recessed splined spindle, 6 hole end etg. dim.: 8¼in. long 4¼in. dia.
ASK FOR X/H870 **10/-** Each CARRIAGE PAID

MIDGET MOTOR, Ref. 5U/2705.
Input 24 v. D.C. 2 a. R.p.m. 2,800 drive pulley each end, Overall dim.: 2 x 2 x 5¼in.
ASK FOR X/H98 **7/6** Each POST PAID

ENCLOSED, END THRUST, SHADED POLE MOTOR.
230 v. A.C. 50 c/s, 1/100th h.p., 1,500 r.p.m. Drive spindle ¼in. long, ¼in. dia. size: 4 x 3½in. dia. Wgt. 4lb. Colour Black.
ASK FOR X/H314 **22/6** Each POST PAID

Illustrated Catalogue No. 8D. Price 1/6 (credited on first purchase of 10/- or over).

AMPLIFIER A1271. Ref.: 10U/549.
Used with T/R's 1133, 1143, 1143A, 1430, 1464, and Aerial System type 62. With valve VR56 (EF36) Relay, Transformers, etc., in metal case, dim.: 5 x 5 x 4¾in.
ASK FOR X/H532 **7/6** Each POST PAID
Circuit 1/3.

AMPLIFIER A1368.
For Battery operation.
2 stage, 2 valve intercom. and transmitter modulator pre-amplifier used with TR9, etc. With valves, VR35 (240QP), VR21 (210LF), etc., in metal case 7 x 4¾ x 4¼in. and Circuit.
ASK FOR X/E898 **8/6** Each POST PAID

AMPLIFIERS

TWO COMPLETE KITS OF PARTS

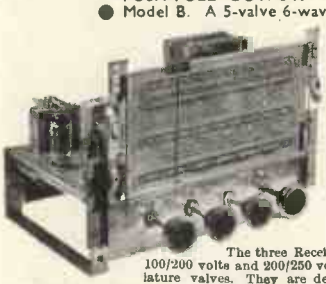
A 6-8 watt QUALITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, incorporating a simple arrangement to enable either a magnetic-crystal or lightweight pick-up to be used, and is suitable for use with Standard or long-playing records. A tone control is incorporated, and the 10-watt output transformer is designed to match 2 to 15 ohm speakers.

The overall size of the assembled chassis is 10in. × 8in. × 7½in. high, and full practical diagrams are supplied. Price, including drilled chassis and valves, of complete kit, £6/17/6. Price of assembled chassis, supplied ready for use, £8/12/6. Full descriptive leaflets are available separately for 1/-. 5/- carriage and insurance.

A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier, with negative feedback, and comprises a main amplifier chassis and a remote controlled Preamplifier and Tone Control Unit, incorporating four controls—bass, treble, main volume or mixing control, and a radiogram, microphone, selector switch. This control unit measures only 7 × 4 × 2in. The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore that ample correction is provided to suit any type of pickup with any type of recording. Input voltage for maximum output is 70 mV. 6.3 volts at 2 amps and 30 mA. H.T. is provided for tuning unit, etc. Price of complete kit, amplifier and control unit, including drilled chassis and valves £14. Complete specification and layout, 2/-. We can also supply completely assembled and ready for use at £17. 7/6 carriage and insurance. THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THEIR COST.

THREE COMPLETELY ASSEMBLED ALL-WAVE SUPERHET CHASSIS

- Model B.3. A 5-valve 3-waveband Receiver.
- Model B.3. P.P. A 6-valve 3-waveband Receiver with PUSH-PULL OUTPUT.
- Model B. A 5-valve 6-waveband (4 Bandspread) Receiver.



The three Receivers are for operation on A.C. mains 100/200 volts and 200/250 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent clarity of speech and music on both gram and radio, making them the ideal replacement chassis for that "old Radiogram," etc.

Brief specifications: Model B.3.—Valve line-up, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage, short 16-50, medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel type); (3) wavechange and gram: (4) tone (3-position switch operative on gram and radio). Negative feedback is employed over the entire audio stages. Chassis size: 11 × 7½ × 8½in. high. Dial size: 9½in. × 4½in. Price, complete and READY FOR USE, excluding speaker, £12/12/-. (Carr. and Ins. 7/6 extra). Model B.3. P.P.—This model is the B.3 Receiver but incorporates two 6BW6 VALVES in PUSH-PULL, resulting in really excellent quality reproduction up to approximately 6 watts. Price £15/15/-. (Plus 7/6 carr. and ins.).

Model B. Employs a similar valve line up as the B.3., but covers 6 wavebands. Short wave 11-16, 16-25, 22-23, 31-46 and 43-120 metres, and medium wave 187-550 metres. The first four short bands are bandspread. The controls employed are as used on the B.3 model, but the tone control operates a six-position switch, having three additional positions for varying bass and treble on gram reproduction. Negative feedback is employed over the entire audio stage. Size of chassis and dial is as given for B.3. Price complete and READY FOR USE, excluding speaker, £15/15/-. Carr. & Ins. 7/6 extra.

MODERNISE YOUR OLD RADIOGRAM FOR £25

(plus 10/- carriage and insurance)

with the very latest equipment. We will supply the 3 waveband chassis on the left with the automatic changer on the right, complete with 10in. speaker for £25 (£28/7/6 with the Model B3P.P. or B.). This is less than half the price of comparable commercial three speed auto radiograms.

A GENUINE SPECIAL OFFER!

3-SPEED AUTO CHANGE UNITS BY A FAMOUS MANUFACTURER

(Normal price is £16/10/-).

£11-14-6

(plus 7/6 carr. and insurance).

Brand New in Maker's Cartons, complete with mounting instructions.

- These units will auto change on all three speeds, 7in., 10in., and 12in.
- They play MIXED 7in., 10in. and 12in. records.
- They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- Minimum baseboard size required 16in. × 12½in. with height above 5½in. and height below baseboard 2½in.

A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

THE WILLIAMSON AMPLIFIER

WE have the complete range of specified Components in stock for this famous quality Amplifier. Enquiries are welcomed and immediately dealt with. The complete assembly instructions and diagrams are available for 3/6.

SELENIUM RECTIFIERS

6 or 12 Volt 1 amp. rating	7/6
6 or 12 Volt 2½ ,, ,,	12/6
6 or 12 Volt 4 ,, ,,	17/6
6 or 12 Volt 6 ,, ,,	£1/7/9

A DUAL CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

This comprehensive PRE-AMPLIFIER and TONE CONTROL UNIT provides a full control of bass and treble in conjunction with a main Volume /Mixer Control.

It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-up and all natures of recordings, i.e., English American and long playing, without recourse to pick-up correction.

The extreme flexibility of the bass and treble controls is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier.

Response characteristics are given in 12-watt amplifier advt.

The unit measures only 7in. × 4in. × 2in., including self-contained power supply, and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price, including drilled chassis, valves (6SN7 and 6J5), £3/16/9. Complete assembly data is available separately for 1/-. Completely assembled and ready for use, £5/5/-.

A Complete Kit of Parts to build a 3-4 WATT HIGH GAIN AMPLIFIER

for operation on A.C. or D.C. Mains, 200-250 volts.

This amplifier will give 3 watts output for the small input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H/F Magnetic type.

A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 9in. × 5in. × 7in. and valve line up 25Y5-beH7-25L6.

Price of complete kit, including drilled chassis and valves, £4/2/9, plus 6½in. P.M. (which fits on chassis), 16/-, or 8in. P.M., 18/9.

Price of fully assembled chassis ready for use. £5/5/- (plus cost of speaker).

Copy of assembly instructions and components price list available for 1/3.

BATTERY CHARGER KITS

All Kits are for A.C. Mains 200-250 Volts. They comprise of a Metal Rectifier and Transformer, tapped for 6 or 12 Volt charging, and a tapped Resistor, with Selector Switch, to enable the charging rate to be varied.

For 6 or 12 volt batteries at max. 1 amp.	£1/17/6
For 6 or 12 volt batteries at max. 2½ amp.	£2/5/3
For 6 or 12 volt batteries at max. 4 amp.	£3/2/6

An easily followed Wiring Diagram is included with each Kit.

THE COLLARO MODEL AC47.

GRAM UNIT £4/17/6

(plus 3/- carriage and insurance)

For use with 78 r.p.m. Records. Includes 12 inch Turntable and incorporates a variable speed control.

STERN RADIO Ltd.

109 & 115, FLEET STREET, E.C.4

Tel.: CENTRAL 5812-3-4

R.S.C. MAINS AND OUTPUT TRANSFORMERS

Fully Guaranteed, Interleaved and Impregnated

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

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

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1.5 a., 14/9; 0-9-15 v. 3 a., 16/9; 0-9-15 v. 6 a., 22/9; 0-4-9-15-24 v. 3 a., 22/9; 0-9-15-30 v. 3 a., 23/9.

Primaries 200-230-250 v. 50 c/s.
TOP SHROUDED DROP THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2.5 a.	12/11
260-0-260 v. 70 mA., 6.3 v. 3 a., 5 v. 2 a.	14/11
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
350-0-350 v. 80 mA., 6.3 v. 3 a., 4 v. 2.5 a.	14/11
250-0-250 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.	23/9
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.	29/11
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	29/11

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 or ACR2X 35/-

Primaries 200-230-250 v. 50 c/cs.
FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type 2½-3-3in.	16/9
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
300-0-300 v. 60 mA., 12 v. 1.5 a., c.t.	18/11
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. 6 a., 5 v. 3 a., for R1355 conversion	29/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
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
350-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a.	45/9
350-0-350 v. 250 mA., 6.3 v. 6 a., 4 v. 8 a., 0-2-6 v. 2 a., 6 v. 3 a. for Electronic Eng. Televisor	67/6
425-0-425 v. 200 mA., 6.3 v.-4 v. 4 a. c.t., 6.3-4 v. 4 a., c.t., 0-4-5 v. 3 a., suitable Williamson Amplifier, etc.	49/9
425-0-425 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	65/6

SMOOTHING CHOKES

250 mA. 7-10 H. 200 ohms	16/9
250 mA., 3 H. 50 ohms	11/9
150 mA., 6-10 H. 100 ohms	11/9
100 mA., 10 H. 175 ohms	7/6
80 mA., 10 H. 350 ohms	5/6
60 mA., 10 H. 400 ohms	4/11

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/cs.

120 v. 40 mA.	7/11
90 v. 10 mA., 8-0-8 v. 250 mA.	9/11
120 v. 40 mA., 6 v. 1.5 a.	14/9
120 v. 40 mA., 6-0-6 v. 1 a.	15/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	3/6
Small Pentode, 5,000Ω to 3Ω	3/9
Small Pentode, 8,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000Ω to 3Ω	4/9
Standard Pentode, 10,000 ohms to 3 ohms	4/9
Multi-ratio 40 mA. 30 : 1, 45 : 1, 60 : 1, 90 : 1, Class B Push-Pull	5/6
Push-Pull 8 watts 6V6s to 3 ohms	7/11
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 to match 6L6, etc., to 3Ω or 15Ω Speaker	22/9
Push-Pull 20 Watts, high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9
Williamson type, exact to author's specification	85/-

MICROPHONE TRANSFORMERS

100 : 1	5/9

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

COLLARO TAPE DESK MOTORS, shaded pole type, clockwise or anti-clockwise, 29/9 each.

DIAL BULBS, M.E.S., 8 v. 0.15 a., 6/9 doz.

M.E. SPEAKERS. All 2-3 ohms, 6½in. Rola field 700 ohms, 11/9, 10in. R.A. field 600 omhs, 23/9. 10in. R.A. field 1,500 ohms, 23/9. 10in.R.A. Field 1,000 ohms, 23/9.

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

WIRE WOUND POTS.: 5K, 10K, 20K, 25K, 50K (medium length spindles), 2/9.

AMMETERS. Moving coil. G.E.C. 0-5 amps., 2in. scale, 12/6.

ELECTROLYTICS (Current production. NOT ex-Govt.).

Tubular Types		Can Types	
8μF 450 v.	1/11	16μF 450 v.	2/9
8μF 500 v.	2/9	24μF 350 v.	2/11
16μF 350 v.	2/3	32μF 350 v.	2/11
16μF 450 v.	2/9	32 mfd. 450 v.	4/9
16μF 500 v.	3/9	40μF 450 v.	4/9
24μF 350 v.	3/3	64 mfd. 450 v.	4/9
32μF 350 v.	3/9	8-8μF 350 v.	3/9
32 mfd. 500 v.	5/9	8-8μF 450 v.	3/11
8-16μF 500 v.	4/11	8-16μF 450 v.	4/6
25μF 25 v.	1/3	16-16μF 450 v.	4/11
50μF 12 v.	1/2	16-16 mfd. 500 v.	5/9
50μF 50 v.	2/3	16-32μF 350 v.	4/9
Can Types		32-32μF 350 v.	4/9
8 mfd. 450 v.	2/3	32-32μF 450 v.	5/11
8 mfd. 500 v.	2/11	60-100 mfd. 350 v.	7/6
16 mfd. 350 v.	1/11	3,000 mfd. 6 v.	6/9

SPECIAL OFFERS. Germanium Crystal Diodes 2/3. Midget Mains Transformers (size approx. 2½ × 3 × 2½in.). Screened Primary 220/240 v. 50 c/s. Output, 250-0-250 v. 60 mA., 6.3 v. 2.5 a. Only 11/9. Auto Transformers (with separate l.t. 6.3 v. 1.5 a.), 0-110-200-210, 230-250 v. 50 watts, 4/9 each.

CO-AXIAL CABLE. 75 ohms ¼ in., 9d. yard. Twin screened feeder, 8d. yard.

EX-GOVT. CATHODE ISOLATING FILAMENT TRANSFORMERS. 6.3 v. to 6.3 v. c.t., 3/9 ea

MISCELLANEOUS EX-GOVT. ITEMS
Slydelock Fuses, 15 amp., 1/9. Bulgin panel mounting Fuseholders (ex-equipt.), 11d. Bulgin octal type moulded Bakelite, 5-pin or 7-pin Plugs and Sockets, 1/11 pr.

BAKELITE AND WALNUT VENEERED CABINETS

Size approximately 12in. × 6½in. × 5in. Bakelite type available in Brown or Cream. Price of Cabinets, 17/6 ea., carr. 2/6.

Suitable fully punched T.R.F. 3-valve and rectifier chassis	3/9
Suitable fully punched superhet chassis (4 valves and rect.)	4/9
Dial Scales, 2 colour, 2 waveband, station named, glass	1/6
Dial Scales, 3 colour, 3 waveband, station named, glass	1/9
Suitable coloured Metal Backplates	1/3
"Push-on" Pointers	6d.
T.R.F. Coils, 2 waveband with circuit	6/9
Drum Drives, complete	2/6
Constructional Envelope of an All Mains T.R.F. Receiver (3 valves and rectifier) which can be built in any of above cabinets (for approximately £5)	2/6

SELENIUM RECTIFIERS

L.T. Types		H.T. Types H.W.	
2/6 v. ½ a. h.w.	1/11	70 v. 20 mA.	2/11
6/12 v. 1 a. h.w.	3/11	90 v. 20 mA.	3/6
F.W. Bridge Types		120 v. 40 mA.	3/11
6/12 v. 1 a.	6/11	250 v. 50 mA.	5/9
6/12 v. 2 a.	9/9	350 v. 50 mA.	7/9
6/12 v. 4 a.	17/9	250/350 v. 80 mA.	8/9

EX-GOVT. E.H.T. SMOOTHING CONDENSERS

.02 mfd. 5,000 v. Bakelite Tubulars	1/9
.02 mfd. 8,000 v. Cans	1/11
.1 mfd. 2,500 v. Bakelite Tubulars	3/6
.1 mfd. plus .1 mfd. 8,000 v., large blocks (common negative isolated)	9/6

SPECIAL PURPOSE EX-GOVT. VALVES (GUARANTEED)
VR91, 4/11, SP61 (VR65) 2/9, VR56 3/11, AC6Pen 5/3, 807 7/11, 7193 1/3, 6J6 9/6, 954 1/11, 955 3/9, 6SH7Met 6/11, 12SC7GT 6/11, RK34 2/6. VU120A 2/9.

EX-GOVT. WIRE WOUND POTS.
(Ex-equipt., insulated spindles).
Bakelite type, spindles approx. 1in. 2K, 2.5K, 5K, 10K, 15K, 20K, 50K, 100K, 2/3 ea.

CHASSIS
18 s.w.g. undrilled aluminium amplifier type (4 sided).

