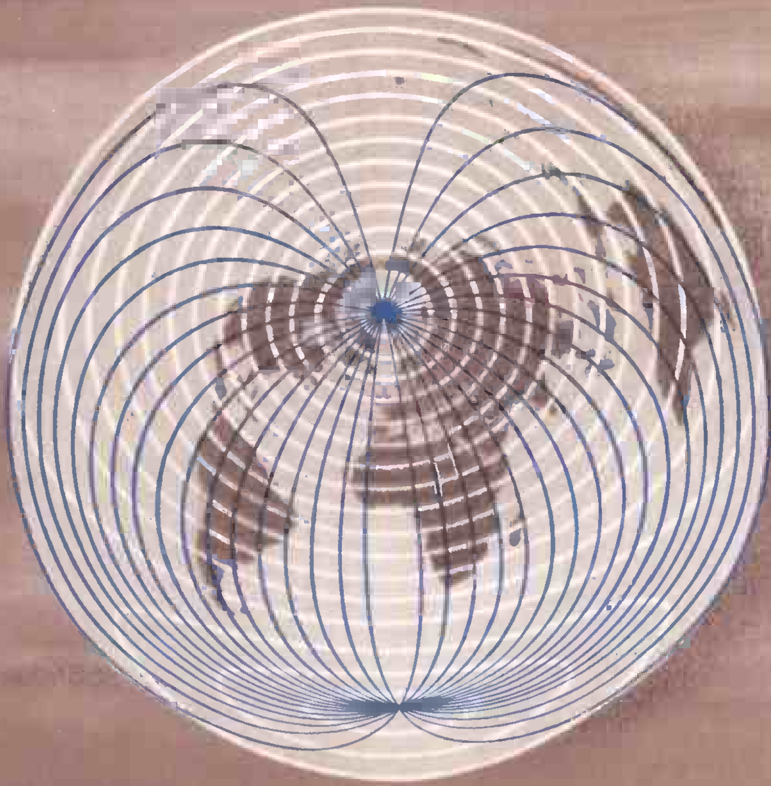
JUNE 1955

TWO SHILLINGS

Wireless World

Radio · Electronics · Television



FORTY-FIFTH YEAR OF PUBLICATION

Wireless World

RADIO, ELECTRONICS, TELEVISION

Managing Editor:
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Editor:
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JUNE 1955

In This Issue

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OF PUBLICATION

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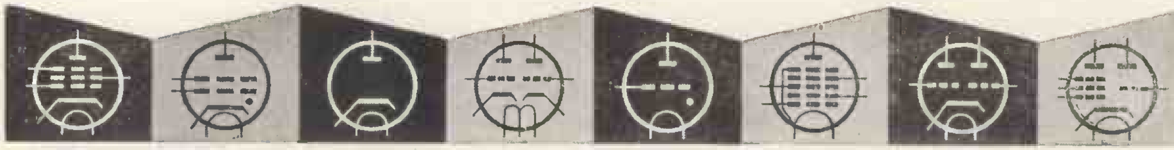


VALVES, TUBES & CIRCUITS

30. GERMANIUM DIODES FOR TELEVISION RECEIVERS

Advantages and Disadvantages

The point-contact germanium diode can often be used with advantage in place of its thermionic counterpart. Its compactness and long life make it suitable for inclusion in a coil unit. It is robust and non-microphonic. The inter-electrode capacitance is low. There is no heater, therefore supplies are simplified and a possible source of hum is eliminated. And the forward resistance is low, giving improved detection efficiency.

The main limitations of the germanium diode, namely its reverse current at negative voltages and its relatively large temperature dependence, can be easily allowed for in circuit design and chassis layout. Earlier diode troubles, such as sensitivity to atmospheric moisture, have been eliminated by present-day manufacturing techniques.

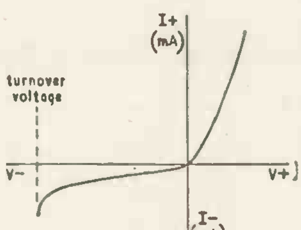


FIG. 1

The Diode Characteristic

The general form of the germanium diode current/voltage characteristic is shown in Fig. 1. There are certain significant differences from the characteristic of a thermionic diode. The comparatively steep rise of the positive portion obeys an exponential rather than a three-halves power law, with forward currents which are normally of the order of 5 or 10mA at 1 or 2V. At high positive voltages, beyond the normal working range, the characteristic becomes nearly linear (that is resistive), without the saturation effect which is seen in a thermionic diode.

The negative characteristic shows not only a negative current for negative voltages, but also a rapid growth of this current if the voltage is made sufficiently great. In this region (which is well beyond the working range) *turnover* takes place, and the characteristic reverses. This condition produces overheating and a destructive runaway. The normal reverse currents are quite small (a few micro-amps) and, if the published temperature and peak reverse voltage ratings are observed, reverse currents have no harmful effect.

The characteristic, as it changes from the positive to the negative region, passes through the origin, therefore at zero voltage there is no current flow. In the immediate vicinity of this point (say within $\pm$ 10mV) the ratio of forward to reverse resistance becomes small, and detection efficiency is much reduced.

High and Low Current Types

The steeply rising forward characteristic of a high-current type of germanium diode implies a comparatively large reverse current and a comparatively low turnover voltage. Conversely, the less steep forward characteristic of a low-current type gives an extended reverse characteristic. These contrasted pairs of features are the basis of the possible range of diode types. They are the key to the choice of type for a particular application, and they are important influences on circuit design.

Temperature Effects

Germanium diodes are affected by temperature, and all ratings apply at specified temperatures. It is necessary for the circuit designer to take into account not only the air temperature which is likely to occur in the receiver but also any heat which may be transmitted through the chassis. The appropriate forward current and reverse voltage ratings must be observed if the diode itself is not to generate destructive heat. It is not to be assumed, however, that a germanium diode is excessively sensitive in this respect. The dangers have been mentioned only in order to draw attention to the temperature rating—a rating which is not normally of much consequence where thermionic valves are used.

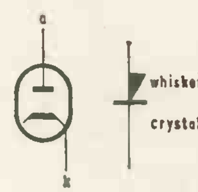


FIG. 2

Fig. 2 shows the standard symbol for a germanium diode in parallel with the familiar diode valve symbol. The figure is intended to assist in the reading of circuit diagrams. The differences between the two kinds of diodes should, of course, be borne in mind.

Further advertisements in this series will discuss the employment of the diode characteristic in a number of typical applications in television and f.m. receivers.

Reprints of this advertisement, supplemented by data for Mullard diode types, are available without charge.

Wireless World

JUNE 1955 VOL. 61 No. 6

Television and V.H.F. Sound

THOUGH prophets are usually not lacking in courage, not many of them have been bold enough to speculate on the future of sound broadcasting *vis-à-vis* television. But, without entering into competition with those few who have chanced an opinion, we may suggest that the B.B.C.'s newly launched scheme for v.h.f. broadcasting may well point the way towards a closely integrated sound/vision system of the future.

The new B.B.C. scheme, conceived several years ago, represents an idea in large-scale broadcasting that is without parallel in the world. Essentially it is based on combining Band I television stations with Band II three-channel v.h.f. sound transmitters. Propagation characteristics of these two sets of signals are not wildly different, and the scheme represents good engineering, being economical in both equipment and manpower.

Just as the addition of sound broadcasting transmitters to the television stations is a relatively inexpensive matter, the provision of v.h.f. sound facilities in television receivers is even more economical. A number of these combined sets have already made an appearance, and more are to be expected. Such combined broadcast receivers may, in the future, well satisfy the needs of the majority, and their widespread use may well lead to a closer integration between sound and vision broadcasting.

Apart from these possibilities, there is the question of quality of the new service. Interference is now almost intolerable on the medium frequencies; it goes without saying that listeners within the v.h.f. service areas will get a much quieter background. But what of improved frequency range and dynamic range? Here there are obvious limitations, including the landlines, but the B.B.C. has given assurances that the new transmissions will permit a substantial improvement in receiver performance.

Electrostatic Loudspeakers

DEVELOPMENTS in electrostatic speakers, now being described in articles appearing in our pages, may conceivably have an important effect on the combined vision/sound receiver discussed in the preceding paragraphs. High-quality sound is not usually considered necessary in a television set, but improvement in this direction may be demanded when the set includes provision for v.h.f. sound reception. An obvious advantage of using the electrostatic speaker for such a set is that the necessary high polarizing voltage is already there without extra cost. It is too early to make guesses about the shape an ideal speaker would take; perhaps some change in the now-almost-traditional proportions of the television receiver cabinet would be needed.

Whether these speculations be justified or not, the resurgence of the electrostatic speaker is certainly a matter of the greatest interest. Every conceivable method of artificially reproducing sound has been explored, but for over a quarter of a century the moving-coil principle has met no serious challenger; now, good as it can be, further development seems unlikely. The moving-coil speaker has always had to carry two onerous limitations: the mass of its moving parts and the necessity for providing a diaphragm that is at one and the same time rigid and flexible. True, the mass has been utilized in designing for level output at low and medium frequencies, but the price of linearity in this range is a steady deterioration in output at high frequencies. This disability can be lessened only by allowing the diaphragm to "break up."

The electrostatic speaker, on the other hand, would appear to be the answer to the designer's dream. As was pointed out last month, its performance is always predictable, no matter what the size and shape of the diaphragm.

Since it has been shown that the electrostatic principle is not inherently non-linear, the field is open to almost limitless development. We have already heard working a prototype speaker which covers a frequency range from 40 c/s to the upper limits of audibility. There can be no denying that the quality of reproduction has a freshness not usually associated with the heavier diaphragms of moving-coil speakers. No doubt practical problems remain to be solved, but it seems likely that the electrostatic speaker, after a long period of hibernation, is coming back to vigorous life.

V.H.F. Broadcasting Starts

ON May 2nd, the v.h.f. station at Wrotham ceased to operate experimentally and started to work a regular service as the first station of the B.B.C.'s new f.m. broadcasting system. By the end of 1956, it is expected that eleven stations will be in operation and will cover 83% of the country with the Light, Home and Third programmes in a way which will be but little affected by interference. After Wrotham, a further ten stations are scheduled:—at Pontop Pike, Divis, Meldrum, Norwich, South Devon, Sutton Coldfield, Wenvoe, Holme Moss, Blaen Plwy, and Penmon.

At each station the three programmes will be radiated on frequencies 2.2 Mc/s apart in Band II. For Wrotham, the frequencies are 89.1 Mc/s (Light), 91.3 Mc/s (Third) and 93.5 Mc/s (Home). They will all be radiated from a common aerial array of the slot type. This has already been provided on many television stations (e.g., Sutton Coldfield and Holme Moss) and is evidence of the long-term planning of which this Band II service is the result.

The general plan is to have six 10-kW transmitters at each station. In effect, they will operate in parallel pairs to provide three transmitters of 20 kW each and, with the aerial gain, an effective radiated power of 120 kW each. The interconnection of the transmitters is not straightforward paralleling, however.

If we call one pair A_1 and A_2, another B_1 and B_2 and the third C_1 and C_2, then the outputs of A_1 and B_1 are combined and then mixed with the output of C_1 and fed to one-half of the aerial array. The outputs of A_2 and B_2 are similarly combined and mixed with the output of C_2 and fed to the other half of the aerial array.

The object of this somewhat curious arrangement is to minimize the effects of any fault. If any one transmitter develops a fault, the other one of the pair continues in operation and the result is merely a 3-db drop in signal strength. If a fault occurs in one-half of the aerial, the same thing happens. Indeed, there can be simultaneous faults in one-half of the aerial and in three of the transmitters on the same side of the chain with only a 6-db reduction in the signal. Arrangements are made to reverse the connections of the transmitters to the aerials so that, in the event of such a double fault, the good half of the aerial can be connected to the good transmitters.

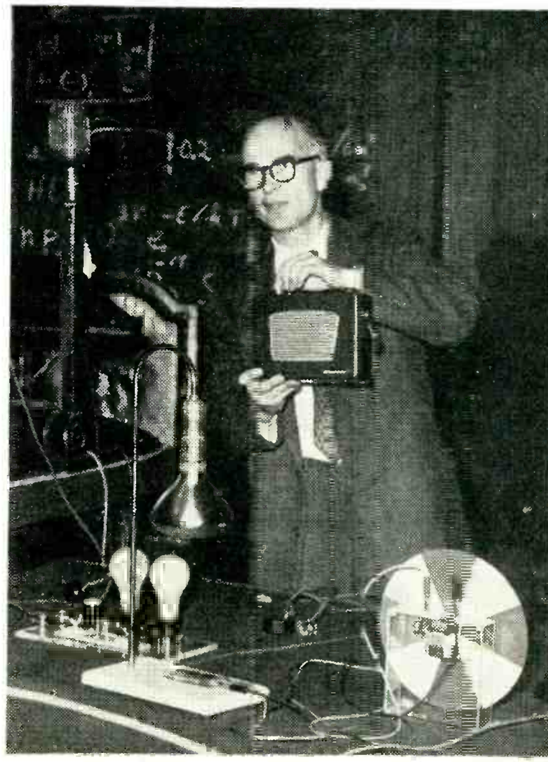
It might be thought that the parallel operation of transmitters around 100 Mc/s would be a difficult matter. Actually, however, they have a common drive. Each basic transmitter has its own drive unit but only one is used at a time to drive both transmitters of a pair, the other acting as a spare.

The system of modulation used is F.M.Q.[1], developed by Marconi's, who built the Wrotham station and from whom 46 other transmitters for the scheme have been ordered. The mean frequency is determined by a high-stability crystal oscillator and modulation is effected by a reactance-valve circuit which "pulls" the crystal frequency.

The general arrangement has been dictated by the requirement of extreme reliability, so that operating personnel are virtually unnecessary. Automatic monitoring devices are installed to call attention to any defect and, except for the repair of a fault, the stations should need no attention beyond routine maintenance.

The station at Wrotham differs quite a bit from this general description, for the apparatus is, in the main, that used for the experimental transmissions over the last few years. There are two 25-kW transmitters with two 4½-kW stand-by types and two 10-kW transmitters. The outputs of the two 25-kW ones are combined and then the signal is split into two. With each half is mixed the output of one of the 10-kW transmitters and each is fed, as before, to one-half of the aerial array. The final result is much the same, but the way in which it is achieved is different. It would clearly have been uneconomical to scrap two 25-kW transmitters, which is what would have been necessary if Wrotham were to keep to the general plan for the other stations.

[1] "F.M.Q.," by W. S. Mortley, A.M.I.E.E., *Wireless World*, October 1951, p. 399.



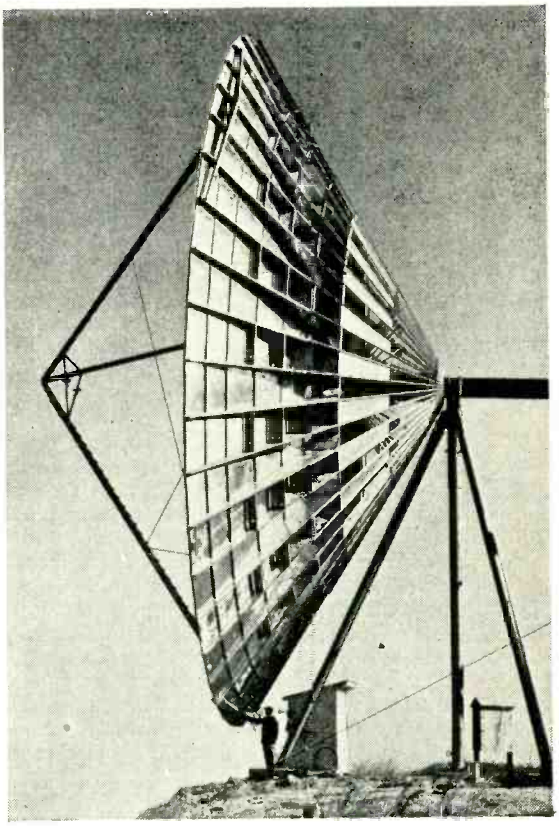
FATHER OF THE TRANSISTOR. This year's I.E.E. Kelvin Lecture was delivered by Dr. W. Shockley, leader of a team at Bell Telephone Laboratories which extended the foundations of semi-conductor physics and ultimately evolved the transistor. Dr. Shockley gave an account of the basis of transistor physics and described some of the many applications of this device, such as in hearing aids and portable radio receivers. He also dealt with the prospects of using semi-conductor junctions for converting light into electrical energy and disclosed that trials are to be carried out on rural telephone lines powered by sunlight.

Tropospheric Scatter Propagation

200-*mile Transmission on Frequencies in the U.H.F. Band*

IN *Wireless World* for July, 1952[1], a type of relatively long-distance transmission for frequencies in the lower part of the v.h.f. range was described, in which propagation is by a forward scattering process from irregularities in the lower part of the ionosphere, so that a portion of the radiated energy is returned to the ground and is receivable at distances up to about 1,250 miles.

According to the theory of Booker and Gordon[2] a similar, but distinct, type of scattering should take place in the troposphere, even though the air there is not ionized. In this region the air is in a state of irregular motion, this turbulence being due to local irregularities in the speed and direction of the air flow, thermal instabilities, etc. Such a turbulent medium may be visualized as one containing a large number of spherical blobs, and the dielectric constant of the individual blobs may differ widely from the mean dielectric constant of the medium as a whole. Therefore their refractive indices differ from that of the medium, in a degree depending on the scale of the turbulence, and they thus constitute a system of scattering centres for radio energy, the amount of energy scattered depending on the relation between the size of the blobs and the wavelength. The energy is scattered mainly in a forward direction, so as to be receivable at points far beyond the radio horizon of the transmitting aerial. Of course the amount of energy scattered by unit volume of the atmosphere is extremely small, but by the use of highly directive beam aerials for both transmitting and receiving, both being directed on to a given area in the troposphere, a large number of scattering centres can be brought into use, and a usable amount of energy made available at the receiver. There is increased forward beaming of the scattering with increased frequency, so that on frequencies in the u.h.f. band the scattered energy per unit volume of atmosphere is much greater than on lower frequencies.



The 60-ft. experimental aerial reflector used to receive u.h.f. television pictures at a distance of 200 miles by means of tropospheric scatter propagation.

Courtesy Bell Telephone Laboratories

Practical Applications

Some experiments designed to put the above facts to a practical use have recently been carried out in America. They have been conducted jointly by Bell Telephone Laboratories and Massachusetts Institute of Technology on the lower frequencies in the u.h.f. band, and also by Syracuse University on a frequency of 915 Mc/s, the latter experiment being still in progress.

The result of the first of these experiments has been to develop a system of "over the horizon" transmission, capable of being used for television picture transmission, as well as for multi-channel telephone service. The propagation medium will thus support the wide-band transmission necessary for the above services, and signals would appear to be usable over a range of about 200 miles. It is visualized, therefore, that the present requirement for u.h.f. radio links to be within "line of sight," i.e., about 30 miles apart, will no longer apply, and that the new system may, in time, supersede the present microwave radio relay network across the United States, in which the stations are spaced by about that distance. If that is so, and the system is economical in use, one can see immediate useful applications for it in Europe; for example, in the international exchange of television programmes.

The experiment was based on the fact that signals were consistently obtained beyond the radio horizon with the present radio link system: signals which were most probably propagated according to the Booker and Gordon theory. The next step was to use higher power and erect larger aerials than are used in the conventional system. Ten-kilowatt transmitters were employed using aerial reflectors of 60 feet in diameter, that is 20,000 times the power and 30 times the aerial reflector area as compared with that used in the ordinary links. One of these aerial systems is shown in the accompanying illustration. By this means it was found possible to "beam" enough power on to the appropriate area of the lower atmosphere that sufficient energy was scattered in a forward direction so as to reach the receiving aerial far over the horizon, and there provide a workable signal. Towards the end of 1953 it was found possible to transmit 12 speech-frequency channels over the system, and in 1954 television was first successfully transmitted between Holmdel, N.J., and New Bedford, Mass., a distance of 188 miles.

The system may be likened to that of a powerful searchlight, which casts a beam in a straight line. Such a searchlight aimed at the sky can be seen from the ground miles away, even when the searchlight is behind a hill. This is possible only because some of the light is scattered by the atmosphere and reaches the observer on the ground.

It is emphasized that, in the United States, the new system will, at first, probably act as a supplement to, rather than as a replacement of, the present radio relay link system.

The system should not be confused with the ionospheric scatter system mentioned at the beginning of this article. The maximum distances possible are much less in the present case, but, on the other hand, the ionospheric system will not support the wide-band transmission necessary for television.

The experiment being conducted by Syracuse University appears to be on much the same lines as that just mentioned, the transmitter being at Lexington, Mass., and the receiver at Syracuse, N.Y., a distance of 254 miles, the intervening mountains ranging up to 3,000ft. The transmitter power is 12 kW and the aerial reflectors 28ft in diameter, these being identical at transmitter and receiver. A.M., f.m. and pulse signals are being used. The transmitting and receiving aerials are manually adjustable in azimuth and elevation in order to determine the most suitable angles for optimum results. These tests are designed to determine which type of modulation is best suited to this type of radio link, and to determine the variations in reception with time of day, weather and seasons of the year.

REFERENCES

[1] "New Kind of V.H.F. Propagation," *Wireless World*, p. 273, July, 1952.

[2] Booker, H. G., and Gordon, W. E., "A Theory of Radio Scattering in the Troposphere," *P.I.R.E.*, Vol. 38, No. 4, p. 401, April, 1950.

"Adjacent-Channel" Colour Television

INVESTIGATIONS by the radio industry into the merits of various colour television systems for this country were discussed at a recent lecture by L. C. Jesty to the Television Society. One system under consideration, which has often been mentioned in *Wireless World*, is the modified version of the American N.T.S.C. system in which the colour signal is transmitted outside of the normal monochrome band, but overlapping the monochrome band of the station in the adjacent channel. For example, the colour signal of Kirk O'Shotts (Channel 3) would be transmitted within the monochrome band of Sutton Coldfield (Channel 4), and although this would undoubtedly cause some interference it would probably not be so bad for the Midland viewers as having their own colour signal continuously present and interfering in Channel 4.

Of course, the amount of interference in this system would depend on the geographical proximity of the stations in the adjacent channels, and it appears that the radio industry's investigation so far has been largely concerned with this matter. Mr. Jesty showed a map which indicated the areas most likely to suffer from the colour-signal interference, the worst-affected ones appearing to be largely in the North and the West. This, however, was only based on calculation and it would be necessary to carry out actual field tests if the system proved worthy of further investigation. Expressed in actual figures, the calculated results suggested that only about 1.5-2% of the viewing public would suffer from the interference for 1% of the time, and this, said Mr. Jesty, did not look too impossible.

F.M. Tuner Kit

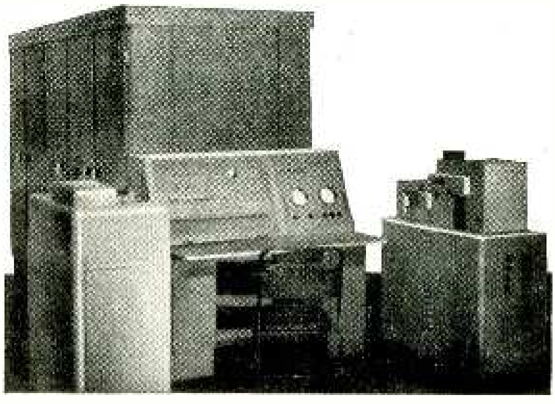
CAPACITOR and resistor kits for the F.M. Tuner described in our May 1955 issue have been put up by Erie Resistor, Ltd., and should now be obtainable from retailers. To assist constructors the 270-Ω, ±10% and the 180-Ω, ±10% resistors for R_2, R_8 and R_{10} are included so that either EF80 or EF91 valves may be employed. The alternative resistors are included free of charge. Resistors R_{20} and R_{29} are, however, not included as the former is not made by Erie and the value of the latter has to be found experimentally.

The capacitor kit costs £2 5s 6d and the resistor kit £1 7s 2d. It should be noted that type NPOL is included for C_6 and type NPOM for C_{11} as these are more suitable than type NPOK which was originally specified.

Election Result Computor

BELOW is the electronic digital computor which the B.B.C. are using on election night to calculate the totals of seats won, lost and retained by the parties and also to forecast the final result. Built by English Electric, it is an engineered version of the N.P.L. ACE (Automatic Computing Engine) and is therefore appropriately named DEUCE (Digital Electronic Universal Calculating Engine). A feature of the machine is a magnetic drum storage system in which the two sets of recording and pick-up heads (16 heads on each) can be shifted automatically to any one of 16 positions across the 256 tracks on the drum in 25 milliseconds. This facility permits a great saving in electronic equipment and in fact about 1,300 miniature valves are used.

Numbers are represented in binary form by trains of pulses at a p.r.f. of 1 Mc/s, each train (or "word") containing 32 binary digits or the equivalent of 9 decimal places plus a sign. The magnetic storage drum will hold 8,192 of these "words." High speed of operation, however, is achieved partly by the use of acoustic delay lines of limited capacity for the main store, giving quick access to the stored information. Another saving of time is achieved by the precise timing of the coded instructions which initiate the various arithmetical operations. Most operations are, in fact, accomplished in 64 microseconds.



WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

B.B.C. Band III Television

WHEN announcing the plan for the clearance of mobile radio from Band III (see our May issue) the retiring P.M.G.—Earl De La Warr—stated that four of the eight channels ultimately to be made available for television would be allocated to the I.T.A. and the remainder for an alternative service in that band. In anticipation, therefore, of the P.M.G.—whoever he may be in the next Government—granting these channels to the B.B.C. for a second television service, the Corporation has ordered sound and television transmitters for two stations.

The 10-kW vision transmitters with the associated 2.5-kW sound transmitters are scheduled to be delivered by Marconi's towards the end of next year.

Competitive Television

LONDON'S first competitive television programme is to be broadcast on September 22nd from the I.T.A.'s transmitter being built at Beaulieu Heights, Croydon. The I.T.A. announces that for a few weeks prior to the opening, high-power test transmissions will be radiated.

The transmitter, which will have an e.r.p. of 60 kW, will radiate in Channel 9 with offset carriers (vision 194.75675 Mc/s, sound 191.27 Mc/s). The approximate service area was given on page 12[illegible] of our [illegible] issue.

Import-Export Ratio

THE provisional figure of £7,625,000 for British radio equipment exported during the first quarter of this year is an increase of more than £650,000 on the figure for the same period in 1954—a record-breaking year. The Radio Industry Council in announcing this figure draws attention to the continued marked rise in the overseas sales of sound recording and reproducing equipment. The value for the first three months of the year was £1.3M, an increase of more than £430,000 over the same period last year when exports for the whole year were valued at the record figure of £3.7M.

Although exports of valves and c.r. tubes increased during the period under review by some £175,000, and, moreover, imports of these accessories fell by nearly £130,000, there was still an adverse balance of trade of over £50,000 in this section of the industry.

Taking radio equipment as a whole, imports (according to figures issued by the Board of Trade) increased by £650,000—the increase recorded for exports.

PERSONALITIES

Sir Edward Appleton, F.R.S., the new president of the Radio Industry Council in succession to Lord Burghley (who has held the office since 1952), has been principal and vice-chancellor of Edinburgh University since 1949. For ten years prior to going to Edinburgh Sir Edward was secretary (administrative head) of the Department of Scientific and Industrial Research. It will be recalled that in 1947 he was awarded the Nobel Physics Prize for his work on atmospherical physics and his discovery of the Appleton layer.

R. H. Hammans, recently appointed chief television engineer of Granada Theatres—one of the four programme contractors to I.T.A.—was with the B.B.C. from 1935 until taking up his new appointment. Originally on sound outside broadcasts he transferred to television O.B.s in 1937. Before going to the B.B.C. he was with the International Marine Radio Company for four years. Mr. Hammans, who operates an amateur station with the call G2IG, is executive vice-president of the **R.S.G.B.**

Alfred H. Whiteley, O.B.E., Comp. Brit.I.R.E., the new president of the Association of Public Address Engineers, founded in 1926 at the age of 33 the Whiteley Electrical Radio Company, manufacturers of components, accessories and electronic equipment. He was elected a Companion of the Brit.I.R.E. in 1949 and became the first Companion to serve on the Council of the Institution.

T. D. Humphreys, M.Brit.I.R.E., who joined Reproducers and Ampliers, Ltd., as general manager in 1953, has been elected to the board. Before going to R. & A., he was general manager of Radar Components, Ltd., and was previously with A. C. Cossor, Ltd.

L. Kearton Parker has joined Winston Electronics, Ltd., of Hampton Hill, Middlesex, as chief sales engineer. He was for ten years with the Telephone Manufacturing Company, Ltd., which he joined in 1945 at the age of 29, and was for some time head of the audio and acoustics section of the Development Department. From 1952 to February this year he was telecommunications consultant to the company.

In addition to those mentioned in our last issue who had received the Insignia Award in Technology (C.G.I.A.) **Charles H. Rumble** received the award for his thesis on the manufacture of matrices for the production of long-playing records. Mr. Rumble is a director of the Transcription Manufacturing and Recording Company, Ltd., of Mitcham, Surrey.

Sir George Nelson, who is chairman and managing director of the English Electric group of companies, which includes Marconi's, has been appointed a governor of the Imperial College of Science and Technology.

OUR AUTHORS

W. C. Pafford, contributor of the article on some problems of lighting in television studios, is both a television engineer and lighting engineer. In 1932 he joined the B.B.C. Midland Regional transmitter which was then transmitting sound for the 30-line television experiments. He became a maintenance engineer on 405-line television in 1936 and was later in charge of maintenance and wartime operations at Alexandra Palace. Mr. Pafford, who is now a lighting supervisor on television O.B.s, is also an artist and a number of his cartoons, signed "Paff," have appeared in *Wireless World.*

G. H. Leonard, who describes a wobbulator adaptor for Band III in this issue, has for six years been with Ultra Electric, Ltd., where he is senior engineer in charge of radio and television test equipment. He was educated at University College, London, graduating with honours in physics in 1947.

OBITUARY

Charles J. Pannill, who was the first chairman of the Board of editors of our American contemporary, *RCA Review*, until publication was temporarily suspended in 1942, died in New York in February. He was associated with Professor R. A. Fessenden in his early wireless experiments and in 1912 received the first American radio operator's licence. He became general manager of Radiomarine Corporation of America in 1928 and was president when he retired in 1947.

Arthur H. Morse, who was with the Marconi Company as an engineer specializing in direction finding before going to N. America in the early 1920s to become managing director of the Canadian Marconi Company, died in New York on April 6th, aged 74. He joined Marconi's on their acquisition of United Wireless Telegraph Co., of which he was superintendent. In his book "Radio: Beam and Broadcast," published in 1925, he reviewed the history of radio patents, on which he was an acknowledged authority.

IN BRIEF

Television Licences in force in the United Kingdom increased during March by 96,373, bringing the total to over 4.5 million. The number of domestic sound-only licences totalled 9,208,936 (including 62,506 issued free to blind persons). Television licences totalled 4,503,766 and car radio 267,794, giving an overall total of 13,980,496.

Competitive Television.—The licence granted by the P.M.G. to the I.T.A. on April 6th for the operation of its stations will continue in force until July, 1964. It names only the Croydon station but permits the establishment of stations "at such other places in the United Kingdom, the Isle of Man or the Channel Islands, as shall be approved." The annual fee payable is £500.

B.R.E.M.A. Council.—The following member firms of the British Radio Equipment Manufacturers' Association have been re-elected to the executive council for the ensuing year. The names of the companies' representatives are in parentheses: Balcombe (E. K. Balcombe); Bush (G. Darnley Smith); Cole (G. W. Godfrey); Cossor (J. S. Clark); English Electric (D. C. Spink); Ferguson (L. Bentley-Jones); G.E.C. (M. M. Macqueen, chairman); Gramophone Co. (F. W. Perks); Kolster-Brandes (P. H. Spagnoletti); Philips (A. L. Sutherland); Pilot (H. L. Levy) and Ultra (E. E. Rosen).

At the annual general meeting of the **British Sound Recording Association** on May 13th Norman Leevers, director of Leevers Rich and Company, was re-elected president for a second year of office. R. W. Lowden continues as honorary secretary, H. J. Houlgate, membership secretary and D. W. Aldous, technical secretary.

It was announced at the annual dinner of the **British Wireless Dinner Club** that Harold Bishop (B.B.C. Director of Technical Services) and Earl Mountbatten had accepted the invitations to become president and vice-president respectively. The membership now totals 368.

Independent Commercial TV? A special licence was granted by the Post Office to the J. Arthur Rank Organization for relaying television programmes, including specimen "commercials," by a 6,800-Mc/s transmitter from the State Theatre, Kilburn, to the British Industries Fair at Olympia, where demonstrations of Cintel large-screen television were given.

The present extended schedule of B.B.C. **Television Trade Tests** (weekdays 11.0-1.0) which was introduced last September will continue until August 31st.

Since we published particulars of the international contest for **Radio-Controlled Models** in our May issue the dates have been changed. The boat competition will be on July 30th and the aircraft contest on the following day. Further details are obtainable from D. W. Aldridge, 1, Fowberry Crescent, Fenham, Newcastle-upon-Tyne, 4.

I.T.A. Headquarters.—Towards the end of June the I.T.A. plans to move from the temporary premises at Woods Mews, Park Lane, occupied since last October, to its permanent administrative headquarters at 13-14, Princes Gate, London, S.W.7.

Transistor-Grade Germanium—single crystal or polycrystalline—is available to specified characteristics from G. A. Stanley Palmer, Maxwell House, Arundel Street, Strand, London, W.C.2, who will supply small quantities if required.

Band III Tests.—There has been some confusion regarding the times of the transmissions (vision 194.75 Mc/s, sound 191.27 Mc/s) from the Belling-Lee station, G9AED, at Croydon. A test pattern is now radiated from 10.30-12.30 and 2.0-4.0 (Monday to Friday) and 10.0-1.0 (Saturday).

What is V.H.F.? What is f.m.? Shall I need a new set to receive v.h.f.? These questions and many more are answered for the non-technical listener in a booklet prepared by the Engineering Information Department of the B.B.C. Sketch maps giving the approximate coverage of the first ten v.h.f. stations planned are included in the 12-page booklet obtainable free from the B.B.C. Publicity Department, 12, Cavendish Place, London, W.1.

Maximum Allowances for second-hand sound and television receivers purchased by dealers are given in the booklet "Used Radio and Television Set Values (1955)" prepared by the Radio and Television Retailers' Association and published by the Trader Publishing Company. It costs 2s 9d, including postage. The oldest sound and television receivers listed are of 1949 vintage. A nominal allowance of £2 is quoted for older television sets.

EXHIBITIONS

Twenty papers on the production and properties of plastics will be presented at the Convention which is being held during the **British Plastics Exhibition** at Olympia from June 1st to 11th. Admission to the exhibition, which is organized by *British Plastics* and will be open daily from 10.0-6.0, is 2s 6d.

"Silicones for Industry" is the title of an exhibition covering the production and application of silicones, which is being held at the Midland Hotel, Manchester, from June 13th to 18th. Invitation tickets can be obtained from the organizers, Midland Silicones, Ltd., 19, Upper Brook Street, London, W.1.

Instruments on Show.—The third British Instrument Industries Exhibition opens at Earls Court on June 28th. It will be open from 10.0-6.30 daily (except Sunday) until July 9th. Admission is 2s 6d.

Amateur Radio Show.—The R.S.G.B. has tentatively booked accommodation in the Royal Hotel, Woburn Place, London, W.C.1, for the week November 21st-26th for this year's amateur radio show.

A Scottish Exhibition of electronic equipment in which 26 firms are participating has been arranged at the School of Engineering, Burnbank, Lanarkshire. It will be open daily (10.0 to 9.0) from June 6th to 11th.

BUSINESS NOTES

An order for six more v.h.f. transmitters, making 46 in all, has been placed by the B.B.C. with **Marconi's.** They will provide a three-programme service from Holme Moss; two transmitters being operated in parallel for each programme. The Corporation also has on order 38 transmitters from Standard Telephones & Cables.

Aveley Electric, Ltd., representatives for Rohde and Schwarz, Munich (communication and laboratory equipment), are closing their office in Tottenham Court Road, London, W.1, on June 12th and moving into a new factory at Ayron Road, Aveley Industrial Estate, South Ockendon, Essex (Tel.: South Ockendon 3292).

Closed-circuit television equipment has been installed in a ship of the Royal Canadian Navy by **Pye Canada, Ltd.**, to permit visual communication from the operations room to various key points in the vessel. A camera in the operations room will be focused on the plotting chart upon which the movements of other vessels are recorded. Receivers will be installed at five or six key points in the ship so that officers will have an immediate picture of the tactical situation rather than mere information about it.

Radio communication equipment, radar and other electronic aids to navigation and fishing have been installed by the **Marconi International Marine Communication Company** in the new fishery research vessel *Sir William Hardy*. Other recent Marconi Marine installations include communication equipment and d.f. gear in the new 32,000-ton-capacity steam turbine tanker *British Victory*, telegraphy-telephony transmitter, receivers, echometers and direction finders in the motor trawler *Princess Anne*, and an R/T transmitter-receiver and echometers in the motor trawler *Bermuda*.

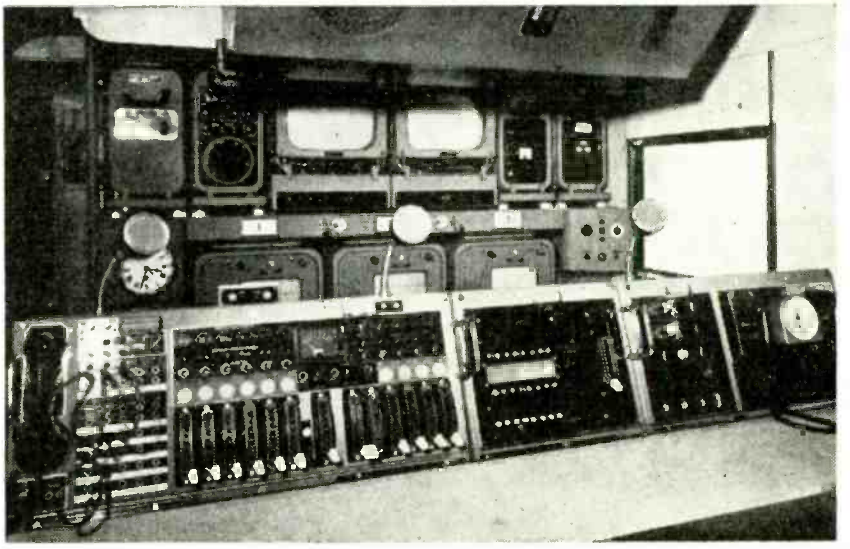
McMurdo Instrument Company, of Ashtead, Surrey, announce that sales of their Unitags, both unassembled and assembled, are now conducted by Harwin (Engineers), Ltd., 101, Nibthwaite Road, Harrow, Middx. (Tel.: Harrow 0381), to whom all enquiries and orders for this component should be sent direct.

Airtech, Ltd., of Aylesbury and Thame Airport, Haddenham, Bucks, have been awarded, by the Canadian Department of Defence Production, the contract for the maintenance and repair of all radio and electronic equipment used by the Canadian air force in the United Kingdom.

Gresham Transformers, Ltd., have transferred the production of small transformers for the Electronics Division to their Lion Works on Hanworth Trading Estate, Feltham, Middlesex. K. G. Lockyer, B.Sc., A.M.I.E.E., A.M.Brit.I.R.E., who has been appointed manager of Lion Works, was formerly production manager with Solartron Laboratory Instruments, having previously been with Philips (Mitcham Works), Plessey and London Electrical Company.

A transposition of figures in **Goodmans'** advertisement in this issue has been noticed since the page went to press. The fundamental resonance of Type 1205 is 75 c/s and that of Type 1210 is 35 c/s.

Among the contracts recently placed with **Pye Marine** for v.h.f. radio-telephone equipment are installations for 10 tankers operating on the Manchester Ship Canal; for Aberdeen fishing vessels—providing short-range intercommunication whilst fishing in pairs; and for the new Trinity House pilot vessel *Pathfinder*. Pye Marine have also provided a fixed station at the boat yard of Saunders-Roe (Anglesey), Ltd., and a mobile set is taken on board new craft undergoing sea trials so that results of the tests can continually be communicated to the yard at Beaumaris.



THE LATEST B.B.C. mobile control room for television O.B.s which is fitted with three Marconi cameras and associated control and monitoring equipment. In the foreground are the 10-channel sound-mixing panel and the vision-mixer which will accept eight inputs. Behind are the picture monitors.

A new factory at West End, Congleton, Cheshire, has been bought by **Aerialite, Ltd.,** for the manufacture of television aerial equipment, convertors and components.

The radio components (Clix) and wiring accessories departments of the **Edison Swan Electric Company, Ltd.**, have moved from 21, Bruton Street, London, W.1, to the company's head office at 155, Charing Cross Road, London, W.C.2 (Tel.: Gerrard 8660).

EXPORT NEWS

The equipment for another radio link for the Swiss television network has been supplied by the **General Electric Company**, who equipped the trans-Alpine link in time for the European programme exchange last year. The new link connects Uetliberg (Zurich) with La Dole (Geneva)—a distance of about 150 miles—and also ties in with the earlier installation linking Chasseral and Monte Generoso.

An order worth over £20,000 to supply the Eire Department of Posts and Telegraphs with three 12-channel open-wire telephone carrier systems has been secured by the **Automatic Telephone and Electric Company** in face of keen Continental and American competition. The equipment will link Limerick and Tralee, Limerick and Ennis, and Mulingar and Cavan.

A technical assistance mission from the International Civil Aviation Organization is advising the Afghanistan government on bringing the country's two main airfields up to international standards. As part of the development scheme the Department of Civil Aviation has ordered from **Redifon, Ltd.**, twelve 5-W radio-telephones, three 50-W radio-telephones, two 500-W h.f. transmitters for ground-to-air telephony, two non-directional beacons and four communication receivers. Twelve of these communication receivers, which cover the range 13.5 kc/s to 32 Mc/s, have also been ordered by the New Zealand Posts and Telegraphs Department.

Six studio tape recorders (Type BTR/2A) have been ordered from **E.M.I. International, Ltd.**, by All India Radio, which has previously ordered 17 transportable tape recorders (Type TR/50A). Thirty-two of these transportable instruments have also been supplied to the Indian Ministry of Information and Broadcasting.

Redifon radio equipment has been installed in the fleet of 75-ft motor trawlers built in Hong Kong for the South Korean government under a United National Korean Reconstruction Agency procurement plan.

Components Exhibition

TRENDS EVIDENT AT THIS YEAR'S R.E.C.M.F. SHOW

The "private" exhibition held in London by the Radio and Electronic Component Manufacturers' Federation from 19th to 21st April is reviewed in these pages. In addition to describing in detail some of the new components and accessories shown, we give in each category a list of exhibitors and their main products. Test and measuring equipment, and also valves, are dealt with on pp. 274 and 277. New sound-reproducing equipment will be discussed in a later issue.

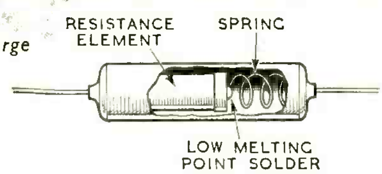
RESISTORS

ONE of the most interesting and useful resistance devices seen for some time was shown this year by Erie. It consists of a low-value resistor with a tensioned coil spring soft-soldered to one end, the whole being enclosed in a ceramic capsule. It is intended to combine the functions of a surge limiting resistor and fuse in the anode circuit of mains rectifiers and is appropriately called a fuse resistor. In the event of a heavy current flowing for an appreciable time the heat generated in the resistor melts the solder and releases the spring and so opens the circuit. The fuse "blows" about 15 sec after the breakdown, or short circuit developing.

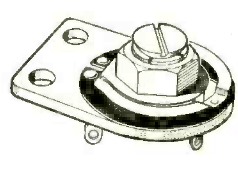
Metallized film resistors are being more widely adopted where high stability is required and although the technique is not new it laid dormant for many years before revival in admittedly a modernized form a few years ago. The latest addition to this type is the new "Q" model developed by Erg. It measures 2in long by $\frac{11}{32}$in in diameter and is rated at 2 W. The metal film is deposited on a glass rod and then spirally cut to give the required resistance values.

Two main lines of development can be seen in connection with the ubiquitous carbon volume control. One is the introduction of still smaller models with, of course, lower wattage ratings. For transistor equipments only low-wattage types are required at present. Egen have a sub-miniature pre-set open type rated at $\frac{1}{10}$ W and measuring approximately $\frac{3}{4}$in × $\frac{1}{2}$in; Plessey have one, described as the Type G, on a circular base of just over $\frac{1}{2}$in in diameter while Morganite have some models designed originally for hearing aids and later developed for other uses.

Right: Erie anti-surge fuse resistor



Left: Double "Q" volume control made by Dubilier



Right: Miniature $\frac{1}{10}$W pre-set volume control (Egen)

Reduction in size of the domestic-type volume control proceeds apace and several firms, Dubilier being one, have extended the idea by ganging their miniature "Q" type in order to save panel space. Concentric spindles are employed. Ganged type are popular in mobile equipments and especially in car radio sets where the frontal aspect has to be kept down.

The final main development is complete sealing of the element, the object being to give better stability under widely varying conditions of temperature and humidity. Many ingenious ways are employed to seal the spindle without introducing too much friction.

Manufacturers: A.B. Metal Prodts.; British Elect. Res.; Bulgin; Colvern; Dubilier; Egen; Electronic Comp.; Electrothermal; Erg; Erie; Labgear; Morganite; N.S.F.; Painton; Plessey; Salford; Welwyn; W.B.; Zenith.

CAPACITORS

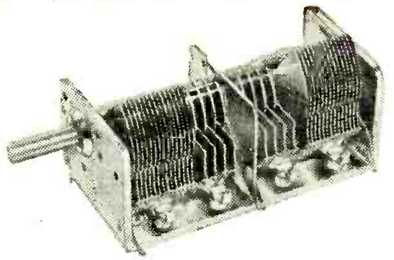
TWO fairly recent developments in electronics are largely responsible for a new trend in capacitor design. One is the transistor, which has called for some quite high-value capacitors for low-voltage operation (1.5 volts upwards). The other is the more recent jump to popularity of the printed circuit. This, and the transistor assault, has required capacitor makers to think in terms of sub-miniature parts, so we now have quite a large number of what can only be described as lilliputian capacitors, fixed and variable.

T.C.C. have introduced a range of low-voltage electrolytics designed especially for transistor circuits. Known as the CE58 series, they have capacitances ranging from 0.25 μF to 6 μF and in working voltages of from 25 for the small capacitance to 1.5 for the larger. Those in this series measure $\frac{5}{8}$in long and only $\frac{1}{8}$in in diameter. Some slightly larger models with higher working voltages are also available.

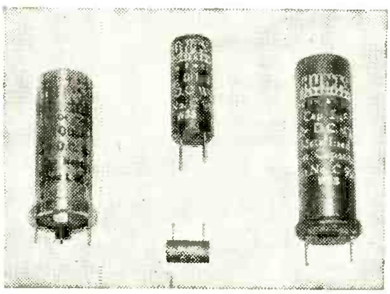
Sub-miniaturization of ceramic and other types is being applied for use in printed circuits, also the position and kind of connecting wires may be almost, if not quite, as important as the size of the component itself. Erie has introduced a range of components, including capacitors, described as "stripped." The omission of moulded cases and other "protection" has resulted in quite a big reduction in size. While the lead-out wires are arranged to suit their own particular versions of the printed circuit there are many Erie capacitors that meet without modification the requirements of other styles of printed circuitry.

Hunt's have modified several of their existing capacitors for printed circuit use. The main changes consist of fitting thin easily solderable wires to electrolytics and other capacitors which previously had unsuitable connections and bringing out the leads along the side of a tubular rather than at the extreme ends. The "Thermetic" Type W97 is a new Hunt's product and is one of the smallest metal-clad metallized-paper capacitors seen so far. A 400-V, 0.001-μF capacitor in this range measures only 0.135in in diameter and 0.61in long. The range includes 200-, 400- and 600-V type from 50 pF to 0.04 μF.

A smaller version of the Polystyrene series of capacitor made by Suflex is now available; it measures only $\frac{1}{2}$in



Wingrove and Rogers a.m./f.m. two-gang capacitor.



Hunt's capacitors modified for printed circuits.

long and $\frac{3}{16}$in in diameter and is made in capacitance ranging from 5 to 250 pF. Some Suflex models now have the connecting wires brought at one end instead of at both ends; these are intended primarily for printed circuit use, but have other applications as well.

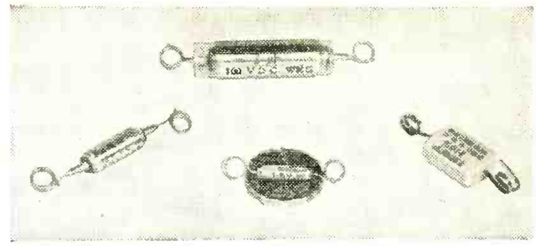
Although Dubilier did not show capacitors made especially for printed circuits it was pointed out that so many of their capacitors are in the lilliputian class that they fit the requirements without modification. They have introduced a new range of lead-through capacitors for use with screened rooms and screened equipment of various kinds. They are metal clad and some models are actually two capacitors back-to-back with a common "earthing" plate between them. Some of the larger (physically speaking) models will carry as much as 5A; a 0.1-μF type in this category measures only $\frac{3}{4}$in in diameter and extends $1\frac{1}{8}$in either side of the earthing flange. This model is for 250 V a.c. or d.c. working.

An interesting development is a vitreous capacitor using glaze for both the coating and the dielectric. Known as the Vitricon range they are made by Welwyn Laboratories, and are said to be quite satisfactory for use up to 150° C. At this temperature the insulation resistance is better than $10^{10}\,\Omega$. They are quite small and available in a wide range of values.

The demand for a tuning capacitor suitable for an a.m./f.m. receiver has been met by Wingrove and Rogers with a model having a normal capacitor section associated with a special wide-spaced anti-microphonic v.h.f. section. The v.h.f. sections are set in the middle of a 2-gang assembly each side of the dividing screen with the a.m. sections before and behind them respectively. A capacitance swing of 17.4 pF is provided for f.m. tuning. These are available to manufacturers only.

Jackson Bros. have a range of gang capacitors embodying what is described as a band-spread section in each unit. These sections can be of various values and the smallest, giving about a 12-pF swing, would serve a.m./f.m. requirements. The main capacitor unit is of the usual size for medium- and long-wave use.

Special two-gang variable capacitors for f.m. units and convertors giving under 20 pF coverage were shown by Plessey, Jackson and Wingrove and Rogers, while a long range of lilliputian variables in single, butterfly and split-stator patterns were seen on the Stratton stand. These have small-diameter spindles and provision is made for



Selection of latest T.C.C. capacitors including transistor sub-miniature types.

ganging any number by means of appropriately small flexible couplers.

Manufacturers: B.I. Callenders Cyldon; Daly; Dubilier; Erie; Hunt; Jackson Bros.; London Elect. Manf.; Mullard; Plessey; Stability Radio; Stratton; Suflex; T.C.C.; T.M.C.; Walter Inst.; Wego; Wingrove and Rogers.

COILS AND TRANSFORMERS

BY combining a 10.7-Mc/s i.f. transformer with one of 465 kc/s or so in a single screening can a considerable saving can be effected in the space taken up by i.f. transformers in an a.m./f.m. receiver. Dual i.f. transformers of this kind were shown by the Wireless Telephone Company (one of the Plessey group) and by Weymouth.

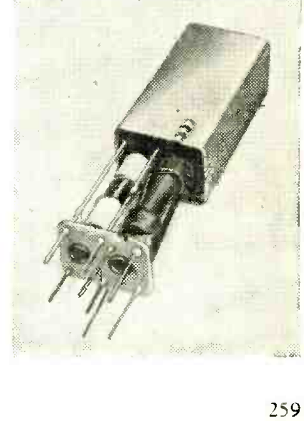
The W.T.C. model is housed in an aluminium can measuring $1\frac{1}{4}$in × 1in × $2\frac{1}{2}$in high and the two transformers are mounted side-by-side lengthwise in the can with the dust cores accessible from top and bottom. Each is independently trimmed. The "Q" of the a.m. transformer is given as 110 and that of the f.m. one somewhat less. The f.m. bandwidth is said to be about 330 kc/s. In addition to the dual i.f.s. there is a dual a.m./f.m. ratio detector unit and a separate 10.7-Mc/s i.f. transformer.

In the Weymouth models the two transformers are assembled crosswise in the can with the dust cores accessible from two opposite sides. The f.m. transformer is designed for 10.7-Mc/s working, has a bandwidth of 330 kc/s measured between 6-db points and a nominal "Q" of 80. The companion a.m. transformer is designed for an 11-kc/s bandwidth (6-db points), has a "Q" of 55 and is centred on 470 kc/s. The ratio detector model has a peak-to-peak bandwidth of 400 kc/s and the a.m.-rejection is said to be −45 db.

Stratton also were showing some 10.7-Mc/s and some 5.2-Mc/s transformers, and these included both ratio detector and Foster-Seeley types.

Except for improvements to detail nothing outstanding was seen in the design of iron-cored components. Further developments and expansion in the application of the resin potting technique was evident, and in the principal makes there are now some four different styles available; resin cast, metal potted with some kind of filling, hermetically sealed and open windings, now almost always vacuum impregnated.

Manufacturers: Advance; Associated Electronic; Elac; English Electric; Ferranti; Goodmans; Gresham; Igranic; Parmeko; Partridge; Plessey; R. & A.; Rola; Stratton; T.M.C.; Weymouth; Wireless Telephone; W.B.; Wodeh; Wearite; Zenith.



Wireless Telephone (Plessey) a.m./f.m. dual i.f. transformer.

TELEVISION COMPONENTS

THE double-triode cascode r.f. amplifier and the triode-pentode frequency-changer form the basis of nearly all television receiver "front-ends." Tuners embodying them fall into two groups of similar external appearance and controls. Most have switch station selectors with 12 positions giving a choice among five Band I and seven Band III stations. The other control is an oscillator trimmer.

In one group, the turret tuners, there are individual coils for each station, fixed to strips carrying the connecting contacts which are mounted on a rotating framework. The individual coils are thus brought round to the circuit for connection. The other group is of the incremental inductance type. Wafer switches are used and between each pair of contacts is connected the small inductance needed to change the tuning from one channel to the next. With this type, alignment must be done first on the highest frequency channel, then on the next channel lower and so on. With the turret tuner, however, the coils for each channel can be aligned independently.

The Cyldon Teletuner Mark 1 is of the turret type and is claimed to have noise factors of 5 db and 9 db on channels 1 and 8 with gains of 43 db and 36 db. The oscillator drift is stated to be under 100 kc/s for a temperature rise to 60°C.

The N.S.F. tuners are examples of the incremental-inductance type. One model covers not only the 13 Bands I and III stations but has an extra switch position to enable reception to be obtained in the u.h.f. band if it becomes necessary in the future.

The Weymouth television i.f. strips are virtually complete receivers except for the scanning circuits and power supplies. They comprise sound and vision i.f. amplifiers with the detectors, noise limiters, video stage and sync separator. The r.f. side is made as a separate unit which can be dropped into a cut-out in the main chassis.

This firm also showed a two-valve convertor for Band III which is designed to provide an output in Band I at the frequency of the local station. Aerialite also showed Band III convertors intended for use with any Band I receiver.

Little change was evident this year in scanning components save in details of design. The use of Ferroxcube, dust-iron and similar materials has obviously come to stay, as has the castellated yoke. Mullard now have such a yoke with 16 slots, enabling a better field distribution to be secured. Deflection assemblies for 90° tubes were shown by several firms, including Igranic and Plessey, and can be picked out at once from the 70° types by the enormous turned-up front ends of the line coils. It is interesting to see that in these assemblies the frame coils are not the conventional saddle type but are the so-called toroidal type. That is, there are four frame coils wound around the core material.

Line-scan transformers are of the type that has now become conventional, but it is obvious that increasing attention is being paid to insulation. In some Igranic models, for instance, the e.h.t. rectifier is mounted inside what can only be termed a plastic "bath-tub"!