12in. × 9in. × 2½in.	6/11
14in. × 9in. × 2½in.	6/11
14in. × 10in. × 3in.	7/11
16in. × 10in. × 3in.	8/3

18 s.w.g. aluminium, receiver type.

6in. × 3⅜in. × 1½in.	1/11
7½in. × 4⅜in. × 2in.	2/9
10in. × 5½in. × 2in.	3/3
11in. × 6in. × 2½in.	3/11

16 s.w.g. aluminium, receiver type.

12in. × 8in. × 2½in.	5/3
16in. × 8in. × 2½in.	7/6
20in. × 8in. × 2½in.	8/11

16 s.w.g. aluminium, amplifier type, 4 sided.

12in. × 8in. × 2½in.	7/11
16in. × 8in. × 2½in.	10/11
20in. × 8in. × 2½in.	13/6
14in. × 10in. × 3in.	13/6

VALVE SCREENING CANS. International Octal 3 piece, 10/6 doz., 1/3 each.

EX-GOVT. SMOOTHING CHOKES

330 mA. 5 H. 50 ohms. Potted type	12/9
250 mA., 40 H. 200 ohms. Trop. type	17/6
250 mA. 20 H. 250 ohms. Trop.	13/9
250 mA. 5 H. 100 ohms. Potted type	9/6
150 mA. 15 H. 200 ohms. Potted type	10/11
100 mA. 10 H. 100 ohms.	6/11
100 mA. 15 H. 450 ohms.	5/9
100 mA. 5 H. 100 ohms. Tropicalised	4/6
50 mA. 50 H. 1,250 ohms. Potted type	8/11

EX-GOVT. T.V. TRANSFORMERS. All 230 v. 50 c/s input.

2 v. 3 a., 2 v. 3 a., 2 v. 3 a., 2 v. 3 a.	8/9
415-360-0-360-415 v. 250 mA.	25/-
375-345-0-345-375 v. 250 mA.	22/6
6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a., 5 v. 3 a., 4 v. 3 a.	22/6
2 v. 2 a., 2 v. 2 a., 4 v. 3 a., 4 v. 3 a., high ins.	9/6
278-0-278 v. 80 mA.	7/9
350-0-350 v. 160 mA., 6.3 v. 6 a., 5 v. 3 a.	29/6

EX-GOVT. RF26 UNITS. Brand new, cartoned, 49/6, plus carr. 5/-.

EX-GOVT. BLOCK PAPER CONDENSERS

4 mfd. 500 v., 2/9.	8 mfd. 1,000 v., 6/9.
4 mfd. 750 v., 3/3.	6 mfd. 1,500 v., 6/9.
4 mfd. 1,000 v. 3/11.	10 mfd. 1,000 v., 7/9.

EX-GOVT. HEAVY DUTY FIL. TRANS.
All for 230 v. 50 c/cs. input. 6.3 v. 10 a., 17/6. 6.3 v. 12 a., 18/6. 6.3 v. 20 a., 22/6.

EX-GOVT. CATHODE RAY TUBES

VCR517 (guaranteed full picture)	29/6
ACR2X (guaranteed full picture)	12/6
VCR139A with screen	19/6

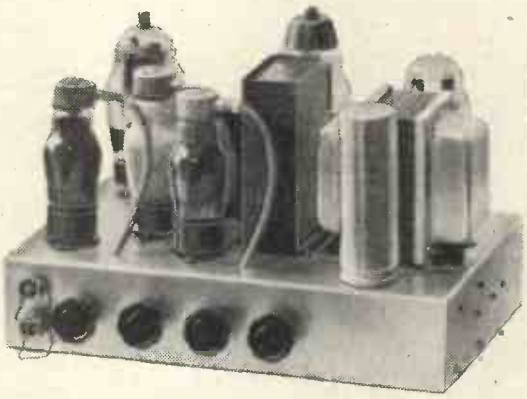
Carr. 5/- ea. on first 2 items & 2/6 on last item.

R.S.C. 25 WATT "PUSH PULL" AMPLIFIER

We are proud to introduce our A II Quality Amplifier, which we consider to be the best value in amplifiers offered to-day. The volume of its high fidelity reproduction is completely controllable, from the sound of a quiet intimate conversation to the full glorious volume of a great orchestra. Its sensitivity is so high that in areas of fair signal strength it can be operated straight from a crystal receiver. Entirely suitable for standard or long playing records in small homes or in large auditoriums. For electronic organ or guitar or for garden parties or dance bands.

The kit is complete to the last detail, and includes easy to follow point-to-point wiring diagrams.

Twin volume controls with twin input sockets allow SIMULTANEOUS INPUTS for BOTH MICROPHONE and GRAM, or TAPE and RADIO. SEPARATE BASS and TREBLE CONTROLS giving both LIFT and CUT. FOUR NEGATIVE FEEDBACK LOOPS with 15 db in the main loop from output transformer to voltage amplifier. Frequency response ± 3 db. 50-20,000 c.p.s. HUM AND DISTORTION LESS THAN 0·5 per cent. measured at 10 watts, six B.V.A. valves, Marconi/Osram KT series output valves. A.C. only, 200-230-250 v. 50 c/cs. input. 420 v. H.T. LINE. Paper reservoir condenser. Compact chassis. Matched components. OVERALL SIZE 14-10-9in. approx.



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Or ready for use 30/- extra.

R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen—Talk Back Units" A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are supplied. A walnut veneered wood cabinet is included. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHASSIS IS NOT "ALIVE." Ideal also for use as "Baby Alarm." Sound amplification 4 watts. Price only **£5/19/6.** "Listen—Talk Back Unit" as illustration can be supplied at **27/6** each. Full descriptive leaflet **1/-.**
The Master Unit can be supplied assembled and tested for **27/6** extra.

R.S.C. BATTERY CHARGER KITS. For mains input 200-250 v. 50 c/s. To charge 6 v. accumulator at 2 amps., **25/9.**

To charge 6 v. or 12 v. accumulator at 2 amps., **31/6.**
To charge 6 v. or 12 v. accumulator at 4 amps. **49/9.**
ABOVE KITS CONSIST OF BLACK CRACKLE STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSES, FUSEHOLDERS AND CIRCUIT. Due to careful design the use of resistors for regulation of charge has been obviated. The mean charging rates are as indicated above, and complete safety is ensured by fusing of both input and output. Chargers supplied assembled and tested for **6/9** extra.

A PUSH-PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR £3/12/6, plus carr. 2/6. For mains input 200-250 v. 50 c/s. Complete kit of parts including point-to-point wiring diagrams and instructions. Amplifier can be used with any type of feeder unit or pick-up. Output is for 2.3 ohm speaker. (We can supply a very suitable 10in. unit by Goodmans at **31/-.**) The amplifier can be supplied ready for use for **25/-** extra. Full descriptive leaflet **1/-.**

PERSONAL SET BATTERY SUPERSEDER KIT.

Complete with case. Supplies 90 v. 10 mA. and 1.4 v. 250 mA. fully smoothed, from normal 200-250 v. 50 c/s. mains. For 4-valve superhet receivers. Price with circuit **33/9.** Or ready for use **39/9.** Size of unit 5½ × 3½ × 1½in.

P.M. SPEAKERS. All 2-3 ohms. 5in., Goodmans, **14/9,** 6½in. Elac, **14/11,** 6¼in. Plessey with Pentode Trans., **14/11,** 8in. Plessey, **15/9,** 8in. R.A. Heavy duty, **18/9,** 10in. Goodmans, **31/-,** 10In. Plessey, **18/6,** 10in. Rola with Trans., **29/6,** 12in. Truvox, **49/9.**

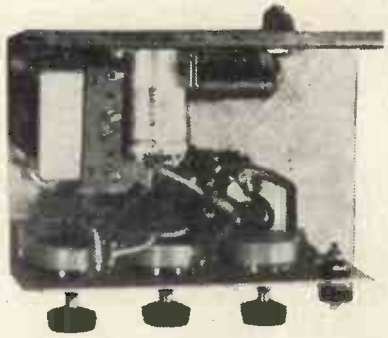
BATTERY SET CONVERTER KITS. All parts for converting any type of battery receiver to all mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed h.t. of 120 v. 90 v. or 60 v. at up to 40 mA., and fully smoothed l.t. of 2 v. at up to 1 a. Price complete with circuit and instructions only **48/9.** Supplied ready for use for **7/9** extra.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT. Consists of h.t. and l.t. transformer, h.t. and l.t. rectifiers, smoothing electrolytic, choke, and steel case. For mains input of 200-250 v. Output 120 v. 40 mA. and 2 v. ½ a. Price with circuit **29/6.**
Or in working order **37/6.**

WILLIAMSON AMPLIFIER KIT. Complete set of parts (exact to author's specification) for construction of the original amplifier.

PRICE COMPLETE **14 gns.**

R.S.C. TONE CONTROL-PRE-AMP. UNIT. A complete set of parts for the construction of a very efficient but simple pre-amplifier and tone control unit. Suitable for use with any amplifier and pick-up. Fil. supply is self-contained. Overall size is 7¼-5-5½in. approx. Full descriptive leaflet **5d.**



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Or ready for use **15/-** extra.

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COMMUNICATIONS RECEIVER R1155. The famous ex-Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges 18.5-7.5 Mc/s, 7.5-3.0 Mc/s, 1,500-600 kc/s, 500-200 kc/s, 200-75 kc/s, and is easily and simply adapted for normal mains use, full details being supplied. Aerial tested before despatch. These are BRAND NEW AND UNUSED IN MAKER'S ORIGINAL TRANSIT CASES, ONLY **£11/19/6.**
A few used receivers, also tested working before despatch, are available at **£7/19/6.**
A few of the R1155N model can also be supplied. This is the latest version which covers the Trawler Bands, and in addition is fitted with ultra slow motion tuning. Used, but tested working before despatch. ONLY **£17/19/6.**
A factory made Power Pack, Output Stage and Speaker, contained in a black crackled cabinet to match the receiver, can be supplied at ONLY **£5/10/-.** Operates receiver immediately. **DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.**
Please add carriage costs of 10/6 for receiver, and 5/- for power pack.
RECEIVERS R1355, as specified for "Inexpensive Television." Complete with 8 valves SP61, and 1 each 5U4G and VU 120 or VU111. Used, good condition, ONLY **29/6** (carriage etc., 5/6).
RF UNITS TYPE 26 AND 27 for use with the above receiver. The very popular variable tuning units, which use 2 valves EF54 and 1 EC 52. Type 26 covers 65-50 Mc/s (5-6 metres), and Type 27 covers 85-65 Mc/s (3.5-5 metres). **BRAND NEW IN MAKER'S CARTONS.** ONLY **59/6** each.
V.H.F. RECEIVER R1132A. Covers 100-124 mc/s. with variable tuning. Complete with all valves, and in BRAND NEW condition, ONLY **59/6** (carriage, etc., 10/6).
POWER PACK TYPE 3. Used by the Services with the above. A standard 19in. rack mounting job to match the receiver, this is for 200/250 v. 50 cycles mains with output of 250 v. D.C. 100 mA., and 6.3 v. 4 amps. Is fitted with H.T. current meter and voltmeter, and is a really superb unit, which can be used for a variety of sets. Tested working before despatch, ONLY **90/-** (carriage, etc., 5/-).
RECEIVER 25/73. Part of the TR1196. Covers 4.3-6.7 Mc/s and makes an ideal basis for an All Wave Superhet, full modification data being supplied. Complete with valves, 2 each EF36 and EF39, and 1 each EK32 and EBC33. ONLY **25/-** (postage, etc., 2/6).
INDICATOR UNIT TYPE 95. Exactly the same as the Type 62, but for 50 cycle operation. Built on a two deck chassis, it contains VCR97 tube with mu-metal screen, 16 valves, SP61, 2 of EB34, and 4 of EA50. Also shoals of components. In new condition. A snip at ONLY **59/6** (carriage, etc., 7/6).
AVO MODEL 40 UNIVERSAL TEST METERS. Have had some use but every meter has been thoroughly checked and tested, and is GUARANTEED IN PERFECT WORKING ORDER. An ideal opportunity to acquire a first grade tester at low cost. ONLY **£9/19/6.**
12in. SPEAKER CABINETS. Very heavy construction, covered in brown rexine, and fitted with carrying handle and removable back. Has lead compartment, and is ideal for use as a portable amplifier and speaker cabinet. Size 19in. × 17in. × 13in. BRAND NEW. ONLY **59/6** (carriage, etc., 4/6).
AMERICAN DYNAMOTORS. Input 12.7 v. 2.7 amps. Output 255 v. 60 mA. ONLY **29/6.**
BLOWER MOTORS. 12 v. and 24 v. types available. ONLY **17/6** each.
TELESCOPIC AERIAL. Pulls out of metal tube 15in. long to extend to 73in. BRAND NEW. ONLY **7/6** (post 10d).
194 I.F. STRIP. An easily modified I.F. Strip recommended for TV constructors who want good results at moderate cost, or for those who have built televisors but are having trouble in the vision or sound receivers. Can also be modified for 2 channel working as per details in "Practical Television" October issue. This 6 stage strip measures 18in. × 5in. × 5in., and contains 6 valves VR65, 1 VR92 and 1 of VT56 or VR53. Mod. data supplied. ONLY **45/-** (postage, etc., 2/6). Or less Valves **19/6** (post 2/6).
208 AMPLIFIER. Ideal for conversion into a high gain TV pre-amp. Complete with 2 valves EF50. ONLY **15/-** (postage, etc., 1/6).
CERAMIC 2 WAY 3 BANK SWITCHES, 7/6 each.
TRANSFORMERS. Manufactured to our specification and fully guaranteed. Upright mounting, fully shrouded normal primaries.
425-0-425 v. 200 mA, 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a., **50/-.**
350-0-350 v. 160 mA, 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a., **42/6.**
350-0-350 v. 150 mA, 6.3 v. 5 a., 5 v. 3 a., **32/6.**
250-0-250 v. 100 mA, 6.3 v. 6 a., 5 v. 3 a., **32/6.**
Please add 2/- per transformer postage.
TRANSFORMERS, FILAMENT. 6.3 v. 2 a., **7/6**; 6.3 v. 3 a., **10/6.** (Postage 1/-).
TRANSFORMERS EHT. Upright mounting. EHT for VCR 97 tube, 2,500 v. 5 mA, 2-0-2 v. 1.1 a., 2-0-2 v. 2 a., **37/6.**
EHT 5,500 v. 5 mA, 2 v. 1 a., 2 v. 1 a., **72/6.**
EHT 7,000 v. 5 mA, 4 v. 1 a., **82/6.** Please add 2/- per transformer postage.
2½in. SQUARE FLANGE 0-1 M.A. METERS. Brand new. ONLY **15/-.**
10in. P.M. SPEAKERS with output trans. Brand new. ONLY **27/6** (postage 2/-).

Cash with order please, and print name and address clearly Amounts given for carriage refer to inland only.

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AIR MINISTRY COMMUNICATION RECEIVER R1155A. Brand New. Frequency ranges—18.5-7.5 Mc/s. 7.5-3 Mc/s, 1,500-600 kc/s, 500-200 kc/s, 200-75 kc/s. Complete with 9 valves and Magic Eye. Guaranteed absolutely perfect. Price **£9/10/-,** plus 10/- for packing and carriage.

1155 POWER PACK AND OUTPUT STAGE complete with U50 and KT61 valves (not surplus) Black crackle case 12 x 8 x 5in. built-in 5in. pm Speaker and phone jack. 200-250 v. A.C. All connections terminate in Jones plug which enables instant operation of receiver **without any modifications whatever.** Matches in appearance with receiver. Made to "Wireless World" specifications. Built entirely from top grade new components, **£7/10/-** plus 3/6 carriage.

G.E.C. VHF RECEIVERS complete with 10 valves. Ex-Govt. As used by police. Used but guaranteed in excellent condition. Valves comprise ZA2's, 954's, or EF50's in HF and 1st Det. stages. Det 19 in local oscillator, KTW63's in three IF stages, D63 Det and AVC, LF H63, Output KT63, Noise suppressor D63, Power requirements 6v. 3a, 270 v. 80 ma. Frequency range 78.5-82 Mc/s. Intermediate frequency adjustable 8.3-9.8 Mc/s. Oscillator Crystal controlled (No Crystal included). Grey enamel steel case with lid 10 x 8 x 7in. Weight 22lbs. Note the amazingly low price, **39/6** plus 5/- carr.