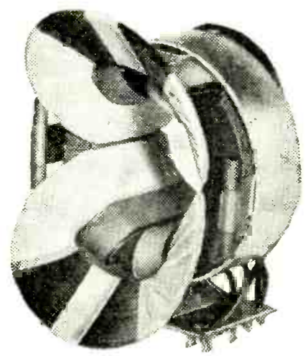
The permanent magnet for focusing and for ion traps was well in evidence. Goodmans showed a new focusing unit in which the magnets are held by a die-casting, while Elac showed several types. Among these is the Duomagnette with two opposing ring magnets. The Marrison & Catherall unit is designed to minimize astigmatism and both the focus and the shift controls can be adjusted from outside the receiver.

***Makers:** Aerialite (C); Cyldon (T); Elac (F); Goodmans (F); Igranic (D, Tr.); Long & Hambly (M); Marrison & Catherall (F); James Neill (F); N.S.F. (T); Plessey (D, F, T, Tr); Weymouth (C); W.B. (D, F, Tr).

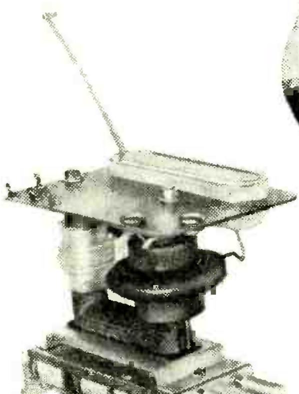
***Abbreviations:** C, convertors; D, deflector coils; F, focus units and ion-trap magnets; M, masks; T, tuners; Tr, transformers.

SUB-ASSEMBLIES

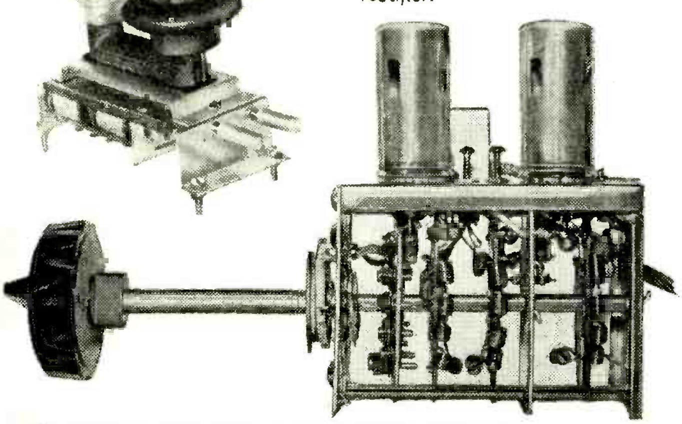
AMONG the larger items in this category was a new a.m./f.m. tuner shown by Weymouth. It covers the medium- and long-wave bands and the full f.m. allocation from 84 to 96 Mc/s, and the wavechange switch also has a position for "Gram." The r.f. amplifier is a 6AM6 and is operative only on the f.m. band, while the frequency changer is a 6BE6. Maximum power consumption is 0.6 A at 6.3 V for l.t. and 12-22 mA at 200 V for h.t. Another new tuning unit, for the medium-wave band, was shown by Cyldon, but this contained no valves and was simply a



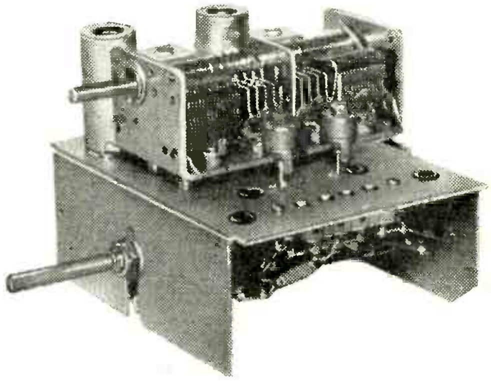
Right: Plessey deflector coil for 90 degree tube.



Left: Igranic line-scan transformer; note the "bath-tub" for the rectifier.



N.S.F. television tuner of the incremental-inductance type.



Weymouth a.m./f.m. tuner.

system of pre-set permeability-tuned coils operated by push-buttons, with facilities also for manual tuning.

Printed circuits were very much in evidence and a wide range of circuit configurations, including Band I/Band III television tuners and aerial cross-over networks, 35-Mc/s i.f. transformers, computor panels, transistor circuits and r.f. filters, were displayed by T.C.C. These were made by the conventional etching process, but examples of a new method of manufacture were to be seen on the Erie stand. In this the insulating base material is embossed with the required circuit and the copper foil is pressed into the declivities, the excess copper on the raised parts being milled off afterwards. The method is claimed to avoid any troubles which may be caused by acid remaining from the etching process and also to give thicker conductors capable of carrying more current.

The valve-circuit support shown by McMurdo last year, with the valveholder mounted on top of a plug-in pedestal, is now supplied by the makers with the customer's circuit components already assembled and potted in a solid cylinder of resin around the pedestal.

Makers*: Advance (D); B.I.C. (D); Cyldon (T); Erie (P); Ferranti (D); Hunt (P); McMurdo (VC); Plessey (P, LA); T.C.C. (P); Wego (D); Weymouth (T, LA); Wright and Weaire (LA).

***Abbreviations:** D, delay networks; LA, coil assemblies; P, printed circuits; T, tuning units; VC, valve circuit assemblies.

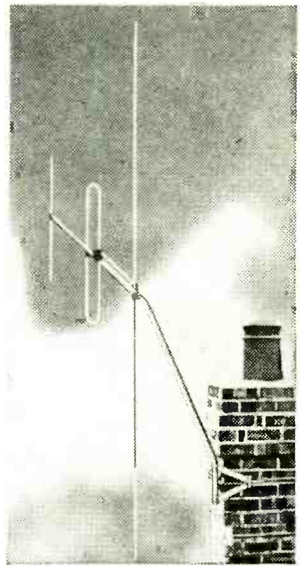
AERIAL EQUIPMENT

ALTHOUGH the new f.m. broadcast service is due to commence long before Band III television will materialize the whole emphasis in the aerial display at the show this year was Band III aerials and adaptors.

It is now apparent that anywhere outside the immediate vicinity, or swamp area, of a Band III station something more elaborate than a simple dipole, or dipole adaptor, will have to be used. This may not always be necessary in order to get a strong enough signal, but very often to differentiate between the direct signal and a signal arriving by an alternative path or paths and produced by reflections from buildings of one kind or another. These invariably give rise to ghost images.

Simple adaptors for existing types of Band I aerials will find many applications and some quite ingenious and inexpensive arrangements were seen this year. For example, Belling-Lee have a kit comprising a number of rods and two plastic insulators for holding them in position on a single dipole. The rods extend each side of the centre insulator and lie parallel with the dipole and partially enclose it. They behave on Band III as two transmission lines end-feeding the exposed end parts of the Band I aerial. These end parts behave as three-quarter wavelength aerials fed in phase. The result is that on Band III there is a gain of about 3 db over a plain dipole.

Belling-Lee combined Band-I dipole and director and folded dipole for Band III.

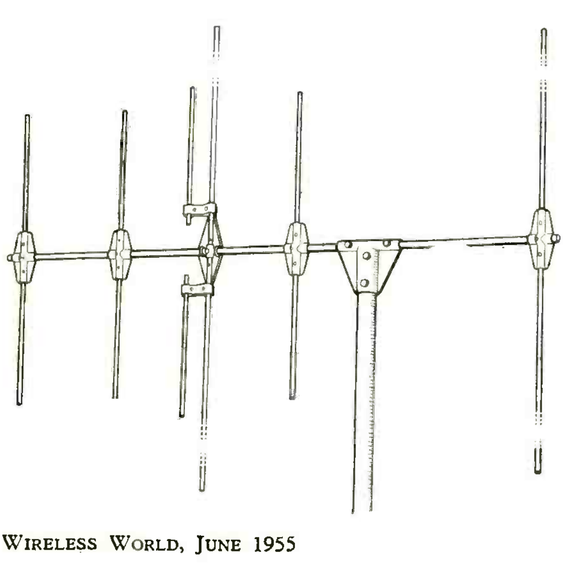


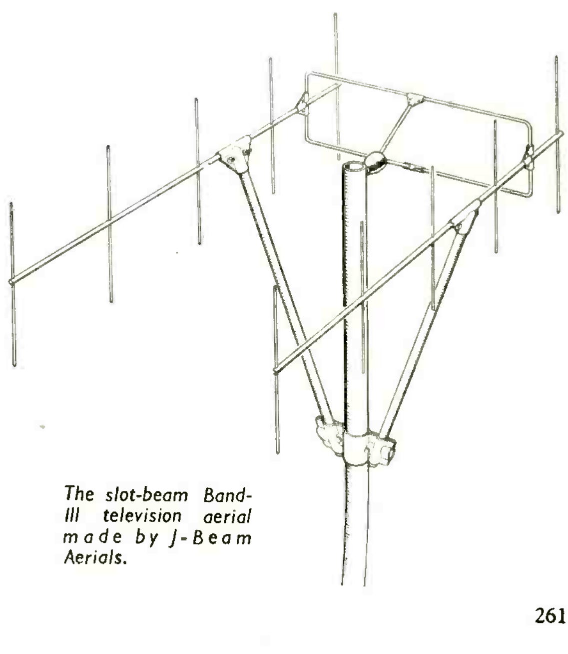
Other firms have applied various schemes which enable the Band I aerial to be made to operate as an harmonic-type aerial giving a gain over the existing aerial. Adaptors of one kind or another for "H" and "X" aerials were shown by Aerialite and Antiference.

The more elaborate kind of adaptor takes the form of two or more elements of Band III length fitted to an existing "H" or multi-element aerial and utilizing in some cases one of the existing larger elements to reinforce the pick-up on Band III. Sometimes the mast is employed as an untuned reflector element. These adaptors are arranged to be fixed either in line with the existing Band I elements or at any desired angle, the latter to cope with conditions arising from the Band I and Band III stations being differently sited. Aerialite, Antiference and Belling-Lee showed these additional aerial parts mounted on outriggers for attachment to the cross arm of an existing "H" type and capable of swinging to any direction required irrespective of the alignment of the "H." In all cases the aim is to provide more gain from the Band III system than given by the accompanying Band I aerial, as this will generally be found necessary.

Whereas a four-element aerial is about the largest it is practical to use for Band I, it will be quite practical to go to a 10- or 12-element Yagi on Band III, given a suitable kind of mast. The smallest independent Band III aerial was a 3-element one, the largest had 10 to 12

Antiference combined Band-I "H" and Band-III 4-element Yagi television aerial.





The slot-beam Band-III television aerial made by J-Beam Aerials.

elements, giving a gain over a plain dipole of 14 db or more. Like the Band I 4-element Yagi these multi-element types can be mounted either as a stack, i.e., one above the other with appropriate spacing, or as a broadside array; the two system being a half wavelength apart and side-by-side. Being generally smaller stacking or broadside mounting is more practical on Band III than on Band I. All the firms making aerials had several designs of this kind.

When separate Band I and III aerials feed into a single input on the receiver, or a combined aerial such as a Band I with adaptor elements feeds into separate inputs on the set, a filter is required between the aerial system and the receiver to prevent inter-action between the aerials. These filters take various forms, but basically they separate out the signals on the two bands and direct them along their correct courses. Belling-Lee call their unit a "Diplexer Tuned Filter." Antiference call theirs a "Y Box" and it provides rejection of the unwanted band of something over 20 db; its insertion loss is said to be no greater than 0.75 db on any channel and it is intended for 70- to 80-Ω cables.

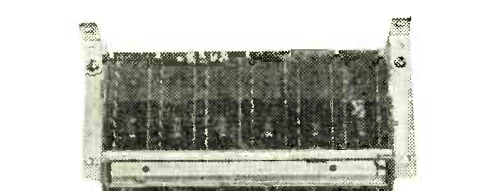
A Band III aerial of very unusual design is made by J-Beam Aerials. It consists of a horizontal skeleton slot flanked on each side by a 4-element vertical Yagi. The combination is matched to an 80-Ω cable and it is said to give a gain over a plain dipole of 14 db. The ends of the slot form bent-over aerial elements for the Yagis and the long sides the matching section for end-feeding the two Yagis. Although J-Beam Aerials specialize in end-fed television aerials this must surely be a unique application of the principle.

Manufacturers: A.B. Metal Products; Aerialite; Antiference; Belling-Lee; B.I. Callenders Cables; Henley's; J. Beam; Permanoid; Sutlex; Telcon; Transradio.

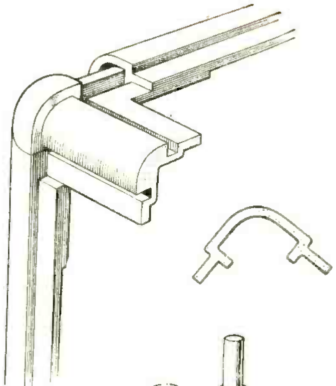
SWITCHES

THE advent of a.m./f.m. reception has obviously brought with it some complications in receiver switching. The new switches designed for this type of circuit by A.B. Metal Products bring to mind the days of press-button tuning, for they use a piano-key type of action. A maximum of eight keys can be provided in one unit and there are six sets of changeover contacts on each key. Mountings for coils are also incorporated. Slider switches intended for a.m./f.m. receivers were shown by Plessey, and these had a two-way action with as many as 10 poles available.

Amongst the rotary switches a new precision type on the Electronic Components stand was notable for the even pressure of the wiper contacts on the fixed contacts, obtained by a helical spring inside the wiper (see sketch). The switch has 32 positions and can be supplied with one, two or three poles and up to six banks. Another rotary switch using helical springs in a similar way was shown by N.S.F. and was capable of carrying up to 10 amps. A version of the well-known German Winkler rotary switch is now being made by Painton, and a notable improve-



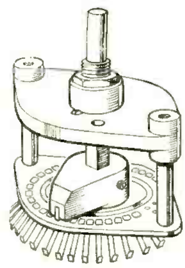
A.B. Metal Products piano-action switch.

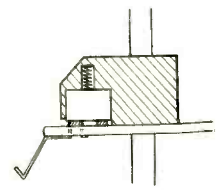


Carr Fastener plastic locking nut.

Left: Imhof-Elliott interlocking system for cabinets.

Electronic Components precision rotary switch.





ment is the use of a moulded panel to carry the fixed contact studs. The contacts can be silver-, gold- or rhodium-plated.

A new range of micro-switches was shown this year by Pye, with operating pressures ranging from 3 oz to 18 oz. Some of these are worked directly by the plunger while others have a lever acting on it. The contact ratings are all 5 A, 250 V for a.c. and 5 A, 12-29 V for d.c. Bulgin have extended their range of micro-switches and were again showing the more recent sub-miniature types which are not in the usual Bakelite cases.

Makers*: A.B. Metal Products (L, P, R, S); B.E.R.C.O. (R); Bulgin (L, M, P, R); Diamond, H. (L, R); Electronic Components (P, R); Erie (R); N.S.F. (L, P, R, S); Painton (L, P, R); Plessey (L, P, R, S); Pullin (R); Pye (M); T.M.C. (L, P); Walter (L, P, R, S); Whiteley (P, R, S); Wright and Weaire (R).

***Abbreviations:** L, lever or toggle; M, micro-switch; P, push-button; R, rotary; S, slide.

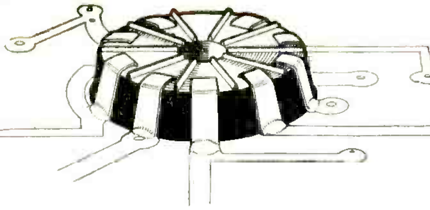
CHASSIS FITTINGS

THE rapid development of printed circuits is having a noticeable effect on the type of chassis fittings now coming on to the market. Flat, strip-type connectors were shown by Bulgin, McMurdo and Belling-Lee (see picture) and specially designed valveholders by Carr Fastener, McMurdo and British Mechanical Productions. Some of the valveholders have tags which project downwards through holes in the printed circuit plate, but the one shown by British Mechanical Productions has long spring fingers bent upwards which press on the edges of the circuit when the holder is let into a hole in the plate.

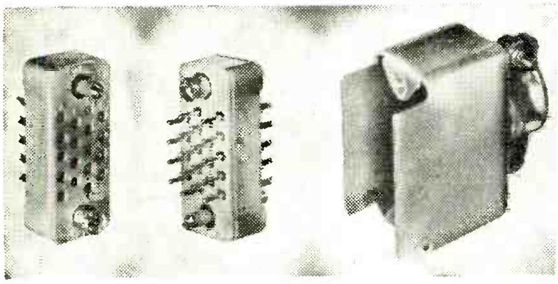
A wide range of spring clips for various applications was displayed by Simmonds Aerocessories, the two latest additions being clips for holding screening cans and a small coil-former support (see sketch). Another new fixing device was a self-locking plastic nut shown by Carr Fastener. It snaps into a hole in the metal and when a self-tapping screw is driven into it the plastic expands and grips tightly.

Tag-strip in a very simple and cheap form was a popular exhibit on the Creators stand. Known as "Plantag" it consists of a rigid P.V.C. moulding of L-shape cross-section with tags in one plane and fixing holes in the other, and it can be supplied in any length. By warming the P.V.C. the strip can be bent round in a circle if required.

Prefabricated cabinets were again the main feature of



Printed-circuit valveholder by British Mechanical Productions



McMurdo miniature connectors

the Widney Dorlec stand, and this year die-cast corner units were on view. Imhof have now entered this field in conjunction with Elliott Brothers, the instrument manufacturers, and they were showing an interlocking system for fixing the struts of the cabinet frame into the corner pieces (see sketch).

Makers: Aerialite; Antiference; Associated Electronic Engineers; Belling-Lee; British Mechanical Productions; Bulgin; Carr Fastener; Creators; Colvern; Egen; Electrothermal; Electronic Components; Hassett & Harper; Hellerman; Igranic; Imhof; Long & Hambly; McMurdo; Micanite; Painton; Plessey; Ross Courtney; Simmonds; Spear; Standard Insulator; Stocko; Stratton; Telcon; Thermoplastics; T.M.C.; Transradio; Tucker-Eyelet; Tufnol; Weymouth; Whiteley; Widney-Dorlec; Wimbledon; Wingrove & Rogers.

RELAYS

THE switching of r.f. circuits on coaxial cable presents a difficult problem in relay design because of the impedance mismatching which can occur. Besson & Robinson have tackled it successfully, however, and were showing three coaxial changeover relays with very low standing-wave ratios. The latest one, type A07, is characterized by having permanently fixed cable tails instead of sockets. The v.s.w.r. is 1:1.1 while the impedance is 45/60 ohms or 70/80 ohms and the operating voltage 17/28 volts d.c.

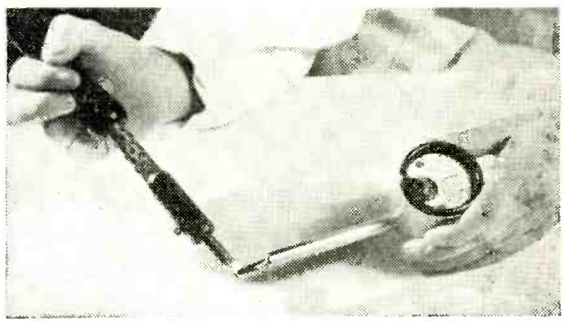
A new relay notable for its sensitivity was shown by Magnetic Devices. It operates on a current of 1 mA at under 0.5 V and will switch two circuits of either 5 A at 250 V a.c. or 5 A at 30 V d.c. The mechanism is hermetically sealed and mounted on an octal plug-in base. Like many other of the relays on show it has a balanced-type armature to prevent false operation by external shock or vibration. The Besson & Robinson K01, for example, an alternative to the Post Office type 3,000 relay, will withstand accelerations of up to 25*g*.

Makers: Besson & Robinson; Magnetic Devices; N.S.F.; Oliver Pell Control; Plessey; Pullin; T.M.C.; Walter Instruments; Woden; Zenith.

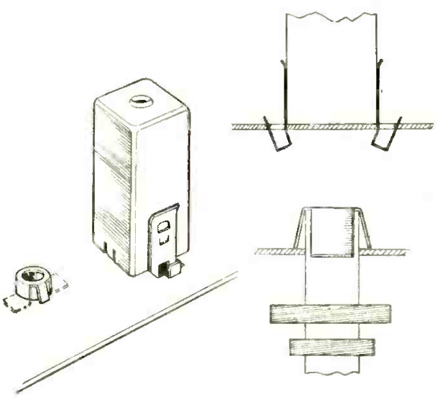
MATERIALS

IN the production of high-permeability nickel-iron alloys by conventional melting processes, the properties of the material are often adversely affected by the inclusion of impurities originating in the crucible lining or de-oxidizing fluxes. It is also difficult to control the composition due to the different rates of loss of the constituent elements. A powder-metallurgy process developed by Henry Wiggin and Company uses carbonyl nickel, iron and other metallic powders as raw materials, and retains the original measured proportions and produces an alloy which is less susceptible to the presence of water vapour in the hydrogen atmosphere used for final heat treatment. There is also less susceptibility to surface effects which reduce permeability when the strip is rolled, and an initial permeability of 25,000 is maintained down to a thickness of 0.0005in in Ni77, Fe14, Mo4, Cu5 alloy.

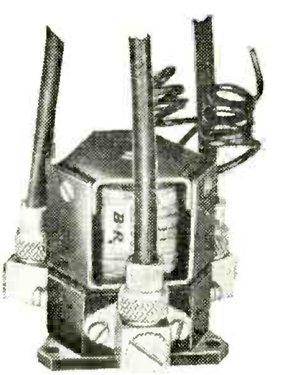
Most manufacturers of core laminations are concentrating on the production of oriented-grain silicon steels, primarily for "C" and "E" cores fabricated from bent strip. Strip thickness down to 0.002in are available from



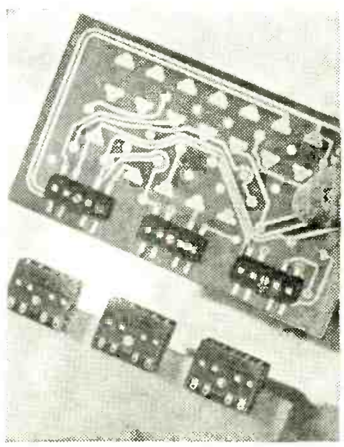
Multicore solder thermometer.



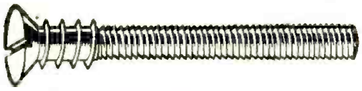
Clips for screening cans and coil former support by Simmonds Aerocessories.



Besson & Robinson coaxial relay with fixed cable tails.



Belling-Lee connectors for printed circuits.



G.K.N. loudspeaker fixing screw

Telcon-Magnetic Cores. Geo. L. Scott also supply flat laminations of this material 0.012in thick for cores assembled in the conventional manner. Joseph Sankey and Sons have introduced a new interlaminar coating which will withstand re-annealing temperatures of 800°C and is also waterproof.

Ferrite moulded cores for television line timebase transformers and deflection yokes, and extruded rod for r.f. inductors and aerials have been added to the range of moulded magnetic materials made by Salford Electrical Instruments.

Among "hard" magnetic materials the new Mullard "Ticonal L" anisotropic alloy, designed for loudspeaker magnets, is of special interest to manufacturers of loudspeakers using a centre-slug type of magnet assembly. It has a remanence of 14,000 gauss, and increases of up to 10 per cent on the previous upper limit of flux density of gauss/cm^2 are possible.

Most manufacturers of winding wires are now in production with polyurethane coatings which need not be previously removed before soldering. A new coating with exceptional resistance to the action of solvents has been developed by Connollys. It is known as "Conyclad" and consists of a basic layer of vinyl acetal enamel, coated with nylon. The outer layer protects the base enamel from "crazing" under the action of varnish solvents, and eliminates the annealing process which is normally adopted to reduce crazing.

The successful production of wave-wound coils depends upon the mechanical as well as the electrical properties of the wire, and Fine Wires, Ltd., have produced a range of single and multiple conductors with a variety of textile coverings specially for use on wave-winding machines.

Manufacturers of r.f. cables have anticipated the demand for Band III television aerial downleads with coaxial cables in which the dielectric is cellular polythene. Compared with a sold polythene dielectric cable the attenuation may be reduced by as much as 40 per cent, and typical figures for a 0.290in outside diameter cable are 3.3 db/100 ft at 200 Mc/s with a capacitance of 17 pF/ft. Another advantage of the cellular type of filling is that no elaborate precautions are necessary to seal the ends, as there are no connecting passages between the air cells, and moisture cannot penetrate the dielectric.

Polythene-insulated cables can give rise to microphonic noise which may be troublesome at very low signal levels. This has been overcome in Telcon "G" coaxial cables by coating the outer surface of the polythene with graphitic conducting film to disperse charges which might otherwise fluctuate with intermittent movement of the outer braiding. This year a further improvement has been effected in a "GG" cable in which similar treatment is applied to the inner surface of the insulant.

Silicone elastomer materials are finding increasing applications in the preparation of insulating cloths, tapes and sleeving. In the "Symel" grade of sleeving made by H. D. Symons the mechanical strength is improved by glass braiding applied on the inside and/or the outside of the silicone. A similar combination of special interest for high-temperature applications was shown by Suflex, Ltd.

Electrical insulating tapes coated with a thermosetting adhesive have been added to the already wide range of "Scotch Boy" tapes made by the Minnesota Mining and Manufacturing Company. Curing is effected during the normal drying-out process in coil manufacture, to give a permanent bond which will withstand subsequent varnishing or impregnation. The composition of the adhesive is controlled to obviate any possibility of initiating corrosion in the wires.

Impregnating resins of the ethoxyline type with low viscosities at room temperature are among the new plastics introduced by Aero Research, Ltd. No solvent is necessary and polymerization on heating is effected without the evolution of any vapours which might cause voids. Another recent "Araldite" product is a cold-setting adhesive for fixing electrical strain gauges.

Formers for the resistance elements of wire-wound potentiometers are usually of phenolic plastic strip, and difficulty is often experienced in finding material of suitable thickness which will not crack when bent. A suitable grade has been developed by H. Clarke & Co. (Manchester) which can be bent into circles of less than 1in diameter without cracking.

Printed circuits and dip soldering techniques have made new demands on the services of solder manufacturers, who have responded with a full range of special alloys, fluxes, and chemicals for preparing and preserving metal surfaces. Other new products in this field include a neat and robust junction pyrometer by Multicore for measuring rapidly the temperature of soldering baths or soldering iron bits. The scale is calibrated in Centigrade and Fahrenheit with a maximum of 400°C (752°F). Enthoven have demonstrated a new cored aluminium solder which functions at ordinary soldering iron temperatures without any auxiliary aids such as ultrasonic vibration. Copper wires can be soldered to aluminium of light-gauge and commercial purity and also to a number of aluminium alloys.

Finally, since screws can be regarded as a raw material as far as radio engineers are concerned, we mention two interesting developments by Guest, Keen and Nettlefold. One is the introduction of B.A. and wood screws in solid nylon, which, apart from their obvious non-conducting and good dielectric properties, are free from corrosion. The tensile strength is 5 tons/in^2 at room temperature and 7 ton/in^2 at -40°C. The other Nettlefold screw is a combination of a left-hand wood screw and a B.A. screw on the same shank for fixing loudspeakers to baffle boards. The left-hand wood thread ensures that any movement when finally tightening the fixing nuts will tend to draw the screw further into the woodwork.

Makers*: Aerialite (C, IS, W); Aero Research (IM); Associated Technical Manufacturers (B, C, IM, IS, W); Bakelite (IM); Geo. Bray (CF, CE); B. I. Callenders (C, CO, IS, W); British Moulded Plastics (IM); Bullers (CF, CE); Clarke (CF, IM, IS); Connollys (C, IM, W); Cosmocord (CF); Creators (IS); De La Rue (IM, IS); Duratube and Wire (B, C, CO, IS, W); Ediswan (W); English Electric (L); Enthoven (S); Fine Wires (W); Guest, Keen and Nettlefolds (BO); Hellerman (CF, IM, IS); Henley's (C, CO, IM, W); Insulating Components and Materials, Ltd. (IM); Langley, London (IM); Long and Hambley (IM, IS, RP); Magnetic and Electrical Alloys (L, M); Marrison and Catherall (M, L); Micanite and Insulators (CF, IM, IS); Minnesota Mining (IM); Mullard (DC, M); Multicore (S); Murex (RM, M); Mycalex (CF, IM); James Neill (M); Permanoid (C, IM, IS, W); Plessey (CE, DC, M); Reliance Wire (C, CO, IS, W); Rola Celestion (D, L, M); Salford (DC, M); Sankey (L); Geo. L. Scott (L); F. D. Sims (C, CO, W); S.T.C. (M); Steatite (CF, CE); Stratton (CF); Suflex (B, CO, IM, IS, W); Swift Levick (M); H. D. Symons (IM, IS); Taylor Tunnicliff (CE); Telcon (C, DC, IM, L, M, RN, W); Telcon Magnetic (L); Telephone Manufacturing Co. (DC); Thermo Plastics (CF, IM); Transradio (B, C, IS, W); Tufnol (IM); United Insulator (CF, CE, IM); Vactite Wire (RM, W); Whiteley Electrical (CF, M).

***Abbreviations:** B, braiding; BO, bolts; C, cables; CE, ceramics, CF, coil formers, bobbins; CO, cords; DC, dust cores, ferrites; IM, insulating materials; IS, insulating sleeving; L, core laminations and strip; M, magnets and magnetic alloys; RM, refractory metals; RP, rubber products; S, solder; W, bare or covered wires.

Directory of Metals

A COMPREHENSIVE guide to the physical properties of the non-ferrous metal elements and their alloys is contained in the "Metal Industry Handbook and Directory 1955." Not the least useful section of this work is the list of proprietary alloys, their makers, properties and uses.

A separate set of tables gives the specific resistances of alloys which are not normally found in electrical reference books, and there is a large section on the technique of electroplating, anodizing and other electrolytic processes which should be of value to workers in the radio industry.

Published by the Louis Cassier Company, Ltd., Dorset House, Stamford Street, London, S.E.1, this directory costs 15s.

Wide Range Electrostatic Loudspeakers

By P. J. WALKER*

2—*Problems of Air Loading : Different Requirements of Moving-coil and Electrostatic Drive Units*

IN the first part of this article we showed that it was possible to design and construct electrostatic driving units which were capable of applying a force which virtually acted directly on to the air, and we showed that this force was linear. This state of affairs applied over a bandwidth of several octaves for any single unit, depending upon the efficiency required from that unit, and it was further shown that that bandwidth could be placed anywhere in the audio range.

The only mechanical impedance likely to affect performance is the suspension compliance of the diaphragm, necessary to offset the negative compliance due to electrical attraction. We can therefore begin to draw an electrical analogue circuit of the mechanical elements of the loudspeaker as in Fig. 1, showing the force fed in series with a capacitance. In practice the compliance will considerably exceed the electrical negative compliance, so that this capacitance C_d is almost solely due to the diaphragm compliance.

For simplicity we will restrict consideration to units driven from constant-voltage sources, so that no elements need be included to indicate amplifier source impedance.

Since the loudspeaker will be coupled to the air, we can now add the front air load radiation resistance R_f and the front air load mass, M_f and we can include the impedance Z which represents the impedance presented to the back of the diaphragm.

The impedance Z may include dissipative terms in the form of absorption and/or acoustic radiation resistance. With most acoustic devices the analogy elements change with frequency and the problem, as with all loudspeaker design, is to arrange matters so that the power developed in the radiation resistance(s) is independent of frequency.

The electrostatic unit differs from the moving coil in that there is no large mass component (cone and speech coil) which normally appears as a large inductance in series with C_d. The absence of this inductance profoundly alters the requirements for Z, and since Z is the cabinet or back enclosure it is to be expected that the form of cabinet for electrostatic units will follow trends entirely different from those that have been evolved for moving-coil units. A further difference is that the shape of the diaphragm area is more versatile, so that R_f and M_f may be independently varied over reasonable limits.

Due to the absence of large mass we can, if we wish, arrange the constants so that R_f is large compared with the other elements, and therefore becomes the controlling factor for the equivalent current in the circuit, i.e., the velocity of motion of the diaphragm. This means that the impedance looking back into the loudspeaker can be very low. When this is so, any increase in the acoustic resistance on the front of the diaphragm will result in *reduced* power output. If, on the other hand, the impedance of the loudspeaker is made to appear high by arranging that the total impedance is

* Acoustical Manufacturing Co. Ltd.

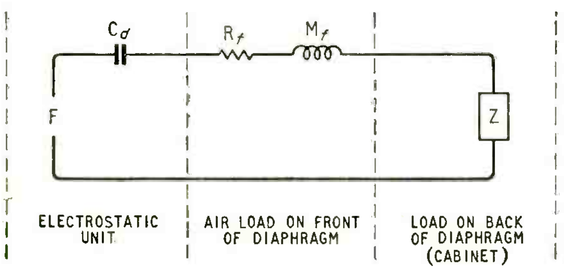


Fig. 1. Elementary equivalent circuit of mechanical and acoustical parameters of an electrostatic loudspeaker.

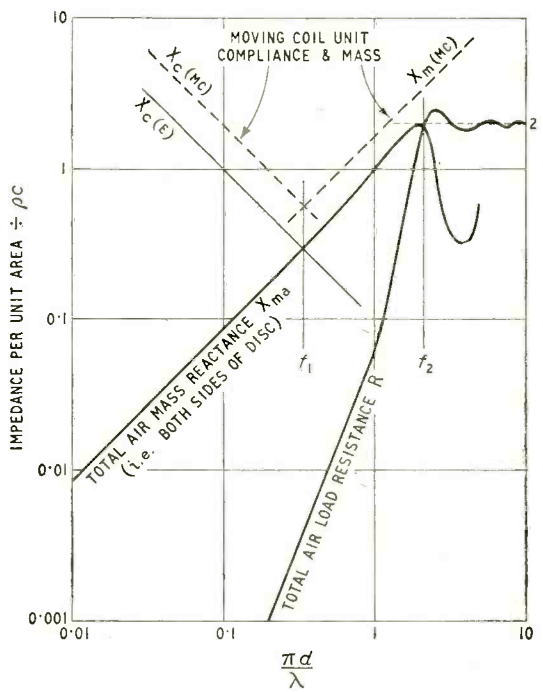


Fig. 2. Mass and radiation resistance loads on circular diaphragm in free air. The normalized frequency scale is in terms of the relationship of diaphragm size to wavelength.

large compared with R_f then an increase in acoustic resistance on the front of the diaphragm will result in *increased* power output. This ability to control the impedance looking back into the diaphragm is a useful feature in designs where R_f is subject to fluctuations due to surroundings, horn reflections, etc., and, in particular, where one loudspeaker unit is influenced by another unit at cross-over frequencies.

In order to show the action of an electrostatic unit which is small compared to the wavelength of the radiated sound it is convenient to commence with a circular shape, because impedance information is readily available for such a shape. Load impedance for other shapes is best obtained by considering the diaphragm as a number of unit areas of equal size and calculating the impedance of each unit area, taking into account the mutual radiation due to the presence of all other unit areas.

Fig. 2 shows the load on a piston operated in an unlimited atmosphere without a baffle. The diaphragm compliance reactance $X_c(E)$ is also drawn. Between f_1 and f_2 the controlling factor is the air mass, and the velocity of motion will vary directly with frequency until resonance between $X_c(E)$ and X_{ma} is approached. R, however, falls rapidly with frequency, and the power output will fall at approximately 6db per octave with declining frequency. (Exactly the same would occur with a moving coil unit, control this time being the mass of cone and speech coil designated $X_m(MC)$. $X_c(MC)$ is the moving-coil suspension compliance.)

Multiple diaphragms without baffles, having the above characteristics, form the basis of design for loudspeakers to provide the directivity of a doublet. Such a system has useful attributes in relation to the listening rooms, a subject to be dealt with in a later article.

Above f_2 the velocity of the moving-coil unit would still be controlled by $X_m(MC)$ (except for cone "break-up") and, since the resistance becomes constant, the response will fall with increasing frequency. In the electrostatic case above f_2 the velocity will be controlled by the air load resistance, and the response will be independent of frequency.

Extending this comparison to units in very large baffles we have the curves of Fig. 3. Here the radiation resistance varies with the square of the frequency below f_2. With a moving coil the response will be level below f_2 and will fall with frequency above f_2. With the electrostatic the response will be level below f_2 and also level above f_2, but there will be a step in response so that the output level above f_2 will be 3db higher than that below f_2.

A simple arithmetical example will make clear the reason for this step. With constant force F applied to the diaphragm, the velocity of movement will be

$$\frac{F}{\sqrt{R^2+X^2}}$$

and the power expended usefully in the radiation resistance will be $P = \left(\frac{F}{\sqrt{R^2+X^2}}\right)^2 \times R$

At f_B in Fig. 3, neglecting Z due to the declining air mass reactance, we have for a constant force $F = 1$, $P = \frac{R}{R^2} = \frac{2}{4} = \frac{1}{2}$. At f_A, on the other hand, the air mass predominates and, if R can be neglected in calculating the velocity of motion, $P = \frac{R}{X^2} = \frac{0.01}{(0.2)^2}$ $= \frac{0.01}{0.04} = \frac{1}{4}$, or half the power at f_B. A similar relationship will be found for any other pair of values of R and X at points below f_2.

This change in level can be overcome by deviating from the circular piston shape. For wavelengths large compared to the diaphragm size the resistance per unit area is dependent upon the new area and not upon the shape, whereas the mass is mainly dependent upon the smaller dimension. By elongating the diaphragm shape the output level below f_2 can be made equal to that above f_2.

We have so far been considering a comparatively small diaphragm in a flat baffle, the latter being very much larger than the piston, and the size of the complete system is obviously that of the baffle. The reason that the piston has been kept small is purely for the convenience of the moving-coil unit, because its diaphragm is driven at only one point. In the electrostatic case we no longer have this restriction, and it will always be preferable to increase the size of the piston (without increasing the total size of the complete system). This will usually be necessary because there is a limit to the available amplitude of movement, and thus, for a given power output per unit area, we have a minimum limit to the radiation resistance in order that the diaphragm excursions may be attainable. Increasing the size of the piston for a given power output has the double advantage of reducing power requirements per unit area, and, where the loading is below $2\rho c$, of increasing the radiation resistance per unit area, and therefore reducing the amplitude required to provide that power output. For reasons of efficiency we shall in any case limit the high-frequency response of the unit so that

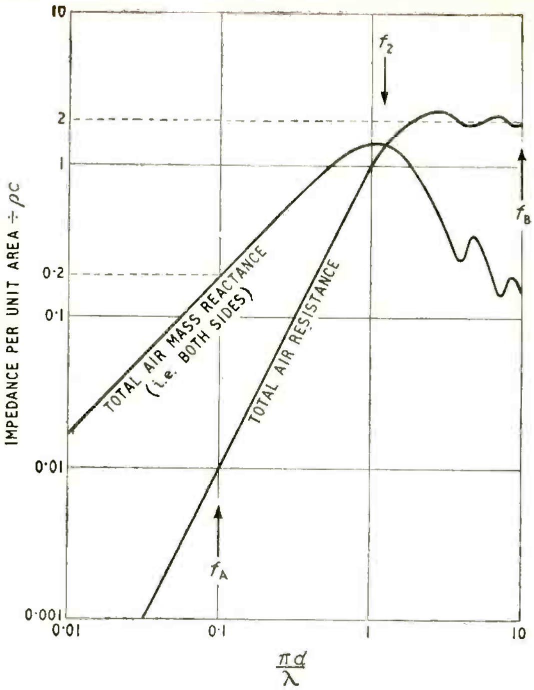


Fig. 3. Mass and radiation resistance curves for a circular diaphragm in a large baffle. The power radiated at any frequency f_A well below f_2 is half that radiated at frequencies f_B well above f_2 (see text).

optimum design is obtained by increasing the area of the diaphragm to the point where the piston just begins to become directional at the frequency which we have chosen for cross-over (set by the efficiency laid down in the design requirements).

Continuing the consideration of the air load on diaphragms, reference should be made to horn loading. Here we have large resistive and mass components due to the horn. Fig. 4 shows the load of an idealized horn to which has been added X_m(MC), the cone mass of a typical moving-coil loudspeaker which might be used with such a horn. It will be seen that at low frequencies the cone mass is largely swamped by the horn impedance, so that the design of horns for electrostatic units differs very little from the design for moving-coil units. Although we can now have the advantages of a virtually distortionless driving unit, we are still left with the disadvantages of practical horns, which are present independently of the drive units. Horns are normally used to match the high impedance of moving-coil diaphragms to the low impedance of the air. Since we have no such fundamental mismatch with the electrostatic loudspeaker, and since diaphragm shape and size are not fundamentally restricted, we shall not normally have to resort to the use of horns to the same degree. It should be remembered, however, that any back enclosed volume is a direct function of throat area, so that in some applications it is possible to use space for providing a length of horn in exchange for saving in size of capacitive enclosure. Again, we may wish to restrict the front-wave expansion in order to maintain a reasonable resistance per unit area at low frequencies (utilizing the corner of a room, for example).

One of the most desirable diaphragm shapes for electrostatic designs is that of a strip having a length (together with floor or wall image) large compared to $\lambda/3$ at the lowest frequency of interest, and a width small compared to wavelength at the highest frequency of interest. The strip may be curved along its length if desired, provided the radius of curvature is not less than $\lambda/3$ at the lowest frequency.

To consider the load on such a strip it is convenient to assume the strip as being infinite in length (legitimate provided it is at least $\lambda/3$ in length). With such a diaphragm there will be no expansion of sound in the direction of the length since all pressures along the length of the strip will be equal. Expansion from any given element of the diaphragm takes place in one plane only and will therefore take the form $S = S_0x$. This is the expansion of a parabolic horn. At low

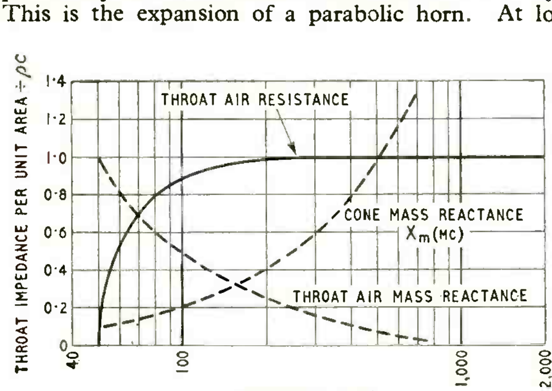


Fig. 4. Throat air resistance and reactance curves of idealized horn with moving-coil mass reactance superimposed.

frequencies the front air load resistance is falling directly with frequency (instead of f_2 as with the circular piston shape). The advantages of the strip shape may now be enumerated:—

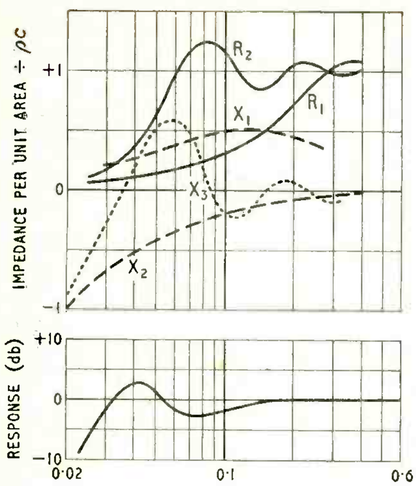
(a) The air resistance even at low frequencies (since $R \propto f$) is sufficient to develop adequate power with reasonable diaphragm amplitude.
(b) The narrow diaphragm gives good dispersion for several octaves (up to the frequency at which width $\approx\lambda/3$).
(c) The narrow diaphragm enables other units to be placed close to it, thus being less than ¼ wavelength apart at cross-over frequency.
(d) The frequency limitations, amplitude at the low end, and directional problems at the high end, fit in nicely with the 4-5 octave range which we established in Part I of this article for satisfactory efficiency. Thus a strip shape can form one basis of design for our ideal—the perfect loudspeaker.

It will be obvious that a curved front source similar to that illustrated in the photograph of Fig. 5 in Part I of this article will give similar distribution to a strip, and, due to the larger surface, smaller spacing may be used and higher efficiency may thus be achieved. In such a case however, the diaphragm must be large compared to wavelength in both dimensions, because it is the nature of curved surfaces to become directional when the radius of curvature is comparable with the wavelength. When the diaphragm is large compared to λ it is impossible to design an intimate acoustic cross-over. This small inherent imperfection would appear to preclude its use in a "perfect" loudspeaker design, although its "efficiency" advantages will have obvious applications in some practical compromise designs.

Although designs free to the air on both sides have useful attributes, it is obviously desirable also to produce loudspeakers in cabinet form, enclosing the rear. This rear enclosure, if it is to be of reasonable size, will be the controlling factor for the diaphragm velocity, at least at low frequencies.

With any unit, the high-frequency limit will be set by efficiency requirements, and the low-frequency limit by amplitude limitation or by the compliance of the enclosure in series with the diaphragm compliance. This compliance will resonate with the air mass on the front and back of the diaphragm (unless the diaphragm is so large that the loading is ρc—for example, as in the curved diaphragms previously mentioned). Since the total mass is small, this resonance will usually occur above the lowest frequency of interest. It may be dealt with in two ways, (1) by adding acoustic mass within the cabinet to reduce the resonant frequency to the lowest required frequency, or (2) critically damping the resonant frequency and maintaining response below this frequency either by re-matching or by a secondary acoustic resonant circuit, or both.

There are innumerable ways in which either of these alternatives may be achieved. Consider the first alternative. Suppose that the enclosure is made deep and narrow (or fitted with partitions so that it appears deep and narrow to the loudspeaker): then, at wavelengths just under four times the depth, the reaction on the diaphragm will be positive. This will effectively force the resonance to the ¼ wavelength reasonance of the depth of the enclosure. Absorbent wedges may now be fitted to control the resonance and to present



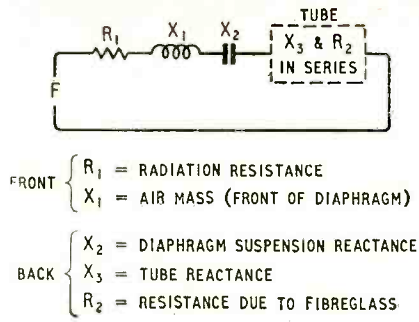


Fig. 5. Strip loudspeaker, long compared with wavelength, and of width d, mounted in a wall, with the back of the diaphragm loaded by a tube with cross-sectional area equal to that of the diaphragm and of a length 5d, blocked at the far end. Resistance (fibre-glass wedge) included in tube to control impedance.

a purely resistive load at all higher frequencies. Sound compression within the wedges becomes isothermal, decreasing the speed of sound, so that the depth of the enclosure can be reduced accordingly.

Fig. 5 shows the impedances of a strip unit loaded on this principle together with a curve showing the power output radiated as sound for constant applied voltage. The output is extended by more than an octave over that which would be obtained if the same volume of enclosure were allowed to act as a lumped capacitance.

Turning now to the second method of extending the low frequency range, Fig. 6 shows a diaphragm loaded by a capacitance leading through resistance and inductance into a larger capacitance. Both volumes have dimensions many times less than the wavelength in the ranges where they are operative.

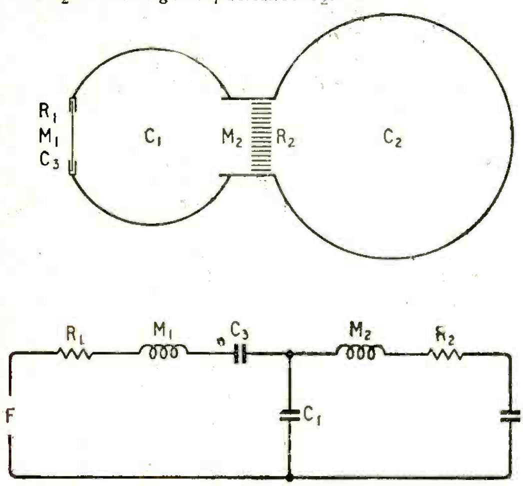
If the constants are adjusted to give a step in response as the frequency is lowered, then the total volume of the enclosure is reduced accordingly and the response restored to level by re-matching at the step frequency.

Fig. 7 shows a strip diaphragm loaded by a capacitance with series resistance, all elements continuing along the whole length of the structure. With this assumption there will be no waves in the enclosure along its length so that the constants can be calculated on a sectional element of thickness t. If the cross section of C_2 has dimensions which are many times smaller than the wavelength, then C_2 will behave as a capacitance (independent of length). If this proviso is not met then R_2 must be distributed to avoid C_2 appearing as a multi-resonant circuit.

Where the unit crosses over to another unit for low frequencies then R_2 may be adjusted to give a Q of 0.7 so that the cross-over components are already present in the acoustic circuit.

When the lower-frequency unit is arranged so that the two diaphragms are close and intimately coupled, then R_1 will be increased in value by the mutual radiation of the low-frequency unit. R_2 is then reduced to restore Q and we find that if R_1 is larger

Fig. 6. Diaphragm loaded by an equivalent capacitance C_1 leading through an acoustic mass and resistance M_2 and R_2 into a larger capacitance C_2.



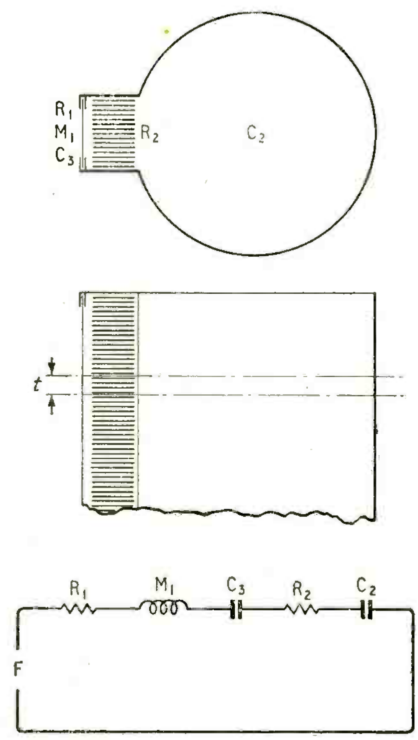


Fig. 7. In a long cylindrical structure the air column will be driven equally at all points along its length and no appreciable longitudinal standing waves can be established, at frequencies other than that corresponding to λ/4.

than R_2 a useful self-compensating effect takes place.

If the voltage applied to the low-frequency unit is reduced at cross-over due to tolerance in its cross-over components then R_1 is automatically reduced and the output of the higher-frequency unit increases at cross-over. At cross-over $P_{out} \propto \frac{R_1}{(R_1+R_2)^2}$

Where the enclosure of Fig. 7 is used for the unit covering the lowest part of the audio range, bass response may be extended by rematching or by introducing a secondary resonant circuit and utilizing back radiation from the diaphragm. If an aperture is provided at one end of the enclosure, opening to the air, then, when the enclosure length is ¼ wavelength, resonance will occur along its length, and there will be radiation from the aperture. 3/4, 5/4 resonances, etc., will not arise, because the enclosure is excited by a force distributed along its length. At frequencies above the ¼ wavelength, the enclosure will behave approximately as a capacitance, as if the aperture were not present.

The next part of this article will deal with electrostatic units as part of delay lines, and the application of various complete designs, "built in," "boxed in" and "doublet" in relation to the listening-room. Complete electrostatic loudspeakers can take several different forms, each of which in terms of frequency response, distortion and sound dispersion can meet a specification virtually to perfection. When the listening-room and subjective factors are considered it becomes impossible to lay down a rigid specification. To adopt a quotation "Each design is perfect, but some designs are more perfect than others"!

Acknowledgement. Fig. 2 is based on Fig. 5. 9, p. 127 of "Acoustics" by Leo. L. Beranek (McGraw Hill).

(To be continued)

LETTERS TO THE EDITOR

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

Situations Vacant

WITH the present state of full employment in the electronic profession, the competition amongst employers to find suitable men is fierce. This is shown by the numerous posts advertised in technical journals. The time has come, however, for employers to pay a little more attention to the "Sits. Vac." replies.

Three members of my laboratory have, over a period of the last six months, written to a dozen advertisers. The results have been very disheartening; only 40 per cent of the applications were acknowledged. The applicants were qualified men: A.M.I.E.E., A.M.Brit.I.R.E., Higher National, National and City and Guilds certificates. In good faith they have taken some trouble to apply for positions, expecting that they would be treated with good manners by the advertiser, and have been embittered by the callous manner in which their applications were treated.

I would ask "Sits. Vac." advertisers to read page 498 of *Electronics* for March, 1955, and then to make moves at least to treat engineers with the courtesy their professional status deserves.

J. GILBERT.

Biophysics Dept.,
Postgraduate Medical School of London.

Transistor Symbols

IT would seem that an over-riding factor when assessing the desirability of a logical system of transistor symbols is whether the advantages of the system are more important than international standardization. It is impossible to ignore the fact that there is a well-established convention at present widely used in both Europe and the U.S.A., and it is, to say the least of it, unlikely that any alternative suggestions at this late stage will replace the accepted practice. I would suggest that it is better to follow the generally accepted convention and concentrate on clearing up minor differences about points such as the thickness of base line and the presence of a circle to isolate the transistor from the rest of the circuit.

Leaving on one side the question of standardization, there is still a doubt whether your suggested symbols (April and May, Editorial Comment) do in fact add to an understanding of the devices. The symbol you suggest is particularly undesirable since it is very misleading to regard a transistor as a back-to-back arrangement of two diodes.

Finally, the point raised about the abbreviation to use in circuit diagrams can be met without causing confusion by using the same "V" for the crystal valve as for the thermionic version.

B. R. BETTRIDGE.

General Electric Company,
London, W.C.2.

BOTH D. Nappin and W. E. Thompson (your May issue) regard the transistor as a new device needing a new symbol, but surely this problem arose as the normal valve developed.

It was no doubt thought that gas triodes and neon stabilizers were separate devices, that each needed a new letter symbol, but in fact they are both given the letter V, and no confusion is caused by this. The type of device is made clear by the circuit symbol.

I suggest, therefore, that the letter V be kept to include the transistor.

London, N.1.

M. LEVY.

WHILST in full agreement with the general scheme of transistor symbols proposed in your April and May Editorials, I should like to plead for the symbol originally shown for the *n-p-n* junction transistor in *Wireless World*, July, 1954, p. 325, Fig. 2(c), rather than the new version in Fig. (f) of the May Editorial. This later version is likely to cause error, particularly when pencil sketches are copied in the drawing office or print room. Furthermore, the original version appears more logical and distinct, being characterized by a black and white triangle like the symbol for the *p-n-p* transistors.

London, N.W.3.

FRANCIS OAKES.

Electronics on the Farm

R. S. DRAKE'S letter (your May issue) is very interesting and certainly very pertinent. Within limits one must admit that a manufacturer should know! However, I beg leave to suggest that there is justification for some comment, if not criticism.

Popularity obviously justifies manufacture and sale, but it does not follow that it confirms excellence of design and practical value. Established habits die hard.

It may be true that there is no serviceable electronic "switch" or "trigger," but I feel that there is no valid objection to a glass-enveloped tube in a fencer unit. These units must in practice be effectively boxed and weather-proofed, and in any case we have electric lights all over the place on farms these days.

I still hope to find an electronic dry battery unit on sale in the not-too-distant future; a unit which is neatly boxed and requires no servicing beyond the occasional plugging in of a relatively inexpensive replacement. Furthermore, I consider that this unit should carry its own test equipment. I see no reason why this should be very expensive, even if it does have to involve more than a neon tube or a blade of grass, and I think loose test equipment is an anachronism. In theory it enables one to test the fence at any point, but in practice this is an advantage of negligible value. Nine times out of ten one naturally puts the unit at the gate or most convenient point of approach, and again nine times out of ten if the fence is "down" the only effective way of locating the fault is to walk the fence. Finally, more often than not it is easier and more convenient to switch off before one walks so that one can repair in comfort. Of course, one *can* wear gloves, one *can* withstand the shock, one *can* use a handkerchief, kick down a weed or pull off a branch. But how often does one in practice? In practice it is far more desirable to be able to check when there, without having to remember to take the tester, than to be able to test at all sorts of odd points.

No doubt my desired unit would not be cheap, but I fail to see why it should be any more expensive than the average unit now on the market.

Hempstead, Essex. H. G. TAYLOR.

"*As She Is Spoke*"

I HAVE just been reading M. G. Scroggie's letter in your May issue, and I notice that the linoleum in my immediate vicinity is very clean. This must be due to the fact that Mr. Scroggie has been wiping the floor with me.

I apologise to him for having wrongly deduced from his previous letter that he objected to the use of the word "recording" as a noun; I now realize that he only objected to its use in reference to a recording.

As Mr. Scroggie now concedes that we can have a recording on a record, I readily agree that there should be no logical objection to using the words "tape record" to refer to a recording on tape. In fact, I notice that this nomenclature has already been adopted by your journal, so that just about clinches the argument.

Wharfedale Wireless Works, Ltd., Bradford. G. A. BRIGGS.

Earthing Metal Braiding

IN the illustration of the component layout for P. J. Baxandall's pre-amplifier in your February issue, the method shown of making a connection to a metal braid screening is by wrapping a connecting wire round it. This, I know, is a common method, but it involves soldering which may injure the sleeve or insulated wire directly beneath. It also does nothing to remove the jagged ends of the braiding, and I have known them penetrate the insulation beneath and cause a short when the conductor is sharply bent.

Another method, suggested to me long ago, is better on both counts, but does not appear to be widely known. About one inch from the end of the braiding the wires of the "warp" are separated and so are the wires of the "weft." This leaves a diamond shaped hole and the sleeve or insulated conductor within the inch of braiding is pulled out through the hole. The braid thus left empty forms a convenient pigtail for connection to the remainder.

London, N.W.7. W. J. CLUFF.

Commercial Literature

Audio Amplifier, the Cape 25, by Cape Electrophonics, mentioned in the March issue. An error of 0.08% was made in the distortion figure, which should be 0.12% at 64 c/s with 26 watts output. At 1,000 c/s, 25 watts output, the distortion is claimed to be 0.03%.

Band-III Aerials, including composite Band-I/Band-III types, add-on units for existing aerials; indoor types and also converters, pre-amplifiers and downleads. Described in a leaflet from Aerialite, Castle Works, Stalybridge, Cheshire. Also a non-technical leaflet explaining aerials and converters for Band III.

Marine Communications Receiver covering long, medium and trawler wavebands with Consol navigational aid. Power supply from 12-V or 24-V ships' battery. General specification in a leaflet (also containing a list of available Consol charts) from Pye Marine, Oulton Works, Lowestoft.

Small Electrolytic Capacitors with paper dielectric construction and very low leakage currents. Capacitances of 0.5-50μF, working voltages of 250-25V d.c. and sizes up to 2in × 0.6in (diam) approx. Technical bulletin from the Telegraph Condenser Co., North Acton, London, W.3.

Magnetic Permeability Tester for measuring metallurgical uniformity of production samples from foundries, rolling-mills, etc. Brief outline in a leaflet from Excel Sound Services, Celsonic Works, Garfield Avenue, Bradford, 8, Yorks.

Impregnation Plants for impregnation of coils, transformers, etc., with varnish, resin or other materials under alternate vacuum and pressure. Also available for "potting" work. Features described in a leaflet from Blickvac Engineering, 96-100, Aldersgate Street, London, E.C.1.

Geared-down Motors, fractional horsepower, either series-wound, variable speed, for a.c./d.c. or capacitor-induction, constant speed, for a.c. only. Output speeds ranging from 0.2 r.p.m. to 840 r.p.m. with torques from 3 lb-in to 75 lb-in. Technical specification from M.R. Supplies, 68, New Oxford Street, London, W.C.1.

High Quality Sound Reproduction equipment including combined amplifier and record-playing units; separate record players and amplifiers; and loudspeaker units. Leaflets from Pye, P.O. Box 49, Cambridge.

Inexpensive Oscilloscope with circuit for measuring voltage of waveform, or a selected portion of it, on a voltmeter within the range 0.2-500V. Deflection sensitivity, 1cm/V; bandwidth, 3Mc/s; and time base frequencies, 3c/s to 120kc/s. Leaflet from E.M.I. Electronics, Hayes, Middlesex.

Power Oscillator, giving 120 watts into 10Ω with frequency range of 10c/s-10kc/s, for driving vibration generator. Leaflets on this, and also on moving-coil electro-dynamic exciters with peak thrusts from 2 to 300lb, from Goodmans Industries, Axiom Works, Wembley.

Timer, for hand-setting, driven by synchronous motor. Can be provided with dial for any time range between 0-30 seconds and 0-7 days. Normal switching capacity 5A at 230V. Descriptive leaflet from the Electrical Remote Control Co., East Industrial Estate, Harlow New Town, Essex.

Aluminium Soldering Tool. A steel wire brush in the soldering bit vibrates and cleans the work surface while a pool of molten solder around the bit protects the cleaned area from the air. Illustrated leaflet from Belark Tool & Stamping Co., 33, Sussex Place, London, W.2.

Nickel Alloys in Valves; applications of the metal in cathodes, grids, anodes, supports, springs, non-magnetic components and glass-to-metal seals described in an illustrated booklet from Henry Wiggin & Co., Thames House, Millbank, London, S.W.1.

"The Cosmocord Story" is the title of an illustrated booklet describing the development of the firm's work in piezo-electric crystal devices and also some of the present manufacturing techniques. From Cosmocord, 700, Great Cambridge Road, Enfield, Middlesex.

V.H.F. Equipment from Germany. F.M. transmitters; receivers for radio relay systems; dual-receiver equipments; f.m. transmitter aerials; broadband receiving aerials; and test equipment; made by Rohde & Schwarz. Leaflets from the British agents, Aveley Electric, 44, Tottenham Court Road, London, W.1.

Physical Society's Exhibition

NEW ELECTRONIC DEVICES AND TECHNIQUES

This report is followed by surveys of recently introduced valves and allied devices; also of test and measuring gear. These surveys cover exhibits at both the Physical Society's and R.E.C.M.F. shows. Some products appeared at both, so no distinction is made here between the two exhibitions.

RESEARCH

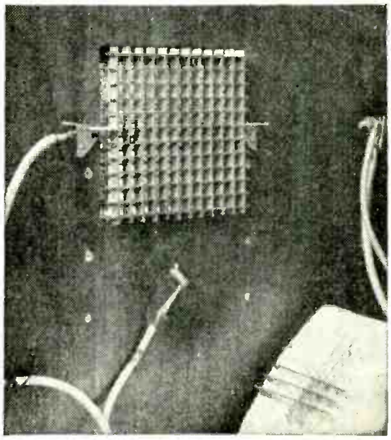
MANY physical effects have been exploited in the search for the ideal electro-acoustic transducer (loudspeaker) and a new one, demonstrated by D. M. Tombs, of Imperial College, makes use of the fact that a corona discharge between points is accompanied by a wind, generated by the migration of ionized air particles. Under normal conditions the wind is unidirectional, because of the difference in mobility between the negative and positive ions, but by interposing a grid, suitably biased, between the point electrodes the opposing streams can be balanced. If, now, an alternating signal voltage is superimposed on the grid, acoustic radiation is possible and was in fact demonstrated. From the initial asymmetry of air movement one deduces that, in its present state of development, the transfer characteristic would be non-linear—a sort of "ionic Stentorphone"; but at least it opens a new line for investigation in improving what most people agree is the weakest link in the sound reproducing chain. A similar electrical principle is involved in the "corona triode" also shown by Mr. Tombs. Like the transistor it requires no heater current, and it gives a gain of 5 with an a.c. resistance of 500 MΩ and a mutual conductance of 25 μA/kV.

A photocell amplifier with a simple wide-range a.g.c. system was shown by the Armament Research Establishment. It makes use of the fact that the input resistance of a valve is inversely proportional to the grid current; thus an input potential divider is established with the photocell impedance which automatically reduces the grid voltage due to steady illumination. The a.c. gain is not affected and light modulation does not vary more than ± 3 db over a frequency range of 10 c/s to 10 kc/s even when the steady background illumination is varied over a range of 1,000 : 1 from, say, 0.0002 lumen to 0.2 lumen.

The basic causes of the residual interference from the gas discharge in fluorescent lamps, and similar phenomena in vacuum filament lamps, are being investigated by Siemens and a demonstration was given showing how the radiation is related to the electrode emission and the filament current. Normal gas-filled filament lamps do not radiate.

Research into the properties of new and existing materials was prominently represented at this exhibition. Wayne Kerr were showing examples of potting resins specially compounded to minimize mechanical and thermal shocks, and the reduction of valve microphony obtained by the use of semi-flexible resins was demonstrated. Butyl rubber as a moulded insulator for high-voltage transformers was shown by B.T.H.

Much interest is being shown in silicon as a semiconductor for diodes on account of its low reverse voltage, which is held to much higher temperatures than in germanium. B.T.H. demonstrated the method of growing crystals and also a method of radioactive analysis to show the distribution of residual impurity in the growing crystal.



Corona wind loudspeaker (D. M. Tombs).

Development continues in the production and utilization of new ferrites. Plessey were demonstrating a ferrite switch depending on the large change of incremental permeability when the operating point is changed from remanence to saturation, and have also produced a range of nickel ferrites with magnetostrictive properties.

The Faraday magneto-optic effect in which the plane of polarization of electromagnetic waves in a medium is rotated under the influence of a magnetic field is exploited in special ferrites to attenuate or modulate microwaves (Radar Research Establishment), (Plessey). It is also used for current measurement in high-tension power distribution systems, where the use of a current transformer would present difficulties (British Electrical and Allied Industries Research Association).

Ferroelectric behaviour in ceramics formed the subject of a comprehensive exhibit by G. E. C. Research Laboratories, and it was shown that the large change in permittivity at the Curie point could be exploited to generate a fire alarm signal. Dielectric amplifiers based on the hysteresis characteristics of these materials were also demonstrated.

NON-INDUSTRIAL ELECTRONICS

IMAGE converter tubes are well known for their use as "electronic shutters" in high-speed photography, but hitherto the shortness of exposure has been limited to about 30×10^{-9} second by the inability of the electrical circuit to convey pulses of such short duration. Mullard were showing how this exposure can be reduced some ten times to 3×10^{-9} second by using r.f. techniques—the pulse being conveyed by a coaxial line to a modified image converter tube with coaxial connections and a ring of resistors providing correct termination of the line. The switching pulse was actually generated by a spark, and it was the light from this spark that was being shuttered, a visual image appearing on the screen of the image converter. By using mirrors to vary the length of the light path from the spark point to the tube photo-cathode (and so altering the arrival time of the spark image relative to the shuttering pulse), it is possible to examine individual stages of the spark formation—reducing the effective exposure time to as small as 3×10^{-10} second.

The scanning and display principle used in the flying-spot microscope (represented at the show by the well-known Cintel model) is now extending into other fields. One particularly interesting example was a scanning X-ray system shown by the Royal Cancer Hospital. Here, the place of the flying-spot c.r. tube is taken by a special X-ray tube in which an electron beam scans a platinum-foil target about the size of a post-card. The raster of X-rays so produced passes through the thin target and the tube face and after being modulated by the object under examination is picked up by a scintillation detector. The signal pulses from this are then integrated and amplified and used to intensity modulate a display c.r. tube which is being scanned in synchronism with the X-ray tube. Because of the great sensitivity of the scintillation detector the system is claimed to be about 20 times more sensitive than conventional X-ray apparatus.

Another exhibit using the flying-spot principle was an equipment for counting and sizing small particles, demonstrated by Mullard. This works on the same general principle as the Mullard apparatus shown last year, but for sizing purposes the scanning spot is given a secondary deflection, downwards across the particle and back again, at the end of the first line scan. The length of the excursion is then used as a measure of the particle size.

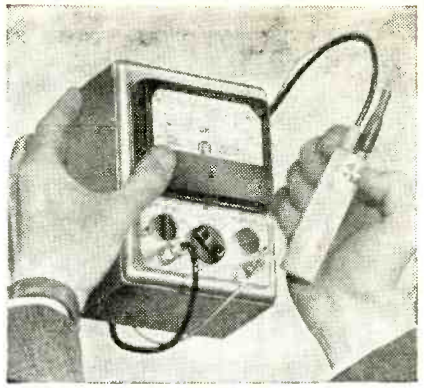
For the actual process of counting and registering pulses the well-known Dekatron was very much in evidence in a large number of instruments. There is now, however, a new type of decade counting tube which is a good deal faster in operation than the glow-discharge transfer method. This is the Mullard E1T, a miniature c.r. tube using electrostatic deflection of the beam into ten different positions, and in a demonstration it was shown counting at a p.r.f. of 100 kc/s. Counting is also the basic operation in digital computors, and in this field the same firm were demonstrating how transistors can be used in place of valves for various functions—with considerable advantage in reliability and heat dissipation.

There were actually no complete digital computors to be seen at the exhibition, but several of the analogue kind. A particularly interesting one, shown by Elliott and using d.c. amplifiers as functional units, is designed so that problems can be set up on a series of detachable panels, each of which plugs into a d.c. amplifier. It is thus possible to remove a problem *en bloc* and keep it set up whilst leaving the main instrument free for other work. A miniature analogue computor was demonstrated by Saunders-Roe, while Southern Instruments had a correlogram computor with photo-electric line followers to work from continuous line records on film or paper.

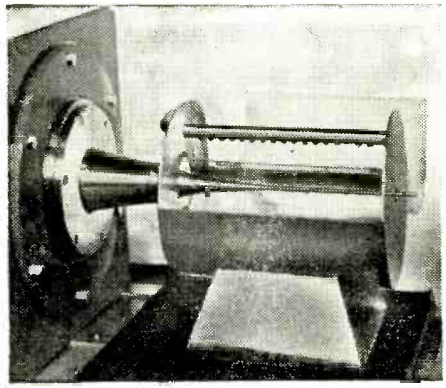
INDUSTRIAL ELECTRONICS

THE measurement and recording of fundamental physical quantities such as displacement, velocity, acceleration, temperature and pressure forms the basis of the application of electronics to industrial processes. Initially, a transducer is required to convert the physical quantity into a voltage or current which can be amplified by valves or magnetic amplifiers. The output from this transducer is generally applied to a self-balancing potentiometer, operated by a servo motor, and the setting of the potentiometer is recorded on a moving chart or may be used to control industrial processes through relays or larger servo motors. Typical of this widely represented branch of the electronic art are the Foster continuous-balance electronic potentiometers, the Cambridge Instrument multi-point electronic recorder and the Boulton and Paul automatic manometer for use in wind tunnels or in any fluid pressure system.

Variation of capacitance forms a sensitive method of measuring distance or displacement and is applied in the prototype of a probe for the exploration of the internal diameter of small bores. It is used in conjunction with the three-terminal bridge shown last year by Wayne Kerr and can be calibrated to give direct readings of distance at balance.



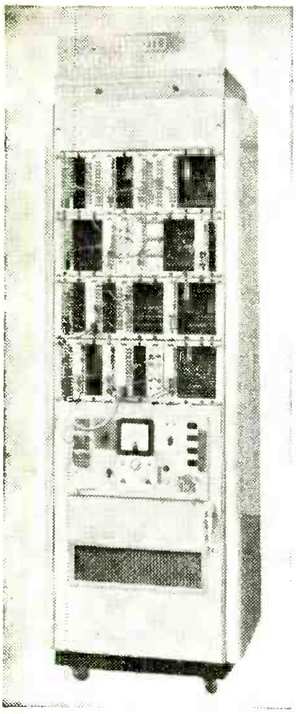
Pye miniature pH meter.



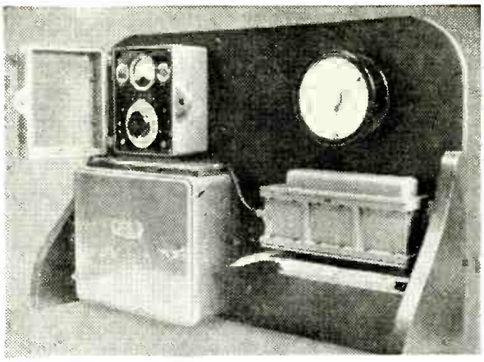
Fatigue testing of rod specimens by ultrasonic vibration (Mullard).

The thickness of electroplated films can be measured magnetically as in the B.S.A.-Tinsley gauge in which the adhesion of a small magnet is balanced against the tension of a light spring balance; or thermo-electrically as in a method developed by the British Non-ferrous Metals Research Association and shown by Elliott Brothers. A hot probe and a cold probe are applied to the surface of the plating and the thermal e.m.f. generated between the plating and the base material appears between the two probes. A magnetic amplifier is used between the probe output and any suitable indicator, recorder or relay.

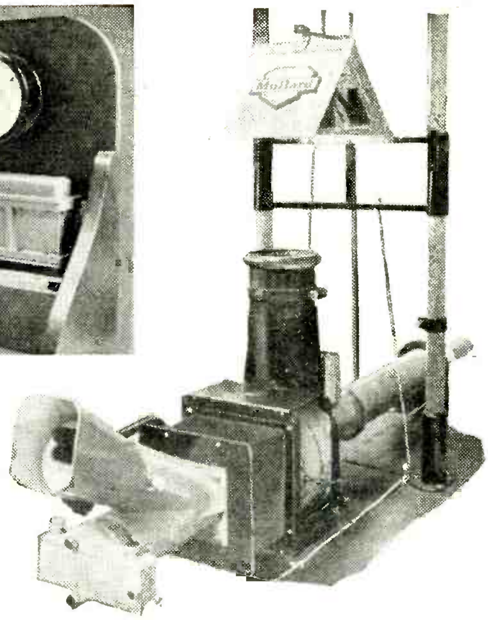
Measurement of thickness by ultrasonic methods where only one side of the material is accessible, as in the case of pressure vessels, may be effected in several ways. In the Dawe Instruments "Visigauge" standing-wave resonance in the thickness of the plate increases the power absorbed from the driving oscillator and this change is displayed as a "pip" on the vertical scale of a cathode-ray tube. The horizontal scale is a function of frequency, which is swept cyclically through an appropriate range, and can be calibrated to read thickness directly. In the Kelvin-Hughes depth and thickness accessory for their standard ultrasonic flaw detector, a short pulse is applied simultaneously to the plating under test and to a liquid delay line of adjustable length. Both return pulses are displayed on a c.r. tube, and, when adjusted to coincidence, the depth can be read off directly. The instrument is calibrated for mild steel and has a range of ¼in to 4in. By a technique, in which an electrical step function is applied to a thick barium titanate disc with heavy mechanical damping to give a stress with a sharply defined leading edge, the Ultrasonoscope Company (London) have succeeded in resolving echoes in steel and aluminium for thicknesses down to 0.02in.



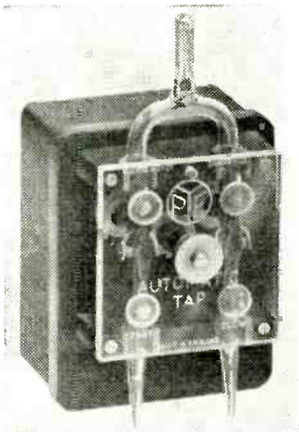
Elliott analogue computor.



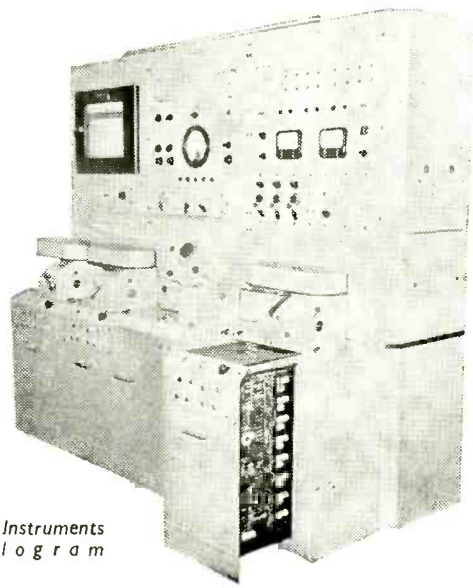
Isotope Developments Type 150 beta ray thickness gauge.



Mullard high-speed photography apparatus.



Magnetically-controlled tap for automatic titration (Pye).



Southern Instruments correlogram computor.

Applications of ultrasonics for the non-destructive testing of materials were shown by the National Coal Board (elastic properties of coal) and by A. E. Cawkell (for checking the compressive strength of concrete in fabricated building units). A spectacular demonstration of the time that can be saved in fatigue testing of metals was given by Mullard. Short rod specimens, welded to a tapered mechanical transformer element were excited with ultrasonic power of the order of kilowatts at a frequency equivalent to the half-wave longitudinal resonance of the bar. Under these conditions velocities are a maximum at each end, and compressional and tensile stresses at the middle. Strain is measured by capacitance probe near the free end. To show the magnitude of the forces which could be applied, specimen bars were raised to incandescence in the centre in a matter of seconds. Normally, of course, the specimen would be water-cooled.

Continuous monitoring of thickness of sheet materials during manufacture by the absorption of beta rays (electrons) from a radioactive source has long passed the development stage, and ruggedly housed units suitable for use under factory and mill conditions are made by a number of firms. Typical of this trend is the Type 150 beta gauge made by Isotope Developments. In the Ekco thickness gauge, provision is made for automatic overall standardization every 30 minutes with servo correction for amplifier sensitivity and source decay or contamination. The thickness at predetermined points across the width can be sampled at intervals, the duration of which can be pre-set by the operator. To meet the needs of the paper industry Baldwin Instruments have produced an accessory to their "Automat" beta ray thickness gauge designed to measure the weight per unit area, and thus the "height" or "profile" of the paper surface, across its whole width. A continuous record is obtained on a pen recorder.

As an alternative to electron penetration, the back-scatter due to gamma radiation is now coming into use for the measurement of thickness. In a prototype instrument shown by Ekco Electronics, cobalt 60 is used as the radiation source and a differential circuit is used to separate the reflected photons from the primary radiation. The detecting photomultiplier tube is associated with a circuit time constant long enough to remove random fluctuations from the indicator. Baldwin Instruments also showed a prototype back-scatter thickness gauge designed to measure metal sheet thickness where only one side is presented, and a transmission gamma-ray thickness gauge for revealing non-uniformity due to variations of ingot temperature in hot steel rolling mills.

In chemical analysis increasing use is being made of electronic methods. The measurement of hydrogen ion concentration (pH) is already well established and the trend is towards miniaturization, as exemplified in the Pye Type 11084 instrument.

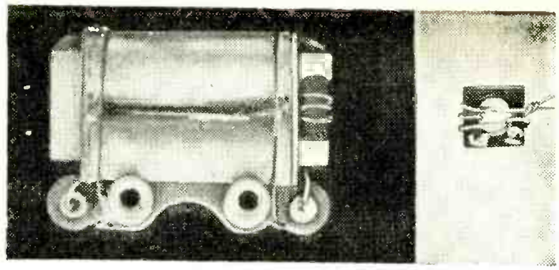
In the estimation of acids and alkalies by titration, the end point is usually indicated by a pH meter and in the Pye Type 11600 instrument the out-of-balance signal from the pH meter is used to control a magnetic stop valve with fast and slow rates of dispensation of the neutralizing reagent. The end point may be pre-set to any value within ± 0.1 pH and the changeover from fast to slow dispensation can be set to come into operation up to 5 pH units before the end point.

A different method of titration with many interesting features is employed in the automatic titrimeter shown by Electronic Instruments. Instead of using calibrated acid or alkaline solutions of known concentration, the starting point is a neutral salt of indeterminate strength. A current is passed through the salt solution in a cell with semi-permeable ends and acid or alkali is liberated at the electrodes, depending on the direction of the current. The current is integrated by a low inertia motor and counter unit of the type designed by Electro Methods and gives a direct measure of the amount of reagent generated and used for the titration (1 gram equivalent ion is equivalent to 96,494 coulombs). The process is stopped automatically when the predetermined end point is reached on the pH meter.

Rapid analysis of the constituent elements of solutions is possible by a method known as polarography, in which a progressively rising e.m.f is applied to a mercury dropping electrode. Current flows in well defined steps in which the starting e.m.f. is related to the identity of the conducting ion and the height of the step to its concentration. In the Tinsley recording polarograph the first derivative di/dv of the current-voltage relationship is displayed, which gives better resolution, and a square-wave method developed by Barker and Jenkins, of A.E.R.E., and utilized in the Mervyn Instruments polarograph gives greater latitude in dealing with constituents of widely different concentration.

MISCELLANEOUS EXHIBITS

A MAGNETIC reactor, having various applications involving frequency shift of an oscillator by means of an externally applied audio or d.c. voltage has been developed by Plessey. A fruitful field of usefulness is for frequency modulating v.h.f. oscillators and transmitters and for automatic frequency control of a v.h.f. oscillator.



Plessey magnetic ferrite reactor.

The reactor consists of a small ferrite former with a few turns of wire wound toroidally on it and forming part of the tuned circuit of the oscillator it is required to control, or frequency-modulate as the case may be. The toroidal coil is mounted in an electromagnet system in such a way that by applying either a d.c. or an a.c. voltage to the electromagnet winding the incremental permeability of the ferrite core, and hence the inductance of the toroidal winding, can be varied. An inductance change of the order of 10 per cent is attainable. The unit shown by Plessey is designed for use at frequencies of from 50 to 100 Mc/s.

Some really lilliputian input and output audio transformers were exhibited by Fortiphone. The company has, of course, had a wide experience in the manufacture of very small parts for hearing aids. The transformers shown were mainly for transistor circuits and were in ratios of between 2 and 10 to 1 and either encapsulated in potting resin or open. The smallest measures $\frac{1}{4}$in × $\frac{3}{8}$in × $\frac{3}{8}$in, while the largest of the miniatures is only $\frac{3}{4}$in × $\frac{3}{4}$in × $\frac{5}{8}$in. Primary inductances (with no d.c. flowing) of 30H or so are achievable with some of these tiny transformers.

Recent improvements in the precision-type silvered-mica capacitors made by Johnson, Matthey consist of using thinner mica and a larger silvered area than hitherto and thus providing more pFs per unit area.

TEST AND MEASURING GEAR

Apparatus Shown at the R.E.C.M.F. and Physical Society's Exhibitions

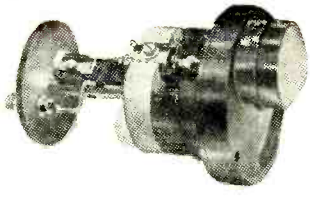
MANY of the instruments to be mentioned were shown in prototype or pre-production form, and are therefore subject to modification before they become available, if they do. Likewise many of those which were available for the first time had been previously reported in *Wireless World* so are not mentioned again unless the modifications were substantial.

After a period during which the design of unamplified meters had seemed almost to have reached finality, signs of renewed activity were to be seen in a considerable number of new models. The demand by the Services for hermetical sealing has been met by several makers. The well-known Avometers 7 and 8 now have counterparts in Araldite "D" tropical dress as 7X and 8X. The trend towards wide-angle deflection continues. British Physical Laboratories showed sub-panel-mounted meters to accord with contemporary styling, and Everett Edgcumbe a new system of scale lighting distributed by a Perspex surround. Pullin now have two multi-range d.c./a.c. test meters of the Amp-Volt-Ohm type, one with a 1 mA movement and the other 50 μA, for which a special 20-way multi-bank switch was developed; there is also a miniature d.c./a.c. 19-range set. The same firm showed a moving-coil voltmeter mounted in a probe for measuring television e.h.t. up to 25 kV; full-scale current, 40 μA. An ingenious device enables the whole of the scale to be used for either positive or negative voltages without reversing connections. To the Pye series of "Scalamp" high-sensitivity instruments has been added a voltmeter taking a full-scale current of 1 μA (i.e., 1 MΩ per volt, for those who prefer to put it in that roundabout way). The lowest range is 10 mV f.s.

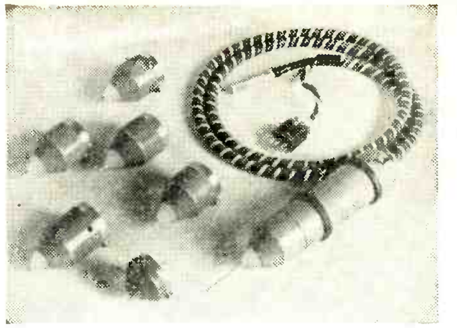
Another conception of rugged sensitivity is the Doran portable combined pointer and reflecting galvanometer, obtainable with various full-scale readings; examples are ± 0.12 mV (10-Ω coil) and ± 1.5 μA. Among new frequency meters are those by Pullin and Electrical Instrument Co.; the latter also showed differential a.c. meters in which two opposing rectifiers are connected to a centre-zero movement, obtainable with f.s.r. from ± 50 μA upwards.

The valves in valve voltmeters have hitherto been of the vacuum type, but this year a sign of the times is the British Physical Laboratories' "Transranger" multi-range voltmeter and megohmmeter in which an instrument outwardly uniform with their test meters having a movement requiring 25 μA for f.s.d. nevertheless is fully deflected by 1 μA, the gain being provided by an internal

Pullin e.h.t. probe voltmeter.



Combined pointer and reflecting galvo made by Doran Instruments.



E.M.I. cathode follower probe with some of the interchangeable heads available.

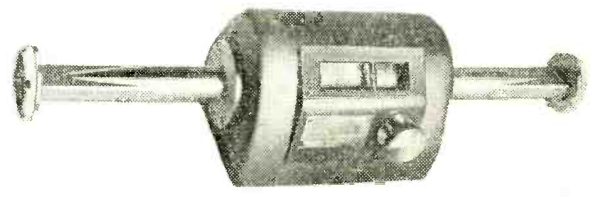
transistor amplifier. Changes due to temperature coefficient are neutralized by initial setting-up procedure. Voltage is measurable from 0.001 to 500, and resistance from 0.001 to 100 MΩ. A new Avo multi-range d.c. voltmeter also takes 1 μA f.s., but uses conventional valves. So does the Marconi Instruments TF1041 on its d.c. ranges, which extend up to 1,000 V; but for a.c. measurements use is made of a probe containing a rectifier valve of the coaxial type, by means of which the frequency range is maintained level within 1 db up to 700 Mc/s. Resistance is measurable from 0.2 Ω to 500 MΩ. This instrument is in production. So is the latest version of the Pye d.c. microvoltmeter, in which a galvanometer moving coil is made to set up an a.c. signal which is amplified and rectified. A somewhat similar means of stepping-up sensitivity is used in a new Pye instrument, called a "Nanoammeter" because on its most sensitive range the f.s. reading is 10×10^{-9} A.

A considerable number of new or improved oscilloscopes were shown, including several each by Cossor, Nagard and Solartron. Most if not all of these use post-deflection accelerator tubes to give adequate traces at the very high speeds which now are expected of even general-purpose instruments. Along with this goes wide bandwidth in the deflection amplifier; for example, 5 c/s to 10 Mc/s in the "Solascope" CD514, notwithstanding that this is a relatively inexpensive model. A new Cossor model (1056) covers from 5 kc/s up to no less than 80 Mc/s. The E.M.I. Type WM5 includes the valuable feature of meter-read voltage and time along the X and Y axes of the trace, together with the ability to put a television picture on the screen and select any part of any line of it by means of a marker and then switch over to normal waveform examination of the selected part. A cathode-follower probe unit with interchangeable attenuator heads enables the wide frequency band to be maintained up to the point of application. E.M.I. distributed amplifiers, suitable for oscilloscopes, handle a bandwidth of over 100 Mc/s; to the earlier high-level Type 2C has now been added a low-level type that can be cascaded with it to give an overall gain of $\times 300$.

It is interesting to compare methods of providing more than one trace. Cossor continue to use their single-gun split beam, with improved non-interaction, in their new Model 1059. Nagard and Southern Instruments use the 20th Century Electronics multi-gun tubes, of which advantage is taken in Southern's M972 of the ability to make one of the traces a horizontally expanded version of the other. In the Mullard L101 the two traces result from electronic to-and-fro switching of a single beam during each flyback. Lastly, Cintel provide any number of traces by means of separate c.r. tube units, which can be assembled like bricks. Incidentally, the Nagard "Unitel" system imparts similar flexibility to the oscilloscope as a whole.

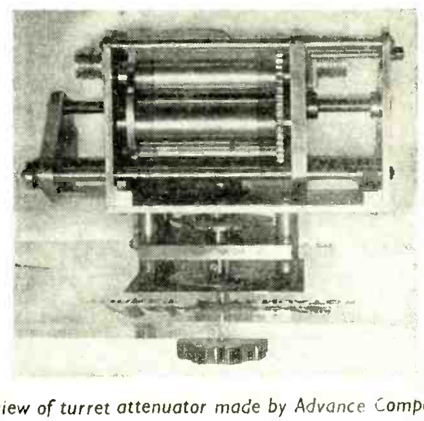
A number of new attenuators were to be seen. The Advance A63 turret model for frequencies from zero to 1,000 Mc/s provides 10 db steps from 0-50 db using resistance arms. It is of 75-ohm coaxial construction, and the operations of withdrawing both end connections axially, bringing a new attenuator pad into line, and closing up the contacts, are all performed by a continuous rotational movement of the control knob. Separate 75-ohm encapsulated attenuator pads for use up to 300 Mc/s were shown by British Physical Laboratories. Coming to microwaves, an assembly was shown by Wayne Kerr for calibrating S-band attenuators from a piston attenuator at 80 Mc/s to within 0.015-0.02 db. Elliott demonstrated absolute calibration of X-band attenuators by a process of adding together two signal outputs previously adjusted to equality, thereby giving a 6.02 db step, from which further steps can be determined. The B443 continuously-variable X-band attenuator shown by the same firm is a beautiful piece of instrument making. It is calibrated direct in db, standing-wave ratio and voltage reflection coefficient, and of the total range up to 100 db that up to 40 db is of high precision.

In the field of bridge work a most imposing exhibit



Elliott precision "X"-band attenuator.

Encapsulated attenuator unit, FA200, made by British Physical Laboratories.



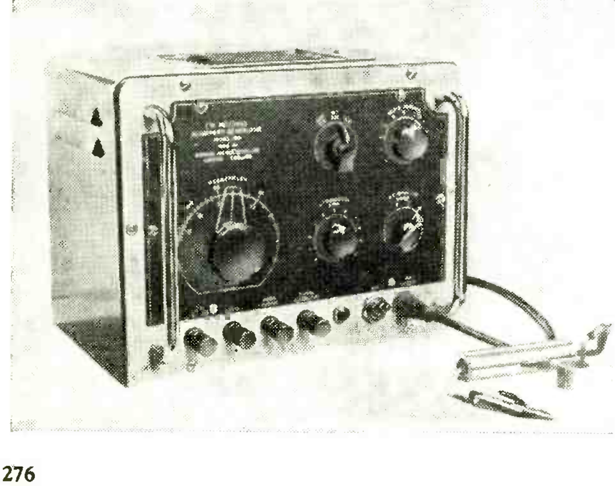
Top view of turret attenuator made by Advance Components.

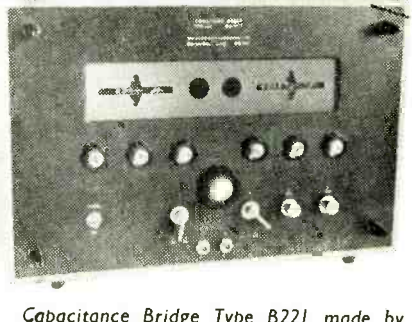
was the Smith bridge on the Tinsley stand, for the measurement of thermometer resistors to within 4 in 10^6. Notable features are the massive switchgear and the elaborate precautions to ensure constancy of the manganin resistance standards, such as the method of spirally winding a helix of the annealed wire between Perspex discs, and the devices for maintaining constant and uniform temperature. A modern version of the Kelvin double bridge for low resistances was shown by the Cambridge Instrument Co. For use with the r.f. capacitance bridge by Electronic Tubes for the measurement of interelectrode capacitances can now be obtained a series of jigs to Anglo-American Service standards, each for a particular type of valve holder. Doran showed a new universal a.c./d.c. bridge and a bridge amplifier-indicator; Griffin and George a "Nivoc" unit system from which bridges can be assembled; and Salford Instruments an incremental-inductance bridge of the Owen type, with c.r.t. balance indicator. In the Muirhead D728 equipment the impedance and phase angle of two-terminal networks between 0.3 and 100 kΩ are measured at 50 and $10^4/2\pi$ c/s by comparison with resistance in a balanced amplifier circuit. The same firm showed an instrument for comparing the voltage and phase of two sinusoidal signals. Comparison is also the basis of an instrument by the Electrical Instrument Co. for measuring and grading components. Its standard is normally their push-button decade capacitor (also shown), and a useful feature of the comparator is a sensitivity switch by which the meter can be made direct-reading in percentage deviation of the component under test. The display mechanism in the Wayne Kerr CR and LR bridges, by which mistakes in reading are rendered almost impossible, appears in improved form in the production versions of those instruments.

The same admirable attention to operational convenience is found in the new decade oscillator of the same make, in which the frequency from 10 c/s to 110 kc/s is directly shown. The decade principle for oscillators has been used by Muirhead for some years, and the latest example is their D695, considerably smaller than previous models but with a high performance. Where spot frequencies (5 c/s to 50 kc/s) and output voltages (5 mV to 20 V) will do, the Cawkell OSP31 oscillator gives 0.1 per cent frequency calibration at a low price—and there is a 1-per cent model at a lower price. The beat-frequency principle is used in the Furzehill 50 c/s to 20 kc/s oscillator, a feature of which is a ±50 c/s incremental control. For the exceptionally low frequency range 0.03-30 c/s Airmec use a rotating capacitor to modulate a h.f. signal which is rectified and amplified to yield the output.

Most of the new oscillators and signal generators for the higher frequencies have been inspired by developments in television and f.m. broadcasting. The Advance range has been supplemented by Type R1, covering the whole v.f. 30 c/s to 3 Mc/s in one range, and 3-10 Mc/s in another, using a RC type of oscillator. Bands I, II and III and the relevant i.f.s are included in a low-priced sweep oscillator by Taylor, in which 5-250 Mc/s is covered in one beat-frequency range; wobbulation is by reactance valve. The Cossor "Telecheck" Model 1323 also covers all three bands and their i.f.s in a more elaborate specification that includes a crystal oscillator to provide accurate frequency marker pips on the trace. Owners of the earlier Model 1322, which is similar except for the absence of Band II, may be interested in Model 1324, which is an alignment generator specifically for testing f.m. receivers, and includes a display of the discriminator characteristic. The Avo Type TFM a.m. and f.m. signal generator, shown in prototype last year, has not yet reached finality, but is expected to cover 5-255 Mc/s with an a.m. signal and 80-100 Mc/s with f.m. The frequency scale is direct reading and fitted with a device for correcting it by known frequencies. At the laboratory level, Marconi Instruments have recently introduced the TF1077 f.m. signal generator covering 19.7-102.5 Mc/s. A piston attenuator is used, and frequency modulation is by varying the permeability of a ferrite core on which the r.f. inductor is wound. A new M.I. a.m. signal generator is the TF801B, covering the unusually wide frequency range of 10-500 Mc/s. Range changing is by contactless switch, and the r.f. valves are of the disc-seal type. For still higher frequencies (L band, 960-1,250 Mc/s) there is now the TF1078, with a piston attenuator having a range up to 110 dbm. Yet another new generator of the same make is the OA1000, for the increasingly important Q band (33,300-37,500 Mc/s). The oscillator is, of course, a klystron, its frequency being stabilized by a variety of the Pound system. A feature of the latest version of the Airmec general-purpose 30 kc/s to 30 Mc/s signal generator is a horizontal direct-reading illuminated frequency scale 4ft long on every range.

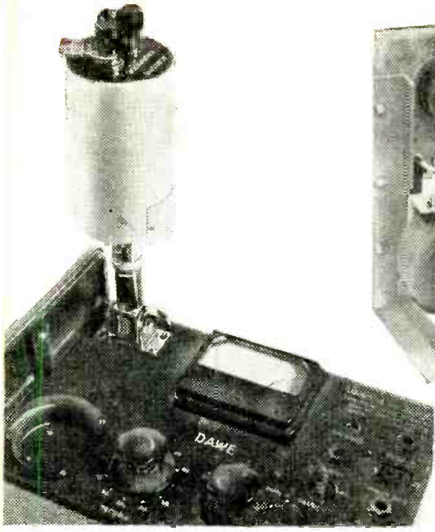
With applications in such fields as television, radar, communications and nucleonics, the need for pulse generators is growing, and new types were shown by Solartron, British Physical Laboratories and E.M.I., with pulse width adjustable down to a few millimicro-seconds. The Mullard L141 generator produces pulses in pairs separated by an interval variable from 1 μsec to 0.1 sec, B.P.L. also exhibited a pulse-height voltmeter, independent of pulse width and repetition rate above 700 p.p.s. For amplified testing Solartron have a square-wave generator (GO511) with rise and fall times as low as 40 and 25 μsec respectively on the highest frequency range. An entirely different kind of special waveform is produced by the Dawe "white noise" generator Type 419, in which a thyratron in a magnetic field generates a noise output uniform from 20 c/s to 5 Mc/s, reducible to 500 kc/s or 20 kc/s for testing apparatus over narrower frequency bands. For taking frequency characteristics, etc., such a generator simulates transient signals such as speech more closely than does c.w., and acoustic standing waves are avoided.



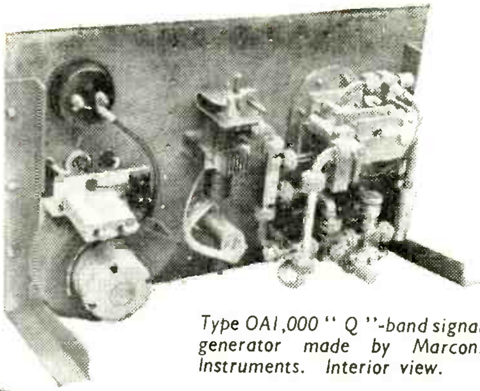


Capacitance Bridge Type B221 made by Wayne Kerr.

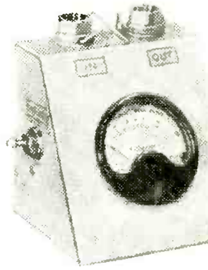
Left: Cossor Model 1324 F.M. alignment signal generator with probe and capacitance coupling.



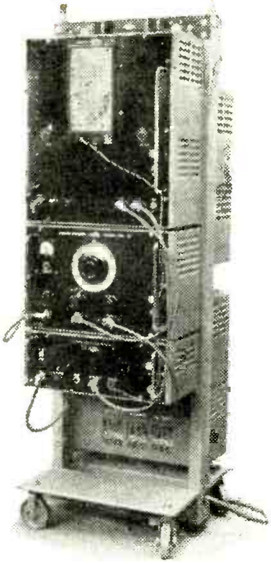
Acoustic calibrator shown in position on microphone of Dawe sound meter.



Type OA1,000 "Q"-band signal generator made by Marconi Instruments. Interior view.



Right: Labgear standing-wave-ratio direct-reading meter.



Airmec rack-mounted frequency measuring equipment with electronic counter.

Useful in conjunction with it, or with other apparatus such as a sound level meter, is the Dawe Type 1410 octave-band analyser, consisting of switched filters selecting six octaves in the range 75-4,800 c/s (also 20-75 c/s and 4.8-10 kc/s), a calibrated attenuator, amplifier and output meter. Another new Dawe instrument is an acoustic calibrator, consisting of a stable $2\frac{1}{2}$in loudspeaker mounted at one end of a cylinder designed to fit over the microphone of a sound level meter. By feeding the loudspeaker with a known signal voltage, the calibration of the meter can be checked.

Both the Avo and Taylor valve testers have been improved into new models, especially as regards ability to cater for new valve types. The Taylor (45C) has additional switch positions and an adaptor for c.r. tubes. Two new laboratory equipments for c.r. presentation of families of valve characteristic curves were shown: one by Cossor, which is capable of displaying two sets of curves simultaneously, and is particularly suitable for revealing the characteristics in the positive-grid region, inaccessible by static tests; and the other an extremely elaborate three-rack set-up by Electronic Tubes, in which not only the valve curves but the graticule is produced via the same amplifier and beam, making the calibration independent of amplifier linearity and stability. Bridge measurements of the valve parameters can also be made at any desired point.

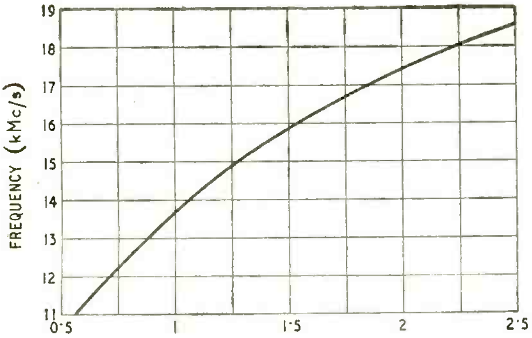
A neat standing-wave-ratio meter by Labgear enables v.h.f. loads to be matched to 75-ohm coaxial lines. The instrument is direct-reading in s.w.r. The Solartron s.w.r. and reflection coefficient indicator is an amplifying detector with an input impedance of 20 kΩ, for use with a slotted-line in microwave circuits. The Advance range of instruments now includes a moderate-priced and versatile Q-meter, Type T1. The basic principle is the conventional one, and a wide frequency range (100 kc/s to 100 Mc/s) is practicable owing to the use of an inductive coupling of very low impedance. The oscillator is modulated at 50 c/s, enabling a sensitive valve voltmeter to be used without the need for zero setting. A still more versatile instrument is the Airmec "TeleVet," which, as its name implies, is for television servicing. It contains in one portable case all that is normally required, including wobbulator, pattern generator, a.m. signal generator, a.f. oscillator, oscilloscope, e.h.t. voltmeter, a.c. and d.c. valve voltmeter, and crystal calibrator. The instrument covers 8-70 and 168-230 Mc/s, is safe when used with a.c./d.c. sets, and for such a comprehensive equipment is inexpensive. The same maker exhibited an electronic counter rack with very clear direct-reading illuminated display of the number of cycles, suitable for quick and accurate frequency measurement.

VALVES AND SEMI-CONDUCTORS

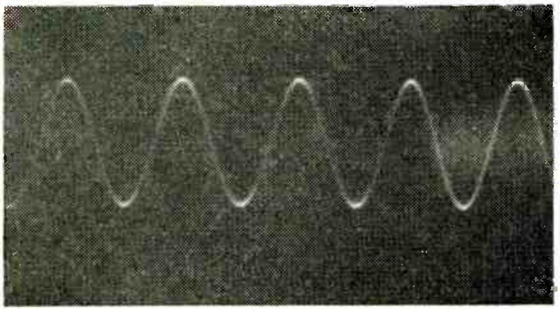
THE most unusual valve be seen this year was undoubtedly the backward-wave oscillator or "carcinotron" shown by Mullard. It is similar in form to the ordinary travelling-wave tube but the r.f. field energy travels in the opposite direction to the electron beam flow. A characteristic feature is the very wide tuning range, which is obtained simply by varying the electron beam accelerating potential (see graph). The collector potential is 200 V and the beam current 25 mA, while the power output is 50 mW at 11,000 Mc/s or 120 mW at 18,000 Mc/s.

In conventional travelling-wave tubes there were two new types shown by English Electric, the N1001 and N1002. Operating as amplifiers, they both have a gain of 25 db over the frequency range 1750-2300 Mc/s, the N1001 giving an output of 20 W and the N1002 an output of 1 mW. Another microwave valve using velocity modulation of the electron beam is the klystron, and on view was a new Ferranti type with the high output power of 500 watts at 9,400-9,700 Mc/s. The cathode of this valve is designed to give a very heavy beam current and the power dissipation of the collector, which has to be water-cooled, is 4 kW.

Of particular interest amongst the receiving-type valves on show was the Osram KT55 beam tetrode. This is intended for use as an audio amplifier in a.c./d.c. circuits (the heater rating is 0.3 A, 52 V) and two of the valves connected as pentodes in push-pull will give an output of 25 watts from a mains supply of 220 volts. In this pentode condition the KT55 has the high mutual conductance of 16 mA/V. Another new audio valve for large output powers was the Mullard EL34. It is notable for its



Tuning range of Mullard carcinotron.



500-Mc/s sine wave recorded on 20th Century oscilloscope tube S6A20-3.

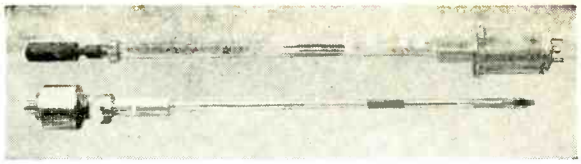
high maximum anode voltage of 800 V, which permits operation in push-pull circuits with output powers up to 100 watts (at 5 per cent distortion). Both the KT55 and the EL34 are on the octal base.

High power and high mutual conductance were also the outstanding features of the new Ediswan beam tetrode 13E1, a d.c. control valve intended for use in stabilized power supplies or servo control systems. The slope is actually 40 mA/V, while the maximum anode dissipation is 90 watts.

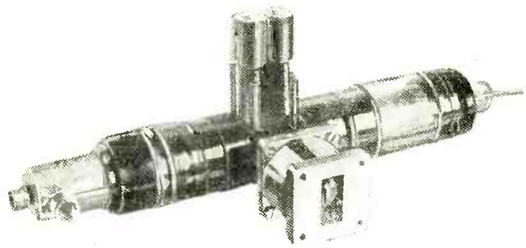
Cold cathode triodes, or trigger tubes, for use in electronic switching circuits are still very popular because they are reliable, long-lived and need no heater supplies. Osram were showing one, the CCT6, which can be used in circuits having wide component tolerances, while the Mullard Z803U is notable for the stability of its trigger characteristics.

New entrants into the transistor field are Pye Industrial Electronics, who have come out with a complete range of germanium junction *p-n-p* types, hermetically sealed, for audio and i.f. applications. Under the series type number of V10, they have collector voltages of 10 V and various input and output resistances. A similar range of junction *p-n-p* types have been produced by G.E.C. It comprises the EW53 and EW59, which are intended for power applications and will operate at frequencies up to a few hundred kilocycles, and the EW58, designed for low-power, low-frequency amplifiers such as in hearing-aids. Yet another series of junction transistors which may be already well known are the TJ1, TJ2 and TJ3, shown by Brimar and S.T.C.

A junction transistor using silicon is the next thing to be expected, but in the meantime we have a range of silicon junction diodes, types ZS10A, B and C, produced by Ferranti. These are characterized by their extremely low reverse current of less than 10 μA for a reverse voltage of -50 V and by their ability to operate at temperatures as high as 100° C. Forward currents are 0.1 A continuous and 1 A peak. A developmental silicon junction diode was also shown by S.T.C.



English Electric travelling-wave tubes N1001 and N1002

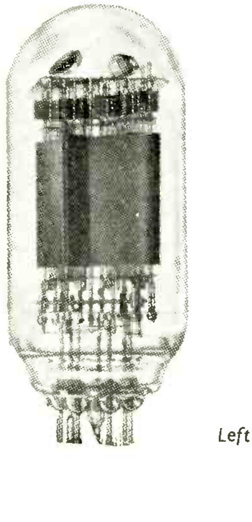


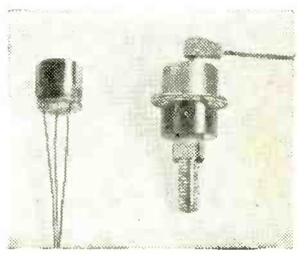
Ferranti 500-watt klystron.

Germanium junction diodes are still being developed, however, and one interesting example was the G.E.C. type EW54, intended for power rectification. Fitted with cooling fins it will give a rectified output of 50 V, 24 A, and good regulation is obtained because of its low forward resistance of 0.05 ohm. For h.t. power supplies based on relaxation-oscillator generators, Mullard were demonstrating a power transistor used with germanium junction rectifiers to produce a d.c. output of 150 V at 5 watts from a 12-volt supply. The photo-electric properties of the germanium junction were also represented, by the S.T.C. miniature germanium photocell type P40A, which is so small that six of them can be arranged in a row across standard teleprinter tape for "reading" the punched holes.

Amongst conventional plate rectifiers the most interesting development was a range of new Westinghouse types with aluminium cases which are bolted flat to the chassis to conduct the heat away. This enables the size of the rectifier to be reduced for a given power rating. A similar reduction in size is given by elements each capable of handling 27 volts in the tubular selenium rectifiers shown by Salford.

Oscilloscope c.r. tubes were well represented, and an outstanding one for high "writing" speeds was the 20th Century S6A20-3, which has three post-deflection accelerator electrodes and is capable of recording a 500-Mc/s sine wave with a time-base speed of 650 cm per microsecond. Mullard were showing two new 3-inch tubes, DG7-32 and -36, the first-mentioned being notable for its low final anode voltage of 500 V.





G.E.C. germanium junction diode EW54 (right) and EW51 point contact transistor (left).

Left: Ediswan beam tetrode 13E1.

DESIGN FOR A

20-Watt High-Quality Amplifier

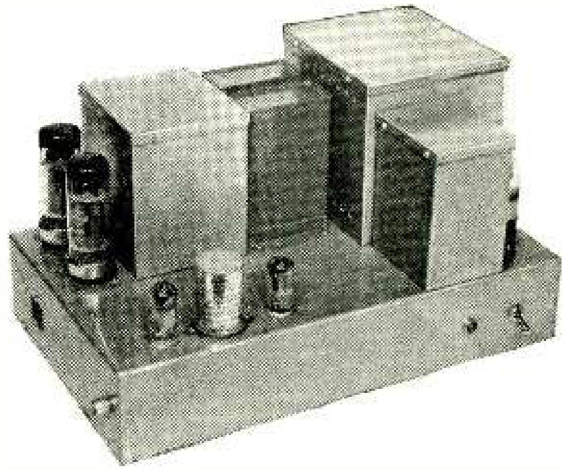
2.—*Constructional Details and Performance*

By W. A. FERGUSON,*
B.Sc.(Eng.), A.C.G.I., Grad. I.E.E.

IN the first part of this article some considerations were discussed which affect the choice of valves and circuit arrangements in the output stages of amplifiers designed for use in high-quality sound reproduction.

In amplifiers designed to handle power outputs greater than 12 to 15 watts and in which low-distortion operation towards peak power output is still required, the use of distributed load operation with valves of the 25-watt anode dissipation class is of particular interest. By using this method of valve loading the effective power output of a low-distortion triode push-pull stage (approximately 12 watts) can be raised to 30 to 35 watts whilst the benefits of low inherent distortion and relatively low output impedance are well maintained. Performance typical of the Mullard EL34 output pentode with partial screen-grid loading was illustrated in Fig. 3 of the previous article.

The present article describes a design for a high-quality amplifier of 20 watts rated output in which similar load conditions are used for the EL34 valves in the output stage. The amplifier is intended to allow of the highest standard of sound reproduction when used in association with suitable pre-amplifier circuits, high-grade pickups and loudspeaker systems.



General view of top of prototype 20-watt amplifier, which uses EL34 output valves.

TABLE I
Summary of Performance of Prototype Amplifier

Power output:
20 watts minimum from 30 c/s-20 kc/s.
Power response:
within 0.5 db of 1 kc/s level at 20 watts over range 30 c/s-20 kc/s.
Frequency response (1 watt level):
within 1 db of 1 kc/s level 2 c/s-100 kc/s.
Harmonic distortion (400 c/s):
<0.05% at 20 watts.
Intermodulation distortion (40 c/s, 10 kc/s; ratio 4:1):
0.7%, with peak corresponding to 20 W sine-wave power.
1.0%, with peak corresponding to 29 W sine-wave power.
Hum and noise:
−89 db relative to 20 W with 10-kΩ source resistance.
Sensitivity:
220 mv for 20 W output.
Phase shift:
10° maximum at 10 c/s.
20° maximum at 20 kc/s.
Output impedance:
approximately 0.3 Ω at 40 c/s, 1 kc/s and 20 kc/s at 20 watts output.

A summary of the overall performance of the amplifier is given in Table 1.

A circuit diagram and list of component values is given in Fig. 1. The circuit arrangement is basically similar, except for the output stage, to that used in the Mullard 5-valve 10-watt high-quality amplifier design in that the output stage is driven from a cathode-coupled twin-triode phase-splitting amplifier which is in turn preceded by a high-gain voltage amplifier stage. The first stage in the amplifier is d.c. coupled to the phase splitter in order to minimize low-frequency phase shifts. The main feedback loop includes the whole circuit, the feedback voltage being derived from the secondary of the output transformer and injected in the cathode circuit of the first stage.

Output Stage.—The main feature of interest in the output stage is the use of the Mullard EL34 high-slope output pentode with partial screen-grid loading, the screen grids being fed from taps on the primary of the output transformer. Measurements during the course of design showed that optimum conditions are obtained in this form of output stage when about 40% of the primary winding of the output transformer is common to anode and screen grid circuits. In the present design a C-core transformer is used which has tappings at 43% of primary turns.†

The anode-to-anode loading of the output stage is 6.6 kΩ and, with a feed voltage of 440 at the centre-tap of the output transformer primary the combined anode and screen-grid dissipation of the output valves is 28 watts per valve. With the particular screen-grid to anode load ratio used, it has been found that improved linearity is obtained at power levels above 15 watts when resistors of the order of 1,000Ω are inserted in the screen-grid feeds. The slight reduction

* Mullard Valve Measurement and Application Laboratory.
† Partridge Transformers, Ltd.—Type P3878.