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G2AK *This Month's Bargains* G2AK

SPECIAL VALVE OFFER. 866A Rectifiers, **17/6** each, 807's **12/6** each or **22/6** pr. 931A, **45/-.** 832, **35/-.** 829B, **80/-.** 813, **70/-.**
METERS. 2½in. Flush mounting M.C. 100 mA., **12/6** each; 2in. Flush M.C. 5 mA, **7/6**; 4 amp. thermo., **5/-**; 2½in. thermo., 0-2 a., **7/6**; 2½in. 2in. Flush 0-15 a. thermo. Proj. 2½in., **7/6** each. 0-9 a. Hot wire, **5/-.**
CELESTION 10in. P.M. SPEAKERS. Few only, **27/6** each.
TWIN RIBBON FEEDER. Heavy duty 300 ohm, **5d.** per yd. Standard K25 300 ohm ribbon, **9d.** per yd. Co-axial cable, ¼in. dia. 50 ohm, 8d. per yd. 7ft. length ¼in. dia. Co-axial with Pye plug one end, **1/6,** post free. All other Co-axial and feeder, plus 1/6 post any length.
POTENTIOMETER Carbon Type Potentiometers, 25k., 50k., 100k., ½ meg., 2 meg., **1/6.** Many W.W. slot types available for T.V. replacements.

SPECIAL OFFER. 300 ohm. Flat Twin 150 w. rating, **6d.** per yd. (minimum 20 yds.) post free.
MULTI METER BASIC UNIT, 400 microamps, F.S.D. scaled 8 ranges A.C./D.C. volts, Lo and Hi, complete with rectifier, made by Triplett, U.S.A., Only **32/6.** Post free
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STREAMLINED BUG KEYS by famous manufacturer. Listed at over £4. Our Price **45/-** only.

SPECIAL TRANSFORMER OFFER. PRI. 115, 210, 240 v. **SES,** 260/260 v. 100 mA, 6.3 v. 3 a., 6.3 v. 1 a. (for 6 x 5 Rec.) Universal Mounting. Limited Quantity, **17/6** each, post free.
CARBON MIKE TRANS., 2/- each. P. & P. 6d.
COMPLETE SET OF AR88 TUBES (14) for LF or D model receivers, **£5/10/-.**
TAPE RECORDING EQUIPMENT. Desks by Bradmatic, Tamsa, Lane and Qualtape. Ex stock. Heads, Oscillator Coils, Tape and Reels always available.
GERMANIUM DIODES. B.T.H. 2/-, G.E.C. 2/6.
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TRUVOX TAPE DESK MARK III. Incorporating high impedance mu-metal twin-track heads. Two-speed capstan, for tape speeds of 7½ and 3¾ inches per second. Three heavy-duty motors allowing for fast forward and rewind facilities without tape handling. All controls operated by electrically and mechanically interlocked push buttons. Price £23/2/-. Send S.A.E. for full particulars. Plus 10/- carriage, etc. Delivery from stock.

THE LATEST LANE TAPE TABLE. Incorporating three heavy duty Lane motors; fast rewind and wind-on without tape handling; automatic braking; high impedance half-track heads; spool locking device. Tape speed 7½in. per second. Price £17/10/-. Carriage 10/-.

"MOTEK" K3 TAPE UNIT. A high impedance Tape Unit embodying 3 motor drive unit with high impedance Record-Playback and erase heads. Electronic braking system, push button controls, rewind and fast forward wind without tape handling. 7½in. per second, twin track thus giving approx. one hour playing time with 7in. spool. Standard size unit: 16½in. x 11½in. x 4½in. Price 16 gns. plus 10/- carriage.

GARLAND UE7B RECORD PLAYBACK AMPLIFIER. A revised version of our popular amplifier designed to suit Truvox Tape Desk or Lane Tape Table. New features include higher gain, magic eye record level indicator, and smaller size for incorporation in portables. Oscillator and power supplies included. Standard valves throughout. Formica control panel. Supplied complete with 8in. P.M. loudspeaker. Price £13/2/6 plus 7/6 carriage, etc.

TAPE RECORDER OSCILLATOR COILS. 6.3 mH, 45 kc/s, for high impedance heads only. Price 6/9 each.

MAGNETIC TAPE. Now available, the new Scotch Boy High Coercivity Tape MC2-III, with higher output and signal-to-noise ratio. Price 35/- per 1,200ft. reel. Still available: Scotch Boy MC1-III: 1,200ft., 35/-; 600ft., 21/-; 300ft., 12/3. Spare 7in. spools, 4/3. Ferrovoice, the new kraft-based medium coercivity tape: 1,200ft., 22/6. Spare 7in. spools, 4/6. Magnetophone Tape: £2 per 1,200ft. reel.

GOODMANS H6 OUTPUT TRANSFORMERS. Rated up to 30 watts push-pull; ten-section wound on silicon steel laminations with primary inductance of 100 H and negligible leakage inductance and capacitance. Primary 10,000 ohms C.T. Secondary 3.75 and 15 ohms. Price £3/3/-, plus 2/6 p. and p.

TAMSA TYPE 100 TAPE RECORDING HEADS. As used by the leading commercial tape recorder manufacturers. Housed in chromium plated brass case on adjustable mounting. Record/playback heads have ½-thou. gaps and erase heads have 2.5 thou. gaps. These heads are of high impedance. Price 45/- each.

CRYSTAL DIODES. Germanium Vacuum sealed glass type with wire ends, 2/8 each or 30/- per dozen.

UNDRILLED CHASSIS. Four-sided size 13in. x 7in. x 2½in. 20 s.w.g. bright mild steel 5/- each, 18 s.w.g. aluminium 6/8 each; two-sided with two straps, 12in. x 4in. x 2½in., 20 g. steel, 3/-, 18 g. Ali, 4/-. Two sided with two straps 6in. x 5in. x 2in., 20 g. steel, price 2/- each, 18 g. Ali, price 2/6 each.

TYANA SOLDERING IRONS. Lightweight 40 watt irons with easily interchangeable elements and 3/16 in. diameter bits. Voltage ranges, 100/110v., 200/220 v. and 230/250 v. Price 16/9. "The iron that makes soldering a pleasure."

VARLEY MAINS TRANSFORMERS. Primary 10-0-200-220-240 volts. Secondary 300-0-300 volts at 150 mA., 5 volt at 3 amps., 6.3 volt at 4 amps., 6.3 volts at 1 amp. Open type construction. Price 45/-, post 2/6.

BRENETTE MICROPHONES. Large sales of these popular microphones has enabled us to make substantial reductions in the prices. The following range is available: **Type 9ND**: Multi-directional ball-type, in black and chrome, £2/2/-, post 2/-. **Type 7D**: Directional type, for instrumental or vocal use; black and chrome, £3/15/-, post 2/6. **Type 11A**: A wide-frequency-response microphone, in brown cast case with chrome grill, £5/5/-, post 2/6. **Type 13U**: A highly sensitive studio microphone with outstanding frequency characteristics. Flexible mounting enables it to be used directionally or not as required. Black and chrome finish, £6/6/-, post 3/6.

DECALS. 500 ⅛in. high white transfer letters and words for marking electronic equipment. Price 4/9 per book. The new Decals book for the amateur now available. 29 words per page, 4 pages radio and audio, 4 pages T/V and Scope, 2 pages misc. incl. Tx. and Tape Recording, 3/6 per book, post 3d.

GENERAL PURPOSE TRIODES. Type 2C/22 (7193), 6.3 v. heater, int. octal base. SImilar to 6J5G, but anode and grid brought out to top caps. Price 11/6 per half-doz., post paid (minimum quantity).

RADAR REFLECTORS. Type MX138/-A. These consist of 6—2ft. x ¼in. dural tubes covered with fine wire mesh. The whole assembly can be used as an omni-directional aerial, and the mesh has many horticultural applications. Price 3/9 each, post 9d. Type MX137A: similar to above, but also include a telescopic aerial rod, extending from 11in. to 3ft. 6in. approx. Price 4/9 each. Post 9d.

TELEVISION MAGNIFYING LENSES. 6in. clear, 19/6; 9in. clear or filter, 50/-; 12in., clear or filter, 70/-. Please state which and add 5/- for carriage and packing.

WHANDA WIRE AND CABLE STRIPPERS, to take all size flexes and cables up to ⅜in. diam. with 3 alternative heads and triple screw adjustment. These are brand new and boxed, and the original price was 15/- each. Our price 5/- each, post paid.

AERIAL RODS. These popular rods, of tough steel copper-plated, are 12in. long, and fit into each other to make any length. Many hundreds of thousands sold to T/V aerial manufacturers and to the public. Price 3/6 per doz. or £1 per 100, post paid. £10 per box of 1,800 carriage paid U.K.

TOROIDAL CERAMIC POTENTIOMETERS. 260 Ω 50 w., 6/6. 17k. 100 watt, 8/6.

MAINS TRANSFORMERS. All at 19/6 each.

MT1. 250-0-250 v., 80 mA, 0-4-5 v., 2 A., 0-4-6.3 v. 3 A.

MT2. 350-0-350 v., 80 mA., 0-4-5 v., 2 A., 0-4-6.3 v. 3 A.

MT3. 0-30 v., tapped to give 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v, 12 v., 15 v., 18 v., 20 v., 24 v., 30 v., all at 2 amp.

MT4. 4 v., 4 amp., 10 v. 4 amp.; 20 v. 3 amp., for battery chargers.

MT5. Auto; 0-10-120-200-230-250 v., at 100 watt.

SMALL PAPER CONDENSERS. In tubular metal cases with wire ends. 0.25 mfd., 250 v., ⅛in. diam. x ⅜in., 1/- each; 1 mfd. 150 v., ⅜in. diam. x 1⅛in., 1/3 each; 2 mfd. 250 v., ⅜in. diam. x 2⅛in., in Neoprene sleeve, 1/9 each.

MINIATURE LIGHT WEIGHT RELAYS. 270 ohm, 18 v. Single pole on-off. Ex-American equipment. Price 2/9 each.

POTENTIOMETERS
Ex-Govt. or Manufacturers Surplus.

Value	Track	Wattage	Spindle length	Price
33	Carbon	1	1in.	1/9
50	W/W	5	Preset	2/3
500 ...	W/W	5	1⅛	3/9
2.2k ...	W/W	5	5in.	3/9
3k	C/Trop	2	⅜in.	1/6
3k	W/W	5	Preset	2/3
5k	,,	2	⅜in.	2/6
8k	,,	5	¼in.	2/3
10k ...	C/Trop	2	⅜in.	1/9
10k ...	Carbon	1	Preset	9d.
10.4k...	W/W	5	¼in.	3/-
20k ...	,,	3	Preset	1/9
20k ...	,,	5	1in.	3/-
20k ...	C/Trop	2	¼in.	1/3
25k ...	W/W*	5	⅜in.	3/-
25k ...	C/Mini	½	Preset	9d.
50k ...	W/W*	3	⅜in.	2/6
50k ...	C/Mini	½	¼in.	9d.
100k ...	,,	½	¼in.	9d.
200k ...	Carbon	1	⅜in.	1/3

All new and unused. Spindle diam. ¼in. in all cases. * are earthed slider.

METAL RECTIFIERS. RM1, 125 v. @ 80 mA., 3/11. RM2, 125 v. @ 100 mA., 4/3. RM4, 250 v. @ 250 mA., 17/-. 14D/972, 250 v. @ 25 mA., 6/6. 12 v. ¾ A., 6/-. 5 v. 1 A., 4/6. 12 v. 2 A., 12/6. 12 v. 2½ A., 16/6. 12 v. 4 A., 21/-.

ELECTRO-MAGNETIC CONTACTORS. Energised at 9-14 volt, ¼ Amp; maximum switched current 40 Amps. In bakelite case. Price 2/9.

PAXOLIN PANELS. 3¼in. x 1¼in. x 3/32in., 1/- per doz., 5/- per 100. 2¼in. x 2in. x 1/16in., 1/3 per doz., 6/- per 100. Many thousands available.

MINIATURE MUMETAL TRANSFORMERS. Auto-wound, giving approx. 2/1 ratio. Ideal rewind as head lift transformer, or lams can be used for recording heads. 2/6 each.

CATHODE-RAY TUBES. Type 5CP1. 5in. green screen, electrostatic focussing and deflection. Callers only. Price 22/6 each.

BRIMISTORS. Non-linear resistors to protect valves from current surges: CZ1, 0.3 A., 3/6; CZ2, 0.3 A., 2/6; CZ3, 0.2 A., 1/6; CZ4, 1.25 A., 5/-; CZ6, 0.45 A., 3/6.

HIGH FREQUENCY PENTODES. Type 6SH7, high slope, octal based. 6.3 v. heaters. Price 6/-.

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Mullard Amateurs Guide to Valve Selection	1/6
Osram Valve Manual, Part 1	5/-
Brimar Radio Valve and Teletube Manual	5/-
Wireless World Radio Valve Data, 3rd edition	3/6
Radio Valve Guide. By W. J. May	5/-
The Williamson Amplifier Manual, latest edition	3/6
Wireless World High Quality Amplifier Manual	2/6
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Television Faults	5/-
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UNIVERSAL AVOMETERS MODEL 40—very little used, thoroughly checked and tested. First-class multi-range test meter for ONLY £9/19/6.

50 Micro-amp. Moving Coil, 2½in. flush panel mtg., 65/-.

1 Milli-amp. 2½in. square panel mtg., 15/-.

5 Milli-amp. M/c. 2½in. square panel mtg., 7/6.

200 Milli-amp. M/c. 2½in. diameter flush panel mtg., 10/6.

20 Amps. 2½in. diameter M/coil, 7/6.

20 Volts 2in. square panel mtg., M/coil, 7/6.

500 Milli-amps. Thermo-ccuple 2in. square panel mtg., 5/-.

3,000 Electro-static 3½in. diameter, 35/-.

All the above meters are brand new and boxed.

BLOCK CONDENSERS

4 mfd. at 1,000 volts. Size, 4¾in. x 4in. x 1¼in., 5/-. New and boxed.

10 mfd. at 1,000 volts D.C. test, will work at 600 volts. Size, 2in. x 3in. x 3in. New and boxed. SPECIAL PRICE at 3 for 10/6. 25 mfd. at 1,500 volts. Size 2¼in. x 2in. x 1¾in. Price 3 for 4/6, post paid. All the above are metal cased with paper insulation and fixing feet. .04 mfd. 12.5 kV. ONLY 7/6 each.

CALIBRATOR UNIT 115

This unit is essentially a heavy duty power pack for 230 volts 50 cycles operation. It contains an extra heavy duty mains transformer with two 6.3 volt windings, 5 volts for rectifier, and the H.T. is 345-0-345 volts. Heavy duty choke, appropriate smoothing condensers, rectifier etc. Supplied complete with nine EF50's and 5Z4. In BRAND NEW condition at the give-away price of 82/6, plus 7/6 carriage.

METAL RECTIFIERS

Selenium 230 volts 60 mA. at 5/- ; 250 volts 100 mA. at 7/6 ; RM2 at 4/3, or two for 8/- ; RM3 at 5/- ; RM4 at 17/-. Heavy duty Westalite with square fins, size 8¼in. x 4in. x 4in. Two units in full wave bridge give 48 volts 10 amps. D.C. BRAND NEW at £5 per pair.

POWER UNIT 247

Enclosed in grey steel case, size 11in. x 9¼in. x 7¼in., with chrome handles. For 230 volts 50 cycles mains operation. Output 600 volts 200 mA., fully smoothed by 1,000 volt working paper condensers and extra heavy duty choke. Also 6.3 volt 3 amps. A complete power unit including 5UnG rectifier and indicator light for only 52/6, plus 7/6 carriage. New and in transit case. THIS IS A REAL SNIP.

POLICE, FIRE, WROTHAM

The R1132A receiver covers 100-124 Mc/s with variable tuning. Very easily altered to other frequencies. Complete with all 10 valves and Jones plug. Requires only 250 volts and 6.3 volts when it is ready to operate. Complete circuit supplied. Only 59/6, BRAND NEW. Will operate from our standard R1155 power pack using special lead, price 10/- extra.

COMMUNICATION RECEIVERS

SKY CHAMPION S2OR. This super Hallicrafter receiver covers 550 kc/s to 45 Mc/s (550 to 6⅔ metres) without gaps. Has bandspread tuning. R.F. stage, two I.F. stages, etc. Built-in power pack for 200/250-volts 50 cycles A.C. mains operation. Complete with all nine valves, built-in speaker and ready for operation. Each set tested prior to despatch and demonstrated to callers. In case size 18in. x 8½in. x 10in. Price £21, plus 10/- carriage and packing.

SKY RIDER DEFIANT SX24 is similar to above but includes crystal I.F. filter and S meter, etc. Complete with valves and crystal for £27/10/-, plus 10/- carriage and packing. For further details send S.A.E.