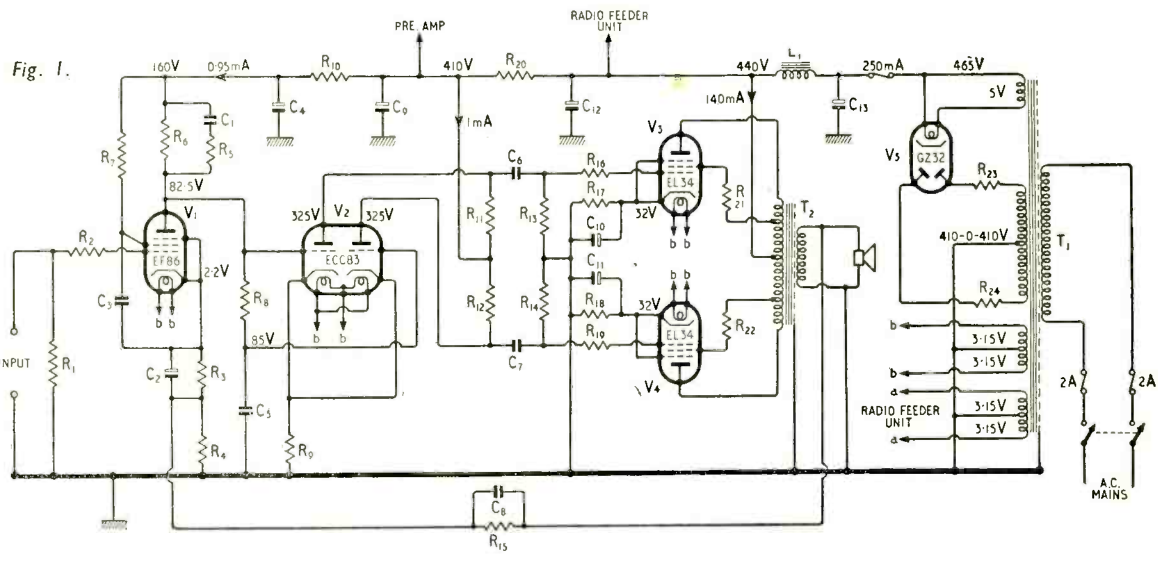
in peak power-handling capacity which results is not significant in practice. Separate cathode-bias resistors are used to limit the out-of-balance d.c. current in the output transformer primary; the use of further d.c. balancing arrangements in the output stage has not been considered necessary. It is likely, however, that some improvement in performance, particularly at low frequencies, would result from the use of d.c. balancing. It is necessary in this type of output stage that the cathodes are bypassed to earth even when a common cathode resistor is used. Thus a low-frequency time-constant in the cathode circuit cannot be eliminated when automatic bias is used.

Power Supply.—The power supply is conventional and uses a Mullard GZ32 indirectly heated full-wave rectifier in conjunction with a capacitor input filter. Paper smoothing capacitors have been used in the prototype amplifier, though the alternative use of electrolytic capacitors is possible. The value of the limiting resistors R_{23} and R_{24} will depend on the winding resistances of the mains transformers used. Their purpose, when required, is normally one of voltage control only. Where a transformer having very low winding resistance is used, a secondary voltage rated at 400-0-400 may be found adequate.

The rating of the mains transformer is such that an additional 30 mA may be drawn from the h.t. supply to feed pre-amplifier circuits and radio feeder. Additional decoupling will be required for these supplies.

Driver Stage.—This stage uses a Mullard ECC83 twin-triode and fulfils the combined function of phase splitter and driver amplifier. It is of the cathode-coupled form and enables a high degree of push-pull balance to be obtained. With the high line voltage available the required drive voltage for the output stage is obtained at a low distortion level, which is approximately 0.4% for 20 watts power output. The anode load resistors R_{11} and R_{12} must be matched within 5%, R_{12} having the higher value for optimum operation. Optimum balance is obtained when the effective anode loads differ by 3%. It is necessary also that the grid resistors R_{13} and R_{14} in the output stage are of small tolerance since they form part of the anode loads of the driver stage. High-frequency balance will be largely determined by wiring layout since equality of shunt capacitances is required. Low-frequency balance is controlled by the value of the time constant R_8 C_5 in the grid circuits

Fig. 1.



LIST OF COMPONENT VALUES

R_1	1 MΩ ¼ watt	±20%
R_2	4.7 kΩ ¼ watt	±20%
R_3	2.2 kΩ*	±10%
R_4	100Ω*	±5%
R_5	4.7 kΩ ¼ watt	±10%
R_6	100 kΩ*	±10%
R_7	390 kΩ*	±10%
R_8	1.0 MΩ ¼ watt	±20%
R_9	82 kΩ ½ watt	±10%
R_{10}	270 kΩ ½ watt	±10%
R_{11}	180 kΩ† ½ watt	±10%
R_{12}	180 kΩ† ½ watt	±10%
R_{13}	470 kΩ‡ ¼ watt	±10%
R_{14}	470 kΩ‡ ¼ watt	±10%
R_{15}	8.2 kΩ* (15-Ω load)	±5%
R_{16}	2.2 kΩ ¼ watt	±20%
R_{17}	470Ω 3 W min	±5%
R_{18}	470Ω 3 W min	±5%
R_{19}	2.2 kΩ ¼ watt	±20%
R_{20}	15 kΩ ½ watt	±20%
R_{21}	1 kΩ ½ watt	±10%
R_{22}	1 kΩ ½ watt	±10%
R_{23}, R_{24}	May be required for voltage control depending on mains transformer.	
C_1	47 pF	±10%
C_2	50 μF 12 V wkg.	
C_3	0.05 μF 350 V wkg.	
C_4	8 μF 450 V wkg.	
C_5	0.25 μF 350 V wkg.	
C_6	0.5 μF 350 V wkg.	
C_7	0.5 μF 350 V wkg.	
C_8	220 pF (15-Ω load) (C_8 R_{15} = 1.8 μ sec)	
C_9	8 μF 450 V wkg.	
C_{10}	50 μF 50 V wkg.	
C_{11}	50 μF 50 V wkg.	
C_{12}	8μF 500 V wkg.	
C_{13}	8μF 500 V wkg.	
L_1	10 H, 180 mA, 200 Ω	
T_1	Power transformer Secondary 410-0-410V, 180 mA; 5 V, 3A; 6.3 V, 4 A centre-tapped; 6.3 V 2.5 A centre-tapped.	
T_2	Partridge Type P3878	
V_1	Mullard EF86	
V_2	Mullard ECC83	
V_3, V_4	Mullard EL34	
V_5	Mullard GZ32	

* High-stability carbon. † Matched within 5%. $R_{12} > R_{11}$. ‡ Preferably matched within 5%.

and this value has been chosen to ensure adequate balance down to very low frequencies. A disadvantage of the cathode-coupled form of phase splitter is that the effective voltage gain is about one-half of that obtained from one section used as a normal voltage amplifier. Due to the high μ of the ECC83 (100) the effective stage gain in the circuit is still about 25 times.

First Stage.—This stage is a high-gain pentode voltage amplifier using the Mullard EF86 low-hum pentode. The stage gain is approximately 120. High-stability cracked-carbon resistors are used in anode, screen-grid and cathode circuits and give appreciable improvement in measured background noise level as compared with ordinary carbon resistors. This stage is d.c. coupled to the input grid of the phase splitter in order to minimize low-frequency phase shift in the amplifier and improve low-frequency stability when feedback is applied.

Negative Feedback.—The sensitivity of the amplifier without feedback is 6.5 mV for 20 watts output. With feedback approximately 220 mV is required for the same output level, the designed overall loop gain being 30 db. The loop gain, overall frequency response and phase shift characteristics of the complete amplifier are shown in Fig. 2.

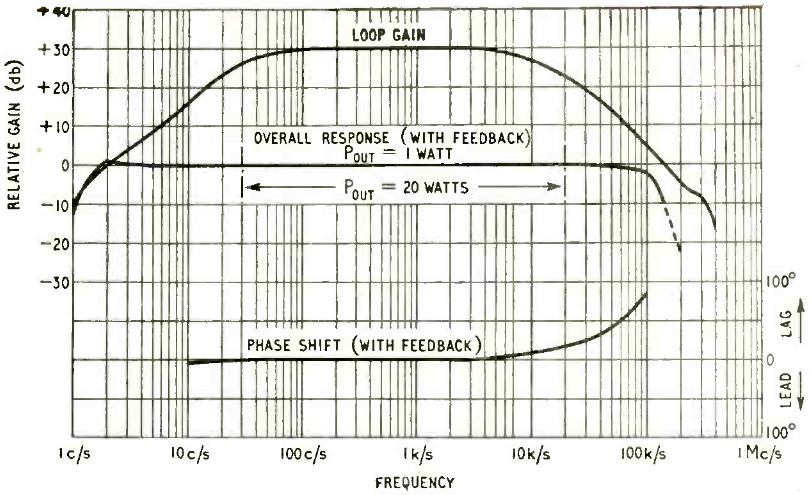


Fig. 2. Loop gain and frequency response and phase shift characteristics with feedback.

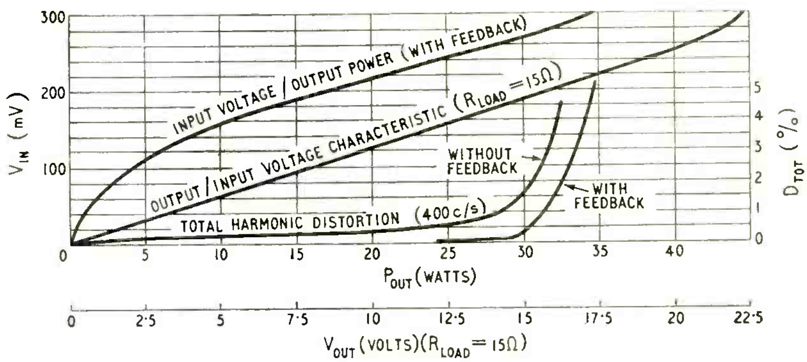


Fig. 3. Harmonic distortion and input/output characteristics of prototype amplifier.

In spite of the high degree of negative feedback used in the present design an adequate margin of stability has been achieved. Complete stability is maintained under open-circuit conditions in the prototype amplifier. An increase in feedback of at least 10 db, obtained by reducing the value of R_{15} should be possible before signs of high-frequency instability occur. In the form of design used oscillation with capacitive loads is the form of instability most likely to occur, but even with very long loudspeaker leads, instability is unlikely to arise.

Distortion.—The harmonic distortion of the prototype amplifier at 400 c/s, measured without feedback under resistive load conditions, is shown in Fig. 3. The distortion curve towards the overload point is also shown for feedback conditions. At the 20 watt level the distortion level without feedback is well below 1% and with feedback applied falls to below 0.05%. Harmonic distortion at 400 c/s reaches 0.1% at approximately 27 watts output. The loop gain characteristics are such that at least 20 db feedback is maintained from 15 c/s to 25 kc/s and 26 db down to 30 c/s.

Measurement of intermodulation products has been made, using a carrier frequency of 10 kc/s, and a modulating frequency of 40 c/s, with a ratio of 40-c/s to 10-kc/s amplitudes of 4:1. With the combined peak amplitude of the mixed output at a level corresponding to the peak sine wave amplitude at 20 watts r.m.s. power, intermodulation products expressed in r.m.s. terms totalled 0.7% of the 10 kc/s carrier amplitude, and at 29 watts approximately 1%.

The output/input characteristic shown in Fig 3 shows that excellent linearity is obtained up to 20 volts across 15 Ω, corresponding to 27 watts output.

Sensitivity.—The sensitivity of the amplifier is approximately 220 mV for 20 watts output and 300 mV at the overload point at mid frequencies. The background level in the prototype amplifier was 89 db below 20 watts, measured with a source resistance of 10 kΩ. This is equivalent to about 5.5 μV at the input terminals. It is possible to increase the overall sensitivity of the amplifier by 6 db whilst still maintaining a low background level, high loop gain and a high margin of stability. However, considerations involved in the design of suitable pre-amplifier circuits, in particular the need for adequate signal-to-noise ratio, render a higher sensitivity of doubtful advantage.

Power Response.—It is important that adequate power-handling capacity is available at the low-frequency end of the audible range. This is determined chiefly by the characteristics of the output

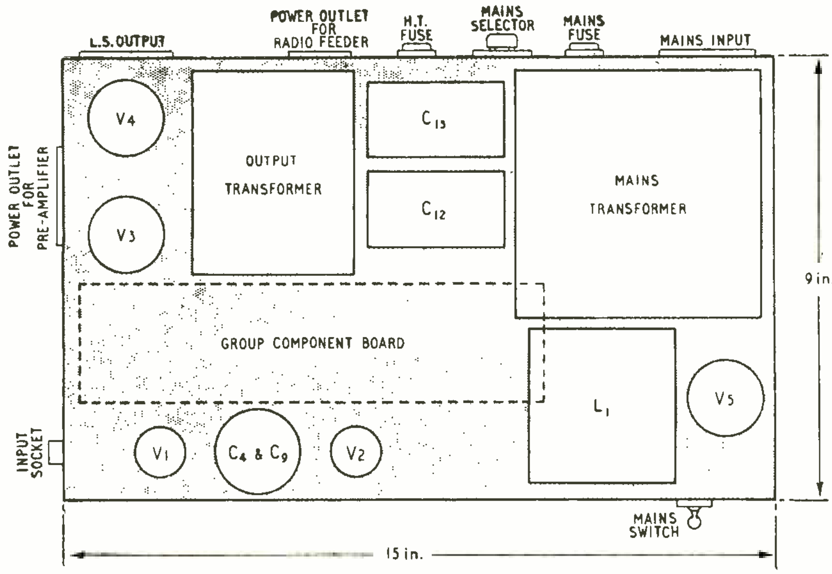


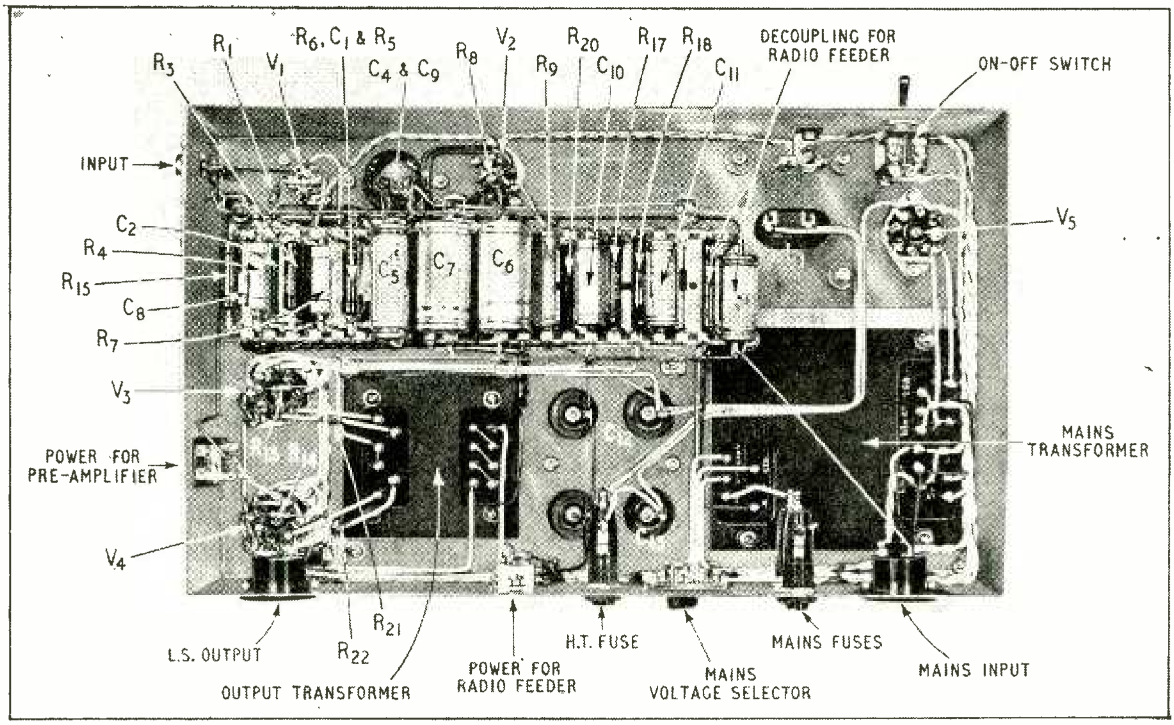
Fig. 4. Layout of principal components in prototype amplifier.

transformer employed, and it is desirable that associated pre-amplifier circuits should attenuate the very low frequencies which the amplifier is incapable of handling at rated power output without excessive distortion. With the output transformer at present employed at least 20-watts capacity is available down to 30 c/s, and the frequency response at the 20-watt level is linear from 30 c/s to 20 kc/s.

Output Impedance.—Due to the low inherent output impedance of the output stage, combined with a high degree of negative feedback, the output impedance is very low, measuring approx. 0.3 Ω on a 15-Ω termination for 20 watts output at 40 c/s, 1 kc/s and 20 kc/s. This corresponds to a damping factor of approximately 50.

Phase Shift and Transient Response.—In practice a compromise must be effected between the phase shift of the amplifier, particularly at high frequencies, and the margin of stability required with a given loop gain. In the present design emphasis has been laid on ensuring as high a margin of stability as possible. The phase shift is held to a comparatively low level in the audible frequency range and, as seen from Fig. 2, reaches about 20° at 20 kc/s. Excellent response to signals of a transient nature is obtained, and the rise time of the amplifier is of the order of 5 μsec.

Mechanical Construction.—A diagram of the layout of the chief components as used in the prototype amplifier is shown in Fig. 4. Although this differs extensively from the layout used in the original experimental circuit no difficulty due to instability has been encountered in either arrangement. A bus-bar earth return has been used with chassis connection at the input socket. With minor exceptions all resistors and capacitors are mounted on group terminal boards, shown dotted on the diagram.



Underside of chassis showing one possible grouping of the smaller components.

Wobbulator Adaptor for Band III

Attachment to Existing Band-I Swept Frequency Oscillators

By G. H. LEONARD, B.Sc. (Hons.) Lond.*

THE introduction of new television channels in Band III has posed many problems for development and manufacturing organizations, not the least of which has been the problem of production test equipment. At the time that the production of Band I/Band III receivers was first contemplated by the author's firm, the few types of test gear for Band III which were then available were not considered suitable for mass production work. The most pressing need was for a swept frequency generator or wobbulator for the alignment of tuner units, and the equipment about to be described was built to fulfil this requirement.

The design of equipment for internal use by a manufacturing organization is inevitably governed to some extent by "domestic" considerations. In this case, the fact that substantial numbers of commercial Band-I wobbulators (Samwell & Hutton Type 41) were already in use for Band I alignment led to consideration being given to the provision of an adaptor to provide r.f. in Band III, the rate of frequency sweep being so arranged that the existing display facilities could be utilized. A further consideration was the company's policy of manufacturing tuners initially for Channels 8 and 9 only, provision being made for interchangeable coils to adapt the tuner for any channel when required. This gave some latitude in the initial specification of the equipment, in that, although the basic system needed to be suitable for any channel, equipment could initially be made with some limitation in performance other than on the two specified channels.

With these requirements in mind, consideration was given to the possibility of a heterodyne adaptor being designed to provide a Band-III output, using the Band -I output of the existing wobbulators in conjunction with a local oscillator. Examination of this proposal showed that each 10-Mc/s sweep available on Band I had at least one, and in many cases, two, harmonic sweeps covering such a large proportion of Band III that the output from such a heterodyne device would be likely to contain unwanted frequencies over at least a portion of the sweep. In practice this could lead to errors in alignment which would not necessarily be predictable, a drawback sufficiently serious to rule out further consideration of heterodyne methods. Examination of the harmonic problem, however, drew attention to a further method which was eventually adopted.

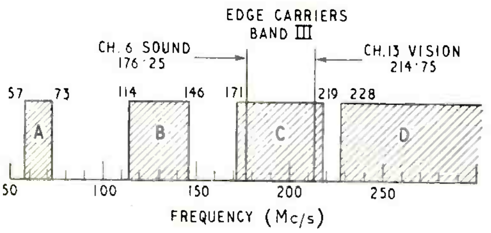


Fig. 1. Frequency sweep of the Band-I wobbulator is shown at A, while its 2nd, 3rd and 4th harmonics are at B, C, and D respectively.

One of the sweep ranges on the Band-I wobbulators was 60-70 Mc/s and it was noticed that the third harmonic of this sweep, 180-210 Mc/s, covered Channels 8 to 11 with a sufficiently large margin to allow for the skirt bandwidth of Band-III tuners. Tripling this output of the wobbulator would therefore cover four channels in one sweep, and the desired channel could be selected by adjustment of the sweep and shift controls of the wobbulator display. A simple prototype showed that the system was workable. Consideration was then given, in consultation with the makers of the wobbulators, to the final design of an instrument capable of covering the whole of Band III.

The frequency sweep obtained from the instrument must ideally cover the whole of Band III plus a considerable margin to allow for the examination of the skirts of a response curve. This calls for a very wide sweep and a compromise has been necessary so that the sweep covered is sufficient to allow some examination of the skirts of Channels 6 and 13 while at the same time excluding unwanted harmonics. The frequency relationships are shown in Fig. 1, the wobbulator coverage being suitably modified.

Using a sweep of 171 to 219 Mc/s, there is a margin of 5.25 Mc/s below Channel 6 sound and 3.25 Mc/s above Channel 13 vision; adjacent harmonics do not fall within the band but are, however, still too close for comfort and special measures are needed to eliminate them.

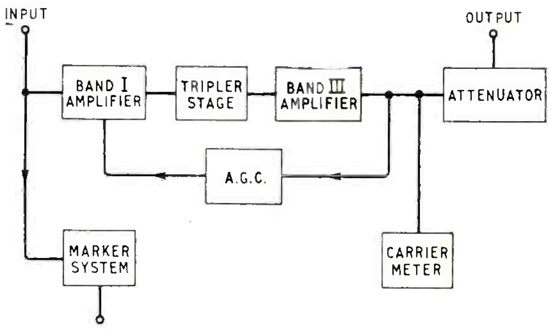


Fig. 2. Block diagram of the adaptor.

Within the desired band the output of the instrument is held flat within close limits. At first sight this does not appear necessary; from the alignment point of view a slope of up to 1db over any one channel might well be tolerable but this would mean that a consider-

* Ultra Electric.

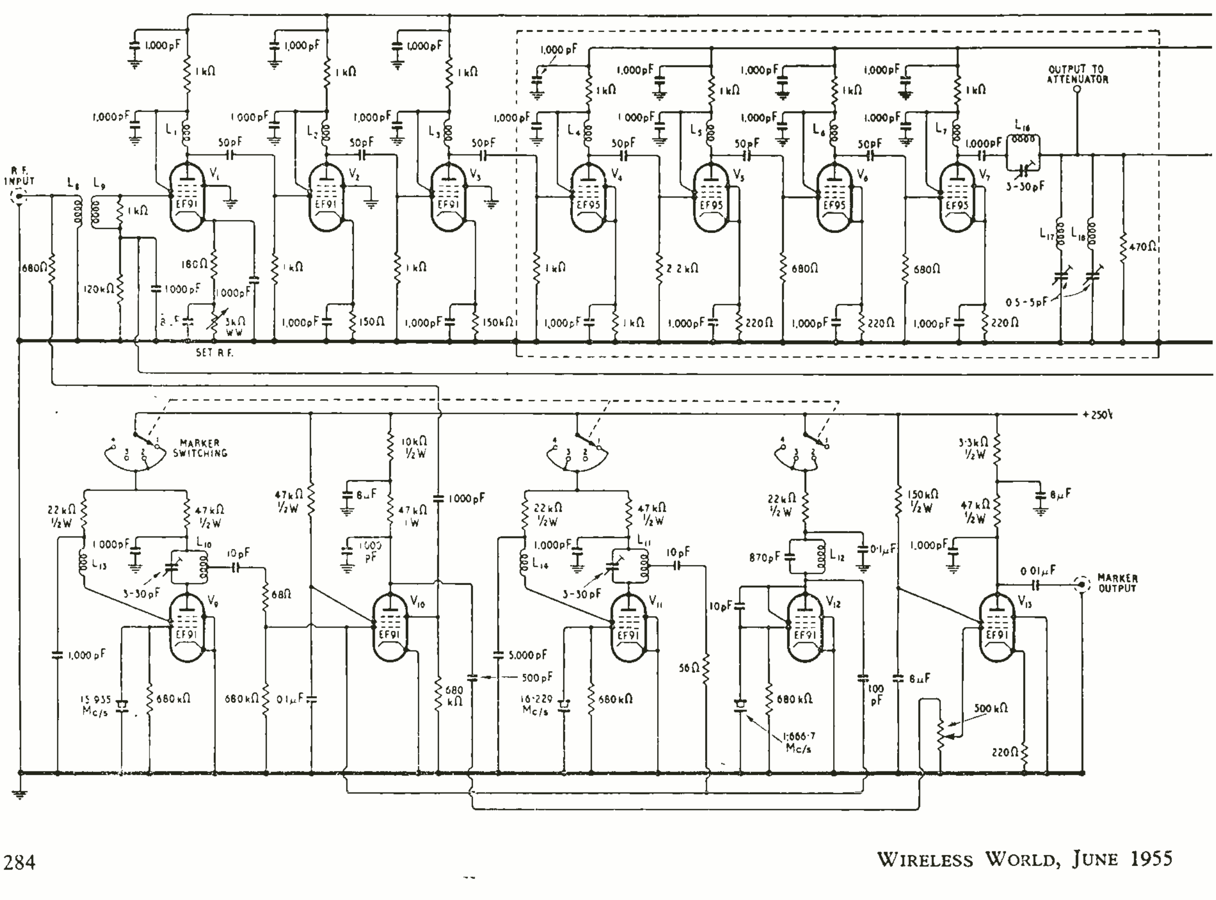
able difference in basic level could exist between, for example, the two end channels, which would then place any comparison of sensitivities in doubt. The flat response, which is achieved by means of an a.g.c. system, enables sensitivity measurements to be made anywhere in the band with some confidence.

Frequency markers are obtained by beating the Band-I input with crystal-controlled oscillators. The use of the input for this purpose enables a conventional form of oscillator to be used, and it is only necessary to select a crystal frequency sufficiently high to ensure that only one harmonic occurs in or near the Band-I sweep.

A block schematic of the adaptor is given in Fig. 2 and the complete theoretical circuit in Fig. 3. V1, V2 and V3 form a stagger-tuned amplifier for the band 57-73 Mc/s, gain control being obtained by cathode biasing of V1 by the "SET R.F." control. The output from V3 is sufficient to severely overdrive the grid of the tripler valve V4. The strong third harmonic component present at the anode is selected by a tuned circuit consisting of the variable inductance L_1 and the stray circuit capacitance, the frequency setting being in the region of 195 Mc/s. The Band-III r.f. so developed is amplified by V5, V6 and V7, all of which are EF95 pentodes, having characteristics which render them particularly suitable for use at this frequency. L_7, the anode coil of V7, is tapped down to give a low impedance feed at approximately 75 ohms to the attenuator and also to the 2nd and 4th harmonic rejection filters containing L_{16}, L_{17} and L_{18}. The Band-III amplifier is only partially stagger-tuned, the response being arranged to peak somewhat below the centre of the passband in order to increase the discrimination against 4th harmonic. This unwanted component is most likely to be developed during the "low" end of the Band-I sweep (input frequencies about 57-58 Mc/s) when the 4th harmonic falls very close to the desired band. Tuning is so arranged that at this end of the band the Band-III amplifier has a response between 171-174 Mc/s which is considerably above the response between 228-232 Mc/s. Since the highest second harmonic is 25 Mc/s below the desired band, this slight bias to the low frequencies has little or no effect upon the second harmonic content and the peak in the amplifier gain is well within the range of the a.g.c. system.

The Band-I wobbulator frequency sweep is generated by an oscillator whose output frequency is continually swept by a motor-operated variable capacitor revolving at 1,500 r.p.m. In consequence, any variation of gain with frequency in the system has the effect of modulating the r.f. output voltage with a waveform whose repetition rate is 25 c/s. This modulation is detected by the upper crystal diode CG12E, so connected that an increase in output gives a positive signal. The resulting 25-c/s waveform is fed to the grid of the high-gain audio stage V8 where it is amplified by over 100 times and reversed in phase. The output from the anode of V8 is fed in the form of an a.c. bias to the "earthy" end of L_9, the grid coil of V1; thus any increase in output appearing at the

Fig. 3. Complete circuit diagram of the adaptor. Lead-through 1,000-pF capacitors are used for decoupling the valve heaters. All resistors not marked with wattages are small $\frac{1}{8}$-watt types. Coil-winding data is given in the separate table.



CG12E will cause a large increase in bias at the grid of V1, with a consequent reduction in gain to cancel the rise in output. The system is very effective and allows considerable latitude in the tuning of the Band-III amplifier; it is therefore possible to arrange the response so that unwanted harmonics are minimized.

The time constants of the a.g.c. system are chosen as a result of practical experience. When the attenuator is switched from one position to another a momentary change in impedance occurs when the wiper is between contacts, giving rise to a large momentary change in output. If the time constants in the circuits of V8 and V1 are too long this causes a damped, very low frequency oscillation of output level which may be observed as a variation in response curve amplitude or as a fluctuation of the carrier meter reading. It has been found possible to make the system "dead beat" by a suitable choice of time constants.

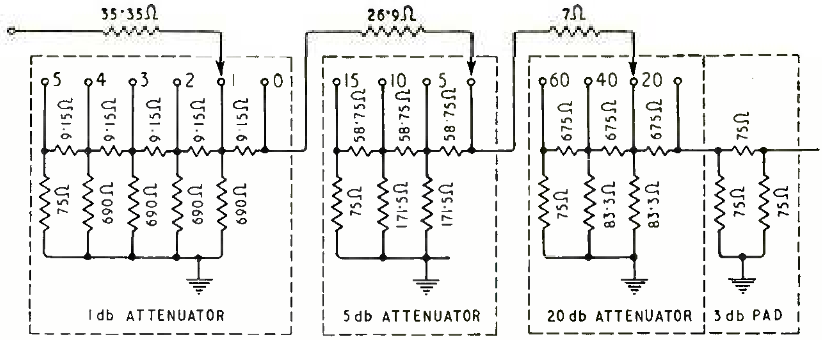
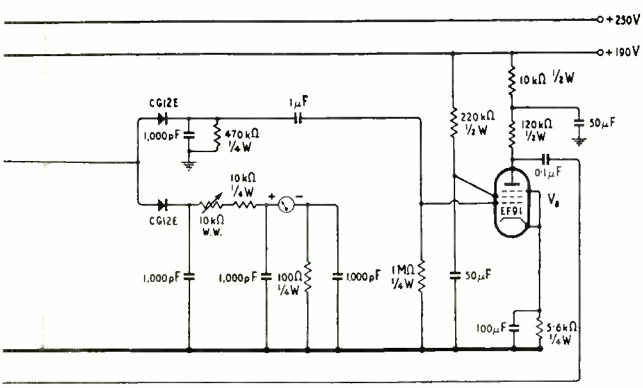


Fig. 4. Circuit of the attenuator used in the output of the adaptor.

The marker system, which was developed in close co-operation with the wobbulator manufacturers, operates in the following manner. V9 and V11 are crystal-controlled oscillators, the screen grid circuit in both cases being tuned to the fundamental and the anode circuit to the 4th harmonic of the crystal frequency. The two frequencies so developed are ⅓ of the sound and vision carrier frequencies of Channel 9. V12 is a crystal-controlled oscillator operating on 1.666 Mc/s (which is ⅓ of the spacing between two sound or vision carriers) and produces a substantial harmonic content. The outputs of the three oscillators are mixed at the grid of V10, producing frequencies at ⅓ of each of the following:—

(1) Channel 9 vision frequency.
(2) Channel 9 sound frequency.
(3) Other vision carrier frequencies (by mixing ⅓ Channel 9 vision frequency with 1.666 Mc/s and its harmonics).
(4) Other sound carrier frequencies (by a similar process).



The 57-73 Mc/s sweep is injected at the suppressor of V10 and a heterodyne beat is produced as the wobbulator sweep passes through each of the above frequencies, the higher frequency components of these beats being by-passed and the lower frequency components being amplified by V13 and fed to one Y plate of the wobbulator display tube. The beats appear on the trace as quite narrow markers, the amplitude of which may be controlled by the potentiometer in the grid circuit of V13.

The four-position switch is arranged to break the h.t. supply to any one oscillator, permitting four marker arrangements to be made available. These are:—

(1) Channel 9 sound and vision only (V12 not oscillating).
(2) All sound markers (V11 not oscillating).
(3) All vision markers (V9 not oscillating).
(4) All sound and vision markers (all oscillators functioning).

This marker system does not lend itself to the im-

COIL DATA

L1: L2: L3: 5 turns 28 s.w.g. enamel covered wire on $\frac{9}{32}$-in former, permeability tuned.

L4: 2½ turns, **L5:** 1½ turns, **L6:** 2½ turns, **L7:** 6½ turns — 22 s.w.g. tinned copper wire on $\frac{9}{32}$-in former, brass-slug tuned.

L8: 2 turns, **L9:** 6 turns — 28 s.w.g. enamel covered wire on $\frac{9}{32}$-in former, permeability tuned.

L10: L11: 7 turns 16 s.w.g. enamel covered wire on ½-in "air" former, tapped 2 turns from h.t. end.

L12: L13: L14: 33 turns 28 s.w.g. enamel covered wire on $\frac{9}{32}$-in former, permeability tuned.

L16: 3½ turns 22 s.w.g. tinned copper wire on "air" former ¼-in long and $\frac{5}{32}$-in internal diameter.

L17: 5½ turns 18 s.w.g. tinned copper wire on "air" former ¾-in long and ⅜-in internal diameter.

L18: 4½ turns 18 s.w.g. tinned copper wire on "air" former $\frac{9}{32}$-in long and ½-in internal diameter.

mediate identification of channels other than Channel 9, but this has been simplified by bringing the wobbulator X shift and sweep control circuits out to a number of preset potentiometers. These are selected by a channel selector switch so that any desired portion of the sweep is presented at the centre of the display, over-riding vernier controls being provided for fine adjustment. The circuit of this section is not shown since it is associated with the wobbulator rather than with the adaptor.

An alternative marker system has been investigated with which no such ambiguity arises. This employs two oscillators, one operating on the desired channel sound frequency and the other on 1.166 Mc/s, i.e., $\frac{1}{3}$ of the sound-to-vision separation. This system gives the sound marker, vision marker, a spurious marker corresponding to sound frequency minus 3.5 Mc/s or, by switching off the 1.166-Mc/s oscillator, the sound marker only. This system possesses the disadvantages that separate crystals are required for each channel and that each must be switched on channel selection. As the preset shift and sweep settings are desirable for mass-production use, the advantages of the second system were not considered to be worth while in view of the extra complication involved.

During development certain facts relating to the attenuator system came to light. It became evident that a constant-input-impedance network was desirable in order to avoid changes in the tuning of L_7 which might affect performance, while other design

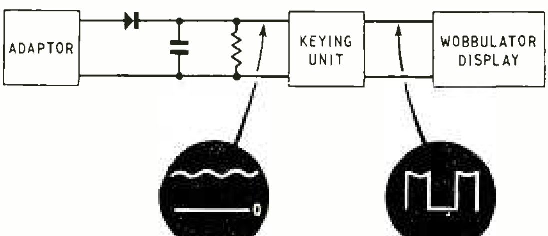


Fig. 5. Keying system used in examining response of the adaptor.

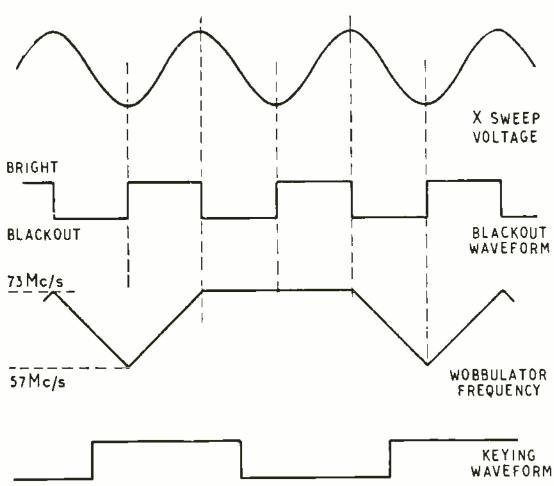


Fig. 6. System for blacking out alternate half-cycles of wobbulator display time-base, showing relationships of waveforms to frequency sweep.

considerations demanded a minimum possible insertion loss and ease of mechanical construction. The final attenuator design chosen was built in three Advance Components A37 attenuator cases, the circuit shown in Fig. 4 being employed.

Considering the 20-db section, it will be observed that, provided the output is terminated in 75 ohms, the input impedance is constant at 68 ohms for any switch position and the resistor values are such as to produce the desired attenuation. A resistor is in series with the input so that the impedance into which the 5-db step attenuator works is also 75 ohms. This, and the 1-db section, have circuits of a similar type. The output impedance of the attenuator is not 75 ohms but this is not important theoretically, since if the output cable is properly terminated no reflections should occur. In practice no undesirable effects have been noticed but a 3-db pad has, however, been incorporated in order to reduce the effects of variations of termination on the attenuation. When measurements are made working into a 75-ohm input circuit, and damping of the circuit by 75 ohms is desired, the use of an external 6-db pad is recommended.

Because of the small values used in the 1-db section and the physical limitations imposed by the Advance Components casting, high-stability resistors cannot be used and, in any case, theoretical considerations suggest that a simple resistive rod should possess better r.f. characteristics than the spiral of high-stability types. The resistors employed were made from ordinary $\frac{1}{4}$-watt resistors by removing the ceramic cases, scraping the rods to the required value and enclosing them in protective plastic sleeves. The lower values of $\frac{1}{4}$-watt resistor frequently have a metal band sprayed on to the rod to obtain the desired value. The presence of this band increases the capacitance between the end caps of the resistor, so for the range where these bands were known to exist a lower value was chosen and the band scraped off. The use of this type of resistor is, of course, theoretically questionable in the matter of stability, but in practice no important errors have yet been observed.

The initial alignment of the Band-I and Band-III amplifiers is carried out using a signal generator. For final adjustments, and in order to establish that the a.g.c. circuit is operating satisfactorily, it is necessary to check the instrument under normal operating conditions with the swept frequency input from the wobbulator. This can, of course, be effected by connecting a detector to the output socket and displaying any variations in the detector voltage on the wobbulator cathode-ray tube. However, this method has the disadvantage that since the wobbulator Y amplifier is a.c. coupled no indication of amplitude is obtained. Although the latter parameter is indicated by the carrier meter, it has been found inconvenient to observe both meter and tube while adjustments are taking place; furthermore, it is desirable that variations in amplitude through the band should be easily observed in relation to the r.f. output level. Since a detector connected to the output produces a d.c. voltage proportional to the mean output level, with superimposed a.c. corresponding to any variations, the desired display is achieved by the use of a piece of ancillary equipment to "chop up" or "key" the detector output as shown in Fig. 5, so that an alternating voltage whose amplitude varies with the total output is produced. The

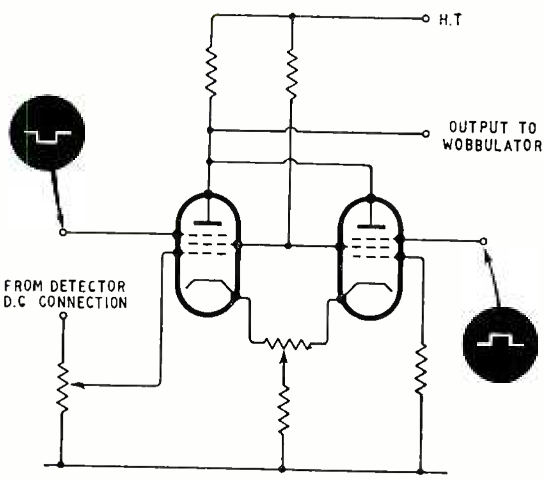


Fig. 7. Circuit diagram of keying unit used in Fig. 5.

wobbulator display employs a 50-c/s sinusoidal time base, with alternate half-cycles blacked out, which is related to the frequency sweep as shown in Fig. 6. The keying device is operated at 25 c/s so that the display shows a zero-volts base line in addition to the response of the adaptor.

The keying unit employs a beam-switch type of circuit (Fig. 7) using two pentode valves with a common anode load. The keying waveform shown in Fig. 6 (derived from a mains-synchronized 25-c/s multivibrator) is applied to the two suppressors in antiphase so that when one valve conducts the other is cut off. One valve has its grid returned to earth and the other is d.c. connected to the detector, a variable biasing arrangement allowing the currents through the valves to be made identical under no-signal conditions. When r.f. is applied to the detector the resulting d.c. alters the bias of one valve so that the currents are no longer equal and a 25-c/s waveform appears at the anodes. This is fed to the wobbulator Y amplifier and, since the time base operates at 50 c/s, produces two traces on the screen, a zero-volts base line and the response of the adaptor. The separation of the two traces indicates the amplitude of the adaptor's output.

The keying unit is used not only to examine the response of the adaptor but also to check the output level against a standard signal generator. For this test the adaptor output is set to give a definite separation between the traces; it is then disconnected and replaced by the signal generator, whose output is adjusted to give the same separation. This method is used to calibrate the carrier meter on the adaptor.

The adaptor is built so that it may be conveniently linked with the wobbulator to provide a compact Band I/Band III unit, the adaptor forming a pedestal on which the wobbulator stands with its display tube at eye level. The unit has a light alloy angle frame, the circuits being built up on flat plates which are screwed in. This arrangement facilitates assembly and provides a rigid pedestal for the wobbulator. The Band-III amplifier is completely screened and this screening is bonded to the rear of the attenuator in order to avoid earth currents. Lead-through capacitors, used for decoupling h.t. and heater lines, form convenient anchoring points and all "hot" leads are kept as short as possible. The channel selector switch and preset controls are mounted along one side, the edge of the switch knob being engraved so that the switch position is easily seen.

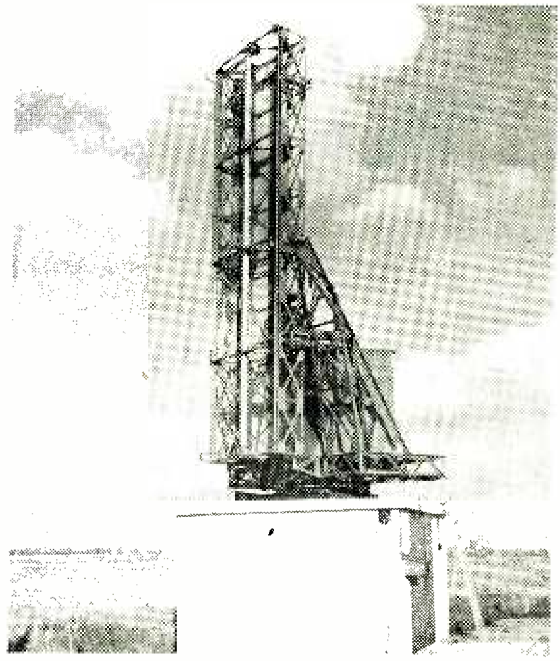
Finally, the author would like to acknowledge the parts played by M. Phillips, who was responsible for the original conception and basic design of the instrument, and A. H. Jacob, who carried out the practical work.

Radar Height Finder

SHOWN in the illustration is the latest Marconi Type S13 long-range radar height finder which, it is understood, will be installed at London Airport by the Ministry of Transport and Civil Aviation. It operates in the 10-cm waveband and provides a peak pulse power output of about 500 kW and has a working range of about 150 nautical miles. An accuracy of ±500ft at 50 nautical miles is claimed.

The aerial system, which is designed to transmit a very narrow beam of radar pulses only 1 degree in the vertical and 4.5 degrees in the horizontal planes respectively, consists of a slotted waveguide positioned along the focal line of a vertical paraboloid reflector. It is made to oscillate in the vertical plane at about 10 times a minute and scans an angle of between −1° and +25° to the horizontal. Horizontal rotation of the aerial is effected as required by remote control when an aircraft has been located on the plan position display of any available search radar. It can also be rotated continuously at about 10 r.p.m. if required.

In the form shown the transmitter and receiver are housed in the concrete building with the aerial mounted on its roof, but a separate gantry can be used for the aerial where existing buildings for the equipment are available.



The photograph shows the Marconi radar height finder, Type S13, with the aerial system mounted on the building housing the transmitter and receiver.

Some Problems in Television Lighting

By W. C. PAFFORD, A.C.G.I., D.I.C.

VIEWERS sometimes complain that the lighting in television appears to vary from one camera to another. This apparently elementary matter is difficult to explain without first briefly outlining the principles involved in lighting for this new medium.

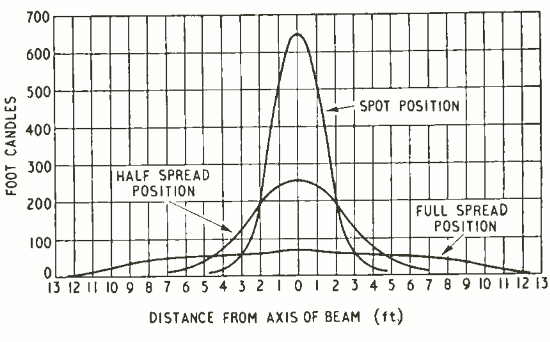
The subject itself is complex, involving not only physical optics and illumination, but also photographic principles and artistic appreciation. Not least among these is the study of the human eye and reaction to tonal quality and balance. Broadly, there are two distinct basic functions of lighting for television.

First, it must create the right artistic effect for any given production so that the mood of drama or comedy is effectively conveyed to the viewer; for example, "drama" is usually portrayed in "low-key" lighting with heavy shadows and contrast, whereas "comedy" is assisted by "high-key" lighting which creates a lighter mood with less contrast and brighter atmosphere. But this aspect of lighting obviously requires special study and may be regarded as beyond the scope of this particular article.

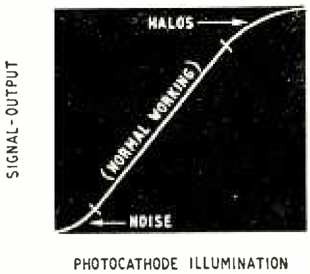
Secondly, television cameras need a certain basic light level and a suitable disposition of lamps in order to obtain pictures which are technically acceptable. In theory it is possible to estimate the total lighting required by any given scene by referring to the illumination-efficiency curves (Fig. 1) of the lamps to be used. In practice, however, the assessment of the kilowatts of lighting required to give a predetermined level of incident light is largely a matter of experience. The pre-war Standard Emitron camera for instance was comparatively insensitive and required a scene brightness of 200-300 foot-candles. The more recent C.P.S. Emitron tube now used in the studios needs less than half this amount of incident light. The latest image-orthicon cameras, used on outside broadcasts, are so sensitive that intelligible pictures can be obtained with as little as 1 foot-candle of incident light.

Although acceptable pictures are obtained with a basic light of about 10 foot-candles, in practice it is found that an incident light value of 25–30 foot-candles allows an image-orthicon camera to use a lens stop of $f/8$, which gives maximum optical efficiency and also a good depth of focus. It also helps in the operation of the tube, which for best results should be made to work on the linear part of the signal-light curve (see Fig. 2).

Type of Camera	Incident foot-candles	Permissible Contrast	Average Lens Stop $f/$ number
Standard Emitron	200–300	50/1	3.0
C.P.S. Emitron	100–130	30/1	6.3
Image-Orthicon	25–30	20/1	8



Above: Fig. 1. Typical curves showing the spread of light for a 2-kW lens spot.



Left: Fig. 2. Signal-light curve of image-orthicon camera tube.

If the illumination on the photocathode is too low we not only run into low signal-noise ratios, but also the detail in the darker parts of the picture is crushed into the blacks. On the other hand, if the level is too high there is a tendency to flatten out the highlights and run into instability. Having established the correct basic illumination, it is now necessary to consider the disposition of the various sources of light.

"Hard light," derived from a lens spotlight or other focus source is suitable for use as a key light, and "soft light" which consists of floods is used for filler and general softening of hard shadows. Additional "sparkle" can be added to the picture by using the film-studio technique of introducing "back light." The diagram in Fig. 3 shows an elementary lighting plot using a single camera at A. In this case the lighting engineer has a fairly straightforward job to do, and by adjusting these three lamps a well-balanced portrait can be obtained.

But if we now introduce a second camera at B, then clearly it will not be looking at a very well-balanced portrait, as the key light is now acting as a three-quarter back light. To put this right it is necessary to re-balance the light sources while with three cameras a further compromise is necessary until the light balance has been restored as seen from each camera position.

It will be appreciated, therefore, that when in addition to this, the subject is, say, a crowded stage in a

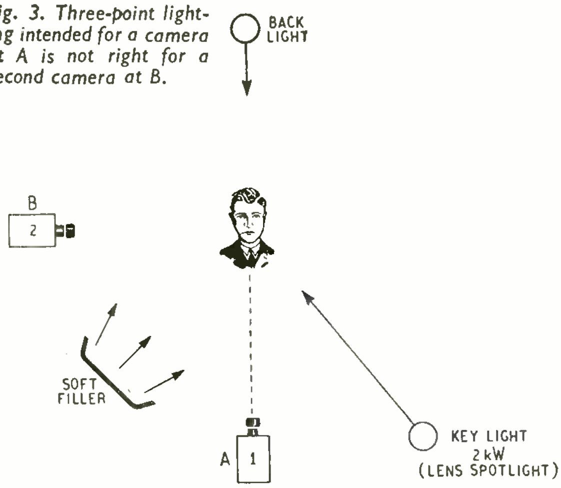


Fig. 3. Three-point lighting intended for a camera at A is not right for a second camera at B.

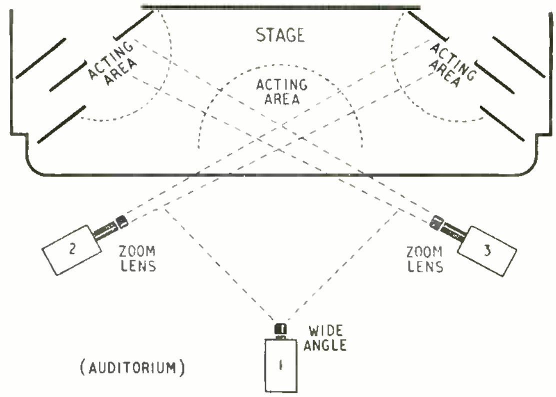


Fig. 4. General arrangement of cameras for, say, a theatre.

theatre, and possibly the available lighting positions in the auditorium or circle are restricted, then it becomes difficult to get a good balance on all three cameras. A good deal of ingenuity is called for and the lighting engineer may have to decide which camera is likely to take most of the important close-ups on principal actors, for instance. The more general shots may have to take second place. Another problem, of course, is that the best camera positions, particularly in a theatre, are not always the easiest from a lighting angle.

Fig. 4 shows a typical camera set up for an outside broadcast from a West End theatre, where two cameras (non-tracking) use zoom lenses for close-up work and usually cut across the stage into the opposite corner of the stage set. A third camera is sometimes used in the auditorium or circle to give wide-angle shots. The main problem is to get sufficient light for the close-up work and at the same time to keep a balance so that rapid switching from one camera to another is not accompanied by an apparent change in light level. In this respect the colour and design of the background become very important.

For example, the background in a stage setting may well depend for its harmony on a delicate choice of colour or, say, a well-balanced composition made up of areas of blue-green and orange-red, which to the eye would be completely satisfying. But when translated into a monochrome picture by a panchromatic camera, the tonal composition will probably be something very different. Generally, the background needs a good a.c. light component or, in other words, a well broken-up design. Supposing, for the sake of argument, we use a chess-board type of background then, in long shot, we shall get good results. But, unfortunately, as soon as we move into a close-up, there is the danger of one camera seeing a portrait against a dark background, and the other camera getting the same portrait lit against a light background, which is usually disastrous.

A good practical example of this sometimes occurs in ice shows where the lens catches a large proportion of reflected light off the ice, leaving the figures sadly silhouetted against an unbroken white background.

A further contributory cause of unbalance, especially on faces, could be due to a mismatch in a colour response of the tubes in question, particularly if fluorescent lighting is present.

Another reason why pictures from different cameras do not always appear to match up can be demonstrated by the case of televising a boxing match with

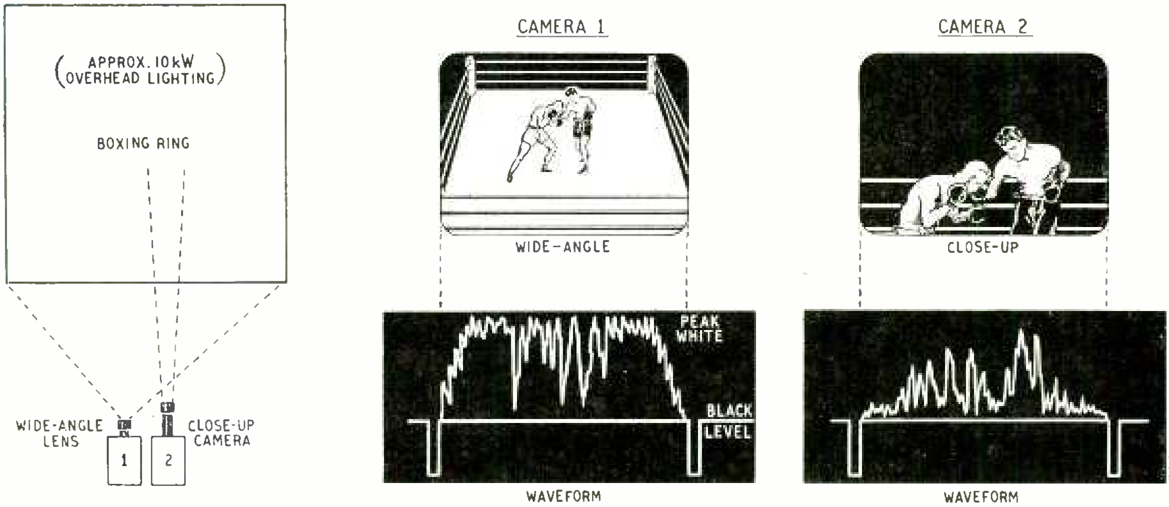


Fig. 5. In a boxing match the lighting is constant, but a wide-angle view gives a higher average brightness than a narrow angle, with the result that the waveforms differ as shown.

two cameras in the same position. In these circumstances there can be no question of different camera angles or of unbalanced lighting because boxing matches are always lit with a perfectly symmetrical overhead rig which remains static. The problem of lighting has now become one of "picture content." This is shown in Fig. 5 where camera 1 may be using a wide-angle lens giving a picture which is largely composed of white. If the adjacent camera is using a close-up lens then the picture content is predominantly black and contrasty. Clearly, a rapid series of cuts from camera 1 to camera 2 will subject the eye of the viewer to sudden changes of brightness as seen on the cathode-ray tube in the receiver. Hence the unfortunate illusion that the lighting is varying. It is, however, possible to introduce an artificial correction in the camera channel circuit by altering the electrical signal.

Probably the most difficult feature of the image-orthicon camera tube is that it has a very limited contrast range, consequently the lighting contrast has also to be kept down to the order of 20 to 1. If this is exceeded we get the familiar "throw-off" (black halo around bright objects), and also "ghosting effect" due to excessive secondary electrons emitted from the target where image highlights occur. It is usual, therefore, to employ much softer lighting for television than that used in film studio work.

Most of the above problems have been taken as typical examples occurring on outside broadcasts where physical limitations are the main obstacles. But lighting difficulties are just as prevalent inside the studios although, in this case, it is more a question of complexity of production, involving camera angles, microphone-boom positions and the use of multiple stage-sets. A fast-moving production, for instance, may use nine or ten different set designs, each requiring its own lighting plot, and each balanced so that there are no irritating changes in light level. In a studio play, for example, it is essential to maintain continuity of mood from camera to camera, whether in close-up or long-shot. This applies even more so with a ballet presentation which relies largely on its pictorial appeal. It is desirable, therefore, that not only should the studio-lighting installation be capable of a high degree of artistic control, but equally important that the receiver should be able to reproduce subtle lighting effects.

A reference has already been made in this article to the importance of having a good a.c. background so that the picture at all times contains well-proportioned areas of black, white and mid-tones. In addition, it is also very important that the overall light level (i.e., the d.c. component*) should be faithfully reproduced on the screen of the receiver. Otherwise, the viewer will probably be looking at pictures which are either suffering from excessive d.c. level with consequent loss of detail in the high lights or, alternatively, a lack of overall brightness resulting in degradation in the dark areas. In either case, the receiver is not conveying the correct photographic qualities intended by the lighting engineer.

* "The Importance of the D.C. Component," by D. C. Birkinshaw, *J. Tel. Soc.*, June 1953.

Terminology of Acoustics

A REVISED edition (1955) of British Standard 661—**Glossary of Acoustical Terms**—has been issued to take into account the change of emphasis and advances in technique since the original issue in 1936. New sections on ultrasonics and underwater sound have been added, and the section on recording and reproduction has been enlarged and now includes terms used in magnetic recording. Copies, price 6s, are obtainable from the British Standards Institution, 2, Park Street, London, W.1.

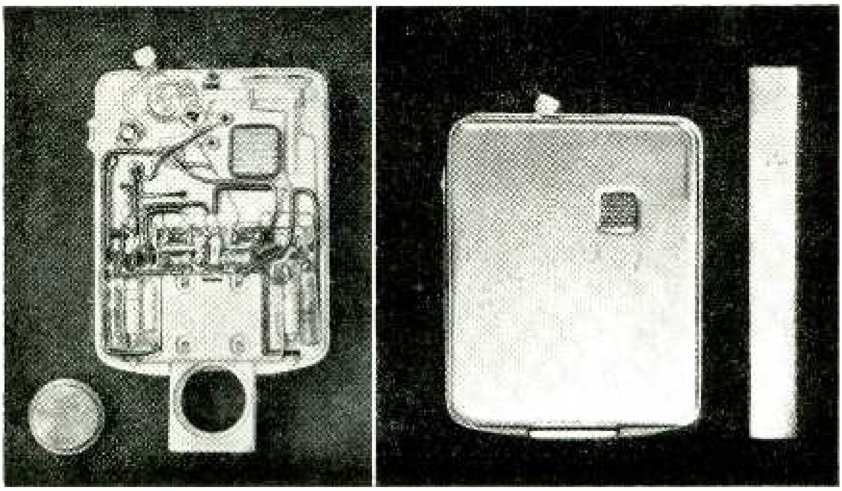
MINIATURE TRANSISTOR HEARING AID

ALTHOUGH weighing only $1\frac{1}{2}$oz and measuring less than $2\frac{3}{8}$in × $1\frac{7}{8}$in × $\frac{1}{2}$in, the "Minuet" hearing aid employs a 4-stage resistance-coupled transistor circuit designed to give high-quality reproduction with sufficient gain and output for the majority of cases of deafness. At 30°C the gain is 20db and the maximum acoustic output 125db referred to 0.0002 dyne/cm^2.

A single 1.3-V Mallory cell (type RM625) gives approximately 175 hours' working on the total current demand of 2mA. This cell, which is of the disc type, fits in a miniature drawer in the base of the instrument and can be replaced without opening the case. An intricate plastic moulding forms the chassis and provides a rigid housing for the various components. The microphone is resiliently mounted to eliminate case noises.

In addition to the usual volume control there is a combined on-off switch and two-position tone control with normal and top-cut responses. Alternative ear-pieces are available with normal rising response or a flat response curve and there is a choice of mounting clips.

The price is £56 13s and the makers are the Multitone Electric Co., Ltd., 223/7, St. John Street, London, E.C.1.



Multitone "Minuet" transistor hearing aid.

B.B.C. Television Frequencies

Medium- and Low-power Stations on Offset Carriers

ONE of the provisions of the Stockholm Plan for v.h.f. broadcasting in Europe is that sound and vision carriers of some television stations should be offset by a maximum of 20 kc/s to avoid mutual interference between transmitters sharing a channel. The B.B.C. is, therefore, operating some of its recently introduced medium- and low-power stations on offset carriers and the deviation adopted is plus or minus 6.75 kc/s for the vision frequency and 20 kc/s for sound. In the appropriate columns in the following table the nominal channel frequencies are accordingly marked + or − where they are offset. With the exception of the frequencies given for Londonderry (which have yet to be approved by the P.M.G.) all the information has been confirmed with the Engineering Information Department of the B.B.C.

In conformity with the general practice on the Continent the B.B.C. has adopted the principle of indicating that the carrier frequencies are offset by suffixing the channel number with + or − (i.e., Channel 2− for North Hessary Tor).

In the fifth column is given the e.r.p. of the permanent vision transmitter, but where there is at present a temporary transmitter in use this figure is followed by the e.r.p. of the low-power installation in brackets. Stations not yet in operation are marked with an asterisk in this column.

Another provision of the Stockholm Plan to minimize interference, and adopted by the B.B.C., is the use of directional aerials. For stations with directional aerials we give in the appropriate column the minimum and maximum e.r.p. for both the permanent and temporary transmitters. No figure is available for the e.r.p. of the temporary North East Scotland transmitter at Redmoss which will be replaced by the permanent station at Meldrum (marked †) at the end of the year. Incidentally, the temporary Belfast station at present operating at Glencairn will be replaced next month by the permanent station at Divis.

The e.r.p. of the new B.B.C. London transmitter which is being built at Crystal Palace and is scheduled to be brought into service next year will be 200 kW.

We are unable to include details of the proposed I.T.A. stations as they have not yet been agreed. It was, of course, stated by the P.M.G. some months ago that the London and Lancashire transmitters would share Channel 9 (194.75 Mc/s vision and 191.25 Mc/s sound) and that the carriers of the London transmitter would be offset by +6.75 kc/s and + 20 kc/s, respectively.

Channel	Station	Carrier Frequencies (Mc/s)		Vision E.R.P. (kW)	Polarization
		Vision	Sound		
1	Alexandra Palace (London)	45.0	41.5	34	V
	Divis (Belfast)	45.0 −	41.5 −	20 (0.4)	H
2	Holme Moss, Yorks. ...	51.75	48.25	100	V
	N. Hessary Tor, Devon ...	51.75−	48.25−	1-16 (0.5)	V
	Rosemarkie, Inverness ...	51.75−	48.25−	1*	H
	Dover area, Kent	51.75+	48.25+	0.1-1*	H
	Londonderry, N. Ireland ...	51.75−	48.25+	0.5*	H
	Truleigh Hill (Brighton) ...	51.75+	48.25+	(0.3)	V
3	Kirk o'Shotts, Lanarks. ...	56.75	53.25	100	V
	Tacolneston (Norwich) ...	56.75	53.25	1-10 (0.14-1.3)	H
	Rowridge, I.O.W.	56.75−	53.25−	1-32 (0.3-9)	V
	Blaen Plwy, Cardigan. ...	56.75+	53.25+	1*	H
4	Sutton Coldfield, Warwicks.	61.75	58.25	100	V
	Meldrum, Aberdeenshire ...	61.75−	58.25−	20(†)	H
	Carlisle area, Northumb'd...	61.75+	58.25+	1*	H
	Jersey, C.I.	61.75+	58.25+	1*	H
5	Wenvoe, Glam.	66.75	63.25	100	V
	Pontop Pike (Newcastle) ...	66.75−	63.25−	10 (1)	H
	Douglas, I.O.M.	66.75+	63.25+	1 (0.25)	V

TV PROGRESS REPORT

WORK began in April on the Channel Islands station at Les Platons, Jersey, which the B.B.C. hopes to bring into service in September. Transmissions from the South Devon station at North Hessary Tor will be received on the S.W. coast of Guernsey and relayed by radio to the Les Platons station—some 20 miles away—for retransmission. Until the permanent transmitter is in use in South Devon—probably early next year—the Channel Islands television service may not be consistent.

The contract has been placed for the erection of the permanent 560-ft stayed mast for the East Anglian station at Tacolneston, near Norwich. This mast will carry the aerials for both television and the v.h.f. sound transmissions. It is hoped that the permanent television transmitters will be installed and the aerials ready for the station to replace the temporary equipment about the middle of next year.

Some difficulty has been experienced in securing a suitable site on the Isle of Man for the permanent station. The ideal position is said to be at the summit of Snaefell, but objections have been raised by the Ministry of Civil Aviation as it is feared the television station might cause interference with the Ministry's transmitting and receiving station already operating on Snaefell. Further tests are, however, to be carried out next year. In the meantime the opening of the permanent station at Divis, Northern Ireland, in July should give a service to the population in the north of the island. The temporary transmitter at Carnane, near Douglas, serves about 60% of the population.

Cathode Followers—

With Particular Reference to Grid Bias Arrangements

By "CATHODE RAY"

LOOKING at the basic circuit diagram (Fig. 1) we might think there wasn't much that could be said about the cathode follower. As for its grid bias, with beautiful simplicity the one and only resistor in the circuit sees to that as well as doing its main job. So it appears.

But when one thinks one knows all about cathode followers, some unsuspected complication comes to light. I hope, however, that you will not take that remark as the prelude to an astonishing new revelation. I doubt whether I am about to disclose anything new, but it may be new to some who have not made a special study of cathode followers or who have not yet had to adapt the theoretical circuits to practical work. There are one or two things about arranging their grid bias, for instance, that are not always made clear in the books.

First we had better have a quick review of cathode followers in general. Their chief use is to enable a waveform derived from a high-impedance source to be reproduced accurately across a comparatively low or variable impedance. They can do this because (1) their input impedance is exceptionally high; (2) their output impedance is exceptionally low; and (3) they cause exceptionally little distortion. These features are due largely to the 100% voltage negative feedback resulting from the position of R, on the cathode side of the valve. From the point of view of the output terminals, the impedance appears to be R in parallel with approximately $1/\mu$ times the valve's actual anode resistance, r_a. This r_a/μ is the same thing as $1/g_m$. For instance, if g_m (the mutual conductance of the valve) is 5 mA/V, that is 0.005 *amps* per volt, and 1/0.005 is 200, which is the apparent number of ohms resistance in parallel with R*. This is far lower than a valve having its output taken from the anode side, and load impedances down to a few thousand ohms can be connected across it without making much difference to the output voltage.

I need hardly repeat the various ways (explained in all the books) by which negative feedback reduces distortion. In the cathode follower *all* the output is fed back, so (as regards a single valve at least) reduction of distortion is a maximum.

The high input impedance comes in two ways. The fact that the anode is held at a constant potential cuts out the "Miller effect," which in an anode-loaded valve greatly magnifies the effective grid-to-anode capacitance. On the other side, the effective grid-to-cathode capacitance is only a small fraction of its book value, because the potential of the cathode *follows* that of the grid†, the grid-to-cathode signal voltage being only the difference between the input and output voltages. Thus the cathode follower has all the benefit of high-resistance input possessed by any valve operated with its grid negative, but without most of the spoiling effect of capacitance to anode and cathode.

Unless we are careful with our grid bias arrangements, however, we may throw away something of these advantages.

As I said at the beginning, R in Fig. 1 provides grid bias at the same time as coupling impedance. But doing two things at once often means that neither is done properly—or at best only one of them. I wouldn't say that the simple Fig. 1 circuit *never* gives satisfaction. Like some of the films reviewed in the cinema trade press ("Might get by with unsophisticated audiences") it is all right if you are easily satisfied. If the resistance of R is too small for grid bias purposes, then grid current flows at the positive peaks of input, and bang go the high input impedance and freedom from distortion. If too large, negative peaks reach the "bottom bend" and the valve ceases to cathode-follow. But if R is chosen midway between these two calamities it will be much smaller than optimum as a coupling resistance.

Adapting the Diagram

To see this in all its naked clarity we should draw a characteristic-curve diagram. Fig. 2 is a sample‡. It starts with an ordinary set of anode-current/anode-voltage curves, as found in valve catalogues. Those in Fig. 2 refer to a rather mediocre triode, having $r_a = 10\text{k}\Omega$, $\mu = 17$, so $g_m = 1.7$ mA/V. Let me emphasize that these figures, like all such published for valves, refer to only one set of working conditions (represented by one point on the diagram) and vary a good deal over the area of the diagram. If it were not so, the curves would be evenly-spaced straight lines. Because they never are, there is always distortion. Each curve, of course, represents the way the anode current (I_a) varies with anode voltage (V_a) at the fixed value of grid voltage (V_g) marked beside the curve. Take special note of the fact that V_g is the voltage *relative to the cathode* (as, indeed, is also V_a). In the ordinary use of a valve that is the same thing as the voltage relative to earth or −h.t. or the lower input terminal, for all these things are tied to cathode either directly or through a by-pass capacitor.

It is because one gets so used to assuming this that the cathode follower is apt to muddle one. When the input voltage varies the grid potential, it varies the cathode potential too; so one can't use the cathode as a fixed-potential point from which to reckon all voltages. The obvious zero-potential reference point is E. And the valve electrode held at constant potential by it is not the cathode but the anode (separated only by the

* To be precise, one should multiply $1/g_m$ by $\mu/(\mu+1)$, but that makes little difference unless μ is exceptionally small.

† That is why the term "anode follower" for the see-saw circuit is so silly; in it the anode does just the opposite of following the grid.

‡ If the principles of this kind of diagram are not understood, see next month's article.

fixed voltage V_{HT}, as shown in the inset to Fig. 2). So our reckoning of the valve electrode voltages has to be upside down as compared with ordinary usage. V_a on the curve sheet therefore really means minus the cathode voltage (relative to fixed anode). And V_g can't be used directly at all, because it is between two varying-potential points. What mathematicians call the independent variable is not V_g but V_{IN}. But this amounts to the same thing as V_{ag}, the voltage of the grid relative to anode. Can we somehow get V_{ag} or V_{IN} curves on to the diagram?

Well, if we look at the inset we see that V_{ag} is the difference between V_a and V_g, which are both on the diagram. So all we have to do to plot a curve of "$V_{ag} = x$ volts" is to join together all points at which $V_a - V_g = x$; that is, $V_a = x + V_g$. So where $V_g = 0$, V_a must be 250 to locate a point on this curve. That is point *a*. Next, at $V_g = -2$, V_a must be $250 - 2 = 248$; so we find the point on the $V_g = -2$ curve at which $V_a = 248$, namely *b*. And so we go down the V_g curves, moving a corresponding number of V_a volts to the left every time, to give the "$V_{ag} = 250$" curve when all the points are joined up. In the same way curves for V_{ag} = anything else can be drawn; I have done the 237.5 and 262.5 volt curves. The reason I chose 250 for a start is that we are going to assume for example that V_{HT} is 250. That being so, V_{IN}, which is $V_{HT} - V_{ag} = 0$ anywhere on the $V_{ag} = 250$ curve, as marked in brackets (to show that it applies only on the assumption that $V_{HT} = 250$). So our starting point, representing zero input voltage, must be somewhere on this curve. But where?

If it were down near the foot, where I_a is small or even zero, there would be plenty of room for increase of current during the positive half-cycles of V_{IN}, but the negative halves would be cut off. And if the starting point were placed at the top, the negative halves would be all right but the positive halves would be in the positive grid region and grid current would flow. So we follow the usual procedure for valve diagrams and put the starting point about half way between zero grid bias and cut-off bias. We see that cut-off bias at $V_a = 250$ is about -16 volts. But half that, -8 volts, looks rather alarmingly low down, so I have put it at -7. Then the "load line" is the one drawn through "$V_a = 250$, $I_a = 0$" (point *c*) and the newly located starting point (*o*). It is shown dotted.

What this dotted load line does is to show the drop in V_a below 250 volts when current passes through the resistance (R) represented by it. At $I_a = 0$, no volts are dropped in R, so V_a is the full 250V h.t. (point *c*). At the starting point *o*, $I_a = 10$mA, and we see that $V_a = 243$; a drop of 7V. The resistance that requires 7V to pass 0.01A through it is $7/0.01 = 700$ ohms. So the dotted line represents a load resistance R of 700 Ω.

Results

Next, let us see what happens when an input signal swings the grid alternately positive and negative. This is where the other two V_{IN} curves are needed. If the peak voltage of the input is $12\frac{1}{2}$ volts, the working point moves along the dotted line as far as the curve "($V_{IN} = +12.5$)"—and where, incidentally, $V_g = -2$, which is about as far as we can go in that direction and still be quite sure of grid current not starting —and in the other direction to "($V_{IN} = -12.5$)" which is about as near cut-off as it is wise to go.

If you like you can try alternative load resistances and working points to see if you can get less distortion at this input, or more output for equal distortion, but I shall be surprised if you do much better working from "$V_{IN} = 0$." How do we know how much output is obtained? Well, the inset shows that any change in V_{OUT} must be at the expense of V_a, so is equal and opposite to it. The movement of the working point along the dotted line takes us from 243V at the start to 235V at the positive peak and 249V at the negative, which is -8V and $+6$V respectively; so the peak values of V_{OUT} are $+8$V and -6V. Another and more accurate way of obtaining these values is to read the rise and fall in I_a and multiply by R; this gives them as $+7.7$V and -6.2V.

We note from this that (1) unlike the anode-loaded amplifier, V_{OUT} has the same polarity (or is in the same phase) as V_{IN}; (2) the device is by no means distortionless, for equal + and − V_{IN} give considerably unequal + and − V_{OUT} (as a matter of interest, the 2nd harmonic distortion calculated in the usual way from the above data is 5.4%); and (3) the voltage

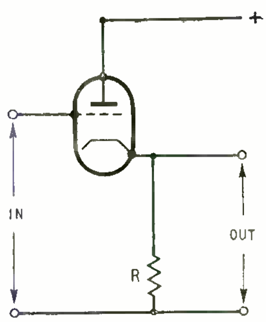


Fig. 1. Basic circuit diagram of cathode follower.

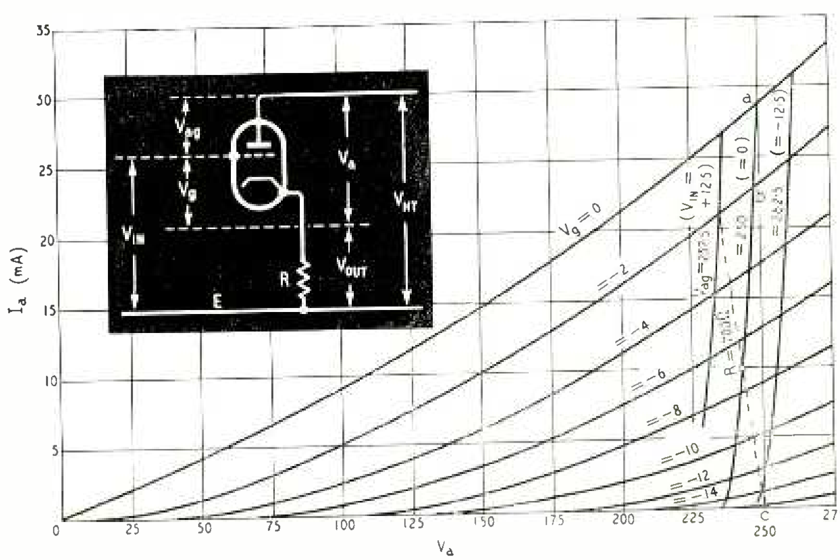


Fig. 2. Showing how to use the ordinary I_a/V_a valve curves to construct cathode-follower characteristic curves.

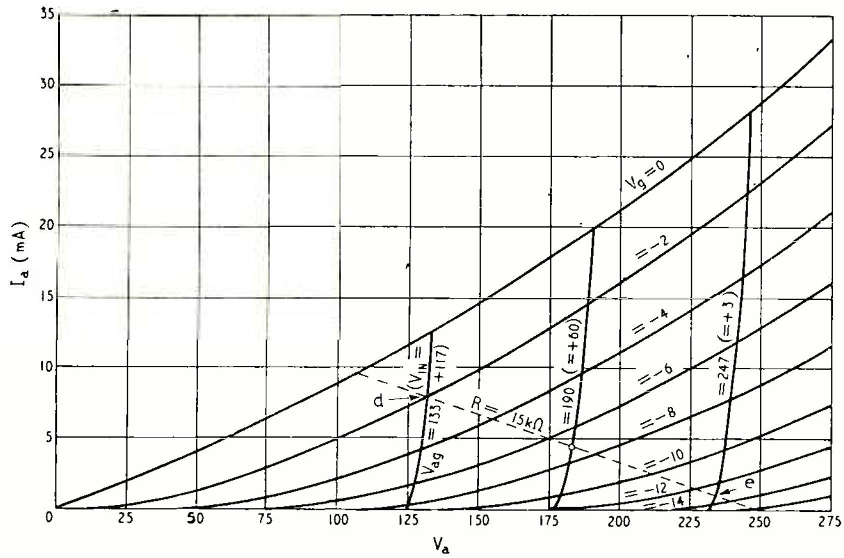


Fig. 3. By using a much higher value for R in Fig. 1 than the 700Ω in Fig. 2, maximum output is greatly increased and distortion reduced.

"amplification," V_{OUT}/V_{IN}, is 13.9/25 (peak to peak), which is 0.56, or a loss of nearly half. We also note that the grid voltage V_g swings between −2 and about −14, or 12V peak to peak, so the voltage amplification of the valve itself is 13.9/12 = 1.16. If the valve were used in the ordinary way, with R on the anode side, V_g would be the same as V_{IN} (as regards signals at least), and its negative peak would be the same as the positive (5V), so the negative V_{OUT} would be only 5.1V and the distortion would be greater (10.2%). As compared with this, the cathode-follower arrangement gives about half the amplification, but about half the distortion and a shade more output.

But it is a pretty miserable output—less than 7V peak using 250V h.t. As anyone who is accustomed to valve load diagrams will see at once, the reason is that the slope of the dotted load line is too steep, signifying that the resistance is too low. The less the slope, the greater the range of voltage represented by it between the grid-current and cut-off boundaries. To get the utmost voltage output, the resistance should be so large as to be represented by a nearly horizontal line right down near the V_a scale. But then the current range would be almost nil, and the valve would be incapable of supplying appreciable signal *power*. For maximum power, a designer would choose a medium slope, such as that of the dotted line in Fig. 3, which represents a resistance of 15kΩ. V_g = −7 again puts the starting point (*o*) about half way along the useful part of the line, and if we draw a V_{ag} line through it we find V_{ag} here is 190V. So V_{IN}, being $V_{HT} - V_{ag}$, is +60V. If again we are cautious about grid current and allow a full −2V as the minimum grid bias, the positive limit is at point *d*, where V_{ag} turns out to be 133V. This makes V_{IN} 57V more positive than at the start, so the negative limit is found by making V_{IN} 57V less than at the start, namely +3V, and drawing the V_{ag} = 250 − 3 = 247V curve.

The output is now probably easier to read direct as change in V_a than indirectly as I_a; it is +52V and −51V. Not only is that more than seven times what it was with R = 700, but the distortion is far less—below a half of one per cent. Actually we could probably go up to at least ±60V peak output without much increase in distortion or risk of grid current. The voltage ratio V_{OUT}/V_{IN} is also better—103/114 = 0.9, or only 10% loss instead of 44%.

By using a higher resistance, the maximum voltage output could be pushed considerably higher and the distortion still lower; but if only a *voltage* output were needed there would be no point in using a cathode follower at all—the input signal would do. Presumably there is some additional load in parallel with R. If it is a d.c. path, then its effect is of course exactly the same as reducing R. If it is an a.c. path (such as a resistance load fed through a blocking capacitor) the real load line pivots on *o* instead of on the 250-volt point on the V_a scale, and if *o* has been placed low by making R very high it is so near cut-off that distortion sets in sharply at quite a small output.

The fact to which everything so far has been leading up, however, is that when the resistance of R has been chosen to give reasonable operating conditions it is far too much for grid bias. In Fig. 3 the preferred starting point is "V_{IN} = +60," and if that positive bias were not supplied it would mean that the grid was 60V too negative. So now we come at last to our main object—to discover how best to provide this +60V or whatever it may be. There are a lot of different ways. Also there are some snags.

The simplest and best, if circumstances make it possible, is to connect the grid straight to a source of signal that also provides the necessary positive bias. If the source is the anode of another valve, that is probably the answer: Fig. 4(a). If 60V is altogether too low for the anode of that stage, it may be practicable to design the cathode follower to work well with a more positive grid.

But perhaps there is some good reason against this —the cathode-follower load is low or widely variable, the previous anode voltage is unavoidably high, or maybe the signal source is not an anode at all, or the cathode-follower may be needed to work from different sources so must be self-contained as regards bias. In such cases it is usually necessary to admit the signal through a blocking capacitor to make sure that the bias it not short-circuited by the signal source. The grid must then be connected to a source of bias through a high resistance "grid leak," so as not to short-circuit the signal source. An obvious method of getting the bias is from a potential divider across V_{HT} (Fig. 4(b)). Perhaps there already is such a potential divider, whether called by that name or the more unpleasant one of "bleeder," needed for some other purpose, and it is only a matter of tapping it at a suitable point. But if not, it is easy enough to find suitable values for R_2 and R_3, because the grid takes no current, so V_{bias} is to V_{HT} as R_3 is to $R_2 + R_3$. For the same reason, R_2 and R_3 can be quite high resistances, of the megohm order, provided they are reliable. If there is any question of an undesirable amount of hum getting at the grid from + h.t., a largish capacitance C_2 can be added.

But if R_2 and R_3 are high, as suggested, why have R_1 at all? True enough; if the resistance of R_2 and R_3 in parallel is made equal to whatever would be considered a suitable grid-leak resistance, then R_1 is unnecessary and the circuit simplifies to Fig. 4(c). A suitable grid-leak resistance is the same as in a conventional amplifier; that is to say, the resistance should not be higher than the valve maker recommends as a top limit, nor low enough to load the signal source seriously. Something of the order of one megohm is usual.

One Resistor ; Two Valves

Since one of the main objects of a cathode follower is to load the signal source as little as possible, it may happen that even the valve maker's top limit for grid resistance is lower than one wants to have across the signal source. My impression is that the valve makers cover themselves pretty well by fixing a low limit, and one can usually get away with a considerably higher value. But however that may be, one of the special features of a cathode follower is that the grid leak resistance seen by the signal source can be far higher than it is from the valve maker's point of view. This remarkable ability to have the best of things both ways is not achieved in the circuits seen so far, but it is in Fig. 4(d). This, I think, is the commonest bias arrangement for cathode followers, but I doubt whether everybody who uses it does so with the conscious intention of obtaining the advantage just mentioned. Nor, perhaps, is everybody who uses it aware of a possible snag that we shall come to in a moment.

The principle of Fig. 4(d), of course, is that R in Fig. 1 provides slightly more than the positive bias needed to neutralize the negative excess provided by it, so a point can be found on it which gives the right amount and to which R_1 can be connected. In our Fig. 3 example the total drop in R was 67V, of which 7 was needed for negative bias and therefore 60 had to be neutralized. A simpler way of looking at it, perhaps, is to regard the upper portion of R, R_4 in Fig. 4(d), as the conventional bias resistor to provide the required voltage, 7 in this example. Either way, if $R_4 + R_5$ were 15kΩ as before, R_4 would have to be 7/67 of this, or 1,565Ω, and R_5 15kΩ less this.

Suppose the valve maker's rating for maximum grid-to-cathode resistance is 1 MΩ. Then we would probably make that the value of R_1 (R_4 being by comparison negligible). It looks at first sight as if the impedance across the input terminals is practically the same (C_1 having been made large enough for its impedance to be negligible at the signal frequency). But imagine for the moment that the lower end of R_1 were taken away from R_4 and R_5 and connected to the grid, so that both ends of R_1 were at the same potential. Then obviously no current would flow through R_1. The same would be true if it were connected to a second signal source the same as the first, for both ends would still be at the same signal potential at every instant. If it were connected to the cathode, that end would receive (in our calculated example) nine tenths of the input signal, in phase. So only one tenth of the input signal voltage would

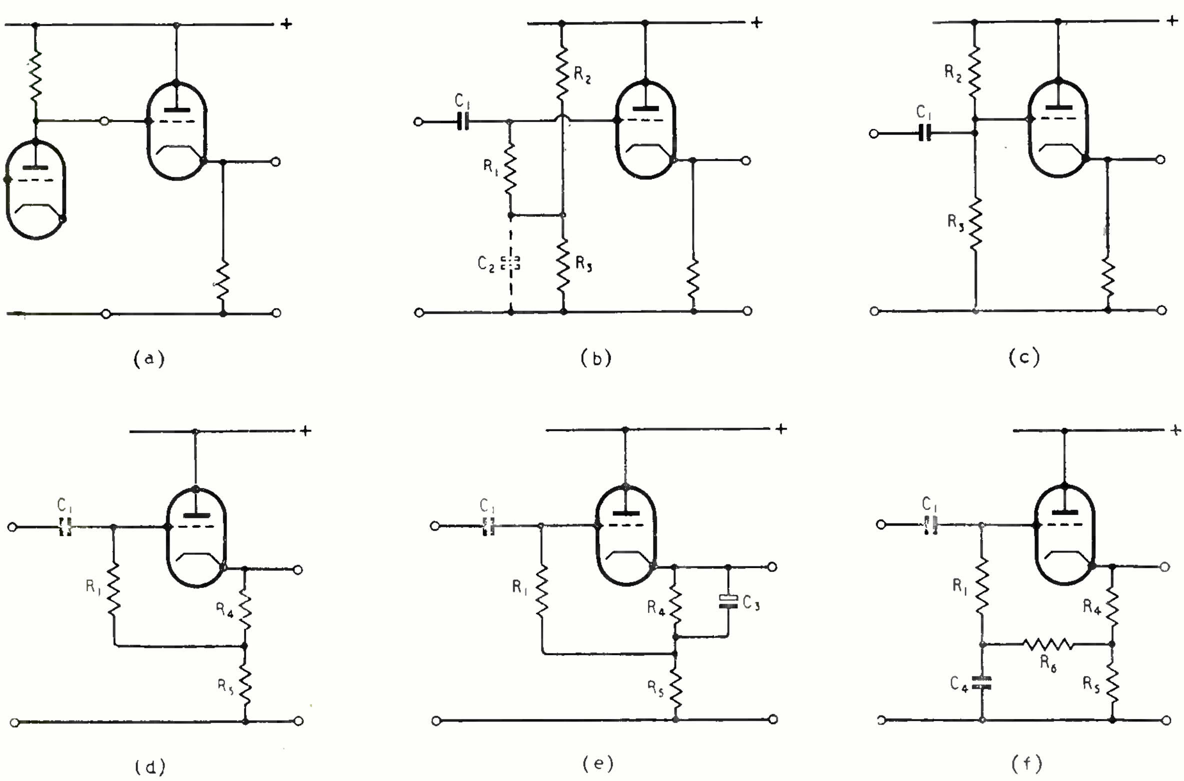


Fig. 4. Various methods for enabling the higher resistance indicated in Fig. 3 to be used in practice, by providing appropriate grid bias.

actually come across R_1, and therefore *it would take no more current than* $10M\Omega$ *connected across the whole input voltage.* Connected as in Fig. 4(d) it receives about eight tenths of the input voltage, and so acts as a load of $5M\Omega$.

There is more juice still left in the orange, for C_1 does not have to be large enough to be negligible in comparison with $1M\Omega$ but with $5M\Omega$. Now the voltage loss in C_1 is only 1% if the reactance of C_1 is one seventh of the effective load resistance. If that resistance were literally R_1, the reactance would have to be one seventh of a megohm; and if the lowest frequency to be handled were 20 c/s that would mean C_1 = a little over $0.05\mu F$. But with R_1 as in Fig. 4(d) it need be only $0.01\mu F$ for the same results.

Now for the snag. The negative feedback in a cathode follower consists of the whole output voltage (signal voltage across $R_4 + R_5$) fed back to the grid, and in this version of the circuit it can only reach the grid via the signal source. To simplify things let us for the moment imagine that the lower end of R_1 is moved up to the cathode. Then the impedance of the signal source and R_1 act as a potential divider across $R_4 + R_5$, and only that part of the fed-back voltage which is developed across R_1 actually reaches the grid. If the signal source impedance at any signal frequency were $1M\Omega$, then, with our $1M\Omega$ R_1, only half the voltage would be fed back, and we would have only half a real cathode follower Things are not quite so bad with R_1 where it actually is, but in our example it would be nine tenths as bad. Remembering again that the main point of using a cathode follower is usually to work from a high-impedance source, this rather subtle propensity must not be overlooked. The impedance of the signal source at any signal frequency should not be more than, say, one tenth of the actual value of R_1. Even this precaution may not be strict enough if the source impedance is largely reactance and we want to keep phase shift in the cathode follower very small.

The signal source impedance normally consists of the anode resistance of the valve (after allowing for the effect of negative feedback, if any) in parallel with the load impedance.

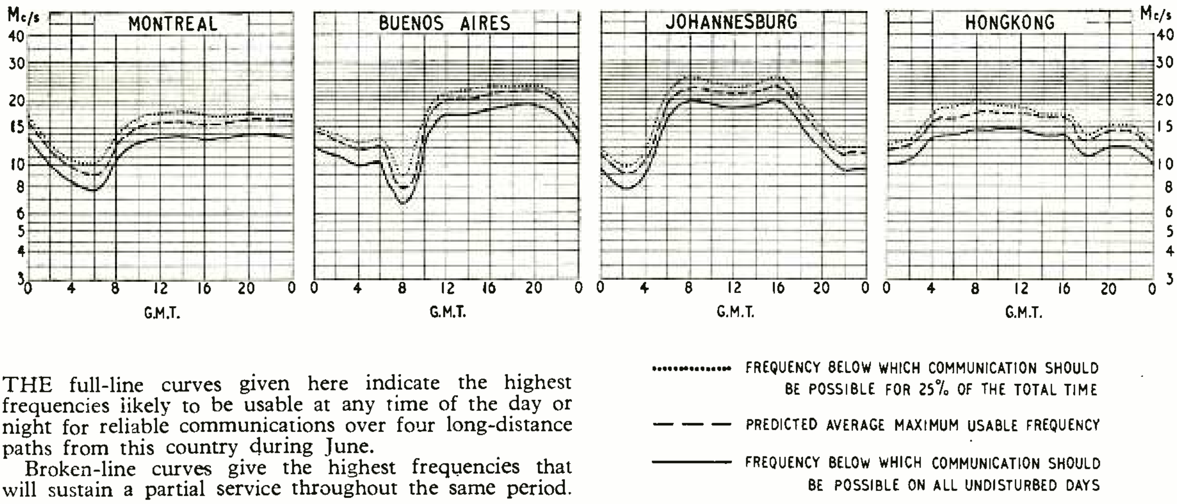
A variation of Fig. 4(d) that one sometimes sees is Fig. 4(e). The only difference is the by-pass capacitor C_3, sufficiently large to have negligible impedance (compared with R_4) at any signal frequency. So far as signals are concerned, R_1 is connected straight to the cathode (which is, if anything, a slight disadvantage), and the cathode-to-earth resistance is R_5. But so far as d.c. is concerned it is $R_5 + R_4$. So if we were doing a Fig. 3 diagram for this circuit we would have to draw the dotted line at a slope to represent $R_5 + R_4$, and then draw through *o* a steeper line representing R_5 alone, this being the line along which signal voltages would operate. Personally I consider C_3 a waste of money.

Lastly, to overcome the loss of feedback in circuits (d) and (e), type (f) has been suggested, in which R_1 is " decoupled to earth " for signal voltages, but receives its bias voltage from the junction of R_4 and R_5 as before. The impedance of C_4 at the lowest signal frequency should be very much less than R_6. For this to be so, $R_1 + R_6$ is almost sure to be appreciably higher than R_1, which means that the input signal load, which is R_1, is appreciably lower than the valve maker's limit which (if we follow his advice) is $R_1 + R_6$. This arrangement seems to me to have no great advantage over (c), and is less simple. On the other hand, (c) — and (b) — have the advantage that the cathode potential is stabilized (given constant V_{HT}) at a few volts above a level fixed by the ratio of R_2 to R_3.

Summing up: (a) is much the best if it can be arranged; if not, (c) is most likely to perform as expected, whereas (d) enables one to achieve a much higher signal input resistance but has to be carefully considered for possible loss of feedback. The others also ran.

SHORT-WAVE CONDITIONS

Predictions for June



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 June.

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

F.M. TUNING INDICATOR

Obtaining Zero Voltage Readings with Conventional "Magic Eye" Indicators

By J. R. DAVIES

THE writer, when engaged in the design and development of an f.m. tuner, was confronted with the necessity of providing a tuning indicator which could be made to give readings that were true and reliable. Also, the indicator had to be reasonably inexpensive and capable of use by non-technical persons.

At present, it seems to be fairly general practice to employ conventional tuning indicators in the f.m. receivers which are manufactured in this country, these indicators being operated from the rectified voltage appearing across the stabilizing capacitor (assuming a ratio discriminator), or from the grid resistor of an i.f. limiter valve. This system is not without its disadvantages; partly because it is necessary to ensure that the i.f. stages are accurately "peaked" (and remain so "peaked" for considerable periods of time) at the centre frequency, and partly because the initial deflection of the indicator on tuning in a strong signal is liable to be much greater than the small additional increment given at what is assumed to be the point of correct tuning.

An alternative method of obtaining tuning indications is available when a balanced ratio discriminator is employed. With such a circuit the audio take-off point provides a d.c. potential with respect to chassis which varies as the receiver is tuned through the signal being received. The d.c. potential decreases as the signal frequency deviation decreases, and it reverses polarity as the signal passes through the centre frequency. Assuming that the diode load resistors are accurately balanced about chassis, this d.c. potential may be employed to operate a tuning indicator; the position of correct tuning being represented by zero voltage.

The circuit described in this article takes advantage of this fact, and employs a conventional 6U5 "Magic Eye" tuning indicator in conjunction with a 12AU7 double triode. Interpretation of the pattern display given by the indicator is obvious since zero voltage is represented as maximum shadow angle, and excursions into either positive or negative voltage cause the shadow to "close." The sensitivity is high, zero shadow angle being given by a voltage around 2 volts on either side of zero. Due to the inherent nature of the circuit, maximum indication may not necessarily be given at zero volts, but at a potential which is very close to zero volts. Empiric tests with sample valves gave errors of less than 0.1 volt on either side of zero for the point of maximum indication. This error is quite small when it is considered that the d.c.-potential swing of the audio take-off point in most conventional f.m. receivers is usually well above 2 volts positive and negative.

The Circuit.—The circuit employed is shown in Fig. 1. In this diagram the audio take-off point from the balanced ratio discriminator is connected, *via* R_1 and R_2, to the grids of a double triode, V1. The cathode of V1(a) is taken direct to chassis, whilst the cathode of V1(b) is taken to a potential which is positive with respect to chassis.

Let us assume that the potential at the audio take-off point is sufficiently negative to allow V1(a) to pass only a small anode current. V1(b), due to the positive potential on its cathode, is cut off. In consequence of this, the potential at the grid of V2 is that given by the potentiometer R_4, R_5 and R_6. Due to the low anode current passed by V1(a), the cathode of V2 has a potential which is considerably higher than that at its grid. In consequence, the triode section of V2 is cut off, and the display indicator presents zero shadow angle.

If the negative potential with respect to the chassis at the audio take-off point is advanced towards zero (ultimately to reach a positive value), V1(a) passes a continually increasing current. This causes the cathode potential of V2 to drop until a stage is reached when the indicator shadow commences to "open." As the audio take-off potential continues to approach zero, the shadow opens further. At a potential close to zero, positive grid current commences to flow through R_1 and the increase of anode current in V1(a) ceases.

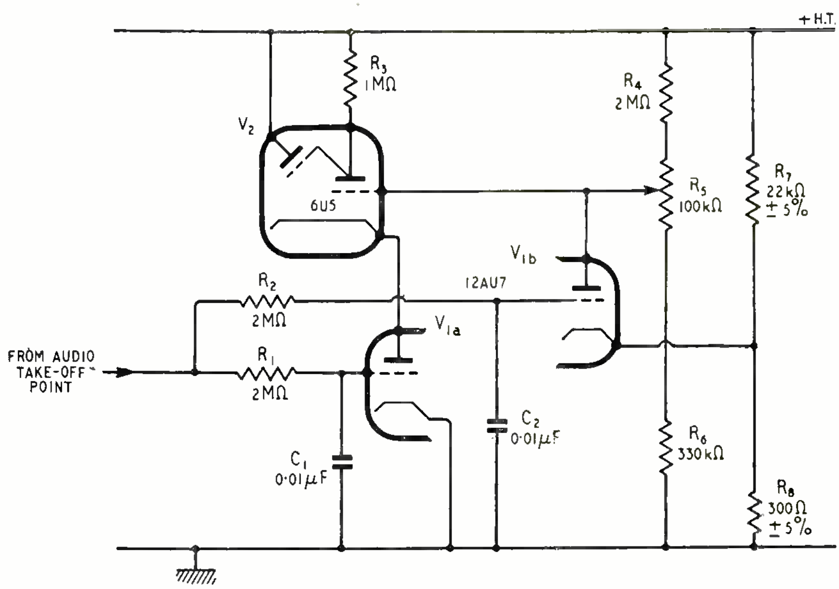


Fig. 1. The circuit of the indicator device described in this article.

The potential at the cathode of V2, in consequence, becomes comparatively steady.

Very shortly before the commencement of grid current in V1(a), V1(b) commences to conduct. However, its rate of change of anode voltage is lower than that of V1(a), and so the latter valve gives the greater control over shadow angle. After the condition of positive grid current has been reached the potential at the anode of V1(a) remains comparatively steady. As the audio take-off potential continues to rise, that at the anode of V1(b) now commences to drop further. In consequence, the grid of V2 goes further negative with respect to its cathode, and the indicator shadow commences to close again. Zero shadow angle is achieved when the audio take-off potential has gone sufficiently positive.

(It may be worth mentioning that, during the positive excursion of the audio take-off voltage, the grid potential of V2 does not affect its cathode current to any large extent, since the latter flows mainly between cathode and target.)

Operation.—It will be remarked that the circuit of Fig. 1 cannot give an accurate indication of zero voltage as the only "reference point" is that at which positive grid current commences to flow in V1(a); and this will vary from valve to valve. Also, the positive potential at the cathode of V1(b) may affect the operation near zero voltage.

However, empiric tests with a working circuit show that the device provides a maximum indication at points which are very close to zero voltage. Four different 12AU7s of varying ages give maximum indications which are all within 0.1 volt on either side of zero. Also, four-hour tests for drift do not show any measurable shift of the potential required for maximum shadow angle. Again, changes in h.t. line voltage between 200 and 250, and in heater voltage between 6 and 6.6, produce no noticeable shift. This is not sufficient evidence, of course, to assume that the circuit will function as well for all 12AU7s; and it is possible that the worst instances of drift, or of inaccurate voltage indication, will occur in the early life of a brand new valve.

The values of R_7 and R_8 are fairly critical. The writer was tempted to make R_8 a variable component, but the values shown in Fig. 1 coped satisfactorily for the valves tested in his particular case. Decreasing the value of R_8 decreases the sensitivity of the circuit, and the indicator ceases to function altogether before the potential which gives maximum indication is shifted at all seriously. Increasing the value of R_8 results in an indication of maximum shadow over a period between the potential which initiates positive grid current and a further positive potential. The consequent lack of sensitivity is immediately apparent.

Due to the fact that the potential at the cathode of V2 rises as the audio take-off potential goes negative, a dimming of the indicator pattern takes place for high negative control voltages. This dimming becomes just noticeable at approximately 4 volts negative, and the indicator is almost completely extinguished around 10 volts negative.

The potentiometer R_5 is employed to set the grid of the 6U5 to the potential which gives optimum sensitivity. Before adjustment, the slider should be set to the high-potential end of the track and the audio take-off point short-circuited to chassis. The slider is then brought down until the 90-degree shadow angle given by the short-circuit is reduced to approximately 85 degrees. The setting of R_5 is not very critical, and it might be possible to use fixed components in this part of the circuit.

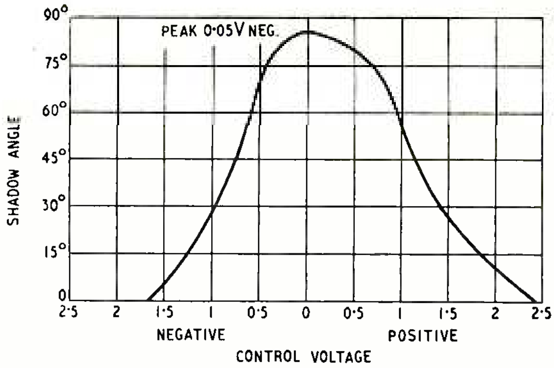


Fig. 2. Relationship between shadow angle and control voltage for typical 6U5 and 12AU7 valves.

The capacitors C_1 and C_2 are included to prevent modulation voltages from blurring the indicator pattern. A graph showing shadow angle against audio take-off potential for a typical 12AU7 and a 6U5 is given in Fig. 2.

Performance.—After the circuit had been put into working order (with the aid of a potentiometer and centre-tapped dry battery to stimulate the voltages appearing at the audio take-off point) it was tested with a working f.m. receiver. To ensure that the different source impedance did not affect accuracy of indication, a valve-voltmeter was also connected between the receiver's audio take-off point and chassis. However, the different source impedance did not introduce any measurable shift in the potential needed to give maximum indication.

In use, it was found that the readings given by the indicator were very satisfactory indeed. Normally, the shadow remained open until a station was tuned in; whereupon the shadow closed abruptly. At the centre frequency of the station, however, the shadow opened once more, and it was consequently possible to obtain a beautifully precise indication of correct tuning. Subjective tests carried out by having non-technical persons tune in the receiver resulted in an accurate position of optimum tuning being achieved in every case.

Acknowledgments.—Acknowledgments are due to Allen Components, Ltd., for facilities made available to the writer for the development of this circuit.

RECEIVER SALES

A SURVEY of the retail sales of domestic receivers during the first quarter of this year, prepared by B.R.E.M.A., shows that by comparison with the same period last year the demand for television receivers increased by 70% and sound receivers and radiogramophones by 51%. The table gives the 1955 monthly retail sales. The totals for the first quarter of 1954 are in parentheses.

	Sound	Radiograms	Television
January	98,000	35,000	103,000
February	99,000	33,000	98,000
March	95,000	24,000	85,000
Quarter's total ...	292,000	92,000	286,000
	(254,500)		(168,500)

NEW DECCA RADAR

JUST over five years ago Decca produced their first radar set (Type 159) which was marketed at about half the price of existing equipment. Two other models (Types 12 and 45) were subsequently produced and together these three models have been fitted in over 3,700 ships—about two-fifths of the world's radar-equipped vessels.

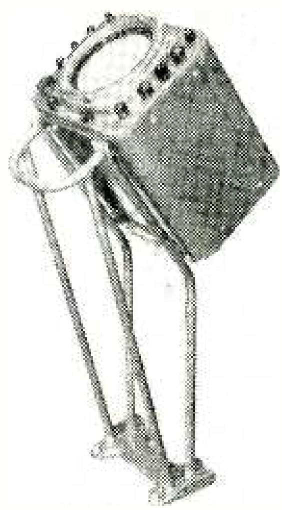
The majority of the world's medium- and large-tonnage vessels are now equipped with radar and it was to meet the demand for a set for small ships—coasters, trawlers, etc.—that Decca recently produced the Type 212. Although considerably smaller, lighter and cheaper than its predecessors it is claimed to meet the stringent M.o.T. specification for marine radar and has been submitted for type approval.

A feature of the earlier Decca sets was the fitting of the r.f. head as part of the scanner unit, thereby eliminating a long waveguide run. As it is essential in smaller vessels to reduce top weight, and, also, it is possible to have a short waveguide run, the r.f. unit in the new model is separate.

The set, which has a 9-in p.p.i., has six ranges—0.5, 1, 3, 8, 15 and 30 miles—with calibration rings varying from 0.2 to 5 miles according to the range scale in use. It has a minimum range of 30 yards and a discrimination of 25 yards on the shorter ranges.

The r.f. unit, giving a peak output power of 10 kW, has a pulse duration of either 0.1 μsec or 0.2 μsec according to the range in use. The unit can be mounted either below deck or (in a special waterproof case) at the base of the mast. The familiar Decca separate half-cheeses for transmission and reception, have given place to a single parabolic cylinder scanner of approximately 4 ft across.

Decca have equipped two vehicles with this radar unit which are now touring the ports in the U.K. and on the Continent.



The 212 display unit may be mounted on the bulkhead, deckhead or, as shown, on a pedestal.

CLUB NEWS

Barnsley.—The subject for the meeting of the Barnsley and District Amateur Radio Club on June 24th is "Fifty Years of Ham Radio" and the speaker is P. Denison (G8OK). Meetings are held at 7.0 at the King George Hotel, Peel Street, Barnsley. Sec.: P. Carbutt (G2AFV), 33, Woodstock Road, Barnsley, Yorks.

Birmingham.—"The Application of Valves for Communication Purposes" is the subject of the talk to be given by G. Nicholson (G3HKC) to members of the Slade Radio Society on June 10th. On 24th L. Glew, of Marconi Instruments, will speak about instruments at v.h.f. The club room at Church House, High Street, Erdington, is open every evening and lecture meetings are held on alternate Fridays at 7.45. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Chelmsford.—At the next meeting of the Chelmsford Group of the British Amateur Television Club—on June 9th—members are to hear a description of a portable monoscope unit. The group meets at the home of the secretary, M. Barlow (G3CVO), 10, Baddow Place Avenue, Gt. Baddow, Essex. Test transmissions are radiated each Saturday evening on 436 Mc/s by R. L. Royle (G2WJ/T), one of the members.

Cleckheaton.—T. C. Isaac (G4RQ), of Ambassador Radio, will speak on "High Quality Sound" at the meeting of the Spen Valley and District Radio and Television Society on June 1st. The club meets on alternate Wednesdays at 7.30 at the Temperance Hall, Cleckheaton. The final meeting of the session will be on July 13th. Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds, Yorks.

Coventry.—At the meeting of the Coventry Amateur Radio Society on June 20th, at 7.30 at 9, Queens Road, Coventry, D. Clift (G3BAK) will speak about v.h.f. transmission and reception. Sec.: J. H. Whitby (G3HDB), 24, Thornby Avenue, Kenilworth, Warwicks.

RANDOM RADIATIONS

By "DIALLIST"

F.M. and Hi-Fi

THE B.B.C.'s decision not to strive after really high fidelity in its Band II service is due mainly to the fact that the cables provided for its use by the G.P.O. have a bandwidth limit of somewhere about 8 kc/s. Nor will the G.P.O. allow radio links. A pity, of course; still, I don't think that those in the Home Counties who buy or build first-rate v.h.f. sets will be very disappointed by the quality of those Wrotham transmissions which emanate from studios or concert halls in London—Broadcasting House and Wrotham are linked by good lines. I have listened to Wrotham for a couple of years and found the programmes a revelation in the quality that can be obtained from a good receiver. There was a high-grade m.w. set in the same room as the v.h.f. receiver. As both were fitted with a muting arrangement it was possible to change instantly from the one to the other. Even to one who can lay no better claim than I to being musical, the difference was amazing. On the v.h.f. transmission, for example, you could pick out particular instruments in a big orchestra and follow them easily. I can't do that on any m.w. orchestral programme.

Blessed Relief

MY new abode is well over 100 yards from the nearest main road. Thanks to the distance and to the fact that the aerial is some 50-60 ft above the level of the road surface, I get no interference with television reception worth talking about; in fact, the limiter isn't in use at all and I can allow my whites to be really white. Much as I rejoice in this happy state of affairs my heart bleeds for those unfortunate enough to live on or near the road in question. It is one of the links between London and the south coast and, at this time of year anyhow, there is a constant stream of motor traffic along it all day and most of the night as well. Perhaps people grow so used to ignition interference that they cease to notice it particularly. I can't think how they can, for I'm sure I couldn't watch pictures that were continually marred by those awful lines of white spots. Nevertheless, one finds that a good many of the houses standing right alongside the road are surmounted by "Hs," "Xs" or "Ks" and that many of these "look" right over it towards Alexandra Palace.

Sets of Yesteryear

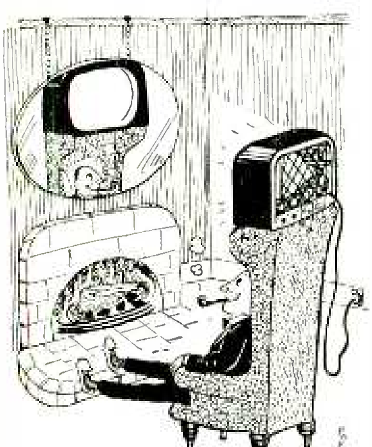
AMONG the long-forgotten papers that came to light when I was sorting things out on the eve of moving house was a 24-page receiver supplement of the then weekly *W.W.* of December 9th, 1932. One of the first things that caught my eye was the advertisement of the Decee-Acee receiver: "Will work off a.c. or d.c. mains without alteration. The *only* set of its kind." With built-in loudspeaker (which many sets of those days had not) this s.g.-det-pentode 3-valve receiver cost 18 guineas. There was also a 4-valve model with two h.f. stages, at 23 guineas. The fashionable set then was clearly the 3-valve "straight" costing £10-£12 for battery models and £16 upwards for mains models. More engaging is a page containing front and back view drawings of a typical 3-valve chassis "which will enable the features of modern sets to be readily identified." The said features include: vari-mu h.f. valve, power-grid detector and pentode output (coupled by l.f. transformer, parallel-fed), screened bandpass coils, single-dial tuning, metal chassis (with decoupling circuits mounted below), full-wave valve rectifier and electrolytic smoothing condenser. There were some bargains in wireless sets in those days. For £3 you could buy a 2-valve "Brownie," complete with moving-iron loudspeaker, but without batteries. Batteries and all, the K-B "Pup" cost £4 10s and there were a.c. and d.c. models of the same set for £7 10s. There were quite a few superhets. The all-wave "Faraday," containing 4 s.g. valves and a power pentode and offered in a.c. or d.c. models went for 27 guineas and the G.E.C. had an a.c. mains model (with heterodyne whistle filter and automatic station index) for 26gns. The same firm offered a 6-valve all-wave, battery-operated superhet, constructed to tropical specification, for 24 guineas.

Wireless: Unlawful Use of

IN these queer days when we are so hedged about by a multiplicity of little-known laws, orders and regulations, many of us must do what we "didn't orter" at one time or another without being aware of the fact. The charge of making unlawful use of wireless telegraphic apparatus, in that he received a police message when not authorized by the Postmaster General to do so, brought recently against an army officer is a case in point. The Andover magistrates very sensibly granted the accused an unconditional discharge, the chairman remarking that not one member of the bench had previously realized that it was an offence. If you own a receiver covering Band II, you can hardly fail to pick up such messages at times. I've often done so when tuning in Wrotham; in fact, I recall puzzling our local police superintendent one day by saying: "I hope you got that report off all right." "What report do you mean?" "Why, the one that headquarters was gingering you up about by wireless this morning." I wasn't run in.

Offenders in Spite of Ourselves

If the authorities are going to make a practice of bringing such charges, one foresees that they'll have their hands pretty full when the B.B.C.'s Band II system gets into its stride and v.h.f. sets are in use in homes everywhere. And what of those who have telephony from near-by police stations forced upon their unwilling ears by way of the loud-speakers of their television sets? Having filled up the appropriate forms, they beg the P.M.G.'s engineers to rid them of the nuisance, only to learn that occasional (or it may be frequent) breakthrough is inevitable at such short range. Will some legal reader of *W.W.* tell us whether such folk could charge the police with aiding and abetting them to break the law?



Back projection ?

1897 needle-using disc gramophone

UNBIASED

By FREE GRID

Talking Machines

I RATHER pride myself on historical accuracy and feel compelled to draw attention to a chronological inexactitude in an otherwise excellent article by S. Kelly on "Needles for Talking Machines" in the May issue.

Speaking of the needle or stylus the author says "Sapphire or diamond in 1900, steel needles from about 1910 to 1935 . . ." which surely implies that steel-needle machines were rare, or at any rate in the minority, before 1910. I have no statistics before me but relying on my memory of those years (which has often made the B.B.C. scrapbooks bite the dust) I venture to say that the author's statement is at least misleading.