COMMUNICATION RECEIVER R1155 for world-wide reception. Can be heard at any time during shop hours. Air tested prior to despatch. Brand new at £11/19/6. A few slightly used at £7/19/6. Also have a number of R1155N's at £17/19/6. Carriage in original transit cases 10/6 extra on all models. Send 1/3 for full details and circuit.

A.C. MAINS POWER PACK OUTPUT STAGE enables the R1155 to be used to operate speaker from 200/250 volts A.C. without ANY MODIFICATIONS WHATEVER. Guaranteed six months. Price £4/10/-, plus 3/6 carriage. Also available, complete with built-in speaker, for only £5/5/-, plus 3/6 carriage. **SAVE £££££££'s**

Deduct 10/- when purchasing any R1155 and power pack together.

POWER PACK NO. 3. Standard 19in. rack mounted power packs for 200/250 volts mains operation. Paper smoothing, two heavy duty chokes, VU39 rectifier. Output 250 volts D.C. 100 mA., 6.3 volts 4 amps. Two types : Mark I with H.T. current meter at £4/4/- ; Mark II with H.T. current and voltmeters at £4/10/-, carriage 5/-. Suitable for use with P48, R1132, R1481, R1392, R1155, etc. Lead for any specified set with Jones plugs, 10/- extra. All power packs guaranteed in working order.

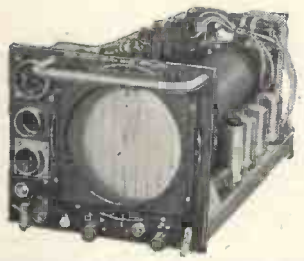
68R RECEIVER. A four-valve battery-operated superhet, with standard 465 kc/s I.F.'s. Complete with all valves. Covers 3 to 5 Mc/s (60-100 metres) Handy for the 80-metre band. Circuit supplied. Price only 32/6.

RECEIVER R1225, covers roughly 100-150 Mc/s, though sold primarily for break-up purposes. It contains 5 EF50's, 2 EF39's, and 1 EB34 and a host of other valuable components. This represents a very good buy at ONLY 25/-, plus 2/6 carriage.

TR1196 RECEIVER

Receiver 25/73. This is a six-valve superhet receiver with 465 kc/s I.F.'s. Complete with all valves—2 EF39, 1 EK32, 2 EF36, 1 EBC33. In brand new condition with full conversion data. SPECIAL EXHIBITION OFFER 25/-,

182A INDICATOR



INDICATOR UNIT 182A contains 3 EF50, 1 5U4G, 4 SP61 and a 6½in. C.R.T. type VCR517 This tube will replace the VCR97 without any alteration, is completely free from cut-off and has a more pleasant tube colour. Contains in addition a very large assortment of pots, resistors, condensers, etc. Tubes demonstrated. Supplied BRAND NEW (less relay) for only 79/6, plus 7/6 carriage in original transit cases. Original circuit supplied FREE with each order, or 1/6 separately.

INDICATOR UNIT TYPE 95. Exactly the same as Indicator Unit 62 but is 50 cycle version Double decker chassis with VCR97, mu-metal screen, 16 SP61's, 2 EB34's, 4 EA50's, loads of components, etc., in BRAND NEW condition. CHEAPEST EVER, 59/6, plus 7/6 carriage.

INDICATOR UNIT 62A, containing VCR97 C.R.T., complete with mu-metal screen. Valves—12 EF50, 4 SP61, 3 EA50, 2 EB34. Otherwise as above. BRAND NEW in original transit cases ONLY £6/10/-, plus 9/6 carriage.

BARGAIN OFFER. The R1355, complete with RF24 unit tuned to whichever station is required (sound or vision) for only 67/6, plus 7/6 carriage. RF26 and RF27 uses 2 EF54 and EC52. RF26 covers 50-65 Mc/s and the RF27 covers 65-85 Mc/s. Brand new and boxed, either type 59/6.

45 Mc/s PYE STRIP Vision unit for London frequency, complete with 6 EF50 and EA50. Circuit provided. Price £3/10/-, plus 2/6 carr.

T.V. PRE-AMP uses 2 EF50's and tunes to 45 Mc/s. Easily altered to other frequency. With valves, 19/6 ; less valves, 10/-. Post 1/- extra.

E.H.T. TRANSFORMER for the VCR97, etc. Mains input. Output 2,500 volts, 4 volts 2 amp., 2-0-2 volts 2 amp. Fully guaranteed at 35/-, plus 1/- post.

6in. MAGNIFYING LENS for the VCR97, etc. First grade, oil filled Now ONLY 17/6, plus 2/6 postage.

CO-AXIAL CABLE. Brand new 70/80 ohm with stranded inner conductor. Not ex-Govt. Price 1/- per yard. Minimum per post dozen yards at 10/-.

STANDARD TRANSFORMERS

Transformers of current manufacture. Two types, both standard tapped primaries. Universal mounting. (1) 350-0-350 volts 80 mA., 0-4-6.3 volts 4 amps, 0-4-5 volts 2 amps. (2) 250-0-250 volts 80 mA., 0-4-6.3 volts 4 amps., 0-4-5 volts 2 amps. Both these transformers are new and boxed, fully guaranteed at 18/- each, post paid.

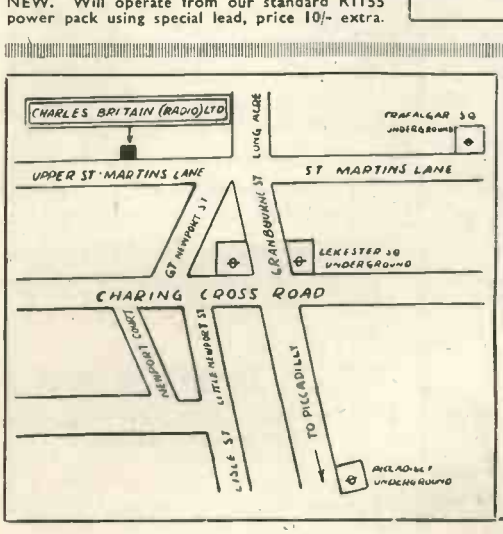
30 VOLT TRANSFORMER standard primary. Secondary 30 volts 2 amps, tapped to give 3, 5, 6, 8, 9 10, 12, 15, 18, 20, 24 volts. Has countless uses. Price 17/6.

METAL RECTIFIER, 12 volt 2 amp. full wave bridge type. Suitable for use with the above transformer. Price 12/6.

BLOWER MOTORS

U.S.A. Blower Motor for 105 volts A.C. operation. Outlet 2½in. diameter. Price 39/6.

12 and 24 VOLT small British blowers at 17/6 each.



"INEXPENSIVE TELEVISION." This book describes the building of a T.V. set from ex-Government surplus equipment. Price 2/9 post paid.

R1355 RECEIVER. This justly famous receiver unit is specified for the "Inexpensive T.V." Valve line-up—8 SP61, 1 VR92, 1 VU120, 1 5U4G. Slightly used, but in very good condition. BARGAIN PRICE 29/6, plus 5/- carriage and packing.

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Primary, 200-250 v. P. & P. 2/-.
400-0-400 250 mA., 4 v. C.T., 3 a., 4 times. Unclamped, 32/6.
300-0-300, 100 mA., 6 volt 3 amp., 5 volt 2 amp., 22/6.
Drop thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., 14/6.
Drop thro' 250-0-250 v. 80 mA., 6 v. 3 amp., 5 v. 2 amp., 14/6.
Drop thro' 110-110 60 mA., 6 v. 0.5 amp., 8/6.
280-0-280, drop-through, 80 mA., 6 v. 3 amp., 5 v. 2 amp., 14/6.

Auto-wound, H.T. 280-volts at 360 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separate 4 v. 3 amp., 10/6.

Auto-transformer, 110 v. 70 watts. 10/6.

250-0-250 80 mA. 6 v. 4 amp., 14/-. Pri. 230 v. Sec. 200-0-200 35 mA., 6 v. 1 amp., 8/6.

Pri. 200/250 v., secondary 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volt at 2 amps., 13/-.

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Semi-shrouded drop thro', 270-0-270, 80 mA., 6 v. 3 amp., 4 v. 1.5 amp., 13/6.

Semi-shrouded drop thro', 270-0-270 60 mA., 6 v. 3 amp., 11/6.

Heater Transformer. Pri. 230-250 v. 6 v. 1½ amp., 6/-; 2 v. 2½ amps., 5/-. 2, 4 or 6 v. at 2 amps., 7/6; 2 v. 2½ amp. and 6 v. 0.6 amp. E.H.T. insulated, 8/6. P. & P. each 1/-.

800-0-800 250 mA., 4 v. 2 amp., 27/6. P. & P. 5/-.

P.M. SPEAKERS (closed field)

	with trans.	less trans.
2½in.	—	15/6
3½in.	—	13/6
5in.	16/6	12/6
6½in.	16/6	12/6
8in.	18/6	15/-

P. & P. on the above 1/- each.
10in. less trans., 21/-. P. & P. 1/6.

R. & A. 8in. M.E. Speaker field coil, 1,600 ohms O.P. trans. 5,000 ohms, imp. 18/6. P. & P. 2/-.

5in. M.E. field coil 750 ohms with O.P. trans., 17/6. P. & P. 1/-.

Extension speaker cabinet, in contrasting walnut veneers, size 15×10½in. Will take 6½ or 8in. speaker. 17/6. P. & P. 2/-.

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

Expanded aluminium speaker fret, 13½×9in. 2/-.

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

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

Twin-Gang .0005 Tuning Condenser, 5/-. With trimmers, 7/6. P. & P. 1/-.

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Twin-gang, .0005 with feet, size 3½×3×1½in., 6/6.

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

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Germanium Crystal Diode, 2/3 post paid.
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T.V. Width Control, 3/6.

USED C.R.T. TUBES. Heater cathode shorts, 9in., 45/-. Ion burn, 9in., 35/-. P. & P. 7/6 each.

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Variable selectivity IF Switch to suit above, 7/6. 465 Kc. I.F.'s to suit above, type 3, 4 and 5, 5/- ea. IFT2 incorporating 465 Kc/s Xtal. 19/6; BFO, 7/6. Special 4-gang, to suit, 15/-

PLESSEY USED AUTOMATIC CHANGER, single speed, in working order, A.C. 200/250 v., magnetic pick-up. 25/5/-. P. & P. 5/-.

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Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/- up to 10/-, 1/6 up to £1, and 2/- up to £2. All enquiries and lists, S.A.E.

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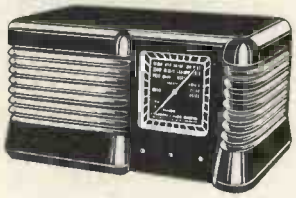

CABINET as illustrated, 11½×6½×5½ in walnut or cream, complete with T.R.F. chassis, 2 waveband scale, station names, new waveband, back-plate, drum, pointer, spring drive spindle, 3 knobs and back, 22/6. P. & P. 3/6.
AS ABOVE but complete with 5in. speaker and O.P. trans. (these speakers have been used but tested O.K.), 30/-. P. & P. 3/6. Metal rectifier 7/6. Gang with trimmers, 7/6. Medium and long T.R.F. coils 5/6. 3 obsolete ex-Govt. valves, 3 v/holders and circuit of an A.C. mains 3-valve plus rec. T.R.F. which can be built for approx. £4, 8/6. Heater trans. 6/-. Volume control with switch 3/6. Wave-change switch 2/-. 32+32 mfd. 4/-. Bias condenser 1/-. Resistor kit 2/-. Condenser kit 4/-.

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3in. P.M. Speaker to fit above, 10/-. Miniature output transformer, 5/-. Miniature wavechange switch, 1/6. Miniature 1-pole 4-way used as Volume and Off, 1/6. 4 B7G valve holders 2/4. Midget twin gang ⅓in. dia., ⅔in. long and pair medium and longwave TRF coils ⅔in. long×⅔in. wide; complete with 4-valve all-dry mains and battery circuit, 8/6. Condenser Kit, comprising 11 miniature condensers, 8/6. Resistor Kit, comprising 16 miniature resistors, 4/-. The above receiver (less valves and batteries) could be built for approximately 51/-. All valves to suit above available. Point to Point Wiring Diagram, 1/-.

G.E.C. USED 30 WATT AMPLIFIER in 2 units (4 K.T.66's in push-pull) complete less valves in very good condition £8/10/-. P. & P. £1.
G.E.C. USED 6 or 12 v. INPUT AMPLIFIER. In oak carrying case, complete less valves (2 K.T.61's in push-pull) in very good condition £7/10/0. P. & P. £1.
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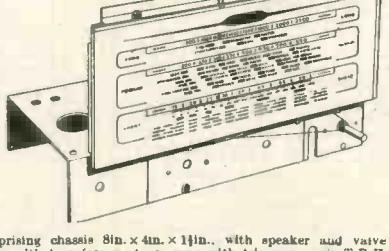
MAINS UNIT comprising chassis 6×4in., fully shrouded mains trans 110/250 input, 32+32 mfd. 350 wkg., U50 rec., octal plug and mains lead. Smoothed output 250 v. 70 mA heaters 6.3 v. 2 amp. 25/-. P. & P. 2/6.
FULLY SHROUDED MAINS TRANSFORMER, input 110/250, sec. 350-0-350 175 mills 6.3 v. 7 amp. 5 v., 3 amp. 35/-. P. & P. 3/-.
FULLY SHROUDED PUSH-PULL TRANS., Pri 6000 ohms sec. 15 ohms (2 6L6's in push-pull) £1. P. & P. 1. 2/-.
FULLY SHROUDED CHOKE 15 Henry 180 mills 15/-. P. & P. 2/-.
FULLY SHROUDED CHOKE 5 Henry 120 mills 8/6. P. & P. 2/-.
These last 4 items by very famous manufacturer.
SPEAKER MATCHING UNIT comprising choke, 2 condensers and chassis size 6×2½in., 3 to 15 ohm. reversible. 12/6. P. & P. 1/6

KIT OF PARTS FOR SIGNAL GENERATOR. Coverage 110 Kc/s.-320 Kc/s., 320 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s. 8.5 Mc/s., 8.5 Mc/s.-20 Mc/s., metal case 10in. ×6½in.×4½in., size of scale 6½in.×3½in., 2 valves and 1 rectifier valve, A.C. mains 230/250. Internal modulation 400 c.p.s. to a depth 30 per cent. Frequency calibration accuracy plus or minus 1 per cent. Modulated or unmodulated R.F. output continuously variable 100 millivolts, £3/10/-. P. & P. 4/-. This includes the return to us for checking and calibration. We will build same for 15/- extra. Circuit and point-to-point wiring diagram, 3/6. Kit of parts for above, less checking and calibration, £3, plus 2/6 P. & P.

CONSTRUCTOR'S PARCEL, comprising chassis 12½×8×2in., cad. plated 18 gauge, v/h., IF and trans. cut-outs, back-plate, 2 supporting brackets, 3 waveband scale, new wavelength station names. Size of scale 11½×4½in., drive spindle, drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin international octal valve holders, 4 knobs, and pair of 465 IFs. 16/6. P. & P. 1/9.
AS ABOVE, but complete with 16+16 mfd. 350 wkg. and semi-shrouded drop thro' 250-0-250 80 m/a., 6 v. 3 amp. Pri. 200-250, and twin-gang 31/6. P. & P. 3/-.



CONSTRUCTOR'S PARCEL comprising chassis 8in.×4in.×1½in., with speaker and valve holder cut-outs, 5in. P.M. speaker with transformer, twin gang with trimmers, pair T.R.F. coils long and medium, four valveholders, 20 K. volume control and wave-change switch 23/-. P. & P. 1/6.
CONSTRUCTOR'S 3-VALVE T.R.F. PARCEL. Comprising chassis, L. and M. coils, gang, pot., switch, resistor and condensers, heater trans., v/holders, smoothing and bias condenser, 4 ex-Govt. obsolete valves, speaker and O.P. trans., choke, with circuit, 37/6. P. & P. 3/-.
465 KC. MIDGET I.F.s. Q 120, size 1½in. long, 1in. wide, ⅔in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair 12/6.