Now let us get this matter straight. At the time of Queen Victoria's death (Jan. 22nd, 1901) there was certainly a large number of sapphire-using cylinder machines in use and I have one on the table before me as I write. But even then the needle-using disc machines were —if I may coin a word—"populescent" and by the time of King Edward's Coronation (Aug. 9th, 1902) had virtually stolen the market. Side by side with my Victorian cylinder machine I have the H.M.V. disc-and-needle-using "dog" model.

Sapphires were available with some disc machines, but, in the early years of the present century, which is the period in question, by far the greater number used needles only; in fact, it is not too much to say that discs necessarily meant needles. If I can be proved wrong I am willing to spend a night of penance on a bed of upturned steel gramophone needles like an Indian fakir.

The author is also rather misleading when, a little later in his article, he says "about 1910 the disc finally ousted the cylinder for domestic reproducers. . . ." Surely this implies that the cylinder died with King Edward (May, 1910). Actually the cylinder, like Charles II was "an unconscionably long time a dying" and although the process started long before 1910, it lingered on until after the beginning of the Kaiser's war.

Several cylinder machines are listed in Gamage's catalogue of 1913 and I recollect buying one for 3s 6d —yes three shillings and sixpence— and it certainly wasn't a toy one. It's only disadvantage over the more costly ones was that it would not take the famous Edison "Amberol" cylinders which were the L.P. "microgroove" records of the period. For these cylinders the screwed rod which moved the stylus across the record had a much finer pitch than the one normally used.

Electronics in the Garden

IN THE SUMMER of 1940 I attended a lecture given by Dr. P. Dalton before the Brit. I.R.E. on the interesting subject of radio therapy. I remember how this new therapy affected the processes of the body and how it had been discovered. Apparently it had been found that wireless operators sitting near the works of powerful s.w. transmitters had suffered ill effects.

I have often wondered whether this therapy with its strong effect on normal biological processes could not be applied to our gardens to speed up the growth of plants and an item I spotted recently in an American newspaper has convinced me that it can. It has been observed that in the vicinity of certain high-powered television transmitters weeds grow wilder and tulips taller and I am getting to work immediately on the problem.

If the editor keeps his promise to let us have *W.W.* on the fourth Tuesday of each month, this issue will appear on May 24th which is not only Queen Victoria's birthday but the day on which the present Queen will open the famous Chelsea Flower Show of the Royal Horticultural Society. I intend to be right there in the electrical section where they always demonstrate how our seedlings can be warmed from the mains via a step-down transformer and a buried cable.

I am going to suggest that a compact oscillator unit working on TV frequencies is marketed enabling us to feed oscillations into a special transmission line and radiator buried among our plant roots or maybe suspended just above them. Frankly I don't know what will be the results as I'm no biologist but I remind myself that the scientists who detonated the first atom bomb in New Mexico in July, 1945, weren't any too sure about results.

"Pidgin" Radio

IT IS an old saying that the lazy man works the hardest and I have been rather forcibly reminded of it by a few remarks that appeared in the correspondence columns of *W.W.* a month or two ago about wireless and mathematics. To my way of thinking the man who tries to take the "easy" way of trying to understand the intricacies of radio without a preliminary grounding in mathematics will find the going very heavy.

He generally proceeds by way of mechanical analogies which, seemingly apt and excellent at first, break down and leave the non-mathematical student stuck firmly in a mental morass. The mathematical man, on the other hand, sails along without the necessity of conjuring up mental pictures of the phenomena which his equations represent.

An analogous state of affairs was often to be observed over a quarter of a century ago, when the home-construction phase of wireless was at its height. I frequently came across men who were very ardent and, indeed, very skilful home constructors who were unable to understand a "theoretical" circuit diagram, a form of shorthand which enabled the essentials of the receiver of that period to be seen literally at a glance. These earnest constructors, however, could and did follow the intricacies of the practical wiring plan with a skill and celerity which left me breathless and which must have needed a lot of hard work to acquire.

If I may be permitted to use an analogy after condemning them earlier in these remarks, the non-mathematical radio aspirant may be likened unto the speakers of "pidgin" English in New Guinea and elsewhere. To learn standard, or at any rate basic, English would take only half the time, pain, power and sheer hard work which they put into acquiring a knowledge of this truly astonishing lingo.

AVO

VALVE Characteristic METER Mk III

The AVO Valve Characteristic Meter Mark III offers the Radio Engineer far more than is generally implied by the words "a valve tester".

This compact and most comprehensive Meter sets a new high standard for instruments of its type. It will quickly test any standard receiving or small transmitting valve on any of its normal characteristics under conditions corresponding to a wide range of D.C. electrode voltages.

A new method of measuring mutual conductance ensures that the instrument can deal adequately with modern valves of high slope and short grid-base such as are commonly used in T.V. receivers.

List Price
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PROVIDES all necessary data to enable Ia/Va, Ia/Vg, Ia/Vs, etc., curves to be drawn.

MEASURES mutual conductance up to 30mA/V.

DETERMINES inter-electrode insulation with heater both hot and cold.

GIVES direct measurement of "gas" current.

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COVERS all normal heater voltages up to 117V.

CIRCUIT improvements provide accurate setting and discrimination of grid voltage over the full range to 100V negative.

A relay protects the instrument against damage through overloading the H.T. circuits and also affords a high measure of protection to the valve under test.

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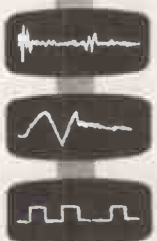
V.C.4

FLAT TUBES SAVE SPACE

DG 16-21

FOR 'A' SCAN RADAR AND INSTRUMENT APPLICATIONS



easily stacked
for multiple trace
comparison

The screen of the DG16-21 cathode ray tube is a rectangle measuring 5½ x 1½ inches — the logical shape for radar 'A' scan and many instrument applications. A number of these tubes can be stacked vertically to provide multiple displays within a confined space . . . they are the answer to those problems in design where circular tubes make equipments excessively bulky.

	TYPICAL OPERATING CONDITIONS					
					Deflection Sensitivity	
	V_{a3}	V_{a2}	V_{a1}	V_g	S_x	S_y
Deflection : Electrostatic, symmetric or asymmetric. V_h : 6.3 volts. I_h : 0.3 amp. Base : B14A.	5,000V	600 to 700V	1,800V	–25 to –70V	0.19mm/V	0.21mm/V

The DG16-21 has a green luminescent medium persistence screen. Versions with other screens are contemplated and your comments are invited.

See Mullard Cathode Ray Tubes and Valves on
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Taylor Signal Generator

For Television frequencies up to 240 Mc/s.

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Frequency range: 100 kc/s.–240 Mc/s. in six ranges.

Accuracy: ± 1%.

Attenuation: 100 dB. Continuously variable.

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Frequency-modulated oscillator designed for the rapid and accurate alignment of TV receivers. Also suitable for checking any band pass amplifier.

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Output: 40 microvolts to 2 millivolts continuously variable.

Freq. Mod. Substantially linear to 6 Mc/s. sweep width—less than 10% max. sweep.

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Response is not all the story

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

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

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

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

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

Ferrograph

BRIEF SPECIFICATION

Twin Track (to International standards)
Playing British and American pre-recorded tapes

Playing Time with 1,750 ft. Reel
45 minutes per track at 7½ i.p.s. (other speeds pro rata)

Quick Rewind
in less than 60 seconds

Signal Level Meter
giving positive reading

Frequency Response
±3 db 50/10,000 c.p.s. at 7½ i.p.s.

"Wow" and Flutter
Less than 0.2% at 7½ i.p.s.

Signal to Noise Ratio
Better than 50 db, 200/12,000 c.p.s. Unweighted, including hum, 45 db.

Longterm Speed Stability
Less than ·5% variation

Output Power
2½ watts into 15 ohms

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

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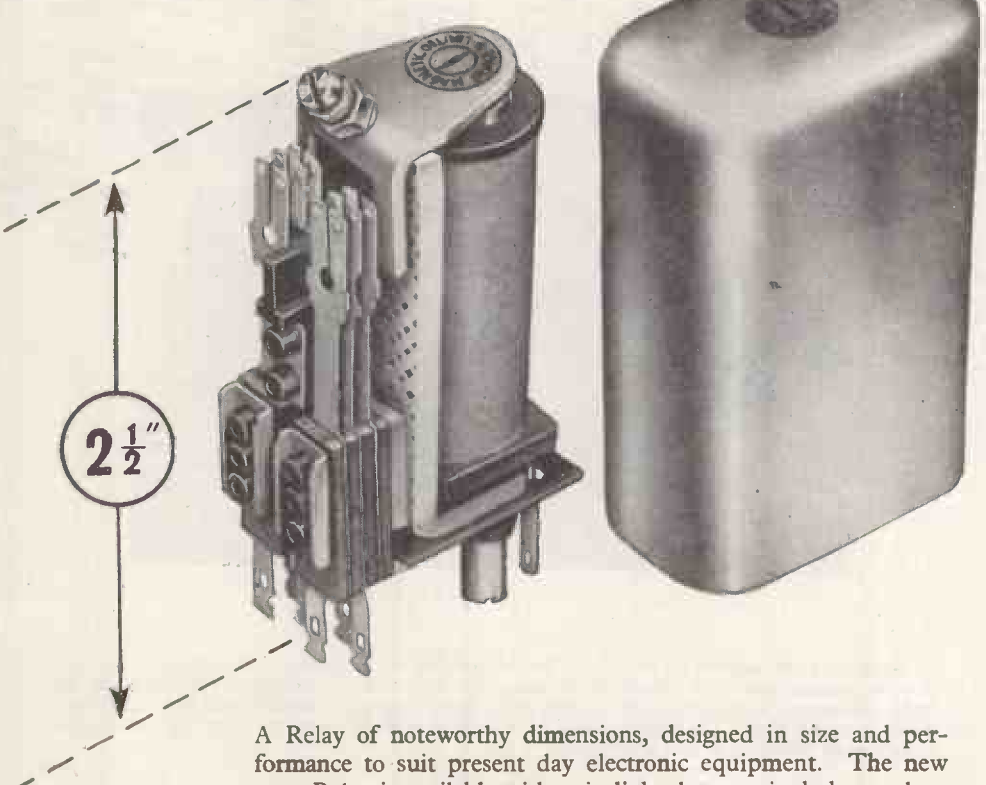
RELAYS

announcing the 2400 RELAY



A Relay of noteworthy dimensions, designed in size and performance to suit present day electronic equipment. The new 2400 Relay is available with twin light duty or single heavy duty contacts.

When fitted with a 10,000 ohm coil, the pull-in is approximately 4 milli-amperes; contact pressure and clearance have not been sacrificed to achieve this sensitivity.

DIMENSIONS: Above chassis 2½" high x 1" wide x 1⅝" deep.

WEIGHT: 4½ ounces.

MAGNETIC DEVICES LTD
NEWMARKET

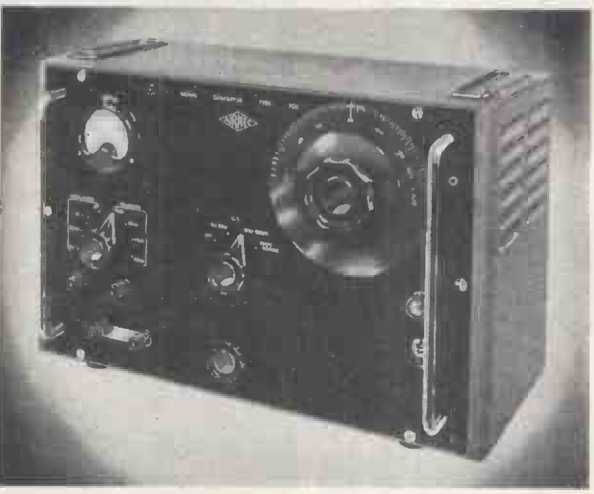
AIRMEC

SIGNAL GENERATORS

for the frequency range 30 c/s - 30 Mc/s

L. F. SIGNAL GENERATOR TYPE 702

- **Frequency Range:** 30 c/s–30 kc/s.
- **Stability:** $\pm$ 0·05% $\pm$ 0·5 c/s.
- **Output:** A screened and balanced transformer enables balanced, unbalanced and fully floating outputs to be obtained.
- **Attenuator:** A 600 ohm constant impedance attenuator provides steps of 20, 40 and 60 db of attenuation under all output conditions.
- **Output Level:** 100 mW into 600 ohms or 15 volts open circuit.



H. F. SIGNAL GENERATOR TYPE 701

- **Frequency Range:** 30 kc/s–30 Mc/s.
- **Output Level:** Constant to within 1 db over entire frequency range.
- **Output Impedance:** 75 ohms $\pm$ 10 ohms on the 0 db step of the attenuator and 75 ohms $\pm$ 3 ohms on all other settings.
- **Attenuators:** A slide wire and step attenuator calibrated both in db and volts open circuit enable the output to be reduced to 1 microvolt.
- **High Output:** A signal voltage of from 5–20 volts is available from a high impedance output socket.

The L.F. Signal Generator Type 702 may be connected to the H.F. Signal Generator Type 701, to enable signals over the complete frequency range 30c/s to 30 Mc/s to be obtained from the output plug of the latter instrument.

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

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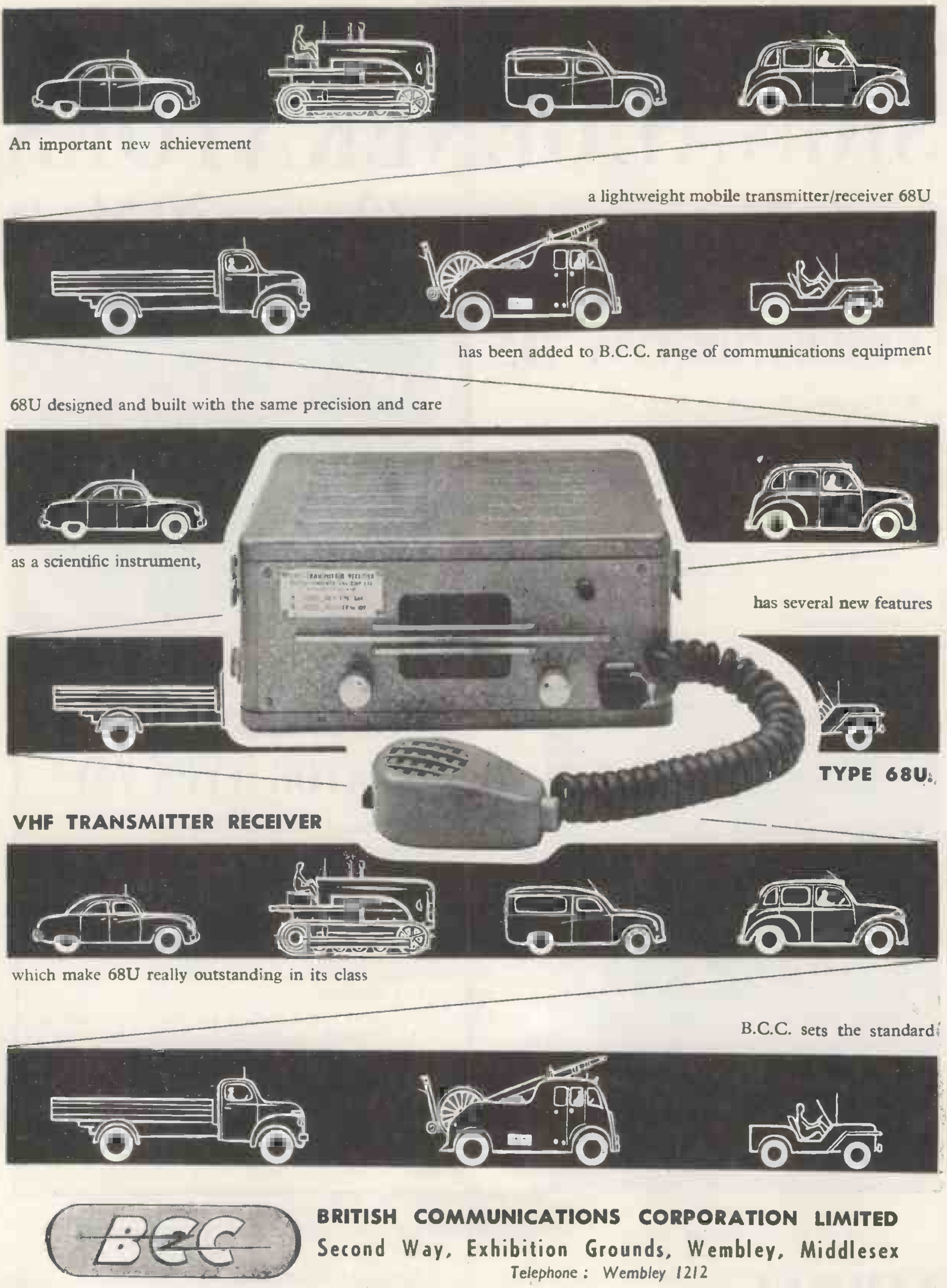
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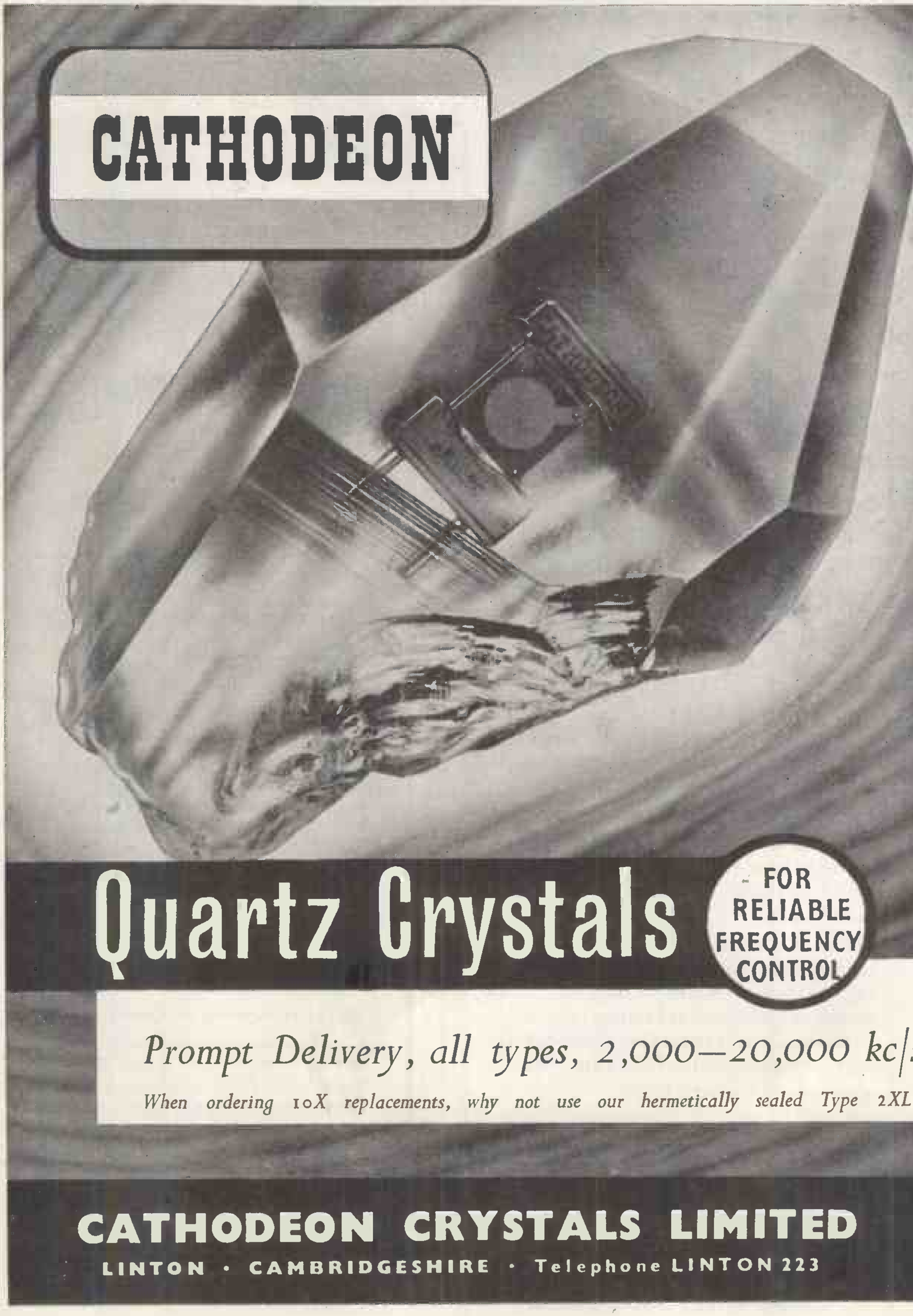
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1 WATT OUTPUT
INTO 600 OHMS
OVER ENTIRE
RANGE

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Full technical data on leaflet W/29

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The Type 'J2' similar to the Type 'J1,' but with output voltage meter.
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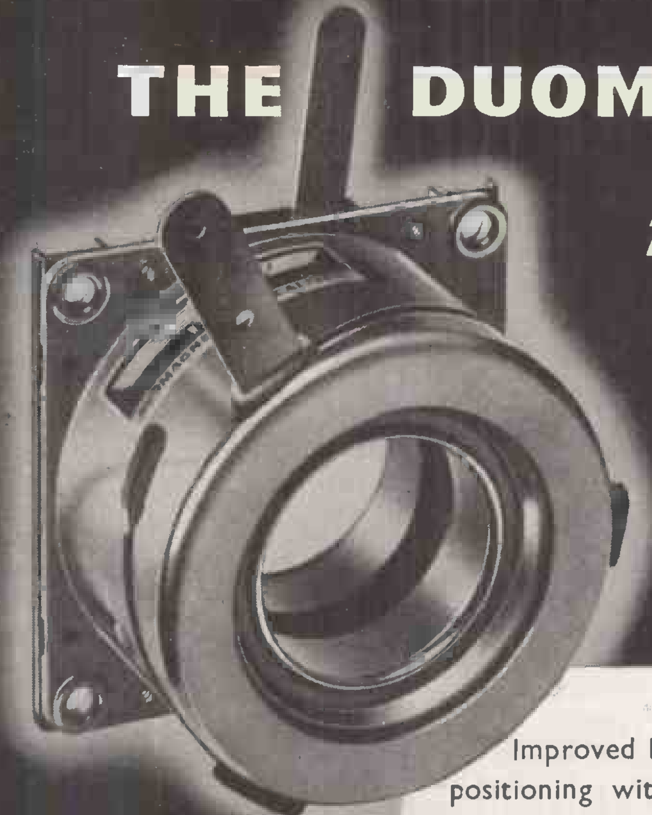

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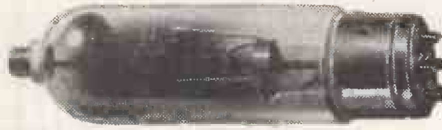
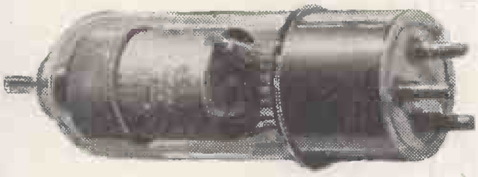
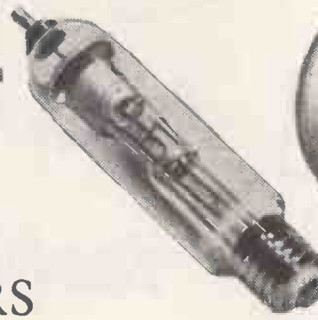
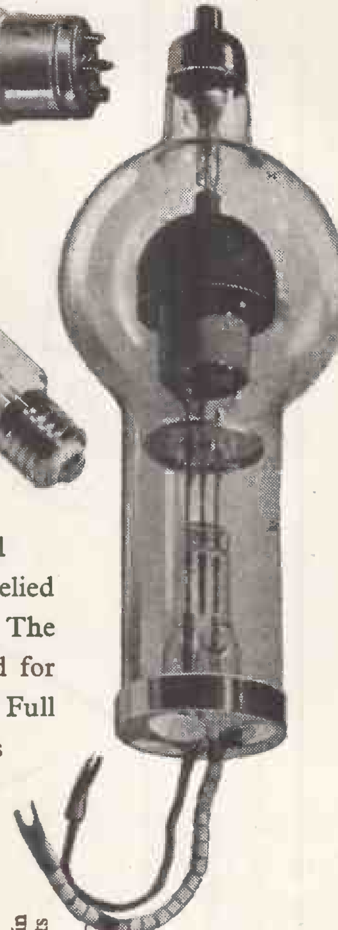

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AH 213	—	,, ,,	90
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AH 205	CV 2673	,, ,,	630
AH 211	CV 532	,, ,,	90
AH 221	CV 5	,, ,,	36
AH 217	—	,, ,,	36
AX 224	CV 1835	Xenon	7
AX 228	—	,,	36
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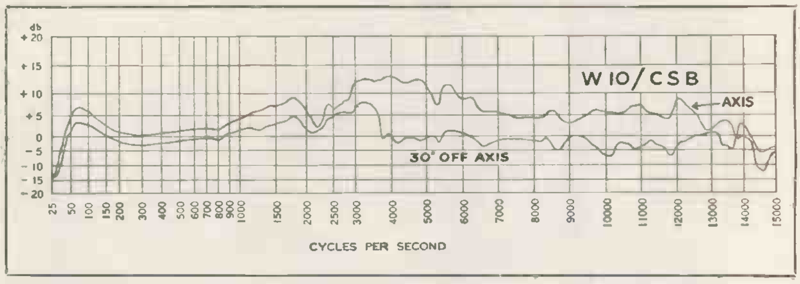

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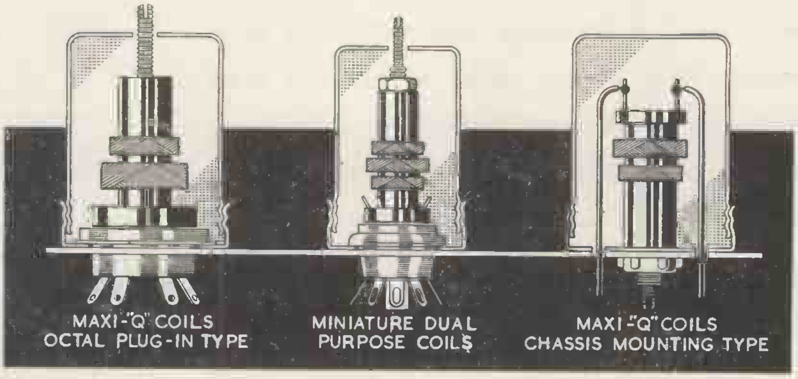

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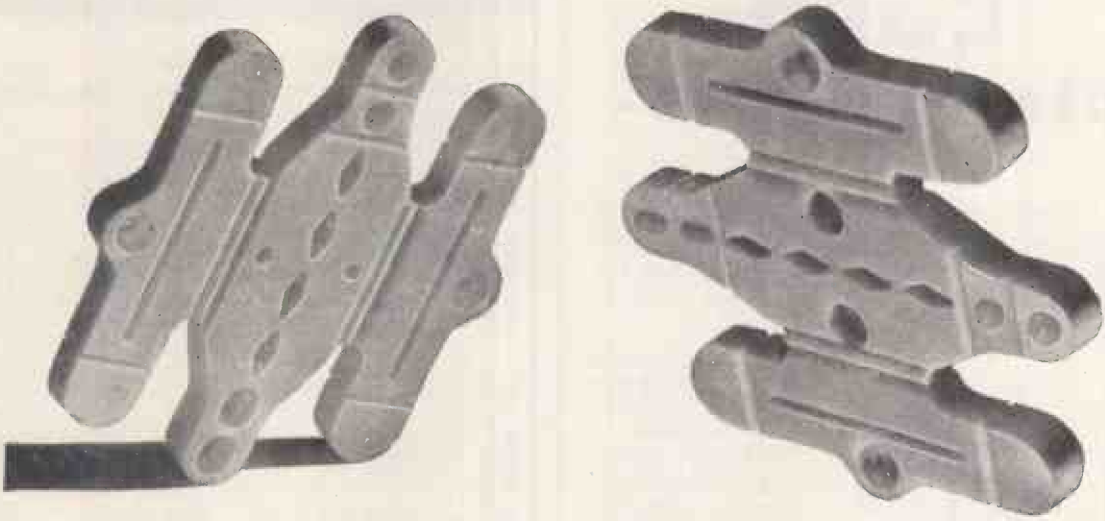

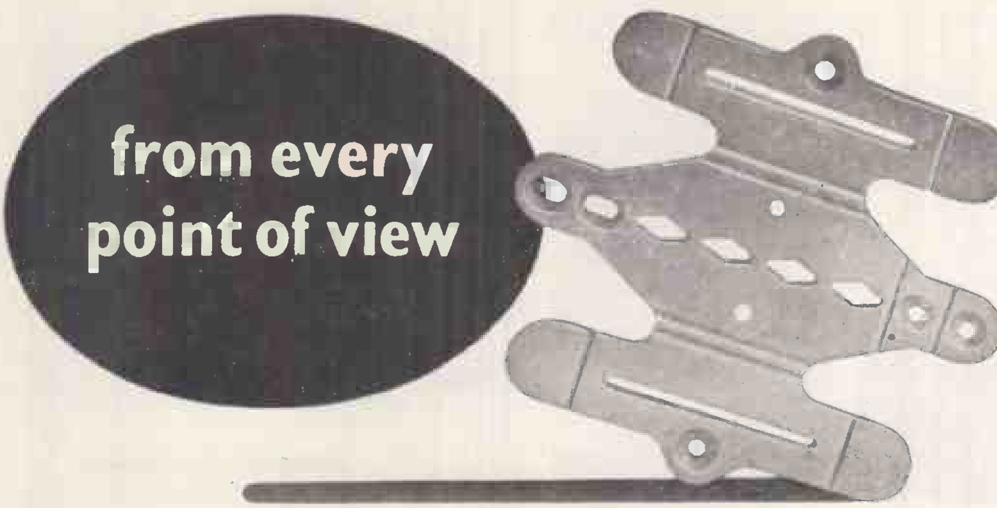

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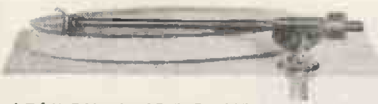

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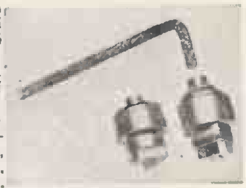

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(12 MILLIMICROSECONDS)

Tektronix Type 545 and 541 CATHODE-RAY OSCILLOSCOPES

TYPE 545—This new high-speed laboratory oscilloscope, in combination with new Type 53K/54K Fast-Rise Plug-In Unit...opens the way to quicker, easier analyses of fast-rising waveforms...providing faithful displays and accurate measurement facilities well beyond the range of previous oscilloscopes of its size and cost. The Type 545-Type 53K/54K combination offers a vertical-amplifier passband of dc to 30 mc (12-millimicrosecond risetime) at calibrated sensitivities to 0.05 v/cm, with a full 4-cm linear vertical deflection. A wide range of calibrated sweeps, with calibrated sweep delay from 1 μsec to 0.1 sec, and high accelerating potential, 10 kv, fully complement this greatly extended vertical-amplifier range.

The Type 545 is the most versatile oscilloscope ever made, for it can be quickly converted to many other applications. By merely plugging in the appropriate Type 53/54 Plug-In Preamplifier you are ready for wide-band, wide-band high gain, dual-trace, high-gain differential, microvolt-sensitivity, or wide-band differential applications. It's a rare oscilloscope application that isn't easily handled by this modern method.

Vertical-Amplifier Characteristics with Type 53K/54K Unit Plugged In

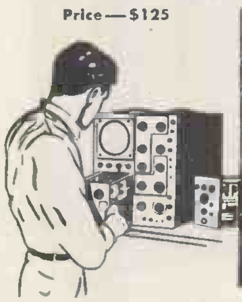
Transient Response—Risetime, 12 millimicroseconds.

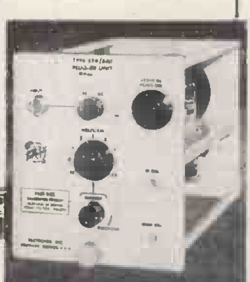
Frequency Response—Passband, dc to 30 mc. (down 3 db $\pm$ ½ db at 30 mc, only 6 db at 45 mc).

Input impedance 20 $\mu\mu$f, 1 megohm.

Sensitivity—0.05 v/cm to 20 v/cm in 9 calibrated steps.

Price—$125





LOW INPUT CAPACITANCE

With Accessory Probes for Type 53K/54K

Probe	Input Impedance	Maximum Sensitivity
P405	11.5 $\mu\mu$f, 5 megohms	0.25 v/cm
P410	7.5 $\mu\mu$f, 10 megohms	0.5 v/cm
P420	4.5 $\mu\mu$f, 10 megohms	1 v/cm
P450	2.5 $\mu\mu$f, 10 megohms	2.5 v/cm
P4100	2.5 $\mu\mu$f, 10 megohms	5 v/cm

Type 545 Oscilloscope Characteristics

Wide Sweep Range
24 Calibrated sweeps from 0.1 μsec/cm to 5 sec/cm, accurate within 3%. Accurate 5-x magnifier extends calibrated range to 0.02 μsec/cm. Continuously variable from 0.02 μsec/cm to 12 sec/cm.

Wide Sweep-Delay Range
Additional delaying-sweep circuitry provides conventional, or triggered jitter-free delay, 1 μsec to 0.1 sec in 12 calibrated ranges. Range accuracy within 2%. Incremental accuracy within 0.2% of full scale.

Versatile Triggering
Internal or external, with amplitude-level selection or AUTOMATIC TRIGGERING. High-frequency synchronization up to 30 mc.

Square-Wave Amplitude Calibrator
0.2 mv to 100 v in 18 steps, accurate within 3%.

New Cathode-Ray Tube
Tektronix T54P 5" precision metallized crt provides 4-cm vertical and 10-cm horizontal linear deflection. 10-kv regulated accelerating potential.

Balanced Delay Network
0.15 μsec vertical signal delay.

DC-Coupled Unblanking
Uniform unblanking at all sweep speeds and repetition rates.

Electronic Voltage Regulation
All voltages affecting calibrations are fully regulated.

CRT Beam Position Indicators

Type 545—$1450 plus price of desired plug-in units.

Type 541—Same characteristics, less delayed-sweep facility—$1145 plus price of desired plug-in units.

Prices f.o.b. Portland (Beaverton), Oregon

Represented in London by Livingston Laboratories, Ltd., Archway 6251.

*TYPE 545...£560 *TYPE 541...£440 *53K/54K....£48
*Delivered in Britain, plus duty if applicable.

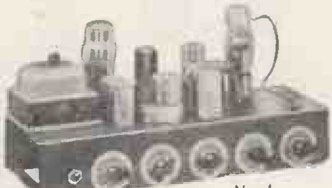
Tektronix, Inc.

P.O. BOX 831D • PORTLAND 7, OREGON, U.S.A.
CYpress 2-2611 CABLE: TEKTRONIX

REAL HIGH FIDELITY *at modest cost . . .*

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

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



No. 1

No. 1 "SYMPHONY" AMPLIFIER is a 3-channel 5-watt Gram/Radio Amplifier with astonishingly flexible tone control. You can lift the treble, the bass, or—and here is the unique feature—the middle frequencies to suit your own ear characteristics and the record or radio programme being heard. It is thus possible to arrange the frequency-response of the amplifier to a curve equal and opposite to the resultant curve of the other items in the chain so that what finally registers in the brain is as per original. This flexibility of control is far more important than mere nominal linear response of the amplifier, as the pick-up, speaker, etc., are not linear. Independent Scratch-Cut is also fitted and special negative-feedback circuit employed. The Amplifier can accommodate a wide variety of records from old 78's to new L.P.'s. Input is for all types of pick-up of 0.1 v. output or more and there is full provision (and power) for Radio Tuner. It is available to match 2/3 or 15 ohms speakers. Price: 10 gns. (carriage 5/-). Fitted in portable Steel Cabinet, 35/- extra.

No. 2

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

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

"STUDIO SYMPHONY" AMPLIFIERS, Models 1 and 2, new models specially designed to get the maximum out of the revolutionary new Collaro Studio pick-ups and heads type "P" or Transcription. Specification as per our Standard Symphony models but with high-gain, low-noise, built-in Pre-amplifier stage with separate switched correctors for Std. and L.P. Third position on switch provides input matching for Acos and similar output pick-ups. These remarkable new models thus provide all the facilities and matching of our Standard Symphony Amplifiers PLUS the specialised Collaro matchings. Send for copy of "The Gramophone" review of these instruments. Price: No. 1, 12 gns.; No. 2, 17 gns. Carriage 5/-.

CURRENT GARRARD PRODUCTS AVAILABLE FOR IMMEDIATE DELIVERY FROM STOCK AT PRESENT.

MODEL TA 3-speed unit, with plug-in turnover head Type G.C.2, £10/16/-, or with Acos HGP 33 or 37 heads, £10/14/-, or with two separate high fidelity Acos HGP35 heads, £12/17/- Unit less heads, £8/11/-, post 2/6. Heads, 42/3 each, post 1/-.

MODEL TB as above, but with long pickup arm. Less heads, £8/11/-, post 2/6.
Heads to fit this unit: Decca XMS, 54/6, Decca Crystal, 30/-, Garrard Standard Magnetic, 28/-, miniature magnetic low impedance, 28/-, miniature magnetic high impedance, 38/-. Post on heads 1/-. Unit can be supplied with any combination of above heads and is carefully adjusted for stylus pressure on despatch.

MODEL RC80M, less heads, £15/5/-, with new turnover head, £17/9/6, with two separate Acos HGP35 heads £19/9/-, carriage 5/-.

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

TRANSCRIPTION MOTORS IN STOCK.

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

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

GARRARD Model 301, £25/3/6.

Cabinets available to house any of the above motor, together with pick-up, price £3/7/6. Carriage 5/-.

SNIP NO. 1

GARRARD LATEST MODEL RC80M AUTO-CHANGER. Fitted with full-length Pick-up Arm to take 3-pin plug-in heads, manufactured end of Oct. 1954. PRICE LESS HEADS, £15/5/-, carriage paid. These extraordinarily versatile units can be supplied fitted with the following combinations of Pickup Heads at the following prices:

- With two Decca XMS ffrr Magnetic Heads, £20/15/-
- With two Decca Crystal Heads, £18/10/-.
- With Decca Crystal for L.P. and Garrard Miniature Mag. for Std. Takes miniature fibre or steel needles. £18/13/-.
- With two Acos HGP39-1 Heads, £20/5/-.
- With one Acos HGP39-1 Head for L.P. and Garrard Miniature Mag. High Impedance for Std. Takes miniature fibre or steel needles, £19/17/-.

The above combinations of heads are matched for output and the stylus pressure is carefully adjusted before despatch. Carriage paid.
Above mounted in Portable Cabinet 90/- extra.
IMMEDIATE DELIVERY from STOCK guaranteed.

"MONARCH" latest model, 3 speed **AUTO CHANGER** with latest ACOS HGP37 turnover head with two sapphire styli, price £13/10/-. Carr, 5/-. Leaflet 2½d. Mounted in Portable Cabinet. £16.10.0 carr. 7/6.

"SYMPHONY" BASS REFLEX CABINET KITS 30in. high, consist of fully-cut ½in. thick, heavy, inert, non-resonant patent acoustic board, deflector plate, felt, all screws, etc., and full instructions, 8in. speaker model, 85/-; 10in. speaker model, 97/6; 12in. speaker model, £5/7/6. The design is the final result of extensive research in our own laboratory and is your safeguard of optimum acoustic results. Carriage 7/6. Ready built, 10/6 extra.

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

NORTHERN RADIO SERVICES

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

"SYMPHONY" BASS REFLEX CABINETS, fully finished in figured walnut, oak or mahogany to our own design and to match our Console Amplifier Cabinet, enabling the housing of a whole equipment in a two piece suite; cost: 12in. speaker model, £11/10/-; 10in., £11; 8in. £10/10/-. Carriage according to area. The 10in. model is ideal for the WB HF 1012 (see "The Gramophone" review March).

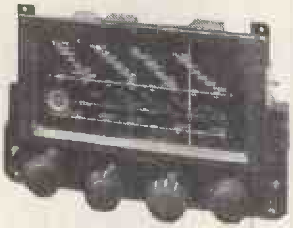
TREBLE BAFFLE veneered to match, optional extra 50/-.

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

Northern Radio Services (CONTD.)

"SYMPHONY" RADIO FEEDER UNITS

NO. 1 "SYMPHONY" TUNER. A T.R.F. model designed for the quality reception of local stations. Quality is adequate for amplifiers of the highest fidelity class. Infinite Impedance detection. Controls: gain, wave-change and radio/gram switch. Illuminated engraved glass dial. Latest miniature valves. Overall dimensions: 9in. wide × 6in. deep × 6in. high. Power required: 6.3 v. at 1 amp. and 250/300 v. at 15 m/a. Price **£7-7-0** Carr. & pkg. 5/-.



NO. 2 "SYMPHONY" SUPERHET TUNER. Three wave-bands, advanced circuit, very newest valve types, floodlit glass dial with bronze escutcheon provided. Suitable for use with the best amplifiers. Overall dimensions: 12in. wide × 8½in. high × 7in. deep. Controls: on/off/gain, radio/gram, wave-change and tuning. Dial cut-out: 8in. × 4½in. reading horizontally or vertically (state which required). Tuner can be readily mounted at any angle. Requires 6.3 v. at 1.5 amp. and 250/300 v. at 20 m/a. Price **£11-11-0**. Carr. & pkg. 5/-.

No. 2/VS "SYMPHONY" SUPERHET TUNER. As No. 2 but incorporating on the wave-change switch an extra position for radio, thus making two radio positions. One is the standard one with 9 kc. separation and the extra one providing virtually T.R.F. band-width and quality on local stations. Price **£13-13-0.** Carr. & pkg. 5/-.

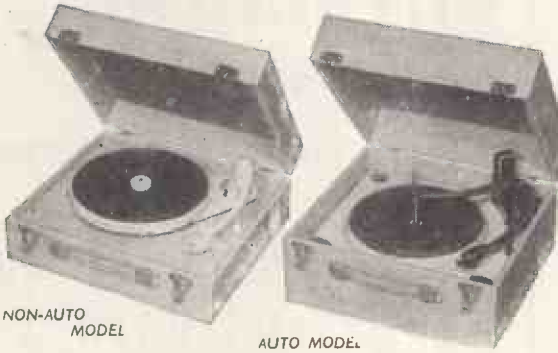
All above tuners are made to plug in to any of our "Symphony" Amplifiers in a matter of seconds by means of the octal plug fitted at the end of a flexible multi-cable. They are ideal for providing in conjunction with our "Symphony" Amplifiers, the same high quality on radio as is obtained from these amplifiers on gramophone, but they are equally suitable for use with other high fidelity amplifiers, and where the output circuit requires modification to match a given amplifier this can be carried out free of charge. Either of the two Superhet models can be fitted with a magic eye tuning indicator for **£2-2-0** extra. Furthermore, they can be fitted with a pre-amplifying stage to match the Decca Magnetic Pickups or the Collaro Studio type "P" pickup head for use with amplifiers which would not otherwise have enough gain for these comparatively low output pickup heads. In these cases, two separate correction circuits—one for standard and one for LP as recommended by the pickup manufacturers—are incorporated in the radio/gram switch. Please send for our catalogue giving further details.

TAPE DECKS AND AMPLIFIERS

TRUVOX TAPE DECK MARK III. TR2/U. Latest version to take pre-recorded tapes. Price 22 gns. Illustrated leaflet 2½d.

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

NEW MODEL PORTABLE RECORD PLAYERS



NON-AUTO MODEL

AUTO MODEL

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

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

Insist

on —

£1 RETAIL

FULL TRADE DISCOUNTS

The only tape giving

a perfect performance at low price

SALFORD ELECTRICAL INSTRUMENTS LTD.

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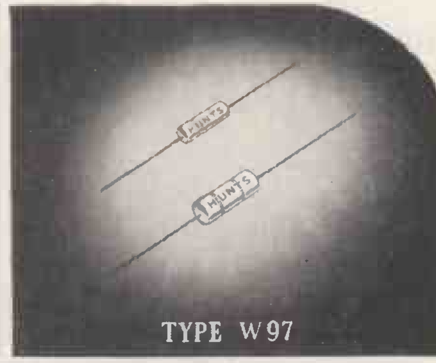
REVOLUTIONARY

in design— and performance!



HUNTS "THERMETIC" MIDGET METALLISED PAPER CAPACITORS WITH A TRUE HERMETIC SEAL

FULLY APPROVED TO JOINT SERVICES STANDARD R.C.S.136/A CATEGORY 40/100, CLASS H.1.

TEMPERATURE RANGE: − 100°C to + 100°C

The W97 capacitor, although of diminutive size, is an extraordinarily robust unit. Most miniature units are prone to weakness in end connections and general mechanical flimsiness. Such undesirable features are eliminated in the W97 by the special processes used and extreme care in manufacture.

CAPACITOR UNIT

A single metallised paper is used to wind this unit which is made possible by the use of Hunt's Patent covering the "castellated" pattern. Recent development by Hunt on a special impregnating material gives the unit remarkable brackets of operating temperature.

CASING

Hunt's patented double metal tube, sealed with the special "Thermetic" compound, provides positive closure on the casing and lead entry, ensuring positive hermetic sealing.

INSULATION OF CASING

The capacitors are supplied without an insulating medium on the case. If specially requested they can be supplied with an approved plastic sleeve which increases the dimensions by 0.07" in length and 0.03" in diameter.

TERMINATIONS

The terminations are of 24 gauge tinned phosphor bronze wire having a nominal length of 1½". Special attention is paid to the retinning of the wires after the capacitor is fully processed. Connection is made to the unit by applying copper spray to the metallising. The pigtail is soldered to this bond giving a perfect connection of exceptional strength.

INDUCTANCE

W97 "Thermetic" Midgets have a very high self resonant frequency—the following figures are quoted as a guide. 50 pF at 600 volts, which is the lowest capacitance in the range, has a self resonant frequency of 280 megacycles. At the other end of the range, 0.04 μF 200 volts, which is the maximum capacitance, it is 8.5 megacycles.

INSULATION RESISTANCE

This is measured at working voltage at a temperature of 20°C. The minimum capacitance in the range, 50 pF at 600 volts, has an insulation resistance greater than 2,000,000 megohms. The maximum capacitance in the range 0.04 μF at 200 volts, has an insulation resistance greater than 25,000 megohms. The intermediate capacitances are approximately pro rata.

POWER FACTOR

Less than 2% at 1,000 cycles per second at 20 C.

CAPACITANCE TOLERANCE

Standard ± 20%. Closer tolerances are available, for capacitances exceeding 500 pF.

TYPE W97 STANDARD RANGE

LIST NO.	CAP μF.	DIMENSIONS (inches) L.	D.
	200 volts D.C.	Wkg.	
BM7	0.002	0.610	0.135
BM8	0.004	0.610	0.135
BM11	0.004	0.500	0.180
BM9	0.005	0.610	0.135
BM12	0.005	0.500	0.180
BM13	0.01	0.500	0.180
BM14	0.02	0.610	0.180
BM15	0.03	0.610	0.260
BM16	0.04	0.610	0.260
	400 volts D.C.	Wkg.	
BM4	0.0004	0.610	0.135
BM5	0.0005	0.610	0.135
BM6	0.001	0.610	0.135
BM18	0.002	0.500	0.180
BM19	0.003	0.500	0.180
BM20	0.005	0.610	0.180
BM21	0.01	0.610	0.260
	600 volts D.C.	Wkg.	
BM25	50 pF.	0.500	0.180
BM1	0.0001	0.610	0.135
BM26	0.0001	0.500	0.180
BM2	0.0002	0.610	0.135
BM27	0.0002	0.500	0.180
BM28	0.00022	0.500	0.180
BM29	0.00025	0.500	0.180
BM3	0.0003	0.610	0.135
BM30	0.0003	0.500	0.180
BM36	0.0004	0.500	0.180
BM31	0.0005	0.500	0.180
BM32	0.001	0.500	0.180
BM33	0.002	0.610	0.260
BM34	0.003	0.610	0.260
BM35	0.004	0.610	0.260

W97 IS A 'MUST' for the MAKERS OF ELECTRONIC EQUIPMENT

A. H. Hunt (Capacitors) Ltd, Wandsworth S.W.18 · BAT 1083

And in Canada: HUNT CAPACITORS (Canada) Ltd., AJAX, ONTARIO.

REGISTERED TRADE MARK

HUNTS CAPACITORS

THE TRADE MARK OF RELIABILITY

ANNOUNCEMENT

FM RECEIVER ALIGNMENT GENERATOR MODEL 1324

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

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

Watch for the release date and price.

COSSOR Model 1322

Telecheck and Marker Generator for Bands I and III

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

TELECHECK CONVERTER FOR BAND III Model 1321

This adaptor provides owners of Model 1320 "Telecheck" with an extension of the frequency range of the original instrument into the BAND III television channel. Thus, alignment procedures adopted for BAND I RF/IF "strips" are available also for BAND III receivers. A selection of the desired BAND is made by means of a switch. Pattern generator facilities for picture time base linearity checks have been retained. Model 1321 Adaptor is designed for permanent attachment to the standard "Telecheck" providing a neat, light and compact unit. Mounting is effected by four screws and the inter-connecting wiring is carried in a single insulating sleeve.

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

COSSOR ELECTRONIC INSTRUMENTS

Write for illustrated leaflets about both these instruments:

C1.60

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

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

Improved filter units

with Ferroxcube pot cores

1 *High performance combined with small size and light weight.*

2 *Designed and built to customers' individual requirements.*

3 *Long term stability, even under conditions of temperature variation.*

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

Mullard Mullard

'Ticonal' permanent magnets
Magnadur ceramic magnets
Ferroxcube magnetic cores.

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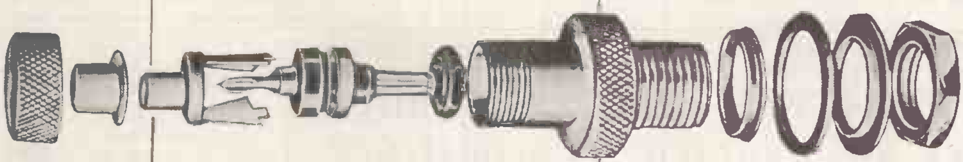


MINIATURE

CO-AXIAL SEALED PLUGS AND SOCKETS

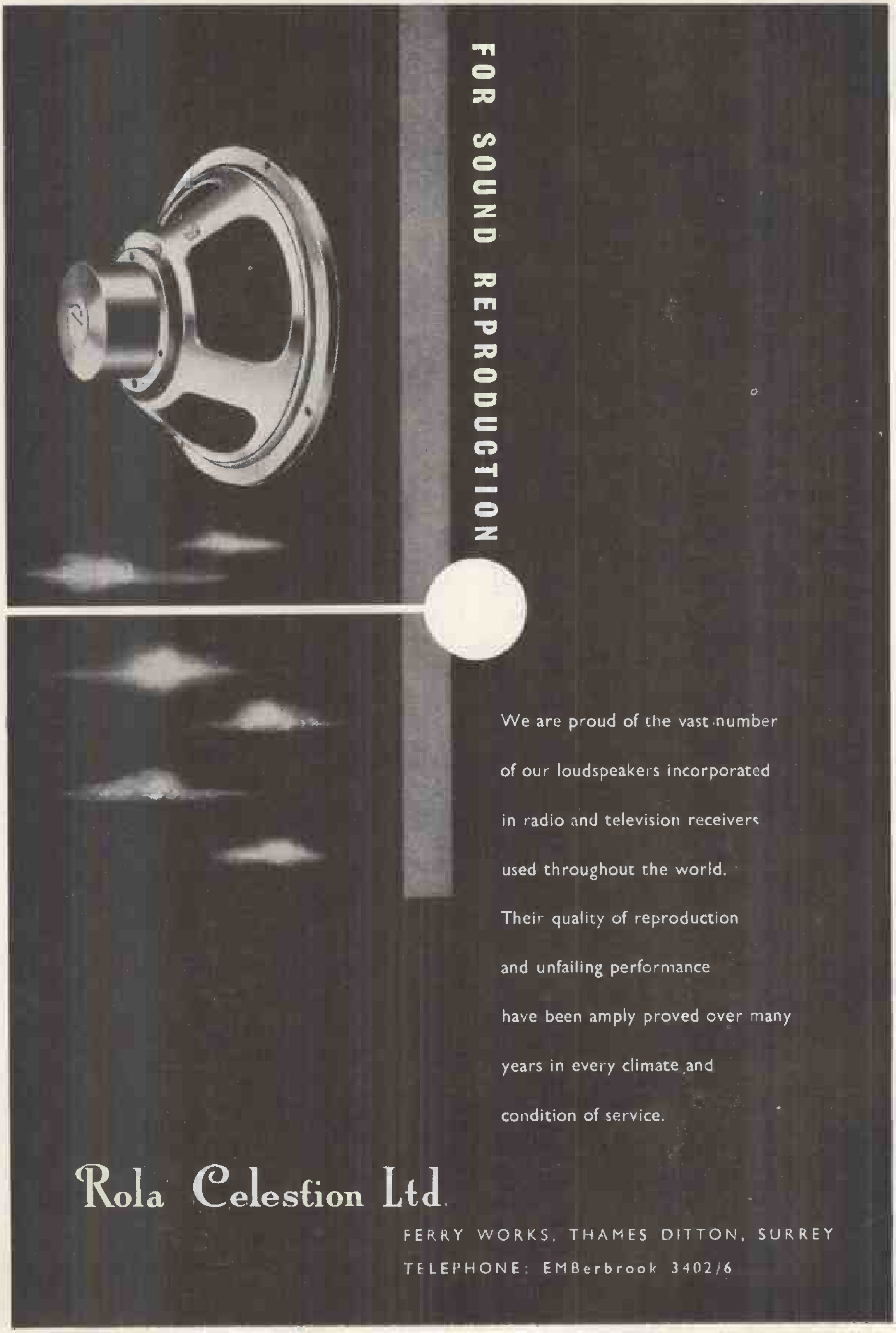
TYPE APPROVED—
COMPLYING WITH R.C.S. 322
PRESSURE SEALED AND
100% TESTED
USED WITH UNIRADIO 43 CABLE

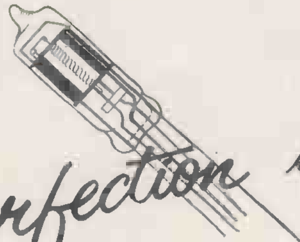
A.I.D & A.R.B — APPROVED

EXNING RD., NEWMARKET

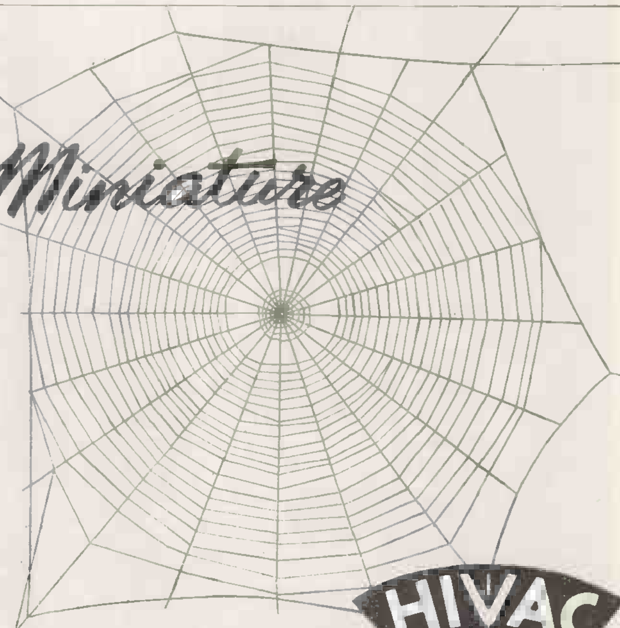
POWER CONTROLS
LIMITED

PHONE: NEW 3181/2/3


FOR SOUND REPRODUCTION
We are proud of the vast number of our loudspeakers incorporated in radio and television receivers used throughout the world. Their quality of reproduction and unfailing performance have been amply proved over many years in every climate and condition of service.
Rola Celestion Ltd.
FERRY WORKS, THAMES DITTON, SURREY
TELEPHONE: EMBerbrook 3402/6



Perfection in Miniature



ARANEUS DIADEMATUS
(the common garden spider)

weaves its web with a thread 0.007mm in diameter, with a tensile strength of about 2 grams.

The "40 series" valves, one of the Hivac ranges of highly specialised subminiature types, uses a tungsten filament of approximately the same diameter but having a tensile strength more than five times as great.

HIVAC THE SCIENTIFIC VALVE

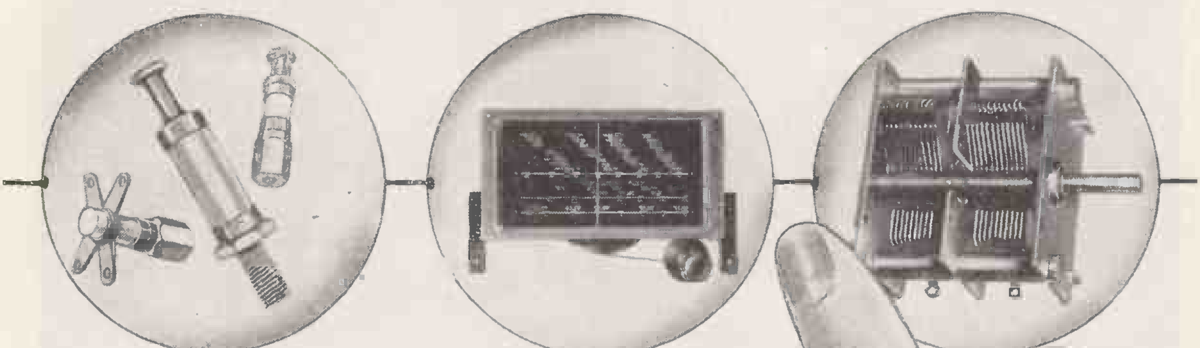
Subminiature, miniature and midget valves, electrometers, cold cathode tubes, transistors, indicator and switchboard lamps, neon indicator lamps.

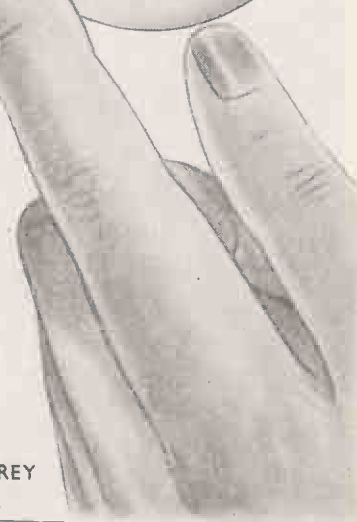
Hivac Limited

STONEFIELD WAY, VICTORIA ROAD, SOUTH RUISLIP, MIDDLESEX.

TELEPHONE: **Ruislip 3366**

P5





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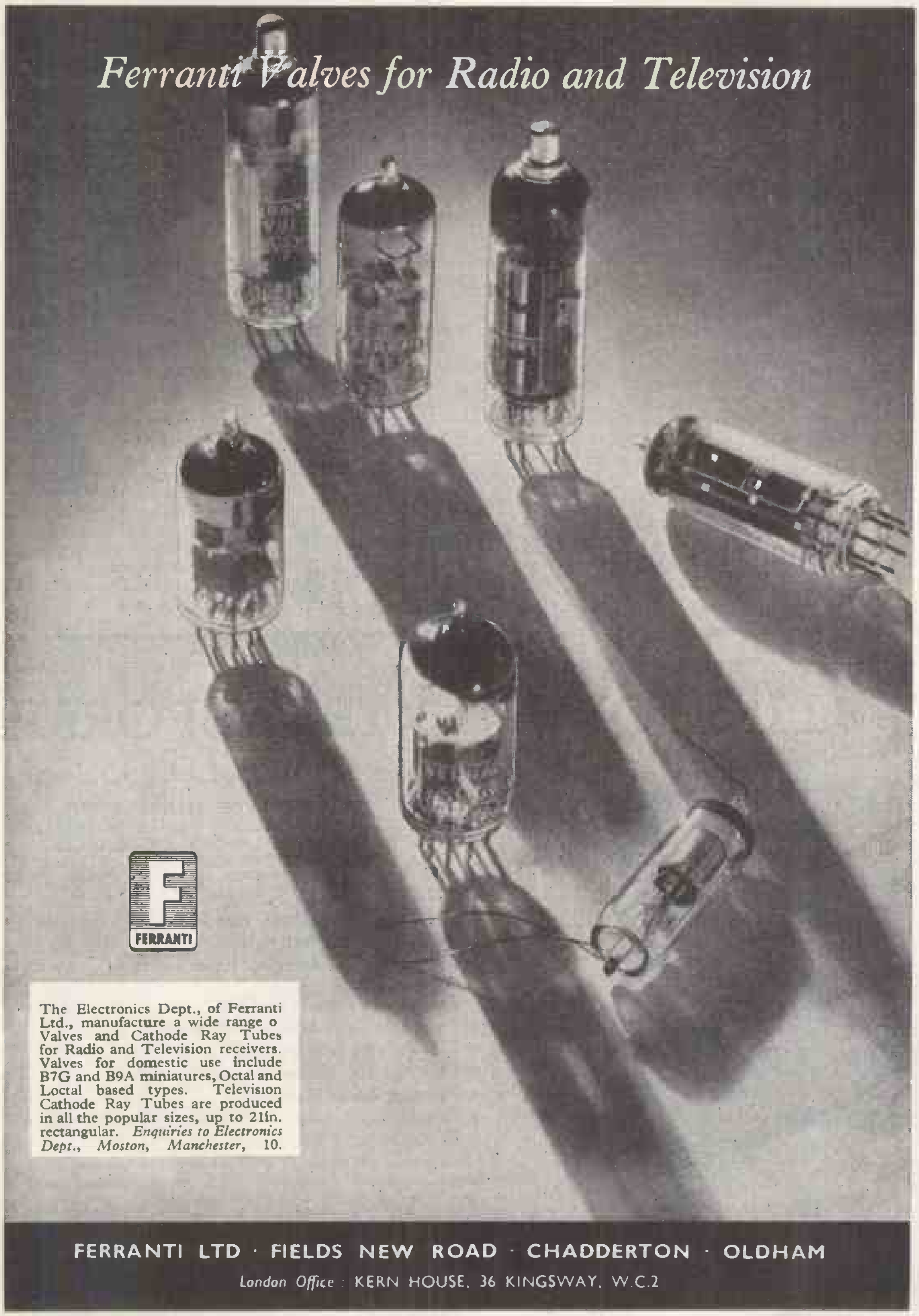
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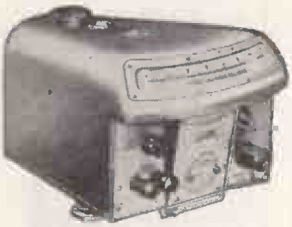

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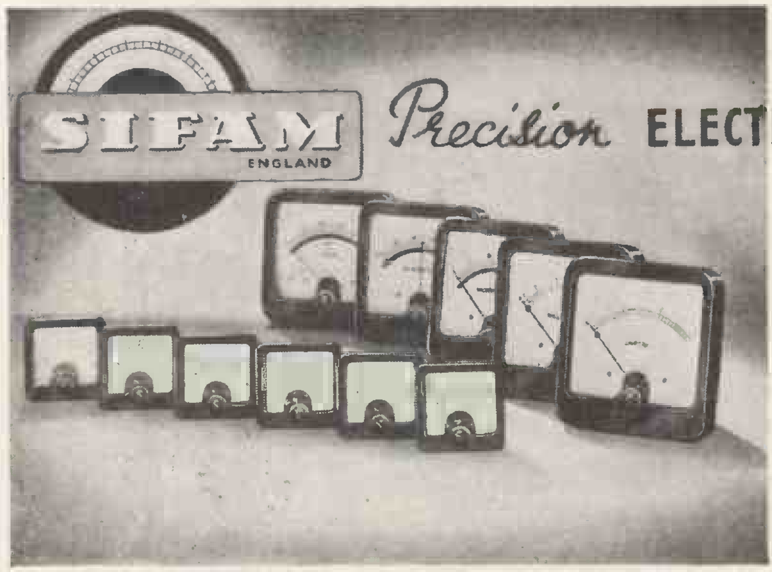

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Block 'C'

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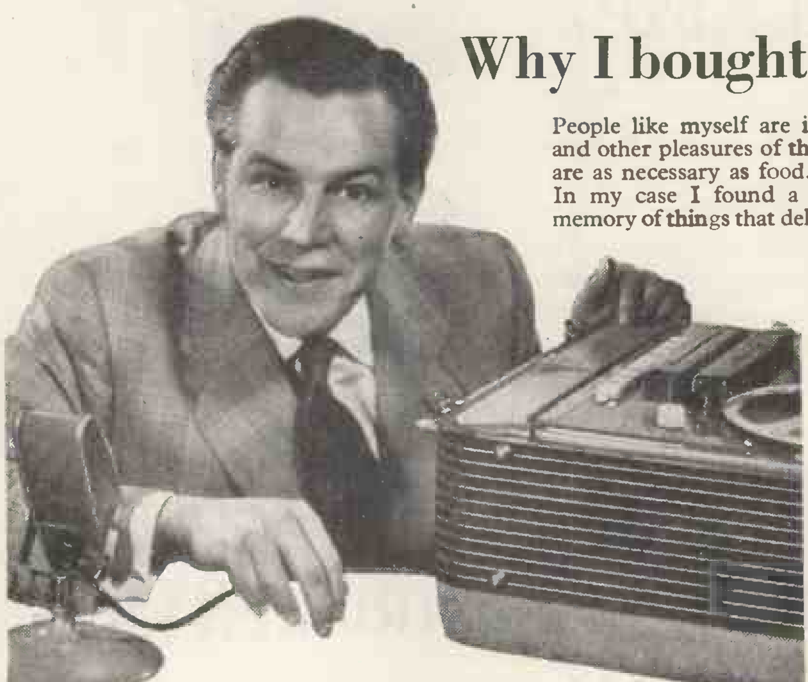

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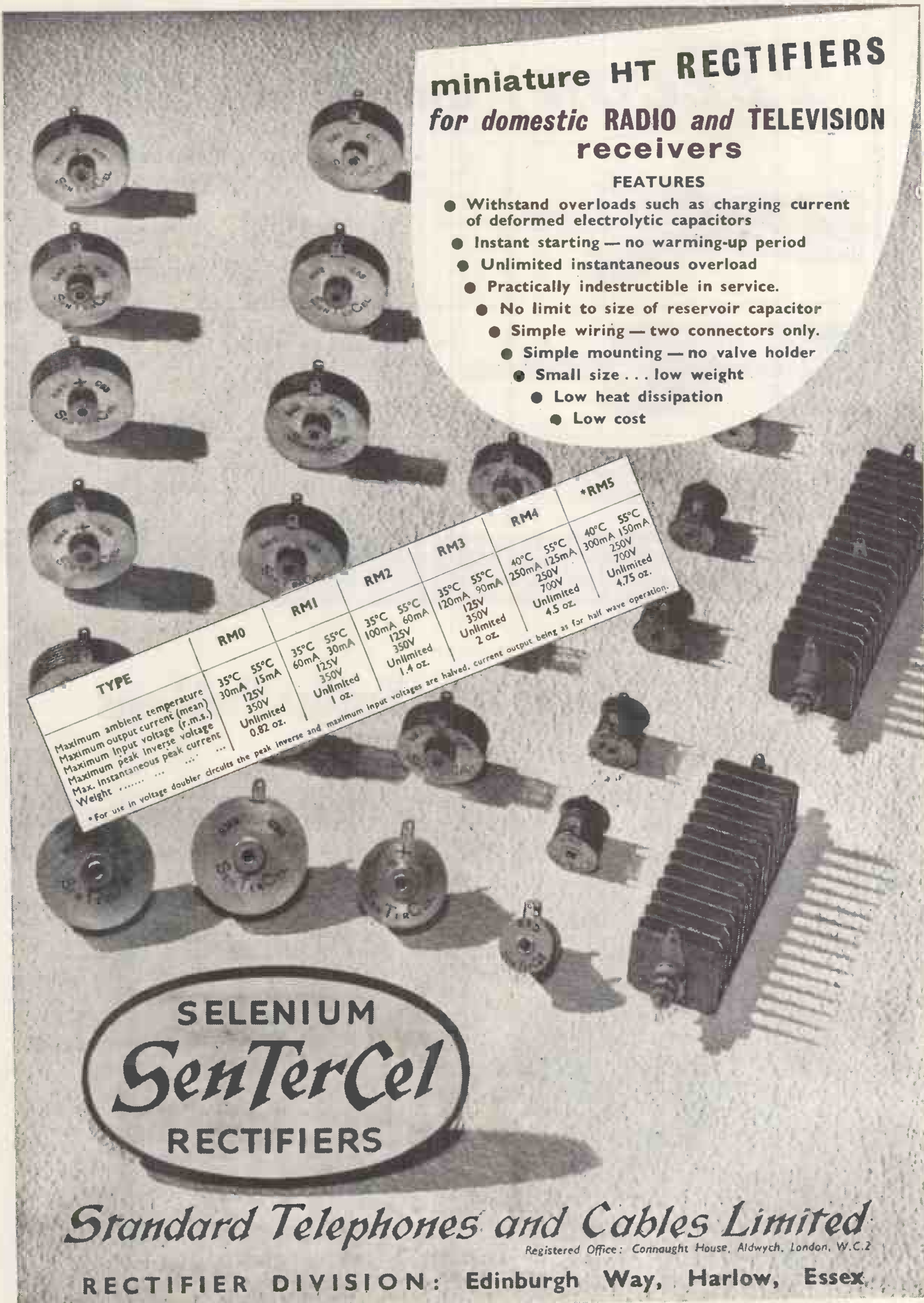

TYPE	RM0		RM1		RM2		RM3		RM4		*RM5	
Maximum ambient temperature	35°C	55°C	35°C	55°C	35°C	55°C	35°C	55°C	40°C	55°C	40°C	55°C
Maximum output current (mean)	30mA	15mA	60mA	30mA	100mA	60mA	120mA	90mA	250mA	125mA	300mA	150mA
Maximum input voltage (r.m.s.)	125V		125V		125V		125V		250V		250V	
Maximum peak inverse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

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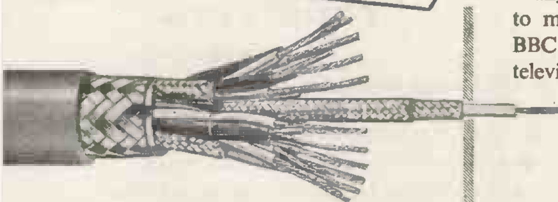

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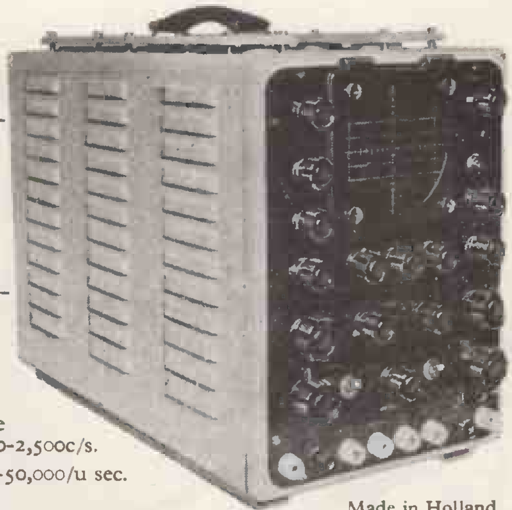

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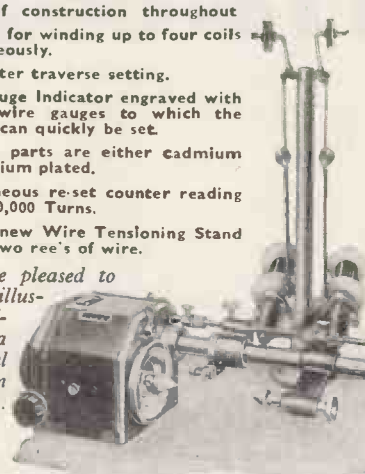

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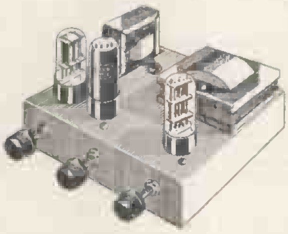

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14 x 9in.	3/2	14 x 7in.	2/11
16 x 9in.	3/8	16 x 7in.	3/5
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Overall dimensions 16¾in. x 14½in. x 10¾in.
Clearance under lid when closed 6½in.

All the above Cabinets are supplied with Panel, Carrying Handle and Clips.
Packing and Postage 2/6.

Famous Manufacturer's Surplus of

ANTI - INTERFERENCE AERIALS

offered at a fraction of original cost.

The aerial is designed for reception of long, medium and short waves, with any ordinary or communications receiver, having an input impedance greater than 1,000 ohms long/medium waves and 150 ohms short waves. The installation discriminates against locally generated electrical interference, especially on the short wavebands. The equipment enables the installation of an 8.3 Mc/s flatly-tuned dipole which operates as a "T" aerial on medium and long waves. The aerial and receiver transformers are intended to be interconnected with a 70 ohms co-axial cable.

COMPONENT PARTS

Aluminium Aerial Transformer Assembly. Comprising one each; Aluminium transformer, Transformer clip rubber sucker, ½in. x ½in. brass screw, 4BA x ½in. brass bolt, 4BA nut.
Receiver Transformer. Complete with insulators, clips, etc.; porcelain insulators, 2 each, 60ft. insulated aerial wire, 60ft. screened co-axial down lead.
Installation instruction leaflet included.
LESS CO-AXIAL CABLE & AERIAL WIRE, **15/-**, plus 1/6 pkg. and carr.
COMPLETE, 35/-, plus 1/6 pkg. and carr.

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

The New "PREMIER PORTABLE" TAPE RECORDER

USING THE NEW LANE 2-SPEED TAPE UNIT MARK 6

COMPLETE 39 GNS CASH

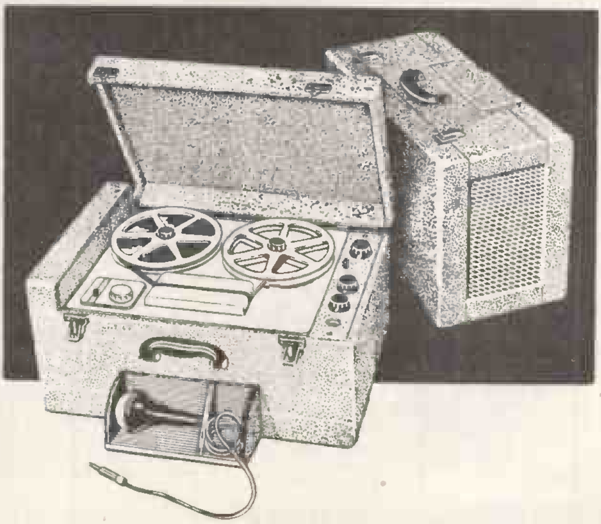
Packing & Carriage 1 gn.

(Including Reel of Scotch Boy Tape and Microphone)

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

or **Complete Kit** Including All Parts, Valves, Speaker Cabinet, Tape Unit, Reel of Scotch Boy Tape, Rewind Spool and Microphone at **£37.4.0** plus pkg. & carr. 15/-.

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



SPECIFICATION

- ★ TWO SPEEDS 7½in. AND 3¾in. PER SECOND.
- ★ THREE SPECIALLY DESIGNED RECORDING MOTORS.
- ★ 1,200ft. TAPE REELS PROVIDING PLAYING TIMES OF 1 HR. AND 2 HRS.
- ★ DROP-IN TAPE LOADING.
- ★ EASY FORWARD OR REWIND WITHOUT REMOVING TAPE.
- ★ ONE KNOB DECK OPERATION.
- ★ 7-VALVE HIGH QUALITY AMPLIFIER.
- ★ INDEPENDENT TREBLE AND BASS CONTROLS.
- ★ MAGIC EYE RECORD LEVEL INDICATOR.
- ★ AMPLIFIER MAY BE USED FOR RECORD REPRODUCTION OF HIGH QUALITY.
- ★ COMPARTMENT FOR HOUSING MICROPHONE.
- ★ SPECIALLY DESIGNED MICROPHONE BY A LEADING MANUFACTURER.

SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW:—

Amplifier (built, wired and tested with Speaker). £14/15/-, plus postage and carriage 7/6.
Hire purchase terms, Deposit £3/13/9 and 12 monthly payments of £1/0/6.
Amplifier Kit (including Speaker). £11/-/- plus packing and carriage 5/-.
Hire purchase terms, Deposit £2/15/- and 9 monthly payments of £1/0/7.
New Lane 2-speed Tape Unit Mark 6. £18/10/- plus packing and carriage 7/6.
Hire purchase terms, Deposit £4/12/6 and 12 monthly payments of £1/5/9.
Portable Cabinet (rexine covered). £4/19/6, plus postage and carriage 5/-.
Microphone, £2/15/-, plus postage and carriage 1/-.
Reel Scotch Boy Tape MC2-111 (1,200ft.), £1/15/-, plus packing and carriage 1/-.
Instruction Booklet. 2/6. Post free.

PREMIER RADIO COMPANY

WILLIAMSON AMPLIFIER KIT 15 gns. plus 7/6 p & p.
H.P. Terms:
Deposit £3.18.9 & 12 m'nthly payments of £1.1.11
This Kit is absolutely complete and all components are guaranteed exactly to author's specification.

WILLIAMSON OUTPUT TRANSFORMER
Author's Specification 3.6 ohms secondaries **£4.4.0**

MAINS TRANSFORMER SP425A (Completely Shrouded)
This Transformer has an additional 6.3 v. 3 A. and is capable of supplying an extra 50 mA. for Pre-amp or Feeder unit........ **£2.12.6**

WILLIAMSON CHOKES
12H 150 mA. Fully shrouded **19/6**
30H 20 mA. Fully shrouded **11/9**

METERS

Full Scale Deflection	External Dimensions in.	Movement	
3.5 A.	2¼ × 2¼	R.F. Thermo	7/6
20 A.	2¼ round	M/C	8/6
40 A.	2¼ round	M/C	8/6
500 mA.	2¼ round	M/C	10/6
30 A.	2¼ × 2¼	M/C	8/6
50 mA.	2¼ × 2¼	M/C	7/6
20 V.	2¼ × 2¼	M/C	6/6
40 V.	2¼ × 2¼	M/C	8/6
1 mA.	2¼ round	M/C	22/6
1 mA.	2¼ round	Desk type M/C	25/-

SEND 2½d. STAMP FOR OUR 1955 CATALOGUE

PREMIER MAINS TRANSFORMERS

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

SP175B, 175-0-175, 50 mA., 4 v. @ 1 a., 4 v. @ 2-3 a. 15/-
SP350A, 350-0-350, 100 mA., 5 v. @ 2-3 a., 6.3 v. @ 2-3 a. 21/-
SP351A, 350 0-350, 150 mA., 4 v. @ 2-3 a., 4 v. @ 3-6 a., 4 v. @ 1-2 a., 4 v. @ 1-2 a. 30/-
SP352, 350-0-350, 150 mA., 5 v. @ 2-3 a., 6.3 v. @ 2-3 a., 6.3 v. @ 2-3 a. 30/-
SP425A, 425-0-425, 200 mA., 6.3 v. @ 2-3 a., 6.3 v. @ 3-5 a., 5 v. @ 2-5 a. 52/6
250-0-250, 80 mA., 6.3 v. @ 4 a., 5 v. @ 2 a. 19/6
350-0-350, 80 mA., 6.3 v. @ 4 a., 5 v. @ 2 a. 19/6
200-230-250 output 3 v.-30 v., @ 2 a. 17/6

E.H.T. primary 230 v., secondary 1.75 Kv., 2 × 4 v. tapped 2 v 37/6
E.H.T. TRANSFORMER, primary 210 v., 230 v., 250 v., secondary 4 Kv. and 2 v. £3/7/6
E.H.T. TRANSFORMER, primary 210 v., 230 v. 250 v., secondary 5Kv. and 2 v. £3/12/6

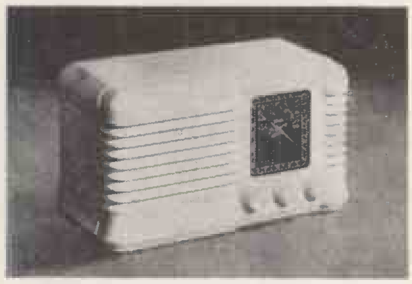
Build these NEW PREMIER DESIGNS

3-BAND SUPERHET RECEIVER

MAY BE BUILT FOR **£7.19.6** Plus 2/6 pk. & Carr.

Latest type Superhet Circuit using 4 valves and metal rectifiers for operation on 200/250 volts A.C. mains. Waveband coverage — short 16-50 metres, medium 180-550 metres, and long 900-2,000 metres. Valve line-up 6K8 freq. changer, 6K7, IF, 6Q7, Detector AVC and first AF, 6V6 output. The attractive cabinet to house the Receiver size 12in. long, 6½in. high, 5¼in. deep can be supplied in either WALNUT or IVORY BAKELITE or WOOD. Instruction Book 1/- post free, which includes assembly and wiring diagrams, also a detailed stock list of priced components.

TRF RECEIVER



MAY BE BUILT FOR **£5.15.0** Plus 2/6 Pkg. & Carr.

The circuit is the latest type TRF using 3 valves and Metal Rectifiers for operation on 200/250 A.C. mains. Waveband coverage is 180-550 metres on medium wave and 800-2,000 metres on long wave. The dial is illuminated and the Valve line-up is 6K7 H.F. Pentode 6J7 Detector and 6V6—Output. The attractive Cabinets to house the Receiver size 12in. long, 6½in. high, 5¼in. deep, can be supplied in either WALNUT or IVORY BAKELITE or WOOD.
INSTRUCTION BOOK 1/- (post free) which includes Assembly and wiring diagrams, also a detailed Stock List of priced components.

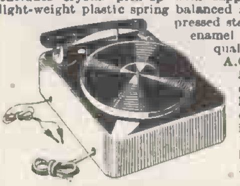
ALL-DRY BATTERY PORTABLE RADIO RECEIVER

MAY BE BUILT FOR **£7.8.0** Plus 2/6 Pkg and Carr

4 miniature Valves in a Superhet Circuit covering medium and long waves. Rexine covered Cabinets 11½in. x 10in. x 5½in. in two contrasting colours. Wine with Grey Panel, or Blue with Grey Panel, please state choice when ordering.
THE SET MAY BE USED EVERYWHERE—*home, office, car or holidays.*
INSTRUCTION BOOK, 1/6 (Post Free) which includes Assembly and wiring diagrams, also a detailed Stock List of priced components.

DECCA MODEL 33A RECORD PLAYER
ADAPTABLE FOR STND. OR L.P.

Includes crystal pick-up with sapphire stylus and a light-weight plastic spring balanced arm. Heavy gauge pressed steel case with brown enamel finish in good quality for operation on A.C. mains 200/250 v. 50 c.p.s. Supplied complete with single head (either standard or long playing). **£4/19/6.** Extra Head can be supplied. Plus Pkg. and carr. 5/-.



3-SPEED AUTOMATIC RECORD CHANGER

Made by World-famous manufacturer. 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. For use on 100/125-200/250 volts 50 cycles. A.C. mains.
LIMITED QUANTITY ONLY.
Plus packing and carriage 5/-. BRAND NEW guaranteed and in manufacturers' original carton.

£9.19.6
LIST PRICE £16/10/-.

LATEST TYPE 3-SPEED SINGLE PLAYER
By famous manufacturer with crystal turnover head, for use on 100-250 v. 50 cycle A.C. mains. **£7.19.6** plus Pkg. and carr. 5/-.

MINIATURE TUNING CONDENSERS

2-gang .0005 mfd. with trimmers.......... 6/9

PREMIER VARIABLE IMPEDANCE "MATCHMAKER" M.O.15 OUTPUT TRANSFORMERS

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 50 henries 15 watts audio 100 mA. Price 45/-.

LOUDSPEAKERS

ELAC—2½in. dia., Moving Coil, 15 ohm imp. 15/-
ELAC—8in. dia. Moving Coil 3 ohms imp. 19/6
PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field) with Pentode Transformer 22/6
PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field) 19/6
PLESSEY—10in. dia. Moving Coil, 3 ohms imp. 23/6
GOODMANS—12in. dia., Moving Coil, 15 ohms. Plus 5/- packing and carriage £8/12/6
VITAVOX—K12/20 12in. dia., Moving Coil 15 ohms. imp. £11/11/-
Plus 5/- packing and carriage.

CRYSTAL MICROPHONE INSERTS

Ideal for tape recording and amplifiers. No Matching transformer required, 8/6 post free.

ACCUMULATORS

2 volt 10 amp. (by famous maker) 4/11
2 volt 16 amp. 5/11

MOVING COIL METER

A super quality Moving Coil Meter basic movement 2 mA. and 4 mA. Scale dimensions 2¼in. Overall dimensions 2¼in. dia. 1¼in. deep. Bakelite Case projecting type. At present scaled 1 amp. R.F. By removing thermocouple, 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 2 mA., 5/9, 4 mA., 4/9.

MICROPHONES

LUSTRAPHONE: Moving Coil; High Impedance, Stand Type: £5/15/6—Hand Mike £6/6/-.
RONETTE—Crystal Mike Incorp. the Filter Cell Insert; High Impd. Ball Type, £2/10/-.
CRYSTAL MICROPHONE—Rothermel 2AD56. Especially recommended. £2/15/- Table stands for all the above 10/6 and 17/6.
ACOS. High impedance Crystal Microphone, type 35-1, 25/-.
ACOS. High Impedance Crystal Microphone, type 33-1, £2/10/-.
ACOS. "MIC30" Impedance Crystal Microphone £2/10/- (This Microphone can be used as either Hand or Desk type.)

CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and sound projectors, price 19/6

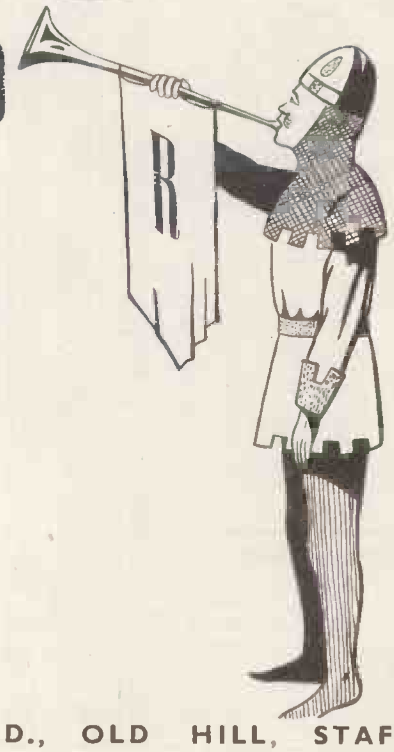
MAINS NOISE ELIMINATOR KIT

Two specially designed chokes with three smoothing condensers with circuit diagrams. Cuts out all mains noise. Can be assembled inside existing receiver, 4/11. plus 6d. pkg. and carr.

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

Introducing

THE REGENT H.F.100



Here is a brilliant new high-fidelity single record player which brings top quality reproduction within the reach of all record lovers.

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

We shall be pleased to send you literature on request.

BSR

BIRMINGHAM SOUND REPRODUCERS LTD., OLD HILL, STAFFS

A89

Wireless World

RADIO, ELECTRONICS, TELEVISION

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

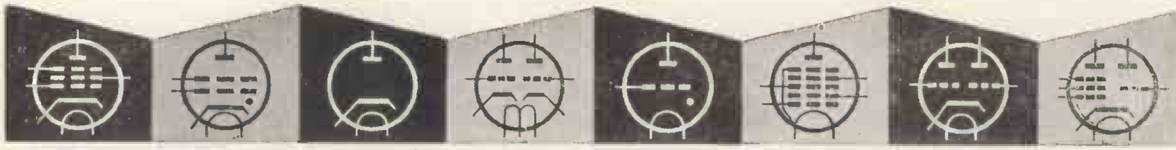
JUNE 1955

In This Issue

VOLUME 61 NO. 6
PRICE: TWO SHILLINGS

FORTY-FIFTH YEAR
OF PUBLICATION

PUBLISHED MONTHLY (4th Tuesday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* "Ethaworld, Sedist, London." *Annual Subscription:* Home and Overseas, £1 7s. 0d. U.S.A. $4.50. Canada $4.00. BRANCH OFFICES: *Birmingham:* King Edward House, New Street, 2. *Coventry:* 8-10 Corporation Street. *Glasgow:* 26B Renfield Street, C.2. *Manchester:* 260 Deansgate, 3.



VALVES, TUBES & CIRCUITS

30. GERMANIUM DIODES FOR TELEVISION RECEIVERS

Advantages and Disadvantages

The point-contact germanium diode can often be used with advantage in place of its thermionic counterpart. Its compactness and long life make it suitable for inclusion in a coil unit. It is robust and non-microphonic. The inter-electrode capacitance is low. There is no heater, therefore supplies are simplified and a possible source of hum is eliminated. And the forward resistance is low, giving improved detection efficiency.

The main limitations of the germanium diode, namely its reverse current at negative voltages and its relatively large temperature dependence, can be easily allowed for in circuit design and chassis layout. Earlier diode troubles, such as sensitivity to atmospheric moisture, have been eliminated by present-day manufacturing techniques.

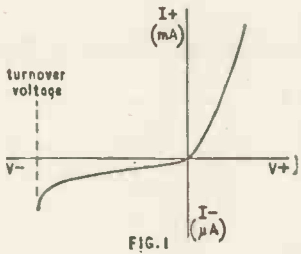


FIG. 1

The Diode Characteristic

The general form of the germanium diode current/voltage characteristic is shown in Fig. 1. There are certain significant differences from the characteristic of a thermionic diode. The comparatively steep rise of the positive portion obeys an exponential rather than a three-halves power law, with forward currents which are normally of the order of 5 or 10mA at 1 or 2V. At high positive voltages, beyond the normal working range, the characteristic becomes nearly linear (that is resistive), without the saturation effect which is seen in a thermionic diode.

The negative characteristic shows not only a negative current for negative voltages, but also a rapid growth of this current if the voltage is made sufficiently great. In this region (which is well beyond the working range) *turnover* takes place, and the characteristic reverses. This condition produces overheating and a destructive runaway. The normal reverse currents are quite small (a few micro-amps) and, if the published temperature and peak reverse voltage ratings are observed, reverse currents have no harmful effect.

The characteristic, as it changes from the positive to the negative region, passes through the origin, therefore at zero voltage there is no current flow. In the immediate vicinity of this point (say within $\pm$ 10mV) the ratio of forward to reverse resistance becomes small, and detection efficiency is much reduced.

High and Low Current Types

The steeply rising forward characteristic of a high-current type of germanium diode implies a comparatively large reverse current and a comparatively low turnover voltage. Conversely, the less steep forward characteristic of a low-current type gives an extended reverse characteristic. These contrasted pairs of features are the basis of the possible range of diode types. They are the key to the choice of type for a particular application, and they are important influences on circuit design.

Temperature Effects

Germanium diodes are affected by temperature, and all ratings apply at specified temperatures. It is necessary for the circuit designer to take into account not only the air temperature which is likely to occur in the receiver but also any heat which may be transmitted through the chassis. The appropriate forward current and reverse voltage ratings must be observed if the diode itself is not to generate destructive heat. It is not to be assumed, however, that a germanium diode is excessively sensitive in this respect. The dangers have been mentioned only in order to draw attention to the temperature rating—a rating which is not normally of much consequence where thermionic valves are used.

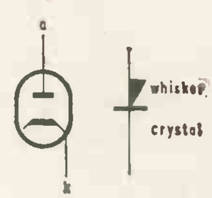


FIG. 2

Fig. 2 shows the standard symbol for a germanium diode in parallel with the familiar diode valve symbol. The figure is intended to assist in the reading of circuit diagrams. The differences between the two kinds of diodes should, of course, be borne in mind.

Further advertisements in this series will discuss the employment of the diode characteristic in a number of typical applications in television and f.m. receivers.

Reprints of this advertisement, supplemented by data for Mullard diode types, are available without charge.

Mullard

Mullard Ltd., Technical Service Department, Century House, Shaftesbury Avenue, London, W.C. 2

MVM 322

BRIMAR TELETUBES

FIRST for picture quality

Another first from BRIMAR—still another natural choice for the manufacturer who is looking for the finest. Here's a tube designed to be the finest. Here's a tube tested (and re-tested) at every stage of manufacture to meet the exacting demands of equipment manufacturers.

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

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

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

Consult BRIMAR

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

Standard Telephones and Cables Limited

FOOTSCRAY : SIDCUP : KENT. *Telephone:* FOOtscray 3333

All these ACOS CRYSTAL PRODUCTS *—and more too—go to show that* FAITHFUL REPRODUCTION NEED NOT BE EXPENSIVE

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

.....always well ahead

COSMOCORD LIMITED ENFIELD MIDDX. *Tel.: ENFIELD 4022*

"BELLING-LEE" NOTES

There may be many readers who do not know the "Q Code." Q.S.L.? means "can you give me acknowledgment of reception," whilst Q.S.L. means "I am receiving you." It is customary amongst amateur transmitters and operators generally to acknowledge the reception of a signal by sending a "Q.S.L." card. We are following the practice, and are sending a card, reproduced above, as acknowledgment of every report of reception of G9 A.E.D., i.e., the "Belling Lee" experimental band III T.V. transmitter on the I.T.A. site at Beulah Hill, Croydon.

We would like the report to give the following information, name and address, type of aerial, nearest higher ground, height of aerial, type of receiver, interference (a) ghost (b) ignition. Sensitivity setting, picture quality, better/equal/worse combined with band I. Date and time of observation.

The hundreds of reports already show a very healthy pattern over the whole of the service area shown by the I.T.A. map. When the I.T.A. go on the air with 60 Kw. against the "Belling Lee" 1 Kw., it will mean that everybody who received our transmitters will receive a picture about 10 times better. This will be due to the increased power and increased mast height. "Wireless World" readers will not need to be reminded that this does not mean reception at ten times the distance.

The report received at the date of going to press indicates that our suspicions and fears regarding ghosts have been justified, but the cure is easier than we thought possible, even if in our favour. Tests have been made with a band III dipole as a reference, and ghosts are received from church towers, lightning arrests, electrical pylons and countless new objects, but in most cases they can be "laid" by the use of a multi-element array.

Generalising, the coverage from G9 A.E.D. is more satisfactory than we expected, but as we are still uncertain as to the effect that roofing materials will have on higher frequencies, we are uncertain as to the ranges that are possible with indoor and loft mounting aerials. We have a reported case of reception on a "doorod" at twelve miles, but we do not attach a lot of importance to it. We believe it to be freak reception.

Advertisement of
BELLING & LEE LTD.
Gt. Cambridge Rd., Enfield, Middx.
Written 18th April, 1955

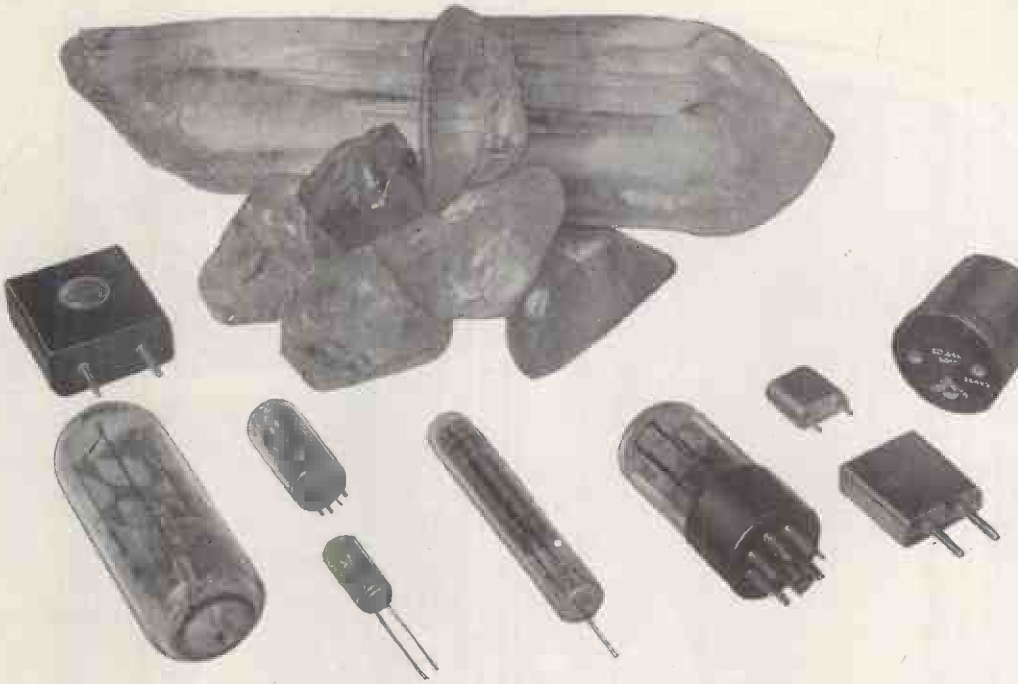
L.576 HERMETICALLY SEALED TERMINALS

750V. d.c. Working at 40,000 feet

1,500V. d.c. Working at sea level

These terminals, employing glass-to-metal seals, are made for bringing connections out of sealed transformers or other sealed components. Very useful as insulated pillars where high insulation is required. When mounted, they withstand instantaneous and repeated thermal shocks of at least 250° C., and will support at least 40 lbs. per sq. in. air pressure without leakage. They are self-capacitant 1.45 mfds. Supplied tin-plated to permit soldering with modern resin cored solders, solder pastes, or solder rings.

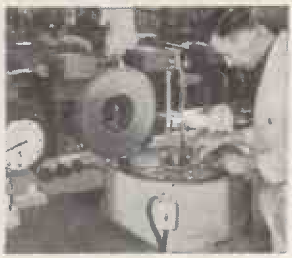
BELLING & LEE LTD
GREAT CAMBRIDGE RD., ENFIELD, MIDDX., ENGLAND



MARCONI CRYSTALS for Stability and Precision

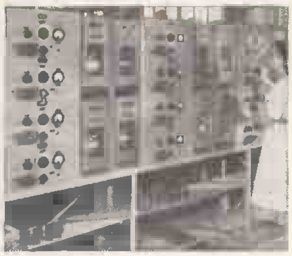
The experience gained in manufacturing quartz crystals to the stringent requirements of our own apparatus and those of the Services, enables us to offer a comprehensive range of crystals covering the frequency band 1.6 Kc/s to 55 mc/s. Years of intensive research and development work in this field guarantee the reliability and quality of this Marconi Product.

Surface Grinding



Planetary Lapping

Finishing to Frequency



Testing–Grid Current Recording

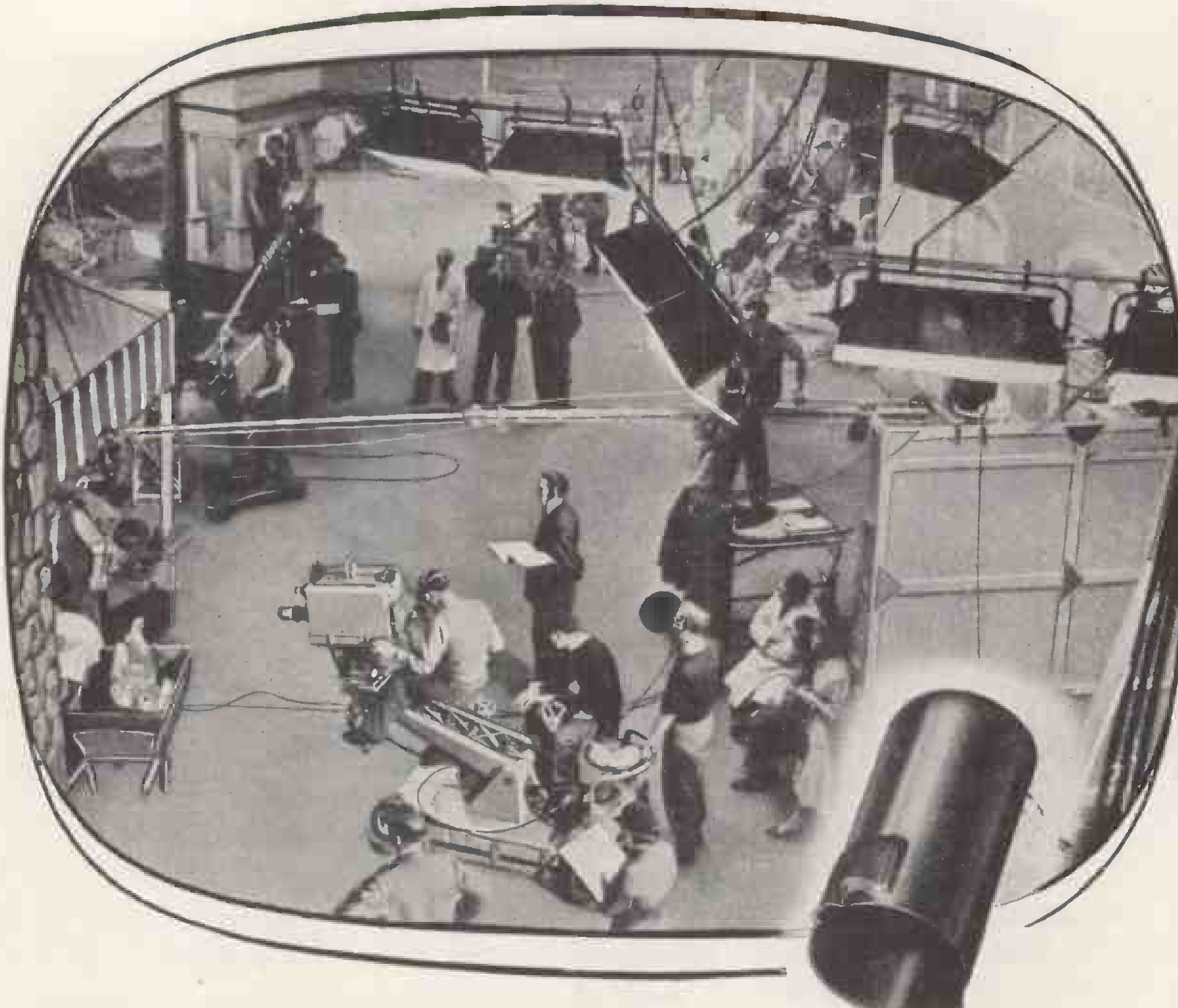
Lifeline of communication

MARCONI

Partners in progress with the **'ENGLISH ELECTRIC'** *Company Limited*

MARCONI'S WIRELESS TELEGRAPH CO. LTD., CHELMSFORD, ESSEX

CR I



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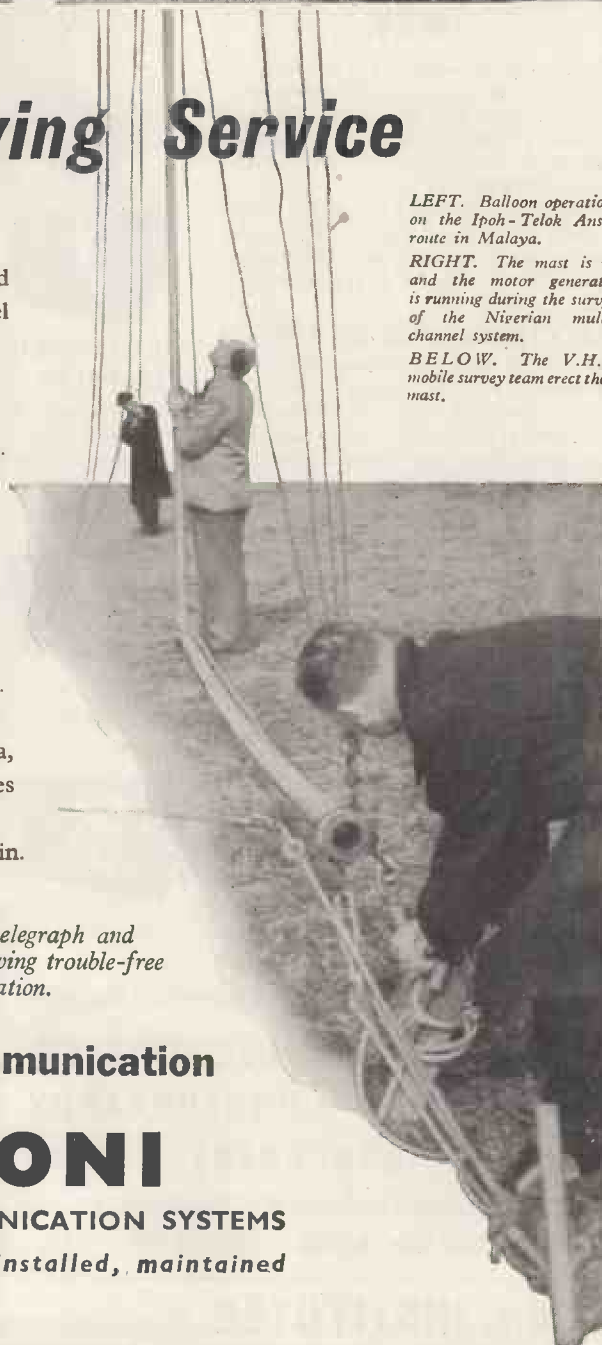
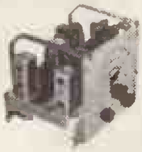


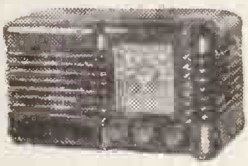
for the best equipment of its kind



GENUINE HALF-PRICE OFFER BEETHOVEN CHASSIS

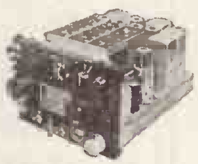
Extremely well built on chassis size approx. 9½ × 7½ × 8½, using only first-class components, fully aligned and tested, 110-240-volt A.C. mains operation. Three wave bands covering medium and two shorts. Complete with five valves, frequency changer, double diode triode, pentode output and full wave rectifier. Special cash-with-order price this month, £5/19/6, carriage and insurance 7/6.

MADE-UP—READY TO WORK



The astonishing "Occasional 55"—two wave band T.R.F.—completely assembled and ready to switch on—complete with all valves and 5in. speaker—Covers both medium and long wave bands and uses dust cored coils in a unique modern circuit which gives almost superhet performance. Price £6/5/-, plus 3/6 post—Bakelite or wooden cabinet available price 16/6, post 2/6.

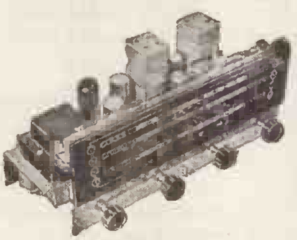
BENDIX RA-IB COMMUNICATIONS RECEIVER



Originally intended for the American Forces this fine receiver. (A small quantity of which has been released by the Ministry of Supply) is available to you if you act promptly. Designed to receive C.W. or R.T. It uses probably the finest Vernier tuning and band spreading arrangement possible, it covers the following bands:—

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

The sensitivity is 4 micro volts for full output. It uses 8 valves and operates from batteries (12 or 24 volt) or from the mains through a power pack. It has built-in outputstage with a jack socket for phones. Controls, all of which are brought to the front panel, include: aerial switch, aerial compensating condenser, main tuning condenser, band selector, C.W. switch, power on/off switch, and volume control.
Very compactly built in crackle finished case, these sets are brand new having never been used and in perfect working order—special price this month is £14/10/- each or 45/- deposit, balance over 12 months—carriage and insurance 10/-. Order now to avoid disappointment. Circuit diagram and component data given free with sets, or available separately price 2/6, post free.
Mains Power Pack for Bendix RA-1B, £3/10/-.



THE "WINDSOR 5"

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

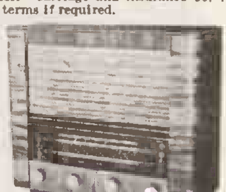
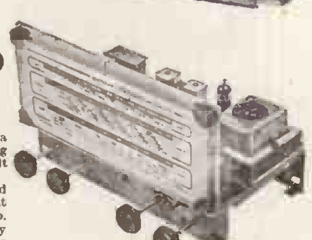


TABLE RADIO CABINET

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

THE CLEVELAND "ORGANTONE"



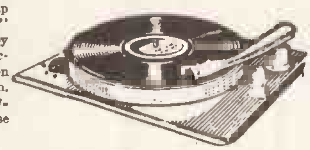
The Cleveland "ORGANTONE" is a 5-valve 3-wave band superhet covering long, medium and short wave. Built to a very stringent specification. Osram miniature valves are employed and low loss iron cored coils account for an excellent signal to noise ratio. Full A.V.C. is applied to both frequency changer and I.F. stages, and particular care has been taken to ensure freedom from frequency drift.
The output stage utilises variable negative feed back for tone control, and, but for standard pentode correction, no cut in the ordinary sense is applied. A gram. position is provided and reproduction of records is particularly good. An amply proportioned power transformer with a primary tapped for 110-280 volts gives complete isolation from the mains.
Chassis size is 12in. × 7in. × 7in.—Scale size is 10½in. × 4½in.
This receiver has been tested in particularly difficult areas and its stability and noise projection have produced exceptional results.
Price £11/10/- or £1/5/- deposit—carriage, etc., 7/6.
Circuit diagram and photograph available price 2/- post free.

ANOTHER CLEVELAND CHASSIS—"THE TREMENDO"

The first Cleveland chassis was good, but this one is really superb. It has a 7-valve circuit with 6 watts output, fitted with independent bass and treble controls. It is really an efficient R.F. circuit coupled to a high-fidelity amplifier. The chassis size is the same as the Organtone, namely 12 × 7 × 7 with the 10½ × 4½ multi-coloured scale, and it is built to the same exacting specification as the Organtone. Price £14/10/-, carriage and packing 7/6. H.P. terms if required.

RECORD PLAYER BARGAIN

3-speed record player with pick-up using the famous Acos "Hi G" turnover crystal—motor also by very famous maker—speed selection is by Bakelite knob. All on unit board ready for installation. A wonderful bargain at £6/10/- plus 5/- carriage—Hire Purchase 15/- deposit.



ELPREQ TAPE RECORDER

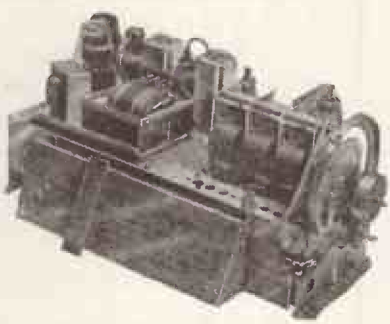
This instrument combines the Mk. IIIU Truvox Tape Deck and the Cleveland Wide Band Amplifier with a special high flux speaker and forms one of the finest tape recorder combinations available to-day. It will, of course, play pre-recorded tapes as well as make its own recordings of radio, music, meetings, telephone conversations, letters, etc. The price, complete with reel of tape and ready to operate, is

39 Gns.

Carriage and insurance 12/6. Hire Purchase terms if required.

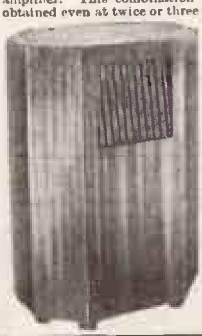
10/- SECURES THIS BARGAIN

The set, a product of one of our famous manufacturers, has H.F. stage, tuning indicator, and all modern refinements, covers 5 wavebands including short waves to 11 metres. Offered less valves, power-pack, scale and drive, otherwise complete and unused. Price £5, or 10/- deposit, balance over 12 months, carriage 7/6 (uses octal range valves).



THE CLEVELAND OCTAVIAN

In this instrument is combined the exceptional qualities of the G.E.C. metal cone loudspeaker in its ideal cabinet (the Octagonal illustrated below) and a most modern 3-valve amplifier. This combination will give a realism of musical reproduction not easily obtained even at twice or three times its price and is definitely the reproducer for bringing out the full frequency now available in long playing microgroove recordings. If you can, please come to one of our branches and hear this fine instrument—failing this, then take our word that it is really good and send an order today. Price 27 guineas or £4/10/- deposit, balance over 12 months. Amplifier available separately at £10/10/-.



OCTAGONAL SPEAKER CABINET

Conforming exactly to the designer's specification—for G.E.C. metal cone speaker—price £12/10/- or 37/6 deposit, carriage and insurance 5/- extra. G.E.C. metal cone (extra octave) speaker £8/15/-

ELECTRONIC PRECISION EQUIPMENT LTD.