R.I. MAINS TRANSFORMERS, chassis mounting, feet and voltage panel Primaries 200/250.
300-0-300 60 mA. 6.3 v. 1 a., tapped at 4 v. 6.3 v. 2 a. tap 4 v., 13/6.
350-0-350 75 mA. 6.3 v. 3 a. tap 4. v. 6.3 v. 1 a., 13/6.
350-0-350 120 mA. 6.3 v. 3 a. tap 4 v., 5 v. 2 a. tap 4 v., 25/-.
350-0-350 70 mA. 4 v. 5 a. 4 v. 2.5 a. C.T., 18/6. P. & P. on the above transformers 2/-.
500-0-500 125 mA. 6.3 v. C.T. 4 a. 6.3 v. C.T. 2 a. 5 v. C.T. 2 a., 27/6.
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. 5 a. 4 v. C.T. 5 a. 4 v. C.T. 4 a., 39/6.
500-0-500 250 mA. 6.3 v. C.T. 4 a 6.3 v. C.T. 3 a. 5 v. C.T. 3 a., 39/6.
P. & P. on the above transformers 3/-.

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32 mfd., 350 wkg.	2/-
16×24 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
40 mfd., 450 wkg.	3/6
16×8 mfd., 500 wkg.	4/6
16×16 mfd., 500 wkg.	5/9
8×16 mfd., 450 wkg.	3/9
32×32 mfd., 350 wkg.	4/-
32×32 mfd. 350 wkg. and 25 mfd., 25 wkg.	6/6
25 mfd., 25 wkg.	11d.
250 mfd., 12 v. wkg.	1/-
16 mfd., 500 wkg., wire ends	3/3
8 mfd., 500 v. wkg., wire ends	2/6
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
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Ex-Govt. 8 mfd., 500 v. wkg., size 3½×1½, 2 for	2/6
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8 mfd., 150 wkg.	1/6
60+100 mfd., 280 wkg.	8/6
50 mfd., 12 wkg.	11d.
32+32 mfd., min., 275 wkg.	4/-
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Miniature wire ends moulded 100 pf., 500 pf., and .001 ea... 7d.
Combined 12in. mask and escutcheon in lightly tinted perspex. New aspect, edged in brown. Fits on front of cabinet. 17/6. P. & P. 2/-.

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Smoothing Choke, 2 henry 150 mA., 3/6. 250 mA. 4 henry, 5/-; 250 mA. 10 henry, 10/6; 250 mA. 8 henry, 8/6.

P.M. Focus Unit for any 9 or 12in. tube except Mazda 12in., with Vernier adjustment, 15/-. P. & P. 1/6.

P.M. Focus Unit for Mazda, 12in. with Vernier adjustment 17/6. P. & P. 1/6.

Wide Angle P.M. Focus Units, vernier adj., state tube, 25/-. P. & P. 2/-.

Energised focus coil, low resistance mounting bracket 17/6 plus 2/- P. & P. Scan Coils, low line low impedance frame, complete with O.P. transformer, 17/6. P. & P. 2/-.

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

465 Kc. I.F.s, size 2½×1½in. Q.110 removed from American equipment, 5/- per pair. Standard 465 Kc. iron-cored IFs. 4×1½×1½in., per pr. 7/6. Wearite standard iron-cored 465 Kc. IFs, 3½×1½×1½in., per pr., 9/6.

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

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., 4/9. 42-1 with extra feed-back windings, 4/3. Miniature 42-1, 3/3. Multi-radio 3,500, 7,000 and 14,000, 5/6. 10-watt push-pull, 6V6 matching, 7/-.

PUSH-BACK CONNECTING WIRE. Doz. yds. 1/6. post paid.

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NEW RECEIVERS AND AMPLIFIERS

12-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co., Ltd., Tomb and, Norwich. [0065

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C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., Bickford Rd., Witton, Birmingham, 6 (Eas. 0435), the Midlands specialist manufacturers of high fidelity sound reproduction equipment for the world-famous Williamson amplifier and associated accessories including tone control stages, loudspeaker crossover units, distortionless contrast expenders and radio feeders; send for details and prices. [0105

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

PYE 39 J/H chassis, 8-valves, eleven waveband, 9 watts output, band spread tuning, less speaker; £21.—Box 8367. [1548

SOUND sales DX Plus Seven receiver, perfect condition, complete spare set valves; £17.—Keen's, Sycamore Rd., Amersham, Bucks. [1640

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

AR 88 D 540 Kc to 32 Mc/s, excellent condition; delivery free London area; £55.—A. J. Whittemore (Aeradio), Ltd., Croydon Airport, Surrey. Cro. 5791. [1623

G.E.C. BRT 400D 14-valve receiver (new price £183). £100; Hallicrafter SX28 15-valve receiver, £60, perfect condition.—Blackwell, 41, Meadway, Old Southgate, London, N.14. [1634

EDDYSTONE 9-valve intercommunication receiver for sale, recently overhauled, for sale with loudspeaker; £30, or nearest offer.—Perkins, Railway Dock Hotel, Rodwell Avenue, Weymouth. [1588

ACOUSTICAL Q.A.12P amplifier and tuner, £30; tape record/replay amplifier, 6-watt output with separate power pack, £40; Decca-lian 2-speed player, £20; Connoisseur motor, 2-speed, £12; Birmingham area.—Box 8765. [1611

LOUDSPEAKERS—SURPLUS AND SECONDHAND

BARKER 148a speaker 12in. perfect, bargain; £8.—Box 8543. [1561

GOODMANS Audiom 80 25 watt 15in loudspeaker, new March, 1953; £16/10.—1, Herbert St., Hemel Hempstead, Herts. [1569

NEW TEST EQUIPMENT

MINIATURE test oscillator, 6in×4in×2¾in, mains driven, hand calibrated, 8/16Mcs, 40/80Mcs, 80/160Mcs (Har), VHF bands FM 50cs mod, or 400cs AM; other bands to order; send for free leaflet, s.a.e. please.—BEL, Marlborough Yard, N.19. Arc. 5078. [0187

TEST EQUIPMENT—SURPLUS AND SECONDHAND

E.M.I. T.V. signal strength meter Q/D151, £50; Ekco pattern generator, TSE/L, £12/10.—Barrett, 110, Charminster Rd., Bournemouth. [1627

OSCILLOSCOPE, industrial electronics, 1200B. X and Y D.C. amps., with instruction book, as new, seen London, listed £33; offers over £16; also advance constant voltage trans., type 267, 230 V, 250 W, offers.—Box 8801. [1626

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

from a range of over

100

STANDARD TYPES

Illustrated are some of the mountings available in the comprehensive range of Partridge Transformers and Chokes. These illustrations are extracted from our 1953 PRICE LIST of over 100 Standard types that are

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All these models are covered by a 12 months' guarantee and provide an assurance of long-life high efficiency.

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CHAS. F. WARD, Lordscroft Works, Haverhill, Suffolk. Tel. 253. [0039

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SEND p.c. for full description and photographs.
ALSO above plant fitted Lister slow-speed water-cooled diesel and electric flywheels.
ALTERNATORS, 230/1/50, 400VA, self-energized, 3,000rpm, ball bearing, £23/15 del.; also special television model same price; voltage regulator 30/- extra.
J.A.P. No. 2A 1.2hp petrol engine, air cooled, 4-stroke, starting rope, tools; £17/10 delivered for above alternators.
SPECIAL rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb d.c. input, 12v 200ma out, 24v 75v, 50v, 110v, 230v d.c. to 230v out, 250va, £28/10 del.; also converters for radiogram and general use, inputs, outputs and prices as above; the above also supplied without smoothing, £25 del., immediate despatch; trade supplied.
AT a purchaser's home 60 mls. S.W. of Sutton Coldfield a 24v
TELEVISION converter was tested on Ekco television, 12in tube, stated consumption 135watts, d.c. current from battery only 9½amps, picture and sound were perfect and completely free of interference or flutter.
THE above are the latest products of British manufacture, and are guaranteed for one year; fullest details of plant, alternators or 400VA alt. or rotary converters, by return post; state which required; terms c.w.o., pro forma invoice c.o.d. (post goods only).
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H.F. alternators, 80v, 25a, 1,500 cycles; also hot wire ammeters, 0-1, 2 amps.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [1613

NEW GRAMOPHONE AND SOUND EQUIPMENT

RECORDING equipment to the trade.
WEARITE tape decks and special parts, disc recording machines.
BLANK discs Scotch-boy tape, Emitape.
RADIO feeder units, microphones, etc
ALL from stock.—Sound Discs (Supplies), Ltd., 178, Bispham Rd., Southport, Lancs. [1087

MAGNETIC recorders, all types, new and secondhand for sale; hire service in greater London area only; mechanical and electronic repairs carried out by specialists; "Magnegraph" limpet telephone pick-ups, suitable for all types of recorders, 25/-; tape storage racks for 12 reels, 37/6; B. & H. recording wire, new and used, from 15/- reel; tape, accessories, etc.; full details, s.a.e.—The Magnegraph Recording Co., Ltd., 1, Hanway Place, W.1. Tel., Langham 2156. [0236

FOR SALE AND WANTED ADVERTISEMENT FORM

TURN TO PAGE NO. 153

NEW GRAMOPHONE AND SOUND EQUIPMENT

TRUVOX desk, quality 4½watt amplifier with meter (as below), 5in L/S in portable cabinet; £57.
WEARITE tape decks 2A, £35; super 12 watts p.-pull amplifiers to suit (Partridge output trans.) freq res. 20-20,000c/s, miniature valves, m. eye level ind. response from tape 30-13 Kc/s at 7½in p.s.±3db, £30; 9 watts model. £25; quality 4½ watts (EL41) junior, with meter level ind. 'phone monitoring, minature valves, 21gns; amps to suit Bradmatic, £30; for Truvox, Lane, M. Master, Motek, etc., 18gns 9watts. p.-pull. or built to order; all tape desks supplied, prompt delivery.—Harding Electronics. 120a, Mora Rd., London, N.W.2. [1400

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., manufacturers of high quality portable and console magnetic tape recorders for professional and amateur use; full details on application.
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CINE-VOX disc recording equipments, type C7J for high-quality recordings from existing microphone equipment, price from 28gns; also available as a complete channel inclusive of mic., amplifier and playback equipment, at 70gns; type C7, for highest quality professional requirements—recorder mechanism at 48gns, or complete channel at 110gns; demonstrations arranged in London.
PLEASE write for details to K.T.S., Ltd., 60, Aylward Rd., London, S.W.20 (Liberty 2426.) Callers by appointment only. [0209

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECONDHAND

TAPE recorder, Scophony Baird, as new; £35. —Rous, 14, Percy Rd., N.W.6. [1610

TAPE recorder, Wearite, new machine; perfect recording of speech, gram. and radio; £65 or near offer.—Box 8705. [1601

GRUNDIG two-speed reporter as new, complete tape, mike, list £84; £65.—Taylor, 125, Manchester Rd., Denton, M/C. [1629

QUALTAPE new, principle desk as new, £12; amplifier and desk if required.—Carter, 38, Gascoigne Gdns., Woodford Green, Essex. [1552

C.D.P. disc recorder, excellent reproduction, fitted with playback pickup modulation meter, swarf brush, etc.; £23.—Bartlett, 50, Kimberley Rd., Southbourne. [1622

ASTRA 7-valve elec. gramophone, bass and treble controls, sep. loudspeaker, mahogany case, perf. condition; cost £60.—Offers to Dewar, Shielling, Kingswood Warren, Tadworth, Surrey. [1643

2250ft Bradmatic-C.J.R. recorder, Charles preamp, Baker speaker, cabinet, MSS blanks, Acos cutter, S.T.C. ball mike; wanted, Baird recorder, ribbon mike.—"Gables," Edward Rd., B'heath, B'ham. Woo. 3557. [1639

VALVES WANTED

45/- paid for new boxed 813s, 20/- for TZ40s, 24Gs, 811s; send details other surplus valves.—Box 8242. [1515

NEW COMPONENTS

CRYSTAL microphone inserts (Cosmocord Mic—6), guaranteed brand new; 15/6 post free; Cosmocord mic., 30 hand stand microphones, black or white, £4/4 each, post free. RADIO-AID, Ltd. (Retail Dept.), 29, Market St., Watford. [0036

FLUORESCENT 80-watt choke 230v with starter lamp, 14/6; battery chargers, 6v and 12v 4 amps meter guaranteed, 67/6; rotaries for car radio, 12v d.c. to 250v, 9/8; metal rectifiers, 12v 3 amp, 12/9; cable twin tough rubber 3.036, 50yd, 45/-.—Malden Transformer Supplies, Rear 2, Coombe Rd., New Malden, Surrey. Mal. 2655. [0033

TELEVISION.—Latest type canned cored ⅜X⅜in screened formers, short and long (1½ & 2½), 2/3 ea.; used on Tele-King, PT, and channel 3 convertor; wound coils for latter 25/-, FM feeder coilsets 75/-; highest Q potcoils to order; filter elements, toroids and general lab. coils, resistors.—BEL, Marlborough Yard, Archway, N.19 (trade supplied). [0186

FOR really good results you can do no better than use Osmor coils and coilpacks, ask anyone of experience! Send 5d (stamps) today for beautifully-drawn free circuits, our new coildata leaflets, and latest lists of matched radio components. A speedy mail order department is at your service, and remember, all Osmor lines are guaranteed. (Trade enquiries invited.) Dept. C.W.1.
OSMOR RADIO PRODUCTS, Ltd., Bridge View Works, Borough Hill, Croydon. Tel. Croydon 5148-9. [0046

CABINETS

LEWIS RADIO have the best selection and finest finish.—See page 78. [0224

WALNUT radiogram cabinets; details.—Cabinetware, 1a, Heyes St., Blackburn. [0091

WALNUT radiogram and television cabinets, soundly constructed; stamp for details.—R. Shaw, 69, Fairlop Rd., Leytonstone, E.11. [1497

COMPONENTS—SURPLUS AND SECONDHAND

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. ELECTROLYTICS, capacity, voltage, size, type of mounting, price post paid, in that order: 400, 6v, 1×2in, lug, 2/3; 250+250, 6v, 1×2in; lug, 2/6; 500+500 6v, 1×3in, lug, 2/6; 40+40, 150v, 1¼in×2in, clip, 3/-; 40, 150v, 1×2in, clip, 2/6; 20+20, 275v, 1×2in, lug, 3/6; 16+32, 275v, 1×2in, lug, 3/6; 16+16, 275v, 1×2in, clip, 3/6; 32+32, 275v+50mf 25v, 1×3in, lug, 4/-; 60+100, 275v, 1⅜×3in, lug, 5/6; 100, 275v, 1⅜×2in, clip, 3/9; 32+12, 350v, 1⅜×2in, clip, 4/6; 16+16+16, 350v, 1⅜×2in, clip, 5/-; 40+40+20, 350v, 1⅜×3in, lug, 5/-; 16, 350v, ¾×2in, lug, 2/-; 40+40, 300v, 1×3in, lug, 4/-; 10, 450v, ¾×2in, lug, 2/-; 16, 450v, ⅞×2in, 3/-; 20, 450v, 1×2in, lug, 2/9; 32, 450/525v, 1⅜×2in, clip, 4/-; 32+32, 450v, 1⅜×3in, clip, 5/6; 30+30, 450v+20mf 25v, 1¾in×3in, lug, 5/6; 15+15, 450v+20mf 25v, 1¼×3in, lug, 5/3; 200, 6v, ⅝×1¾in, clip, 2 -; 100, 12v, ¾×1½in, wire, 1/9; 8, 450v, 1×2in, clip, 2/3; 50, 12v, ¾×1⅝in, wire, 1/6; 150, 25v, ¾×1¼in, clip, 2/-; 250, 12v, ¾×1¼in, wire, 2/3; 350, 25v, 1×2¼in, clip, 2/6; 16+16, 450v, 1¼×2in, clip, 4/-; 40+40, 275v, 1⅜×2in, clip, 3/6; 16+32, 450/525v, 1⅜×2in, clip, 5/6; 24+24+16, 350/425v, 1⅜×2in, clip, 4/9; 60+200, 275/350v, 1⅜×4¼in, clip, 6/6; 4, 150v, ⅝×1¾in, clip, 1/1; 60+100, 350/425v, 1⅜×4½in, clip, 6/6; 500, 12v, 1⅜×2¾in, clip, 2/-; 8, 350v, ¾×2in, 2/-; 6,000, 12v, 1⅜×4⅛in, lug, 4/6; 100+200, 275/350v, 1½×4½in, 6/6; 100+175, 275/350v, 1⅜×4½in, clip, 6/6; 8+16+16, 450/525v, 1⅜×2in, lug, 5/9; 32+32, 350/425v, 1⅜×2in, clip, 5/-; 2,000, 6v, 1×3in, clip, 3/-; 8+16, 450/525, 1×2in, clip, 4/-; 2, 450/525v, ¾×1¾in, tag, 1/6; 2, 350v, ¾×1¾in, tag, 1/3; 8, 350/425v, ¾×2in, clip, 2/-; 16+32+8, 450v, 1⅜×3in, lug, 5/6; all are all cans, some with sleeves. ALL new stock, all voltages WKG, with surge v where marked; trade supplied most types.

TELEVISION! Set of 3 components, comprising line output trans., with E.H.T. winding to give 7kV, using EY51 (heater winding for EY51 also included), and fitted with width control scanning coils, low impedance line and frame, focus coil (res. 10,000Ω, current approx. 20 mA); the set of 3 for 42/-, plus 2/- post. diagram of line trans. supplied.

PERSONAL receivers, 3 valve T.R.F. using 1T4s, contained in handsome bakelite case with lift-up lid, size 7×6½×5in with lid closed, plastic carrying handle, fram. AE in lid, these receivers cover the medium waveband and operate from self-contained dry batts., standard types. W1435 and U2, output to a pair of lightweight 'phones (H.R.) controls, SM tuning and reaction, opening lid switches on, supplied brand new, with valves, batteries, 'phones, an ideal set for invalids hosp. patients, etc., these receivers are not Govt. surplus and are offered ready to play; carr. paid: £4/10.

UNIVERSAL amplifiers, 8-valve 20watt A.C./D.C., black crackle chassis, and black and chrome cover, overall size 15½in×7½in×7in. First-class components (Partridge O.P.T., and driver, Gardner choke, A.E.E. Mu-Metal input trans. for mike) Valves 2×EF37, 4×CL33, 2×UR3C. Switched input for high or low imp., top cut and bass cut switches, V.C., mains switch, mains plug and socket. 220-250v, isolated chassis, 15Ω output. Wired and tested, ready for use, with valves, brand new, £10/19/6, carr. paid. T.V. control panels, 5 adjustable res. on pax. panel 4in×3in, 3 wire wound (1K, 5K, 10K), 2 carbon (50K), Welwyn res., slider type, complete with slider knobs, 6/- each, post paid.

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

MIDGET portable radios, a.c./d.c., two wave, completely self-contained, cream or brown plastic, work anywhere without external aerial, giving good quality and volume, full maker's guarantee, £6/19/6; battery, ditto, all dry, less batts., £6/19/6; trade enquiries invited.

VALVES at 2/-: VR21, 12H6; at 2/6: CV1929, VR109, VU120; at 3/-: CV1931, DET19, CV1051; at 3/6: 2C26, CV535; at 4/-: 2X2, CV1932, 1625, ARDD1, ARDD5, CV1037, VR56; at 4/6: CV1934, CV1941, CV595, 12SC7, CV544; at 5/6: 6AG5, 6B4, CV581, CV1943; at 6/-: 1G6, 3B7, CV1893, CV1074, CV1981, OZ4, CV1732, CV1035, CV1103; at 6/6: 6F8, CV885, 30, 61P; at 7/-: CV1758, CV785, CV1268, CV1186, 6L7, 6N7, 6SC7, CV1993, CV510, CV574, CV522, CV887, CV1777, CV895, CV899, CV901, 12SR7, CV616, 807, CV2999, VR55, 6K6; at 7/6: 1P5, CV575, CV1864, 6Z4, CV1328, CV552, 38, 41, CV561, CV571, 1203A, VR57; at 8/-: CV729, CV1945, CV1985, 6SA7, 7A4, CV882, CV891, CV900, CV455, CV703, CV617, 1619, CV1457; at 8/6: CV531, 6F7, CV588, 6U4G, 12AH7, CV547, CV549, CV2500; at 9/-: CV579, CV1948, CV1988, CV491, 1622; at 10/6: CV1419, CV618; at 12/-: CV1851, 5Y4, CV614; at 13/-: 6C8; all guaranteed; post 6d each; no c.o.d. under £1.

RADIO FACILITIES, Ltd., 38, Chalcot Rd., N.W.1. Primrose 9090. [1648

SPECIAL valves, type 807, brand new, 7/9 each; type 196 unit, brand new, less valves, 22/6; mains trans., 350-0-350, 6v, 5v, 4v, 4v, 80ma, 19/6; Wey-Rad 465kcs I.F. trans., 8/3 pair; midget 465kcs, 9/6 pair; loudspeakers, 3½in, 11/6; 5in, 11/6; 6in, 12/6; 10in, 19/6; fil. trans., 6.3v at 1.5amp, 5/9; metal recs., RM1, 4/6; RM2, 4/9; RM4, 15/6; v/controls, semi-midget, all values, 3/-; SP/sw, 4/6; DP/sw, 5/6; electrolytics, 450vw, 8mfd, 1/3; 16mfd, 2/6; 8×16, 3/6; 16×16, 4/3; 32×32, 4/9; 500vw card tub, 8mfd, 2/6; 16mfd, 3/-; 8×16, 3/9; 32mfd, 3/9; stock list available.—Radio Unlimited, Elm Rd., London, E.17. Key, 4813. [0062

COMPONENTS—SURPLUS AND SECONDHAND

MARCONI C.R.100 C.R.T.'s and other components; s.a.e. list.—Box 8769. [1618

G. A. RYALL, "Utopia," Mayfield Rd., Herne Bay (Kent); please refer to previous adverts. [0205

SUPREME RADIO, 746b, Romford Rd., Manor Park, London, E.12. Tel. Ilf. 1260. Est. 17 yrs.
FOR "Supreme" value at the right price you want "Supreme Radio."
ELECTROLYTIC condensers: 16+16mfd 350v, all. can small type, 2/3 ea.; 32+32+16mfd 350v, small metal can type, 3/6 ea.; 16+8mfd 450v, 4/9 ea.; 60+150mfd, 275 d.c. wkg., 4/11 ea.; 200+200mfd 25v, 1/- ea.; tub./cardboard cond., 8mfd 500v, wire-end, small, 2/9 each; 100mfd 12v tub. cardboard w/end bias cond., 1/6 ea.; metal tag end, 25mfd 25v cond, 1/3 ea.
HEATER trans.; Primary 0-250v, sec, 6.3v at 1.5amp, 5/11 ea.; or 6.3v at 3amp, 8/11 ea.
SMALL type vol. controls with long spindle and d/p switch, 1meg or ½meg, cannot repeat, 3/- ea.
METAL rectifiers: RM2 4/3, RM1 3/11, RM4 18/- ea.
SMASHING bargain line: Mains trans. by "Parmeko," universal fixing, primary tapped, 0-200-220-240v sec., 290-0-290v 80m/a, 6.3v 3amp and 6.3v tapped at 4v 2amp, with screen, our price 15/11 ea. incl. post and packing.
TWIN balanced feeder, 80ohm, for television, our price 4d pr. yd.; wire-end crystal detector diodes, our price 2/3 ea.; complete with crystal set circuit.
MANY other bargain lines in stock.
TERMS, c.w.o., no c.o.d.; send 9d extra for postage orders under £5; 2½d s.a.e. all enquiries and list. [0021

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street London, W.C.2. See our displayed advertisement, page 105. [0016

TRANX No. 1083, less valves, coils, 22/6; RF27, less dial, 25/-; Recorder camera, 23/-; bombsight computer Mk 14A, 60/-; Blowers 24v 12/6; P.V.C. 1,000yds., 35/-; power units No. 33B (24v), 35/-; No. 320 (24v), 17/6. 100 MicroA 2in meters, 35/-; 14A 5in meters, 16/-; 1½-metre responsers, 50 cycle power pack, complete, 63/-; 4-valve welfare MW batt. recr., 40/-; control box No. 227, 4/-; Rem con. No. 223, 5/-; all carriage free; hundreds other bargains; quantity reductions; free lists.—Annakin, 25, Ashfield Place, Otley, Yorks. [1602

WANTED, EXCHANGE, ETC.

VHF test equipment.

TS47AP, TS174, TS175/U, TS148 or TSX-4SE; analysers; BC221 freq. meters, TS69, and any U.S.A. test gear; Klysrons type 723/AB, 2K33 2K39 2K41; receiver, APR4 and units TN16 17-18-19; RCA AR88D, S27 and SX28s and S27CA; microwave equipment; highest offers given by return.—Ger. 8410. Universal Electronics, 27, Lisle St., Leicester Square, London, W.C.2. [0229

45/- each offered for 813 type valves.—Write Box 7050. [1073

WANTED, service data sheets Ultra 12in TV/radio model Y7216.—Box 8816. [1642

MARCONI TF144G signal generator wanted; send price and details to—Box 8426. [1558

WANTED, Wilcox Gay V.F.O. units in new or modified condition.
McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9. [0194

WANTED, receivers A.P.R.4, also T.N. 16, 17, 18, 19, etc., and any radio test gear.
LESLIE DIXON & Co., 214, Queenstown Rd., Battersea, S.W.8. Macaulay 2159. [0176

WANTED, RCA 4331 transmitters.—P.C.A. Radio, Cambridge Grove, Hammersmith, W.6. Tel. Riverside 3279. [0093

WANTED, R.C.A. transmitters, all types or any R.C.A components, including chassis and metal work.
McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9 [0196

WANTED Leak amplifier and tuning unit or similar high quality equipment; also acoustical corner ribbon speaker.—Box 8704. [1600

WANTED. TCS/6 or TCS/12 transmitters in mint condition; also control boxes for same.
McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9. [0195

WANTED, HRO coils, Rxs, etc., A.R.88s, BC348s, S27s, etc.—Details to R.T. & I. Service, 254, Grove Green Rd., London, E.11 Ley. 4986. [0163

WANTED, laboratory test equipment, including standard signal generator, watt meter, oscilloscope, bridges, recorders; send price and details to:
Hanwell. W.7. Tel. Ealing 0779. [0037
HATFIELD INSTRUMENTS, 175, Uxbridge Rd.,

WANTED, EXCHANGE, ETC.

WANTED for Cathode Roxy oscillograph, type G.M. 3156 (year 1945), tube No. A41-G4, or A41-N4, or A41-B4.—Reliance Radio, 20, Patrick St., Dun Laoghaire. [1612

WILL buy first-grade variable condenser similar to Muirhead A411 or General Radio 222L; state price.—29, Rooley Cres., Bradford [1603

WANTED, power supply units for No. 33 transmitters (Z.A. 10729); call or ring.—P.C.A. Radio, The Arches, Cambridge Grove, W.6. Riv. 3279. [0081

WANTED, set manufacturers' or ex-Government radio equipment, large or small quantities of valves, electrolytics, speakers, meters, also components.
LOWE BROS., 5, Fitzroy St., London, W.1. Tel. Museum 4389. [9745

WANTED, BC-610 Hallicrafters, R.C.A. ET-4336 transmitters SX-28, AR-88; S-27 HRO receiver and spare parts for above; best prices.—P.C.A. Radio, The Arches, Cambridge Grove, W.6. [0080

WANTED, R.C.A. speech amplifiers, type MI-11220 J or K and Ariel tuning units BC 939A; offers stating quantity and price to —P.C.A. Radio, The Arches, Cambridge Grove, W.6. [0079

WE purchase all types of domestic or ex-Government radio receivers and equipment; send full details or call and collect cash; large or small quantities.—Walton's Wireless Stores, 48, Stafford St., Wolverhampton. [0146

ALTHAM RADIO Co. pay highest prices in the trade for all American equipment, including test sets, transmitters, receivers, teleprinting gear, etc.—Jersey House, Jersey St., Manchester, 4. Tel. Central 7834-5-6. [0228

WANTED, AN/APR-4 receiver, any units; any other good quality U.S. surplus radio and radar tubes, test sets; laboratory equipments, etc.; give condition and price in first letter.—Engineering Associates, 434, Patterson Rd., Dayton, 9, Ohio, U.S.A. [0234

WANTED, good quality communication rxs., domestic radios, test equipment, etc.; top prices paid; established since 1937.—Miller's Radio, 38a, Newport Court, 1 min. from Leicester Sq. Tube. Tel. Ger. 4638. Call, write or send. Hours of business 10-6 p.m. Open all day Saturday. [0199

WANTED; we will pay 10% more for the following American equipment; test sets with TS prefix, BC221, APR4 receivers, APR4 tuning units, BC342, BC312, power units No. 15 and PE98, teleprinter equipment.—Altham Radio Co., Jersey House, Jersey St., Manchester, 4. Tel. Central 7834-5-6. [0227

REPAIRS AND SERVICE

ARMATURE Re-winding Service to the Trade.

VACUUMS, drills, grinders, hood dryers, dental motors, vacuum cleaner armatures replaced from stock; 24-hour service; every job guaranteed; all vacuum cleaner parts, hoses, etc., in stock for any make.
REGAM ELECTRIC, 95, Park Lane, Leeds, 1. [1573

ANNOUNCING a 48-hr transformer rewind serivce—with a difference.
A FIRST-rate job for a first-rate engineer.
E.H.T.s, Mains, Fields, O.P.s, etc.
NEW transformers made to suit your requirements, designed on "C" core or conventional methods.
WILLIAMSON'S O.P. to original spec.; 80/-.
ALL work fully guaranteed.
WOODROW Transformers, Ltd., 28, Balmoral Rd., Willesden, N.W.2. Tel. Willesden 2014. [1628

MAINS transformers rewound, new transformers to any specification.
MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed.
F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 3855. [0113

REPAIRS.—E.H.T. mains and O.P. transformers, field coils and chokes; also armatures and motors; new transformers designed to any specification; all work fully guaranteed.
WILLESDEN TRANSFORMER Co., Ltd., 2a, Frithville Gdns., Shepherds Bush, London, W.12. Tel. Shepherds Bush 5819. [0076

MAINS transformers, E.H.T. line outputs, chokes and field coils, etc., promptly and efficiently rewound or manufactured to any specification; 12 months' guarantee.
LADBROKE REWIND SERVICE, Ltd., 820a, Harrow Rd., Kensal Rise, N.W.10. Lad. 0914. [0222

TRANSFORMERS.—Mains, EHT, OP and chokes rewound and redesigned to specification, new transformers constructed to your requirements; all items vacuum impregnated; impregnation to RCS 214 if requested.
RADIO, Electronic & Industrial Rewinds, Rear, 21, Church Lane, N.W.10. Willesden 2733. [1608

MOTORS and armatures, all types (vacuum cleaners to 100hp), rewound or rebuilt as new; quick, reliable and competitive service; contractors to leading users since 1920; quotes by return.—Halsons, Dover Rd. Works, Blackpool. Tel. 24774. [1535

REPAIRS AND SERVICE

ELECTRICAL test instruments repaired and standardized, all types British or American, ammeters, voltmeters, ohmmeters, DC/AC multi-range meters, etc.; meters converted to specification. THE ELECTRICAL INSTRUMENT REPAIR SERVICE, 329, Kilburn Lane, London, W.9. Tel. Lad. 4168. [1134

REWINDS and conversions to mains and output trans, pick-ups, fields, clock, coils, etc., from 4/6, P.P. equipment a speciality; all work guaranteed.—N. L. Rewinds, 32, Blackbird Hill, N.W.9. Tel. Wordsworth 7791. [1614

24-HOUR service, 6 months' guarantee, any transformer; rewind, mains outputs and i.f.s., etc.; all types of new trans., etc., supplied to specification; business heading or service card for trade prices.—Majestic Winding Co., 180, Windham Rd., Bournemouth. [6520

AS professional sound recordists and members of the Association of Professional Recording Studios, we are particularly well qualified to give advice and service on all aspects of sound recording and reproduction. Design of tape equipment a speciality. Circuits designed, repairs and modification carried out quickly. Advice freely given. See also below:—COMPREHENSIVE service to trade and amateur; design, manufacture and repair of electronic equipment carried out by specialists; equal attention given to small or large orders. See also below:—Autochangers, 48-hour service, cleaning and adjusting at fixed price of 35/- plus carriage; also all repairs carried out; trade enquiries invited.—Ariel Sound, 57, Lancaster Mews, London, W.2. Tel. Paddington 5092 (2 lines). [1630

MISCELLANEOUS

FOR sale, Douglas No. 3 motorised coilwinder complete; offers.—Box 8425. [1557

ELECTRIC welding plant, used and unused for sale; s.a.e. for lists.—Harmsworth, Townley & Co., 1, Brook Rd., Manchester, 14. [1040

PLYWOOD, hardwood, free list on request, mahogany ply, 12/6 sheet; oak ply, 22/6.—N. Gerver, 10, Mare St., Hackney, London, E. [1432

CABLES, wires and flexibles, P.V.C. covered, at clearance prices.—R. Lowther, Ltd., 100a, St. Vincent St., Ancoats, Manchester, 4 [0223

METALWORK, all types cabinets, chassis, racks, etc., to your own specifications; capacity available for small milling and capstan work up to 1in bar. PHILPOTT'S METAL WORKS, Ltd., (G4BI), Chapman St., Loughborough. [0208

A HIGH vacuum impregnation unit to R.I.C. specification 214 or individual requirements; good delivery at competitive prices from Blickvac Components and Assemblies, 505, Lordship Lane, S.E.22. Forest Hill 7089. [0310

YOUR own tape recording transferred to disc. —Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay 4992. Studio recordings, tape recording service. Price list on request. [1409

PLATED nuts, screws, washers, bolts, soldering tags, hank-bushes, self-tapping screws, grub-screws, socket-screws, wood-screws; large quantities or gross cartons; stamp for list.—Sinden Components, Ltd., Dept. B, 117, Churchfield Rd., Acton, W.3. Acorn 8126. [1415

ENGRAVING amateurs and trade could take the opportunity of engraving problems in the future by getting in touch with A.G. Engraving, 19a, Windmill Rd., London, S.W.18. Bat 5793. Brass, bronze, erinoid, Perspex dials; one knob or repetition equally entertained. [0034

COPPER wires enamelled, tinned, Litz, cotton, silk covered, all gauges; B.A. screws, nuts, washers, soldering tags, eyelets, ebonite and laminated bakelite panels, tubes, coil formers; Tufnol rod; headphones, flexes, etc.; latest radio publications, full range available; list, s.a.e.; trade supplied.—Post Radio Supplies, 33, Bourne Gardens, London, E.4. [0138

DECALS labels for marking radio and electronic equipment, clear permanent lettering 1/8in high, no background, easily applied, permanent, Govt. approved; available in book form, each book containing approx. 750 titles, covering all aspects of radio and electronic equipment; price 4/9 plus 3d post, in black or white.—Alexander Equipment, Ltd., Childs Place, Earls Court, London, S.W.5. [0243

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

GUIDED weapons.

ELECTRICAL engineer, or mathematician with relevant post-graduate experience, required for theoretical work on design of automatic control systems; some knowledge of effect of noise on servo-mechanisms an advantage; senior staff appointment with good salary and prospects; pension scheme.—Write in detail to Personnel Manager, de Havilland Propellers, Ltd., Hatfield, Herts. [1353

SITUATIONS VACANT

ELECTRICAL Engineers.

WAYMOUTH Gauges & Instruments, Ltd., a subsidiary company of Smiths Aircraft Instruments, Ltd., have vacancies in their Aircraft Fuel Gauge Laboratory for Assistant Engineers, required for development of electronic fuel gauging equipment. They should have an engineering degree or Higher National Certificate. Technical Assistants are also required for experimental work in electrical measurements; preference will be given to applicants holding a technical qualification.—Apply in writing to the Chief Development Engineer, Waymouth Gauges & Instruments, Ltd., Station Road, Godalming, Surrey. [1498

WAYNE KERR have the following vacancies:

(A) MICROWAVE engineer to work on the design and development of X Band and associated equipment.
(B) JUNIOR engineers and technical assistants to take part in circuit design and development of test equipment ranging from Audia to S Band.
APPLICANTS for post (a) should be to B.Sc. standard and be familiar with microwave theory.
APPLICANTS for post (b) should be to H.N.C. standard; consideration will be given to applicants with considerable practical experience who have not achieved these qualifications.—Write to The Wayne Kerr Laboratories, Ltd., Sycamore Grove, New Malden, Surrey. [1574

WIRELESS station superintendent required by the NIGERIA GOVERNMENT posts and telegraphs department for one tour of 18 to 24 months in the first instance; commencing salary according to experience in scale £864 rising to £1,392 a year; gratuity £100—£150 a year; outfit allowance £60; free passages for officer and wife and assistance towards cost of children's passages or their maintenance in the United Kingdom; liberal leave on full salary; candidates must have had wide, practical experience of modern radio techniques and equipment, in particular V.H.F. equipment, and preferably also V.H.F. multi-channel equipment.
WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/28927/WF. [1563

SIGNALS Assistant Inspectors of Police (Supernumerary) required by the GOVERNMENT of Kenya for one tour of two years with possible extension. Commencing salary, etc., according to previous experience in scale £767 rising to £1,092 a year. Gratuity (at least £162 after two years' service) payable on satisfactory final completion of service. Outfit allowance £30. Uniform allowance £10 a year. Free passages. Liberal leave on full salary. Candidates aged 20-30 should be at least 5ft 7in without footwear, have normal vision without glasses and be of good education. They should possess a sound knowledge of the installation and maintenance of modern low and medium powered V.H.F., static and mobile equipment, H/F transmitters and receivers, petrol generators and diesel electrical sets.
CANDIDATES with previous United Kingdom or Colonial Police experience will be considered up to 35 years of age.
APPLY in writing to the Crown Agents, 4, Millbank, London, S.W.1, stating age, name in block letters, whether married or single, full qualifications and experience and quote M1/32820/WF. [1549

THE WAR OFFICE requires for No. 35 Base Workshop, R.E.M.E., Old Dalby, Leicestershire:
ONE Mechanical Engineering Officer (Main Grade) to control workshop repairing radar and associated equipment; knowledge and experience of modern electronic and allied engineering progress and process methods and technique of management essential, also ability to organize large repair programmes and production. Inclusive salary range £927 to £1,218 (Provincial). Applicants must be British of British parentage and Corporate Members of the Institution of Electrical Engineers, or have passed or be exempt from Sections A and B of their membership examination. Starting salary fixed according to age, qualification and experience on range quoted. Annual increments subject to satisfactory service. Post temporary, but long-term possibilities.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D72/53A. [1583

TELEVISION, radio and electronic engineering company require the following personnel; West Surrey area.
RADAR mechanics for work on ultra-high frequency equipment.
TELEVISION development engineer—graduate and higher national standards.
ELECTRONIC technician as chief inspector.
PLANNING engineer.
WRITE giving full particulars of experience, age and salary required to Box 8618. [1576

CALIBRATORS and test engineers required for the calibration and test of precision electronic instruments.—Apply Box 8738. [1606

RADIO service engineer required for King's Lynn branch.—Apply Fells, Ltd., Head Office, Nene Quay, Wisbech. [1641

SITUATIONS VACANT

MINISTRY OF SUPPLY requires skilled craftsmen to serve as research and experimental mechanics at Malvern.
ALL applicants must have served a recognised apprenticeship.
INSTRUMENT makers; must be able to read and interpret working drawings English and 3rd angle and to work to rough sketches and verbal instructions; ability to produce individual scientific test gear on a one off basis working to fine tolerances, and to operate the necessary machine tools; knowledge of simple electronic circuits and ability to wire up an instrument from a diagram an advantage.
CENTRE lathe turners; must be able to read and interpret working drawings English and 3rd angle; work to fine limits in a wide range of materials, and have knowledge of relieving work on taps and milling cutters; ability to use horizontal or vertical boring machines an advantage.
UNIVERSAL millers; must be able to set up and operate to fine limits vertical, horizontal, a universal milling machine working in a wide range of materials.
KNOWLEDGE of gear cutting, jig boring and horizontal boring an advantage.
RATES of pay for 44-hour, 5-day week, 165/4 on entry with prospects of advancement to higher rates; hostel accommodation available. APPLY, giving details of apprenticeship, training (including Forces' training), qualification, and experience to Chief Superintendent, Radar Research and Development Establishment, Gt. Malvern, Worcs. [1598

DEVELOPMENT engineers.—Ultra Electric, Ltd., Western Avenue, Acton, W.3, have the following vacancies for engineers on the permanent, pensionable staff:
(a) SENIOR engineers with good qualifications (degree standard) and experience, required for new techniques in design and development of TV receivers.
(b) GENERAL engineers with good academic background and/or experience with a view to training and progression to senior positions.
(c) STANDARDS engineer, preferably with previous experience and H.N.C. standard of education for the control of factory test equipment and Standards Room equipment.
APPLICANTS are invited to write in strict confidence, giving age, experience, qualifications and salary desired to the Personnel Manager. [1594

ELECTRONIC Engineers required by The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry, in their Development Laboratories for work on:—
(a) TRIALS team in connection with guided weapons; 2 senior engineers, also 3 engineers.
(b) SERVO-MECHANISMS; 2 engineers.
(c) MAGNETIC amplifiers; 1 engineer.
(d) PULSE circuitry; 4 engineers.
(e) MICROWAVE circuits; 1 senior engineer; 2 engineers.
(f) TEST equipment; 1 senior engineer, 3 engineers.
(g) GENERAL radar circuit development; 1 senior engineer; 3 engineers.
APPLICANTS, preferably with a degree or an equivalent qualification, should have had at least two years' experience in the development and engineering of Service equipment as well as experience in one of the above.
HOUSES on the outskirts of Coventry, near our laboratories, are now available for offer to successful applicants, and this offer can only remain open for a few months; applicants' holiday requirements will receive special attention. —Reply, stating age, qualifications and experience, to Personnel Manager, Ref. R.G. [1620

TELEVISION service engineer required by old-established London retailer, good position offered to capable man; 5-day week; accommodation could be provided if necessary; state age and full details of career.—Box 8768. [1616

FERRANTI, Ltd., Manchester, have staff vacancies in connection with long-term development work on an important radio telecontrol project at their new laboratories at Wythenshawe, South Manchester.
(I) ENGINEERS for research and development work in the following fields: Radar, radio and electronic circuits, micro-waves, high power centimetric valves, vacuum and/or high voltage techniques, servo control and electro-mechanical devices and testing equipment associated with the above. Qualifications include a degree in Physics or Electrical Engineering or Mechanical Science or equivalent qualifications, and at least two years' previous experience. Salary according to qualifications and experience in the range of £500—£1,000 per annum. Please quote reference WE.
(II) TECHNICAL Assistants for experimental work in the fields listed in (I) above.
QUALIFICATIONS required: a degree or Higher National Certificate in Electrical or Mechanical Engineering or equivalent qualifications. Salary in the range of £400-£600, according to age and experience. Please quote Reference WT.
(III) DESIGNERS and Draughtsmen.
SECTION leaders, leading draughtsmen, draughtsmen and junior draughtsmen, preferably with experience in any of the fields mentioned above. Salaries based on A.E.S.D. rates: in the range of £360-£850 per annum with good allowances for special qualifications and experience. Please quote Reference WD.
THE company has a staff pension scheme. Application forms from Mr. R. J. Hebbert, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. Please quote appropriate reference. [1621

SITUATIONS VACANT

EXPERIENCED TV engineers required for retail service; permanent positions at good salary.—Full details to Shenstones (op. Town Hall), Leyton. E.10. Ley. 1362. [9266

TECHNICAL assistants grade III; vacancies exist in Scotland and Northern Ireland for technical assistants to work on electro-mechanical computers and servo mechanisms. INITIAL salary is in the range of £396 to £533 a year depending upon age and location, rising by annual increments to a maximum of £612 a year.
APPLICANTS should have experience of this type of equipment, and preferably have technical qualifications equivalent to Ordinary National Certificate; knowledge and experience of electronic valve circuits is essential.
APPLICATIONS to ADME, HQ 3 AA Group, Riccarton House, Currie, Midlothian. [1551

RADIO engineer required for responsible position by Cambrian Air Services, Ltd., Cardiff Airport. Must hold "A" licence. Salary in scale £600-£700 per annum, according to qualifications.—Apply Chief Engineer. [1615

ASSISTANT for electrical laboratory of firm manufacturing electro-ceramics; age not over 23 and must have completed National Service; Intermediate B.Sc. or equivalent.—Box 8636. [1587

APPLICATIONS are invited from Radar and electronic technicians for appointments as civilian technical assistants Grade III in 5 Anti-Aircraft Groups in the North Eastern and Midland area.
APPLICANTS should hold Ordinary National Certificate in Electrical Engineering or an equivalent qualification, or be an armament artificer, C.P.O., R.N., or senior N.C.O. R.A.F. with service Radar or electronic qualifications. STARTING salary, at age of 28, including pay additions, is approximately £500 p.a. with £20 annual increment up to a maximum of £597.—Candidates should submit their applications to A.D.M.E., H.Q. 5 A.A. Group,, "Cloverlands," Newdigate Lane, Kimberley, Notts, stating age, qualifications and experience. [1592

SMALL instrument company manufacturing gas analysis equipment requires installation and service engineer; knowledge of electronics essential, some knowledge of chemistry an advantage; salary by arrangement
INFRA RED DEVELOPMENT Co., Ltd., Broadwater Rd., Welwyn Garden City. [1555

AIRCRAFT radio engineers and mechanics required for employment at London Airport. Licensed personnel preferred but not essential; please forward full details of age, experience, etc., to Box 8633. [1584

RADIO testers and inspectors required for production of communication and industrial electronic equipment.—Apply Mr. D. J. Lewendon, Winston Electronics, Ltd., 1, Park Rd., Hampton Hill, Middx. Tel. Molesey 2985. [1645

RADIO service mechanics required by Smiths (Radiomobile), Ltd., for all parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [0342

TELEVISION engineer for old-established Bush, Ekco, H.M.V. and Murphy retailers, capable of taking charge service dept. when occasion arises; qualified driver; salary according to capabilities £500-£600 plus bonus.
WYCOMBE ELECTRICAL SUPPLIES, Ltd., 51/52, Oxford St., High Wycombe, Bucks. Tel. H.W. 457. [1538

SENIOR and Junior Radio Development Engineers, preferably with Higher National Certificate or equivalent; write, stating age, experience, qualifications, etc., to the Personnel Department (T.111), Murphy Radio, Ltd., Chiswick, W.4. [1578

TELEVISION engineer required for Cardiff; experience with all leading makes essential; appointment is with leading dealer with large staff offering good prospects; salary £500 p.a., accommodation provided.—Full particulars in first instance. Box 8814. [1635

TELEVISION and radio engineer required by large retailers operating in Portsmouth and Southsea district; good pay and paid overtime as necessary, applicant must have current driving licence.—Weston Hart, Ltd., 84, London Rd., Portsmouth, Hants. [1560

RADIO engineer with practical knowledge of R.A.F. or Fleet Air Arm Radio or Radar equipment required, post-war experience an advantage.—Applicants should apply in writing to Chief Inspector, A. J. Whittemore (Aeradio), Ltd., Croydon Airport. [1457

FIRST-CLASS radio and television engineers required by old-established, expanding business; good salary and prospects; permanent; all leading agencies, including Murphy, Bush, Pye, Ekco, etc.—E. P. Fox, Ltd., East Molesey, Surrey. Molesey 2721. [0442

TEST gear design engineers required with practical experience of this class of work, based on sound knowledge of electronic principles; these appointments are permanent and progressive; salary £650 to £850 per annum; company pension scheme in operation; London area; please write, in confidence, quoting reference WW/707, giving full details of qualifications, to—Box 8698. [1590

SITUATIONS VACANT

VACANCY in established North-East firm, with prospects of promotion to executive position within two years, open to man, age 35/45, holding Honours Degree in Science or Engineering, with experience in the design of radio and electronic equipment.—Box 8815. [1636

ELECTRONIC Engineer required to work on development projects in small organization situated on South Coast; experience on design of communications receivers essential; H.N.C. standard; write full details and salary expected. —Box 8840 [0251

AIRCRAFT radio mechanics skilled in workshop practice or aircraft installations to work at Stansted Airport, Essex; hostel accommodation available: minimum hourly rates 3/9. —Write to the Personnel Manager, Skyways of London, 7, Berkeley St., W.1. [0019

EXPERIENCED radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wirers and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238

MESSRS. PYE, Ltd., Cambridge, have vacancies for senior and junior test engineers, also electronic wiremen on very interesting work in their television transmission equipment department.—Apply in writing to Personnel Department, St. Andrew's Rd., Cambridge. [1395

ASSISTANT (scientific).—The Civil Service Commissioners invite applications for pensionable posts; applications may be accepted up to 31st December, 1953 but an earlier closing date may be announced either for the competition as a whole or in one or more subjects.
AGE at least 17½ and under 26 years of age on 1st January, 1953, with extension for regular service in H.M. Forces, but candidates over 26 with specialised experience may be admitted.
CANDIDATES must produce evidence of having reached a prescribed standard of education, particularly in a science subject and of thorough experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces, covering a minimum of two years in one of the following groups of scientific subjects:—
(I) ENGINEERING and physical sciences.
(II) CHEMISTRY, bio-chemistry and metallurgy.
(III) BIOLOGICAL sciences.
(IV) GENERAL (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass blowing).
SALARY according to age up to 25: £236 at 18 to £363 (men) or £330 (women) at 25 to £500 (men) or £417 (women); somewhat less in provinces; opportunities for promotion.
FURTHER particulars and application forms from Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington St., London, W.1, quoting No. S 59/53. Application forms should be returned as soon as possible. [1597

SOUTH Wales dealer requires television engineer, must be fully experienced and able to drive; single man preferred, but accommodation can be arranged if necessary; top wages paid; please apply giving full particulars of experience and wages required .—Box 8717. [1604

WIREMEN, skilled, required for high-grade electronic equipment, ability to undertake prototype work from Schematic drawings an advantage; first-rate workshop conditions, West London area, and pension scheme; write, stating age, details experience and present rate.—Box 8276. [1540

LAYOUT engineers required for design of industrial electronic equipment; excellent opportunities for capable men to progress in rapidly expanding organisation.—Apply Technical Director, Winston Electronics, Ltd., 1, Park Rd, Hampton Hill, Middx. Tel. Molesey 2985. [1647

SOUND recording studio, London area, vacancy for assistant recordist, must have thorough electronic knowledge, maintenance, experience, initiative and prepared to accept responsibility; 5-day week; permanent position. —Write, Box 8621, stating age, experience, qualifications and salary required. [1579

ASSISTANT television tube engineers.—Vacancies exist for night and day engineers, experienced in all aspects of manufacture and test of cathode ray tubes.—Write in confidence giving full particulars of qualifications and age to the Personnel Officer, Brimar Valve Works, Footscray, Kent. [1607

DRAUGHTSMAN wanted for a small drawing office engaged in design of electronic equipment, good opportunity for man with initiative in rapidly expanding organisation.—Apply Technical Director, Winston Electronics, Ltd., 1 Park Rd., Hampton Hill, Middx. Tel. Molesey 2985. [1646

TECHNICAL author required for expanding technical publications department of large electronic organisation in S.W London; experience of telephone carrier systems is desirable, but an opportunity will be given to deal with wide range of electronic equipment.—Write, giving age and full details of education, qualifications and previous experience, to Box 8699. [1591

SITUATIONS VACANT

DESIGN draughtsman (research) required; varied work involving drawing, analysing performance and developing precision apparatus from engineers' sketches; opportunity to rise to status of development engineer for man with proven ingenuity and sound critical faculty. APPLY in writing, giving age, previous experience and salary required, to Personnel Department, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Essex. [1577

DRAUGHTSMEN experienced in radio and television receiver design (and small mechanical details) able to prepare drawings for mfr. of prototype equipment.—Apply in writing to Employment Manager, Ferguson Radio Corpn., Gt. Cambridge Rd., Enfield, Middx. [1568

EXPERIENCED fault-finders wanted by Midland manufacturers of radio equipment; permanent posts located in the Midlands are offered to men with experience of radar, radio control, V.H.F. equipment.—Write, stating fully, experience and salary required, to Personnel Manager, Box 7632. [1414

ELECTRONIC engineers required for test and inspection of experimental and prototype equipment; applicants should have sound technical knowledge with wide practical experience.—Please apply in writing with full details to Personnel Dept., ED/115, E.M.I. Eng. Dev., Ltd., Hayes, Middx. [1553

TECHNICAL writer (male or female) required in the N.W. London area by one of the leading radio manufacturers; applicants should have had previous experience in this field; salary will be between £550-£650 per annum, according to qualifications and experience.—Write, giving full details, to Box 8666. [1589

TELEVISION field service engineers required by large company, particularly for the Midlands, West Country and Hants; permanent, progressive positions offered to suitable applicants willing to move to required areas; must have clean driving licence.—Give full particulars in confidence to Box 8562. [1566

RADIO and radar testers; first-class men required for work on V.H.F. communication gear and Government contracts for radio and radar equipment by Midland manufacturers; —Men with wide experience of fault finding in any of the fields mentioned should write, giving full details to Box 7631. [1413

RAPIDLY expanding department of large Wolverhampton firm requires several energetic electronic and electromechanical engineers, preferably with experience of industrial instrumentation and servo mechanisms; degree or equivalent standard preferred for senior posts; expenses for attending for interview refunded.—Box 8634. [1585

DEVELOPMENT engineer required by E.M.I. Engineering Development, Ltd., applicants must have sound, basic training in electronics with experience in design of equip. incorporating servo mechanisms; the post carries a good starting salary and prospects.—Apply in writing with full details to Personnel Dept., (ED/124), E.M.I. Eng. Dev., Ltd., Hayes, Middx. [1570

DECCA RADAR, Ltd., invites applications from young graduate scientists and engineers with good Honours degrees; the posts offer first-class careers with excellent prospects in radar engineering; British Nationality essential. "Only Candidates who have completed their National Service need apply."—Apply, Ref. CPH/1, Decca Radar, Ltd., Research Laboratories, 2, Tolworth Rise, Surbiton, Surrey [0246

RADAR Systems Engineers.—Decca Radar, Ltd. have a number of senior and junior posts available for radar systems engineers in their Tolworth Laboratories; Candidates must be willing to travel when required and be of British Nationality; Preference will be given to candidates who have H.N.C. or equivalent and who have had experience on the field trials and maintenance of radar equipments; the chances of rapid advancement are good. "Only Candidates who have completed their National Service need apply."—Apply, Ref. CPH/B, Decca Radar, Ltd., Research Laboratories, 2, Tolworth Rise, Surbiton, Surrey. [0248

MINISTRY OF SUPPLY, A.E.R.E., Harwell, requires engineers and physicists in Electronics Division for duties ranging from fundamental research on circuitry and the physics of nuclear radiation detectors, to devising and developing (often in collaboration with industry) electronic devices for atomic energy project; both small and large scale electronic engineering involved, with ample scope for originality. Duties mainly involve research on circuitry, but opportunities will occur for work on project engineering. Qualifications: Minimum of 1st or 2nd class honours degree, or equivalent, in physics or elec. eng. Appointment according to age and experience as: Principal scientific officer (min. age 31), £1,033—£1,377; Senior Scientific Officer (min. age 26), £781—£980 (for above grades at least 3 years post-graduate experience required); Scientific Officer, £417—£675; women somewhat less; appointments unestablished; F.S.S.U. benefits may be available; houses available within reasonable period for successful candidates, if married.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A195/53/A. Closing date September 12, 1953. [1633

SITUATIONS VACANT

TEST engineers are required to assist in the production of a variety of precision electronic laboratory instruments; previous test department experience essential (preferably in connection with electronic measuring instruments); salaries in the range of £440-£520 p.a. according to qualifications and experience.—Apply stating full details to the Chief Engineer, Furzehill Laboratories, Ltd., Borehamwood, Herts. [0244

ENGINEER required by well-known firm of mechanical and electrical engineers in West London, to take responsibility for development work on H.F. heating techniques and their application to production; H.N.C. or equivalent qualification and some practical experience in this field desirable; salary £550—£700 p.a. according to age and experience; pension scheme, good opportunities for advancement.—Box 8405. [1554

SENIOR and junior engineers required for responsible work in radio and television laboratories; applicants for senior position should be able to undertake development work with minimum supervision; excellent conditions and salary available for applicants who are accepted.—Apply in first case to Personnel Manager (Dept. R.D.), McMichael Radio, Ltd., Wexham Rd., Slough. Applicants must be of British Nationality. [1527

THE ENGLISH ELECTRIC Co., Ltd., Luton, have a vacancy for a designer of low power (up to 1 k.w.), low frequency transformers and chokes; previous experience very desirable and applicant should be thoroughly familiar with winding and impregnation processes; varied interesting work involving development of a number of designs for small quantities.—Apply, quoting Ref. No. 1137, to Dept. C.P.S., 336/7, Strand, W.C.2 [1444

B.B.C. requires engineer for research into microphones, loudspeakers and other audio-frequency developments; degree or equivalent electrical engineering/physics essential; knowledge electrical communication, music; based Kingswood, Surrey; starting salary £590 (higher if qualifications exceptional) rising by annual increments to £800 max.—Applications to Engineering Establishment Officer, B.B.C., London, W.1, within 7 days. [1562

E.M.I. ENGINEERING DEVELOPMENT, Ltd. have two vacancies for electronic engineers for development work on car radio and magnetic tape recording equipment; applicants should have sound, basic training in electronics with experience in the design and development on kindred equipments; positions offer good salaries and prospects.—Please apply in writing to the Personnel Dept. (ED/123), E.M.I. Eng. Dev., Ltd., Hayes, Middx. [1571

ENGINEER or physicist with experience of problems associated with the design of electronic tubes is required for interesting development work in this field; applicants should have a degree in Physics or equivalent qualifications; vacancies also exist for assistants.—Please write with full details to Personnel Dept., quoting ED/126, E.M.I. Engineering Development, Ltd., Blyth Rd., Hayes, Middx. [1424

BELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television aerials; applicants must be graduates of the I.E.E. or possess equivalent qualifications, together with similar laboratory experience; salary will be commensurate with previous experience; 5-day week; contributory pension scheme.—Applications must be detailed and concise, and will be treated as confidential. [0230

McMICHAEL RADIO, Ltd., require senior and junior engineers in their equipment division laboratory at Slough; training and experience in the field of applied electronics (including communications) and experience of working with Government Departments are the chief qualifications required.—Write, stating age and full details of training, qualifications and experience, to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks. [0198

ELECTRONIC development engineers required for work in laboratory on instrumentation, industrial electronics and guided weapons; must have sound knowledge and experience of electronics and be capable of working on own initiative; salaries up to £1,000 p.a. depending on experience; excellent opportunities for capable men to progress in rapidly expanding organisation.—Apply Technical Director, iWinston Electronics, Ltd., 1, Park Road, Hampton Hill, Middx. Tel. Molesey 2985. [1644

TRANSFORMER manufacturers in South West Eng. and have a vacancy for a Chief Inspector to cover all branches of the Company's activity, including stamping, mass production domestic and special purpose, transformer divisions. Applicants should have a sound knowledge of physics and good experience in mechanical and electrical fields, and also decided administrative ability. Salary will be dependent upon the applicant's experience and ability, and on whether the Company provides accommodation, but will in any case be commensurate with the responsibilities of the position, which is of a permanent and progressive nature.—Apply, in strict confidence, giving full details of age, experience, etc., to Box 8620. [1582

SITUATIONS VACANT

MURPHY RADIO, LTD., have a vacancy in their test instrument laboratory for a senior engineer to undertake the design and development of all types of production and laboratory test equipment. Applicants should possess a degree, H.N.C. or equivalent, and preferably have had a few years' practical experience in this type of work.—Apply to Personel Department (T.I.1), Murphy Radio, Ltd., Welwyn Garden City, giving full details of experience and qualifications. [1580

ELECTRONIC engineer, aged 25-30, with ordinary national certificate or equivalent, required by The Morgan Crucible Co., Ltd., in its instruments laboratory; preference will be given to applicants possessing a wide industrial experience; position is permanent and pensionable; staff canteen on premises with all welfare and recreational facilities; 5-day week; write, giving details of age, experience, qualifications and salary required, to the—Staff Manager, Battersea Church Rd., S.W.11. [0199

ELECTRICAL component manufacturers in Wiltshire have a vacancy for a young and energetic Material Controller to take charge of this section and to train for the ultimate position of buyer; the applicant should be well educated, and have had good experience in the industry and should have decided commercial ability. Salary according to experience and ability, unfurnished self-contained accommodation being provided without charge on establishment.—Apply, in confidence, with full details and present salary, to Box 8619. [1581

BELLING & LEE, Ltd., wish to appoint a working chief for their type-test laboratories; these are fully equipped for testing electronic components to R.I.C. and R.C.S.C. specifications, and the applicant must have had experience in this field; this is a permanent position with wide scope for the right man; salary will be in accordance with experience and qualifications, details of which will be treated confidentially; contributory pension scheme.—Secretary, Cambridge Arterial Rd., Enfield, Middlesex. [0231

RADIO (Meteorological) Mechanics required by meteorological office; qualifications: basic knowledge of radio and radar and experience in maintenance/operation of radar equipment including oscilloscopes; successful applicants serve in U.K. and overseas; commencing London wage £7/17/6 at age 25 or over, rising annually to £9/10/6; deduction of 3/- for each year below 25; overtime, night duty allowances, etc.; promotion prospects.—Apply to Borough Employment Exchange (Dept. W.W.3), 236, Walworth Rd., London, S.E.17. [1518

A MALE graduate research physicist is required by British Cellophane, Ltd., Bridgwater, Somerset. Applicants should have a thorough knowledge of, or some previous experience in, electronics and radio-active isotopes, and be between about 25 and 40 years of age. The post is concerned with the design and construction of apparatus for experimental work in connection with the manufacture of cellulose film. The salary will be according to age, qualifications and experience.—Address applications to the Personnel Officer, quoting Ref. No. W.W. R.20. [1609

THE GENERAL ELECTRIC CO., LTD., Brown's Lane Coventry, requires Senior and Junior Electronic Development Engineers for work on Guided Weapons and like projects, particularly in the field of Microwave and Pulse Applications; Mechanical Development Engineers, Designer Draughtsmen and Draughtsmen, preferably with experience of radar type equipments, also required for the above projects; salary according to age, qualifications and experience; houses available to selected senior staff.—Apply any letter stating age and experience to the Personnel Manager (Ref. R.G.). [0259

ADMIRALTY, Royal Naval Scientific Service. Engineers and Physicists (particularly with electronics) required for appointments in (a) Senior Scientific Officer and Scientific Officer grades (Ref. A246/52A), and (b) Experimental Officer and Assistant Experimental Officer grades (Ref. A247/52A) in Experimental Establishments in London, Portsmouth, Weymouth areas and Scotland. Candidates, British subjects, for (a) must possess first or second-class honours degree in Physics or Engineering, or high professional attainments such as corporate membership of appropriate professional institution with suitable experience and responsibility and for (b) should possess one of following qualifications: University degree in Science, Engineering or Mathematics, Graduate membership of appropriate professional institution, Higher National Certificate, Final certificate of five-year grouped course in relevant subject at City and Guilds of London Institute or comparable institution, Higher School Certificate with Mathematics, or Science as principal subject or equivalent qualification. S.S.O.s at least 26 years of age with at least three years' approved experience, London salary (men) £812—£1,022 per annum; S.O.s at least 21 years £440—£707; E.O.s at least 26 years £681—£838; A.E.O.s at least 17½ years £274—£607. Rates for women and posts in Provinces somewhat lower Starting salaries above minima may be granted according to age and experience. All appointments unestablished (with F.S.S.U. for S.S.O. and S.O.) but with some opportunities to compete for established posts.—Application forms, from M.L.N.S., Technical and Scientific Register (K), Almack House, 26. King St., London, S.W.1, quoting appropriate reference. [1550

SITUATIONS VACANT

ENGINEER required to undertake the development of electronic instruments; the successful applicant must be capable of working substantially on his own initiative; salary will be in accordance with qualifications and experience; degree or equivalent preferred.—Apply in writing to Advance Components, Ltd., Back Rd., Shernhall St., London, E.17. [1479

STANDARD Telephones and Cables, Ltd., North Woolwich, London, E.16, have vacancies in the line transmission laboratory for one senior and one junior engineer or physicist to specialise on the development of coils, filters and equalisers covering the whole of the Telecommunications frequency range. Applicants should have an electrical engineering or physics degree and, for the senior position, experience in the above field; initial salary according to qualifications and experience. The positions are progressive and pensionable.—Apply Personnel Manager. [1632

B.B.C. requires limited number of engineers (minimum age 21) of British Nationality for operation and maintenance duties at transmitter, studio, recording and television centres; must be willing to serve anywhere in U.K.; essential qualifications include University Degree, Higher National Cert. or equivalent in electrical engineering, Grad. Brit. I.R.E. with maths, or C. & G. Final Cert. in telecomms., promotion prospects, salary £500 with annual increments to max. £865.—Applications to Engineering Establishment Officer, B.B.C., London, W.1. [1599

DECCA RADAR, Ltd., invites applications from young engineers who are interested in radar as a career and who have taken or are engaged in taking their H.N.C.; the posts available offer opportunities for undertaking intensive development work over a wide field of radar, microwave link, and associated techniques; the chances of rapid advancement are good for men of ability; British Nationality essential; suitable candidates with no radar experience may be accepted for training. "Only Candidates who have completed their National Service need apply."—Apply, Ref. CPH/A, Decca Radar, Ltd., Research Laboratories, 2, Tolworth Rise, Surbiton, Surrey. [0247

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