249, Kilburn High Road, Kilburn. (Now Open)	**42-46, Windmill Hill, Ruislip, Middlesex.** Phone: RUISLIP 5780 Half-day Wednesday.	152-153, Fleet Street, E.C.4. Phone: CENTRAL 2833 Half-day Saturday.	29, Stroud Green Road, Finsbury Park, N.4. Phone: ARCHWAY 1049 Half-day Thursday.

Post orders should be marked "Dept. 2" and addressed to our Ruislip dept.

RADIO TRADERS LTD.

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$4\frac{1}{2}$ v. Heavy Duty Bell Battery. Size $6\frac{1}{2}$ x $4\frac{1}{2}$ x $2\frac{1}{2}$in.	4/6
72 v. H.T. 1.5 v. L.T. Size 6 x 5 x $1\frac{3}{4}$in.	5/6
150 v. H.T. Size $2\frac{7}{8}$ x $5\frac{1}{2}$ x $1\frac{1}{8}$in.	5/6
$67\frac{1}{2}$ v. Size $2\frac{3}{4}$ x $1\frac{3}{8}$ x $3\frac{3}{4}$in.	6/6

All batteries sealed and unused. All plus 1/6 post and pkg. Special reduction for quantities.

ELECTROLYTIC CONDENSERS	Per doz.
16 mfd. 375 v., 2/- each	21/-
16 x 16 mfd. 350 v. 3/6 each	39/-
16 x 24 mfd. 350 v. 2/6 each	27/-
16 x 32 mfd. 275 v. 1/6 each	15/-
20 x 20 mfd. 275 v. 2/3 each	24/-
24 mfd. 350 v. 1/6 each	15/-
24 mfd. 450 v. 2/3 each	24/-
Condenser Clips for above	3/6

BIAS CONDENSERS

50 mfd. 12 v. Single Hole Fixing 1/- each	10/6
100 mfd. 6 v. Tag End 10d. each	9/-
100 mfd. 25 v. Tag End 1/3 each	12/-

BLOCK PAPER CONDENSERS
4 mfd. 400 v. D.C. 3/6 each. Many other types in stock. Your enquiries invited.

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200 Assorted Silver Micas. Popular Values	£2 10 0
200 Assorted Carbon Resistors: $\frac{1}{4}$, $\frac{1}{2}$ and 1 watt. Good selection	£1 10 0

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0.1 mfd. 12,000 volts test Mansbridge Condensers. Height $6\frac{1}{2}$in. Width $3\frac{1}{2}$in. Depth $2\frac{1}{4}$in. Fixing Centres 4in. Plus 1/- post 5/6

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18 x $4\frac{1}{2}$ x 1/16in., 1/- each; 10 x 10 x 1/16in., 1/6 each; 20 x 10 x 1/32in., 1/6 each; 20 x 10 x 1/16in., 3/- each.

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

WESTINGHOUSE KH1 Half-wave Rectifier, rating 6 v. at 10 mA., 2/6 each ...... 27/6 doz.

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

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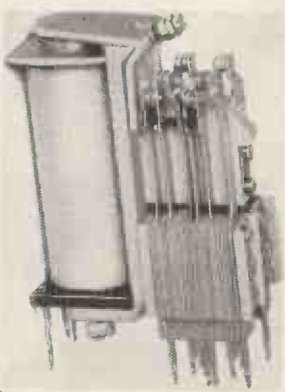

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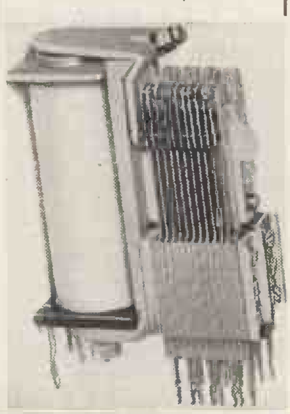

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Whether new or used, it is all guaranteed to be in perfect condition

TS-13/AP
PORTABLE SIGNAL GENERATOR

for 3CM operation with self contained Wavemeter and Power Monitor.

1. FREQUENCY RANGE
For general use 9375 ± 70 mc/sec. Freq. sensitivity of power monitor ± 1 db in range 9375 ± 70 mc/sec. Freq. sensitivity of calibrated attenuator ± 2 db from − 13 dbm to − 65 dbm in above frequency range.

2. FREQUENCY STABILITY
Sawtooth Operation. Frequency modulation of approximately 0.1 mc/v. *Thermal Drift.* Set stabilizes after approximately 3 minutes warm-up. *Frequency Stability.* Wavemeter calibration changes within limits listed below:

Temp. (°F.)	Limits (dial div.)
60	− 3 and + 1
75	− 2 and + 2
90	− 1 and + 3

3. VARIATION OF ATTENUATOR
The attenuator is individually calibrated to be accurate to ± 2 db at approximately 75°F.

4. PULSE CHARACTERISTICS
Triggered Operation. Positive trigger required:—Not less than 15 v., 1–20 microseconds.
Negative trigger required:—Not less than 50 v., 5–20 microseconds (repetition rate 350–4000 c.p.s.). Pulse width:—Continuously variable

4 (*contd.*).—from less than 1 to greater than 2 microseconds, measured at half power points. Pulse phasing:—From 6 microsecs. minimum to 200 microsecs. maximum.
Self Synchronous Operation. Recurrence rate:—1000 c.p.s. ± 20%. Duty cycle:—Between 20 and 60%.

5. TYPES OF OUTPUT
Triggered operation with variable width, phaseable pulse output, self synchronous operation with short and long pulse output (square wave), CW, and FM (with sawtooth input).

6. PEAK POWER OUTPUT (CW) (Pulsed Modulated)
At least 50 microwatts for 1/2 of full scale of meter deflection. Peak power within 10% of CW power.

7. POWER LEAKAGE
Insufficient to interfere with normal operation.

8. SWITCHES AND FUNCTIONS
POWER-ON/OFF. Line switch.
CALIBRATE/USE. CW output in CALIBRATE position, permitting monitoring of output power. Triggered or self synchronous pulsed output in USE position.
PULSE/SQUARE WAVE. Selection of triggered or self synchronous operation.
SYNC/SELF SYNC. Pulsed output in synchronism with input trigger of 350 to 4000/sec. recurrence rate or Self synchronous square wave operation at approx. 1000 c.p.s. ± 20% recurrence rate.

RECEIVERS · KLYSTRONS · MAGNETRONS

U.S.A. type. APR4 Receiver complete. 30–1,000 Mc/s., APR5 1,000–6,000 Mc/s.
Klystrons 723/AB 3 cm. 707A, 707B, 2K28, 2K33 (1.5 cm.) CV129.

Magnetrons. 725A, 2J32, 2K33, 2K25, 2J36, 2J39, 2J54, 2J22, TR cells 1B24, and many other items of equipment covering HF, VHF, UHF and centimetric bands.

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No technical manuals for sale. Please write for prices.
TS45 3CM Signal Generator. **TS3.** S band power frequency meter. **TS13.** X band signal generator. **TS14.** S band signal generator. **TS120.** X band pulsed signal generator. **TS34.** Radar Synchroscope. **TS36.** X band power meter. **TS69.** 300-100 Mc/s. frequency meter. **TS127.** 300-700 Mc/s frequency meter. **TS174** (V.H.F. version of BC221) 20-250 Mc/s. **TS175.** 80-1,000 Mc/s. **GENERAL RADIO** type 804B. 8-300 Mc/s. signal generator.
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BRITISH TEST EQUIPMENT

AVO Model 7 as NEW, £15. Model 40, £12. A.C./D.C. minor, £6/15/-. AVO electronic test meter, £30. Roller panel valve testers, £12. Wide range signal generator, £22. AVO valve characteristic meter, £50. AVO signal generator, £9. Taylor 65C signal generator, £13. 90A test meter, £10. 260A TV Wobbulator, as NEW, £30. Evershed Wee meggers 500 v., £14. Bridge type and others in stock. Cossor Double Beam oscilloscope, type 339 from £35. Mullard Valve Tester, complete with cards, £50.

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for the following receivers:
AR88D-LF, AR77E, Marconi CR100, S20, S20R, SX24, SX28, R107. B2 Transmitter/Receiver, H.R.O.s Photostatic copies of originals £1/7/6, each.

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125 kc/s-20 Mc/s. Complete with calibration charts.
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Frequency range. 16-150 Mc/s.
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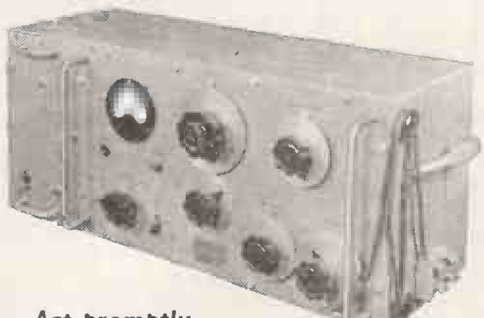

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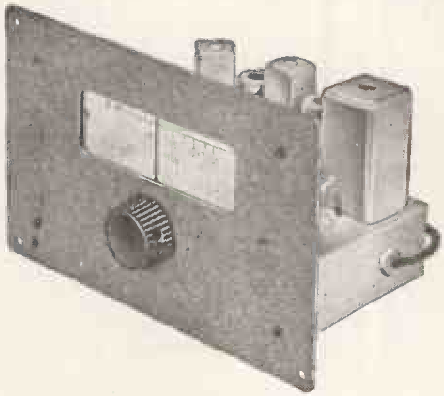

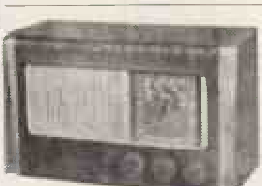

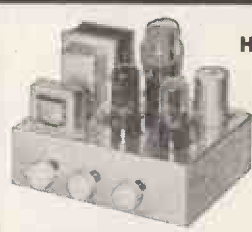

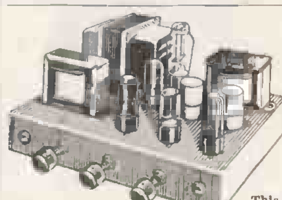

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TYPE C.2. Band 3 Converter. Providing instant choice of four T.V. programmes—B.B.C. (Band 1) and three programmes in Band 3. 10 gns.

Plus 3/- post and pkg.

THESE self-contained tuner units have their own power supply and are very simple to fit. Place your Order today—delivery approximately 3 weeks.

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Terms of Business C.O.D. or C.W.O.

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2in., 2½in. and 3½in. enclosed in cases of black moulded insulating material and provided with scales printed in black on matt white enamelled metal dials.

Available as Ammeters, Voltmeters, Milliammeters and Microammeters.

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Types H.C.8 & H.C.10

For use with high quality 8″ and 10″ loudspeaker units

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Right: Traditional Design

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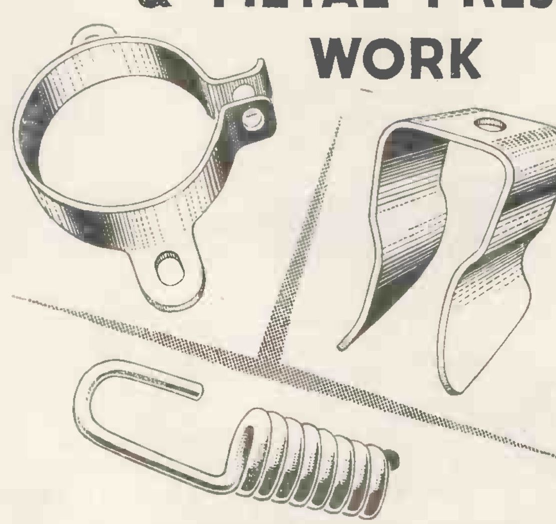
Superior SPRINGS, WIREWORK & METAL PRESS WORK



The HEATH SPRING & NOTION Cº Lᵀᴰ
HEADLESS CROSS, REDDITCH, ENG.
Telephone REDDITCH 861 - 862

!! Home Constructors !!

YOU CAN ASSEMBLE The Stern's "Fidelity" TAPE RECORDER FOR ONLY £40

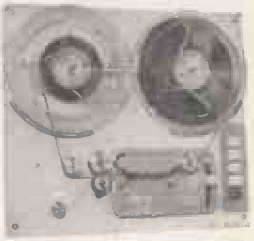
H.P. Terms are shown below.

!! IT ONLY NEEDS CONNECTING UP !!

We are completely satisfied that this Tape Recorder, although supplied at a Genuinely low price, provides absolute Fidelity Recordings and, in addition to being completely dependable, has a performance at least equal to recorders marketed at a far higher price. The actual assembly of the Tape Recorder is extremely simple and only involves a few connections. The Truvox Tape Deck and the Quality Amplifier are supplied tested and ready for use, and all that is required to complete the Recorder is to connect the two together (a connection chart is supplied for this purpose) and secure them by the screws provided into the Attache Case. The items illustrated and described below form the complete equipment.

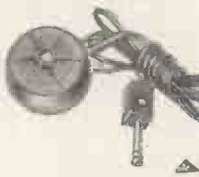
- WILL TAKE ALL STANDARD TAPES UP TO 1,200ft.
- WILL PLAY THE NEW PRE-RECORDED TAPES
- WILL PROVIDE 2 HOURS' PLAYING AT 3¾in. or 1 hour at 7½in. per second.
- INCORPORATES AN ELLIPTICAL P.M. SPEAKER 7in. × 4in., with EXTENDED FREQUENCY RANGE.

SEND S.A.E. FOR DESCRIPTIVE LEAFLET.



THE NEW TRUVOX MODEL TR7U TAPE DECK

THE NEW TRUVOX MODEL TR7U TAPE DECK. 3 Shaded-Pole motors. Drop-in Tape Loading. Push Button Control. Separate Push Button Brake. Fast forward and fast-reverse. Silent drive eliminating Wow and Flutter. Half Track working and 2 speeds, 3¾in. and 7½in. per sec. Positive Azimuth Adjustment. Overall size only 14¼in. × 12¾in.

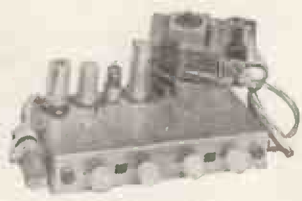


ACOS CRYSTAL MICROPHONE MODEL MIC-33-1. A highly sensitive mike which accurately matches the input arrangement of the amplifier.

SCOTCH BOY MAGNETIC RECORDING TAPE. Supplied with a 1,200ft. reel of Scotch Boy plastic tape famous for its true brilliant quality. The Recorder will take all standard makes of tape.

MODEL T.R.I./F. QUALITY AMPLIFIER

This amplifier has been expressly designed to meet the requirements of enthusiasts for fidelity reproduction, and in particular to CORRECTLY operate the above TRUVOX DECK. It is supplied complete with a matched Elliptical 3 ohm P.M. Speaker, it incorporates an efficient Tone Control arrangement and has a Magic Eye Level Indicator (Operative on Record). In addition it can be used as a general purpose Amplifier for high quality reproduction of gramophone records direct from a Gram Unit.



PORTABLE ATTACHE CASE

This, as may be judged from the illustration opposite, is a neat, compact and attractively finished case, being covered with maroon rexine and having an ivory coloured speaker escutcheon. It contains concealed pockets to accommodate the Microphone, Mains Lead and a spare 1,200ft. reel of tape.

GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS)

PRICE SUMMARY

WE WILL SUPPLY ALL FIVE UNITS LISTED ABOVE, i.e., THE COMPLETE BUT UNASSEMBLED RECORDER FOR £40/-/-. H.P. Terms: Deposit **£10** and 12 monthly payments of **£2/15/10** or in two parts as follows:—

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK MODEL TRIF AMPLIFIER WITH SPEAKER, 1,200ft. REEL OF TAPE..	£33 10 0	£8 10 0	£2 6 8
	See note below re packing charge		
(b) ATTACHE CASE AS ILLUSTRATED ACOS CRYSTAL MICROPHONE ..	£6 10 0	—	—

NOTE: Please send 30/- to cover cost of packing, carriage and insurance. We will refund £1 if the packing case is returned to us intact.

EACH UNIT IS AVAILABLE SEPARATELY AS FOLLOWS:

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK	£23 2 0	£5 17 0	£1 12 4
(b) AMPLIFIER MODEL TRIF WITH SPEAKER	£14 14 0	£4 16 6	£1 0 5
(c) PORTABLE ATTACHE CASE	£5 0 0	—	—
(d) ACOS CRYSTAL MIKE "33"	£2 10 0	—	—
(e) REEL OF TAPE 1,200ft.	£1 15 0	—	—

Please include £1 when ordering (a) or (c) for packing charge, this whole amount will be refunded if case is returned to us intact.

IT CAN BE SUPPLIED COMPLETE *and* READY FOR USE *for* £50

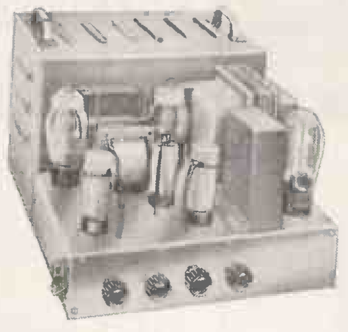
(as illustrated above).

FOR USE ON A.C. MAINS. H.P. Terms: Deposit £12/10/- and 12 monthly payments of £3/10/-. Including MIKE and 1,200ft. REEL of TAPE.

STERN RADIO LTD.

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

A NEW DESIGN FOR 1955



HIGH GAIN "PUSH PULL OUTPUT." BUILT-IN PRE-AMP. TONE CONTROL STAGES. INCLUDES 7 valves, sectionally wound output transformer, block paper reservoir condenser, and reliable small components. AN INPUT OF ONLY 20 millivolts IS REQUIRED FOR FULL OUTPUT. THIS MEANS THAT ANY TYPE OF MICROPHONE OR PICK-UP IS SUITABLE. Two separate inputs controlled by separate volume controls allow simultaneous use of "Mike" and Gram., or Tape and Radio, etc., etc. Individual controls for Bass and Treble "lift" and "cut" Six negative feedback loops giving total of 24 D.B. Frequency response ± 3 D.B. 30-20,000 c/s. Hum level 66 D.B. down. Certified total harmonic distortion of only 0.35% measured at 10 watts. Comparable with the very best designs. SUITABLE FOR SMALL HOMES OR LARGE HALLS, CLUBS, GARDEN PARTIES, DANCE HALLS, etc., etc. For ELECTRONIC ORGAN OR GUITAR. For STANDARD OR LONG PLAYING RECORDS. Size 12 × 10 × 9in. For mains A.C. 200-250 v. 50 c/s. Power consumption 175 watts. Outputs for 3 and 15 ohm speakers. The kit is complete in every detail. Chassis is fully punched. Easy to follow point-to-point wiring diagrams are supplied. EXTRA HIGH SENSITIVITY, HIGHEST QUALITY for **9 Gns.** Or assembled ready for use 50/- extra

H.P. Terms on assembled units. Deposit 26/- and 12 monthly payments 20/-. Plus carr. 10/-
Terms to include cover, mike, speakers, etc., on request. Cover as illustrated if required, price 17/6 extra.

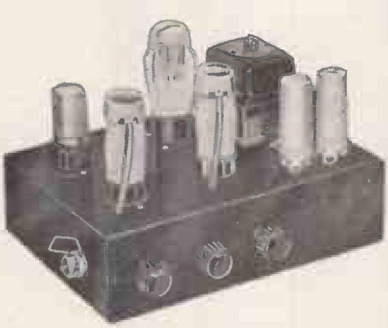
W.B. "STENTORIAN" High fidelity P.M. Speaker HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required we highly recommend this unit with an amazing performance. £3/17/6.

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

PLESSEY 3-SPEED MIXER AUTOCHANGERS with crystal pick-up having alloy stylus with separate sapphire points for long playing or standard records. (Will play 2,000 records before replacement stylus required). Brand new, cartoned, guaranteed. For 200-250 v. A.C. mains. Limited stocks at only 10 gns. plus 5/- carr.

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

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



A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads, in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 25 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate), with green crackle finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 30/- extra, plus 3/6 carr.

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

DEFIANT RECORD PLAYING TURNTABLE COMPLETE WITH PICK-UP.

(High Impedance Magnetic Type). Unit is housed in a beautiful walnut veneered cabinet of attractive design. For all standard records (78 r.p.m.). Limited number. Brand new, cartoned £5/19/6. Carr. 5/-.

A PUSH PULL 3-4 WATT HIGH GAIN AMPLIFIER FOR £3/7/6.

For mains input 200-250 v. 50 c/s. Complete kit of parts including point-to-point wiring diagrams and instructions. Amplifier can be used with any type of feeder unit or pick-up. This is not A.C./D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 2-3 ohm speaker. (We can supply a very suitable 10in. unit by Rola at 27/9). The amplifier can be supplied ready for use for 25/- extra. Full descriptive leaflet, 6d.

R.S.C. MASTER INTERCOMM. UNIT. with provision for up to 4 "Listen-Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are supplied. A walnut veneered wood or Brown Bakelite cabinet is included. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHASSIS IS NOT "ALIVE." Ideal for use as "Baby Alarm." Sound amplification 4 watts. Price only £5/19/6. "Listen Talk Back Unit" in bakelite or walnut veneered cabinet, can be supplied at 35/- each. The Master Unit can be supplied assembled and tested for 30/- extra.

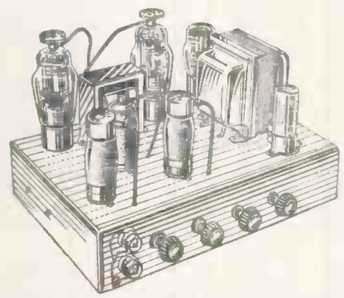
ALL DRY RECEIVER BATTERY SUPERSEDER KIT

All parts for an "All Dry" Battery Eliminator. Complete with case. Completely replaces 1.4 v. and 90 v. batteries where normal mains supply of 200-250 v. 50 c/s is available. Price with circuit, 38/9. Or ready for use. 45/6. Size of unit 5¼ × 4½ × 2½in.

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

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

With Self Contained Pre-amplifier and Tone Control.



This amplifier, whilst having sufficient output to fill a small hall, is the ideal amplifier for the quality enthusiast who knows that though the average listening level is less than one watt it is necessary, for the very highest quality to have an output of at least ten times this figure in order to obtain completely distortionless reproduction of sudden loud sounds.

The layout of the components has been planned to give the very maximum of performance with the minimum of constructional effort. Large safety factors in every component A.C. and H.T. fuses, punched chassis with baseplate, screened input plugs, valves, and with easy-to-follow point to-point wiring diagrams. Everything is supplied down to the last nut and bolt.

Two independent inputs are provided with two associated independent volume controls so that programmes can be mixed together if desired, such as microphone announcements superimposed on a musical programme, or two independently controlled microphones, or even just gramophone/radio, fading over from one to the other. Variable base lift and cut with variable treble lift and cut tone controls are fitted, giving full long playing record equalisation for uncorrected pick-ups. They are also provided so that the user can alter the tonal value to suit his personal taste and surroundings. Because of the large negative feedback employed the output transformer can be so designed that it provides all the specified power even with large variations of loudspeaker impedance. Terminals are provided for 3 ohm and 15 ohm loudspeakers.

H.T. and L.T. available for the supply of a Radio Feeder Unit.

- Six Negative Feedback Loops.
- 130 millivolts input only required for full output.
- Frequency response + 3 DB 50-20,000 cycles.
- Negligible hum and distortion.
- For A.C. mains input 200/230/250 v. 50 c/s.

COMPLETE Kit of Parts **7 GNS.** (carriage 5/-)
Supplied assembled and tested for 45/- extra.

H.P. TERMS AVAILABLE ON ASSEMBLED UNITS

FOUR STAGE RADIO FEEDER UNIT.

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

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS, 2.

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

THE R.C. 3/4 WATT AMPLIFIER KIT.—Just released! Compare the advantages! Treble, bass, AND middle tone controls! For crystal or magnetic pickup! A.C. Mains. 200/250 v Valve line-up, 6V6GT, 6SG7, metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 4in. × 1½in. Four engraved cream knobs are included in the price of the complete Kit with all necessary practical and theoretical diagrams, at £4/5/- only, plus 2/6 packing and post, or Instruction Book, fully illustrated, for 1/-, post free! This amplifier can be supplied assembled, tested, and ready for use at £5/5/-, plus p. & p. Hearing is believing!

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

THE NEW R.C. HIGH-FIDELITY AMPLIFIER. P.P. 6V6 output. Freq. 25—18,000 cps—60 db at 6½ watts. Treble boost and cut—Bass boost—L.P. correction. Provision for Feeder Unit Max. UNDISTORTED OUTPUT 9½ watts. Price 14 gns. plus 7/6. NOW AVAILABLE—Kit of Parts, complete with fully illustrated instructions, £11/19/6, plus 5/- carriage. Illustrated booklet available separately at 1/6. Attractive metal cover, now available, with built in carrying handle 19/6.

We have in stock at our usual competitive prices, ALL the required components for Osram and Mullard amplifiers. Available ex. stock. The LEAK TL10 Amplifier complete. 27 guineas, or H.P. terms available.

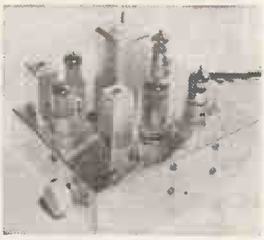
We also have in stock—Connoisseur 3 speed motors, pick ups. Pick ups and heads by Garrard, Decca, Collaro, Acos, Chancery, etc., etc., at current prices.

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

OUR NEW "POPULAR" AMPLIFIER. A.C. Mains 2/3 ohms, 4 watts output. Suitable for either crystal or magnetic pick-up. Valve line-up, 6V6GT, 6SL7GT, 5Y3GT. Provision for radio feeder unit. Volume and tone controls. Built in crackle-finished steel box, with chrome carrying handle. Attractive bakelite engraved front panel. Box measures 9½in. × 7½in. × 6½in. Price only £6/12/6 carriage paid. Ready for use.

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

F.M.!! (Frequency Modulation)

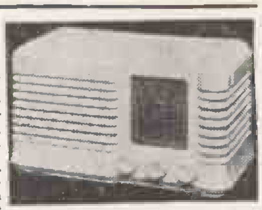


We are pleased to announce our complete Kit for the "Denco" F.M. Feeder Unit.
This unit provides an A.F. output suitable for feeding into the audio section of a standard broadcast receiver where triode/pentode output are available. Within an average of 30 miles from a V.H.F. transmitter one I.F. stage should be adequate, but our complete Kit supplied includes all components and valves for an extra I.F. stage if necessary, or if the unit is used at greater distances. Full Constructional details, theoretical circuit and point-to-point wiring diagram can be supplied for 1/6 post free, or the complete Kit right down to the last nut and bolt, at only £6/7/6, plus 2/6 packing and postage. This unit can be supplied if desired, ready assembled, aligned and tested, at £8/10/-. plus 2/6 packing and postage.
If required we shall be pleased to align this unit for constructors not possessing the necessary equipment, for a charge of 7/6. N.B.—Valve line-up is 6AM6, 12AH8, 2-6BA6 and 6AL5. Chassis measures only 6¾ × 5¼ × 1½in.
Demonstrations at 18, Tottenham Court Road!!

THE "SUPERIOR" FOUR KIT. Our new four-valve receiver. A.C. mains. 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6SG7, 6X5GT and 6V6GT. Chassis ready drilled. Cabinet size, 10½in. × 10in. wide. Maximum depth at base 5in. tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided Booklet. available at 1/6, post free. Our price for complete kit, £6/9/6!!! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wavechange switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at 45/-, plus 2/6 packing and carriage.
N.B.—Our kits are even supplied with sufficient solder for the job.

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

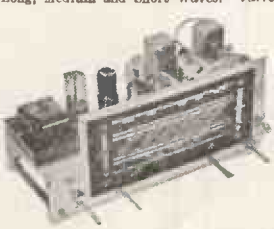
THE "ECONOMY FOUR" T.R.F. KIT



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

THE R.C. GRAM REPLACEMENT CHASSIS KIT

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



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

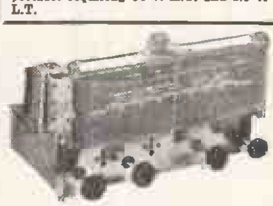
Dulci Radio/Radiogram Chassis. All latest models including F.3 and F.3 push-pull are in stock. Cash or H.P. Ask for illustrated leaflet.

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

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

THE R.C. RAMBLER ALL-DRY PORTABLE KIT
Full assembly details with practical and theoretical diagrams can be supplied at 1/6 post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, adds to the very imposing appearance of this model which is housed in an attractive cream and greyleatherette covered attache-case type cabinet; measuring only 9in. × 7in. × 5½in. Weight less batteries, 4¾lb. with batteries 6¾lb. This set really has everything! Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up: 3V4, 1R5, 1S5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of £7/7/- plus 2/6 p. & p. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at 9/3. Also L.T. 1.5 v. A.D.35 at 1/4.

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



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

REGAL. A well-made cabinet in medium coloured walnut veneer. Size 29½ × 14½ × 29½in. Uncut motor-boardmeasures 25½ × 13½in. Record or tape storage aperture alongside motor board measures 3½in. wide × 12in. deep. Price £9/19/6 plus 10/- P. & P. H.P. terms available.

CLYNE RADIO LTD.
18, Tottenham Court Road, London, W.1.

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

LASKY'S RADIO

HIRE PURCHASE

terms on certain items. Please give details of your requirements.

BUILD THE "TELE-KING"

5 CHANNEL, 16in. or 17in. SUPERHET TV Full constructional data, wiring diagrams, circuit and detailed price list. Post free. **6/-**
Every component supplied separately.

SPECIAL PURCHASE 16" C.R. TUBES

Famous make offered at nearly Half-Price. Metal cone, .3 amp. heater, e.h.t. required 10-14 kV.
LASKY'S PRICE Carr. & Ins. 22/6 ex. **£12/19/6**
16in. FILTER MASK ESCUTCHEON to suit above C.R.T., 15/-. Post extra.

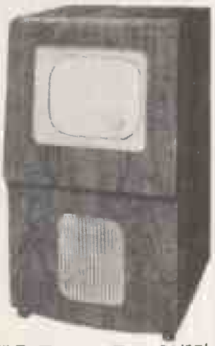
VALUE IN MAGNIFICENT TV CABINETS

THE DE LUXE

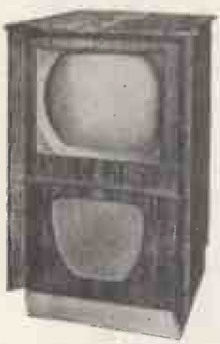
Complete with mask, glass, castors, shelf, bearers, C.R.T. neck end protector, back, speaker fret and baffle board. Finished in beautiful figured medium, light or dark walnut veneer, with high polish. Suitable for most home constructor TV Receivers, including the "Viewmaster," "Practical Television," "Tele-King," "Magnaview," "Wireless World" etc. Can be supplied with cut-out for 14in., 16in. and 17in. C.R. tubes at no extra cost.

An allowance of 4/6 will be made if the mask is not required.
Inside Dimensions: Depth 16½in.; width 17¾in.; height 28in. Overall height 32in. and width 18½in.

WHY NOT CONVERT YOUR TABLE RECEIVER TO A CONSOLE MODEL?
Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.
LASKY'S PRICE Carriage 12/6 extra. **£8/10/0**



H.P. Terms. Dep. £2/17/- plus carriage. Balance plus charges spread over 12 mths.



The Rothesay cabinet with doors. Price £14/9/6.

THE ROTHESAY

The last word in outstanding contemporary design. Absolutely rigid construction throughout with the finest laminated woods, veneered in walnut, polished light, medium or dark shade. Fitted with gold anodised speaker grille. The C.R.T. aperture frame is detachable, supplied to suit any size tube to order. Full length doors if required can be supplied with the cabinet. Veneered both sides, polished to match the cabinet, and mounted with full length piano hinges.

NOTE THESE GENEROUS SIZES. Outside dim. 34½in. high, 21⅞in. wide, 21½in. deep. Inside dim. 18⅞in. wide, 19½in. deep. Size of top 22½ × 21⅞in. Thickness ⅜in.
LASKY'S PRICE Carriage 15/- extra. **£9/19/6**
H.P. Terms. Deposit £3/10/- plus carriage charge. Balance plus charges spread over 12 months.

SPECIAL PURCHASE OF TABLE RADIOGRAM CABINETS

Solidly made of ½in. laminated wood, finished beautiful Walnut veneer. Panel (3in. × 16in.) for dial and controls, baffle for 8in. speaker, gold finish metal grille, fully hinged lid. Overall size: 18in. deep, 18in. wide, 13in. high. Slightly soiled. **LASKY'S PRICE** Carriage 7/6. **£3/19/6**

Cabinet complete with Collaro 3-speed Autochange and dual-purpose crystal pick-up. Brand new. £14/19/6. Carriage 12/6.

MAINS TRANSFORMERS.

All 200-250 v. 50 c.p.s. primary finest quality, fully guaranteed.
MBA/3. 350-0-350 v. 80 mA. 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 volts. 18/-.
MBA/6. 325-0-325 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. 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. 18/-.
MBA/8. Drop through type. 235-0-235 v. 60 mA. 6.3 v. 3 a., 12/6.
MBA/9. 400-0-400 v. 60 mA. 6.3 v. 1 a., 4 v. 2.5 a. 12/6.
AT/3. Auto trans. 0-10-120. 200-230-240 v. 100 watts. 17/6.

ALUMINIUM CHASSIS. 18 S.W.G., undrilled, 4 sides, reinforced corners Depth 2½in.

6 x 4	4/-	12 × 8	7/-	16 × 10	8/3
8 x 6	5/-	14 × 9	7/6	12 × 3	4/9
10 x 7	6/-	16 × 9	8/-	12 × 6	6/6

Post 1/- per chassis extra.

THE "UNIVERTER"

A new book just published, giving full details of a new Band III Converter for any TV receiver, home constructed or factory made. All components and valves in stock, prices on request. Also available as a complete unit. Uses two 6AM6, one 12AT7, one 6X4. Contains its own power supplies. THE BOOK, containing full circuit diagram, wiring instructions and component lists. 3/6 post free.

MICROPHONE BARGAINS

ACOS crystal, MIC.33/1. List 50/-. Lasky's price 32/6.

MIC.22/2, complete with table stand. List 4 gns. Lasky's price 42/-.

Moving Coil Hand Type with switch. List £5/5/-. Lasky's price 45/-.
All above, post 2/6.

MANUFACTURERS' SURPLUS

WIDE ANGLE 38 mm.

Line E.H.T. trans., ferroxcube core. 9-16 kV....	25/–
Scanning Coils, low imp. line and frame........	25/–
Frame Output Transformer	10/6
Scanning Coils low, imp. line and frame........	17/6
Frame blocking, osc. transformer	4/6
Line Blocking osc. transformer, caslam cored..	4/6
Focus Magnets Ferroxdure	25/–
P.M. Focus Magnets. Iron Cored	19/6
Duomag Focalisers......	29/6
300 mA. Smoothing chokes	15/–
Electromagnetic focus coil, with combined scan coils	25/–

TV COMPONENT BARGAINS

STANDARD 35 mm.

Line Output Transformers No. E.H.T. 12/6. Line Output Transformers 6-9 kV. E.H.T. and 6.3 v. winding. Ferroxcube	19/6
Scanning coils. Low imp. line and frame........	12/6
Scanning Coils. Low imp. line and frame, by Igranic	14/6
Line blocking oscillator transformer	4/6
Frame blocking oscillator transformer	4/6
Frame output transformer	7/6
Focus Magnets: Without Vernier	12/6
With Vernier	17/6
Focus Coils, Electromagnetic	12/6
200 mA. Smoothing chokes	10/6

★ THE MULLARD 5/10 AMPLIFIER KIT

All components, chassis and valves in stock. Available separately. **THE BOOK, 2/6, post free.**

★ THE OSRAM 912 AMPLIFIER KIT

All components in stock. Chassis, Partridge trans., chokes, W/B., etc. Available separately. **THE BOOK, 3/6, post free.**

PRINTED CIRCUITS (by T.C.C.) for the MULLARD 5/10 and OSRAM 912 Amplifiers now available. Demonstration models of these famous amplifiers built on printed circuits can be seen and heard at our Tottenham Court Road premises.

LOUDSPEAKERS

12in. Plessey, 3 ohms....	32/6
10in. heavy duty, aluminium speech coil, 3 ohms	26/6
P.M. Speakers: 6½in., 17/6; 8in., 19/6; 10in.	19/–

Goodmans "Audium 60," 15-watt, few only. Listed £8/12/6.
LASKY'S PRICE £6/19/6.

OUTPUT TRANSFORMERS

Midget Pentode	3/6
Miniature Personal, 3S4, etc.	3/6
Standard Pentode	3/11
Push-pull, 6V6	9/6
Multi Ratio, P.P........	12/6
Heavy Duty P.P.........	14/11

R1155 RECEIVERS

Now available on H.P. terms

5 Frequency ranges: 18.5-7.0 Mc/s; 7.5-3.0 Mc/s; 1,500-600 kc/s; 500-200 kc/s; 200-75 kc/s. Supplied in maker's original wood transit case.

LASKY'S PRICE,

Brand new	£11 19 6
Secondhand, Grade 1	£9 19 6
Secondhand, Grade 2	£7 19 6

Carriage 17/6 extra, including 10/- returnable on packing case.
Ask for details of the easy terms on which you can buy this famous receiver.

ASSEMBLED POWER PACK/OUTPUT STAGE for R.1155 RECEIVER. For use on 200-250 v. A.C. Complete with 2 valves. In metal case, size 12 × 7 × 5½in., 79/6. Carriage 5/- extra.
POWER PACK as above, fitted with 6½in. P.M. Speaker, £5/5/-. Carriage 5/- extra.

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COMMUNICATIONS RECEIVER R.1155. 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, BRAND NEW AND UNUSED IN MAKER'S TRANSIT CASES, ONLY **£11/19/6.**
BRAND NEW BUT SHOP-SOILED, also tested working before despatch, **£9/19/6** (carriage 10/6).
A.C. MAINS POWER PACK OUTPUT STAGE, in black metal case, enabling the receiver to be operated immediately, by just plugging in, without any modification. Can be supplied as follows, WITH built-in 6½in. P.M. Speaker, **£5/5/-**, LESS speaker, **£4/10/-** (carriage 3/6).
DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.
Send S.A.E. for Illustrated leaflet, or 1/3 for 14 page booklet, which gives technical information, circuits, etc., and is supplied free with each receiver.

RF UNITS TYPE 26 and 27. For use with the R.1355 or any receiver with a 6.3 v. supply. These are the variable tuning units which use 2 valves EF54 and 1 of EC52. Type 26 covers.65-50 Mc/s (5-6 metres) and Type 27 covers 85-65 Mc/s. (3.5-5.0 metres). Complete with valves, and BRAND NEW IN MAKER'S CARTONS. ONLY **29/6** each.
"PYE" 45 MC/S I.F. STRIP. Ready made for London Vision Channel, this 5-stage strip contains 6 valves EF50 and 1 EA50. Supplied with circuit and details of very slight mods. required. BRAND NEW, ONLY **69/6** or less valves, **50/-.**
TRANSFORMERS. Manufactured to our specification and fully guaranteed. Upright mounting, fully shrouded, normal primaries.
425 v.-0-425 v. 250 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a., **65/-.**
350 v.-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a., **47/6.**
350 v.-0-350 v. 150 mA., 6.3 v. 5 a., 0-4-5 v. 3 a., **37/6.**
250 v.-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., **37/6.**
250 v.-0-250 v. 60 mA., 6.3 v. 3 a., 5 v. 2 a., **21/-.**
Please add 2/- per transformer postage.
TRANSFORMERS, EHT. Upright mounting.
EHT for VCR97 Tube 2,500 v. 5 mA. 2 v.-0-2 v. 1.1 a., 2 v.-0-2 v. 2 a., **42/6.**
EHT 5,500 v. 5 mA., 2 v. 1 a., **79/6.**
EHT 7,000 v. 5 mA., 2 v. 1 a., **89/6.**
EHT 7,000 v. 5 mA., 4 v. 1 a., **89/6.**
Please add 2/- per transformer postage.
L.T. HEAVY DUTY TRANSFORMER. Has 3 separate windings of 5 v.-0-5 v. at 5 amps., and by using combinations will give various voltages at high current. ONLY **39/6.** Please add 2/6 per transformer postage.
MODEL MAKERS MOTOR. Reversible poles. Only 2in. long and 1½in. diameter, with ¼in. long spindle. Will operate on 4, 6, 12 or 24 volts D.C. ONLY **10/6.**
POCKET VOLTMETERS. Not Ex-Govt. Read 0-15 v. and 0-300 v. A.C. or D.C. BRAND NEW AND UNUSED. ONLY **18/6.**
SUNDRIES. Warning light assemblies, Red, Green, or Clear, **2/-** ea. Miniature plugs and sockets, 3 way **7d.** pair, 4-way **9d.** pair, 5-way **10d.** pair. Jack plugs, **2/-** each. ⅜in. coil formers with slug **10d.**, ½in. **8d.** Valveholders I.O. & M.O. Amphenol, **6d.** ea., B3G (diode) **6d.**, B9G ceramic **10d.**, Brit. 5-pin Ceramic **1/-**. Co-axial plugs and sockets, Pye **6d.** ea., Belling, plug **1/3**, socket **1/4**, coupler for joining cable **2/-** (post 3d. per item).
POTENTIOMETERS, less switch, long spindle, 1K, 3K, 5K, 10K, 20K, 25K, 100K, 250K, 500K, 2M, **2/9** ea., short spindle 50K, 75K, 1M, **2/-** ea. WITH switch long spindle, 1K, 2K, 2.5K, 10K, 15K, 20K, 25K, 50K, 75K, 250K, 500K, 2M, **3/9** ea. (post 3d.).
SPRAGUE .1 mfd. 600 v. metal tubulars, **10d.** ea., **9/6** dozen (add post).
SILVER MICAS AND MICAS. 2pf, 5pf, 10pf, 11.5pf, 15pf, 20pf, 25pf, 40pf, 47pf, 50pf, 75pf, 80pf, 100pf, 115pf, 160pf, 300pf, 430pf, 440pf, 1,050pf, 2,300pf, .001mfd., .00016 mfd., .0002 mfd., .00025 mfd., .001 mfd., .002 mfd., .005 mfd., **5d** each, or **3/6** per dozen 1 type.
24 v. BLOWER MOTORS. Only **12/6.**
CRYSTALS. British Standard 2-pin 500 kc/s. **15/-**. Miniature 200 kc/s. and 465 kc/s. **10/-** each.
SPEAKERS. P.M., 6½in. less trans., **19/6**; 8in. less trans., **16/6**; 10in. with trans., **27/6** (postage 2/- ea.).
CHOKES. 10H 60 mA., **4/-**, 5H 200 mA., **7/6**, 10H 120 mA., **10/6** (post 1/- ea.).

METERS

F.S.D.	SIZE AND TYPE		PRICE
5 milliamp.	D.C.	2in. Flush square	7/6
100 ,,	D.C.	2½in. Flush circular	12/6
150 ,,	D.C.	2in. Flush square	7/6
500 ,,	thermo	2in. Flush square	5/-
500 ,,	thermo	2in. Proj. circular	5/-
20 amps.	D.C.	2in. Proj. circular	7/6
40 amps.	D.C.	2in. Proj. circular	7/6
30-0-30 amp.	D.C.	Car type moving iron	5/-
15 volts	A.C.	2½in. Flush, circ., mov. iron	8/6

All meters Brand New in Maker's Cartons.

Cash with order please, and print name and address clearly.

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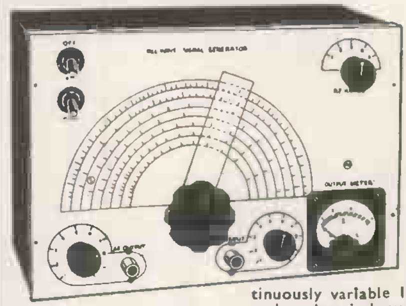
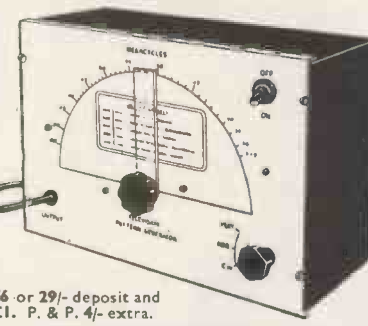
COMPLETELY BUILT SIGNAL GENERATOR



Coverage 120 Kc/s-320 Kc/s., 300 Kc/s-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s 8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s.-84 Mc/s. Metal case 10 x 6½ x 4½in. Size of scale 6½ x 3½in 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated, R.F. output continuously variable 100 milli volts. C.W. and mod. switch, variable A.F. output and moving coil output meter. Black crackle finished case and white panel. Accuracy plus or minus 2%. **£4/19/6** or **34/-** deposit and 3 monthly payments **25/-**. P. & P. **4/-** extra.

PATTERN GENERATOR



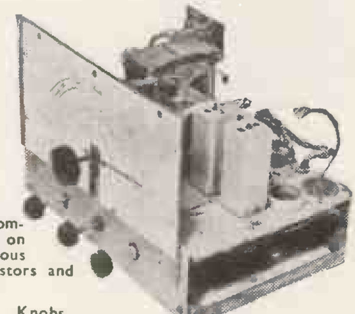
40-70 Mc/s. direct calibration, checks frame and line time base, frequency and linearity, vision channel alignment, sound channel and sound rejection circuits and vision channel band width. Silver plated coils, black crackle finished case 10 x 6¾ x 4¾in. and white front panel. A.C. mains 200/250 volts. This instrument will align any T.V. receiver, accuracy plus or minus 1%. Cash price **£3/19/6** or **29/-** deposit and 3 monthly payments of **£1**. P. & P. **4/-** extra.

EXPORT & TRADE ENQUIRIES INVITED

(N.B. Post and packing charges stated apply to British Isles only.)
★ Both generators guaranteed for 12 months ★

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

CHASSIS



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

19/6 Post & Packing 3/6 Knobs 1/6 extra.

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

USED TELEVISION TUBES WITH HEATER CATHODE SHORT
GUARANTEED FOR THREE MONTHS
6 volt heater, duodecal base: all with bent gun construction.
12in. ....**£3/17/6.** Post & Packing 7/6 extra.
9in. ....**£1/17/6.** Post & Packing 7/6 extra.
Maximum E.H.T. 10 Kv.
Any of the above complete with line and E.H.T. Trans., Ferrocart core, line and width control scan coils and frame. Output Transformer, 35/- extra.

SPECIAL NOTE: NO GOODS SENT WHERE CUSTOMS DECLARATION IS APPLICABLE

Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/6 up to 10/-, 2/- up to £1, and 2/6 up to £2. All enquiries S.A.E., lists 5d. each.

MAINS TRANSFORMERS

Primary, 200-250 v. P. & P. 2/-. 300-0-300, 100 mA., 6 v. 3 amp., 5 v. 2 amp., 22/6.

Semi-Shrouded, drop-through, 380-0-380 v., 120 mA., 6.3 v. 4 amp., 5 v., 2·5 amp., 22/6.

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

Drop thro' 250-0-250 v. 80 mA., 6 v. 3 amp., 5 v. 2 amp., 14/6.

280-0-280, drop through, 80 mA. 6 v. 3 amp., 5 v. 2 amp., 14/6.

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

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

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

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

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

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

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

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

Mains Transformer, fully impregnated, input 210, 220, 230 and 240. Sec. 600-0-600, 275 mA., and 200 v. at 30 mA., complete with separate heater transformer. Input 210, 220, 230, 240. Sec., 6.3 v. 2 amp. three times, 0, 4, 6.3 v. at 3 amp. and 5 v. 3 amp., 45/-. P. & P. 5/-.

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

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

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

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

500-0-500 250 mA. 4 v. C.T. 5 a., 4 v. C.T. 5 a., 4 v. C.T. 4 a., 39/6.

9in. T.V. Cabinet, front in contrasting walnut veneers, size 16¼in. long, 11⅜in. high, by 12½in. wide. Complete with two pieces expanded aluminium in gold 12 x 9in. and 5in. speaker baffle and chassis, 20/-, post paid.

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

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

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

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

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

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

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

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

3-gang .0005, with feet, size 4⅝ x 3 x 1½in., 7/6.

T.V. Coils, moulded former, iron-cored wound for re-winding purposes only. Ali-can 1⅛ x 1⅞in., 1/- each, 2 iron-core Ali-can 2⅛ x ⅞in., 1/6 each.

Used Metal Rectifier, 250 v. 150 mA., 6/6.

Metal Rectifier, 230 v. 45 mA., 6/-.

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

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

T.V. CONVERTER for the new commercial stations complete with 2 valves. Frequency:—can be set to any channel within the 186-196 Mc/s. band. I.F.:—will work into any existing T.V. receiver designed to work between 42-68 Mc/s. Sensitivity:—10 Mu/v. with any normal T.V. set. Input:—arranged for 300 ohm feeder. 80 ohm feeder can be used with slight reduction in R.F. gain. Circuit EF80 as local oscillator. ECC81 as R.F. amplifier and mixer. The gain of the first stage, R.F. AMPLIFIER 10 db. Required power supply of 200 v. D.C. at 25 mA. 6.3 v. A.C. at 0.6 amp. Input filter ensuring complete freedom from unwanted signals. 2 simple adjustments only. £2/10/-. P. & P. 2/6.

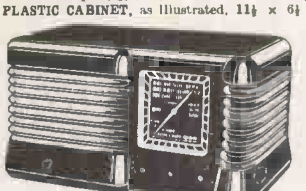
USED 12in. TUBE, aluminized, heater cathode-short, 10KV max. 2 v. heater complete with line and E.H.T. transformer 9 KV with ferrocart core, line and width control, EY51 rec. winding frame O.P. scan coils and 12in. Perspex escutcheon. £6/17/6. P. & P. 7/6.

As above but with 12in. non-aluminized tube 8KV max. £5/17/6. P. & P. 7/6.

GENERAL PURPOSE 3-IN-1 MAINS TRANSFORMER. Input 200/250. Sec. 250 v. 350 mA. 6.3 v. 4 amp. twice, 2 v. 2 amp. 500 v., 350 mA., 6.3 v. 4 amp. twice, 2 v. 2 amp. Auto-transformer, 110, 250 v., 250 watt, 19/6. P. & P. 3/6.

HIGH-IMPEDANCE PLASTIC RECORDING TAPE, by famous manufacturer. 600ft. on aluminium spool, 8/-. 1,200ft. on aluminium spool, 17/6, post paid.

PLASTIC CABINET, as illustrated, 11¼ x 6¼ x 5½in., in Walnut, Cream and Green, also in polished Walnut complete with T.R.F. chassis, 2 waveband scale, station names, new wave-band, back-plate, drum, pointer, spring, drive spindle, 3 knobs and back, 22/6. P. & P. 3/6.



AS ABOVE, with superhet chassis, 23/6. P. & P. 3/6.

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

Cyldon 5 channel T.V. Tuner, uses EF80 and 12AT7 less valves, 12/6, post paid.

Radiogram Chassis, 5 valve A.C./D.C. 3 wave-band superhet 195-255 v., 19-49, 200-550 and 1,000-2,000 metres, I.F. 470 Kc. size of chassis 13 x 6½ x 2½in., size of scale 7½ x 3½in. Valve line-up 10C1, 10F9, 10LD11, U404 and 10P14. Twin mains filter input, 2 dial lights and 8in. P.M., £8/17/6. P. & P. 5/-.

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

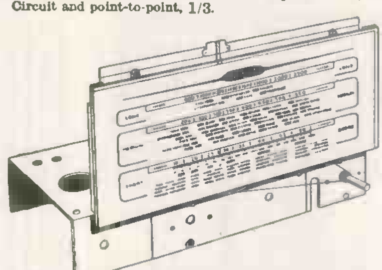
CR100 465 Kc. I.F.s, types 3, 4 and 5 and F.B.O., new condition, 7/6 each.

465 Kc. Xtal for CR100, 12/6.

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

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

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



Battery charger, input 230/250 v. output 6 and 12 volt 1 amp. Black crackle finished case size 10 x 6 x 4in. Incorporating metal rectifier, main on-off switch, and output switch, 21/-. P. & P. 3/-.

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-ratio 3,500, 7,000 and 14,000, 5/6. 10-watt push-pull, 6V6 matching, 7/-. 90-1 3 ohm speech coil, 6/6.

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

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

POTATO AND VEGETABLE PEELER

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

Mains Droppers. 0.3 amps., 460 ohms., tapped 280 and 410, 1/6; 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, 1/6; 0.3 amps. 950 ohms, tapped 700 and 825, 2/6; 0.2 amp., 1,000 ohms, vitreous, tapped 2/6; vitreous, 0.3 amp., 700 tapped 680, 640, 600, 3/6. P. & P. on each 3d.

T.V. Width Controls, 3/6.

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

Germanium Crystal Diode, 1/6, post paid.

Used 9in. Tube with ion burn, 17/6, post paid.

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

Crystal Set, medium and long wave, in plastic cabinet, 16/-.

Headphones, per pair, 8/-.

Speaker Matching Unit on aluminium chassis, 3-15 ohms reversible, 12/6.

Line and E.H.T. Transformer, 14 Kv., using ferrocart core, complete with line and width control, and corona shields U37 rectifier winding, 35/-.

Line and E.H.T. Transformer, 9 Kv., using ferrocart core, complete with built-in line and width control. Mounted on small all-chassis. Overall size 4½ x 1½in. EY51 rec. winding, 27/6.

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

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

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

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

32 mfd., 350 wkg.	2/-
16 x 24, 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
40 mfd., 400 wkg.	3/6
16 x 8 mfd., 500 wkg.	4/6
16 x 16 mfd., 500 wkg.	5/9
16 x 16 mfd., 450 wkg.	3/9
32 x 32 mfd., 350 wkg.	4/-
32 x 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
100 mfd., 350 wkg.	4/-
100 mfd., 450 v. wkg., 280 mA., A.C. ripple	3/11
150 mfd., 350 v. wkg., 280 mA. A.C. ripple	4/6
100 + 200 mfd., 350 wkg.	9/6
16 + 16 mfd., 350 wkg.	3/3
50 mfd., 180 wkg.	1/9
65 mfd., 220 wkg.	1/6
8 mfd., 150 wkg.	1/6
60 + 100 mfd., 280 wkg.	7/6
50 mfd., 12 wkg.	11d.
32 + 32 mfd. min. 275 wkg.	4/-
50 mfd., 50 wkg.	1/9

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

T.V. Filter, in lightly tinted Perspex, size 13½ x 11 x 3/16in., 4/6.

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

Frame Oscillator Blocking Trans., 4/6.

Line Osc. Blocking Trans., 4/6.

Tube Mounting Bracket, size 9½ x 4½in. 12in. tube clamps, 2/-.

CHOKES:

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

P.M. Focus Unit for any 9 or 12in. tube except Mazda 12in. with Vernier adjustment, 15/-.

P.M. Focus Unit for Mazda, 12in., less Vernier adjustment, 15/-.

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

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

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

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

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

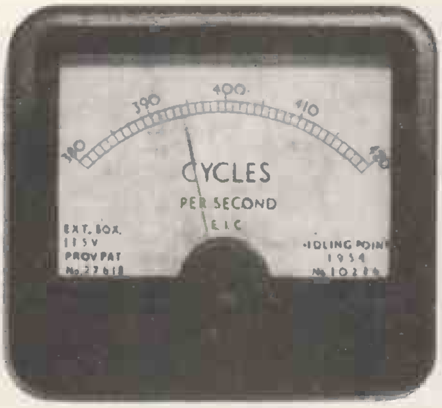
465 KC. MIDGET I.F.s. Q.120 size 1½in. long, 1in. wide, ⅞in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, 12/6.

RADIO & T.V. COMPONENTS (Acton) LTD.

(Late D. COHEN)

23 HIGH STREET (Uxbridge Road) ACTON, W.3. Telephone: ACOrn 5901

Hours of Business: Saturday 9—5 p.m. Wednesday 9—1 p.m. Other days 9—4.30 p.m.



FREQUENCY METERS

2½-8" up to 10,000 cycles

DIFFERENTIAL A.C. CURRENT METERS

COMPARING THE MAGNITUDE OF TWO CURRENTS.

A full range of switchboard and portable instruments, including four types of Millirange Meters.

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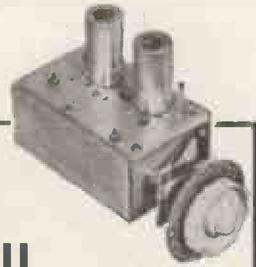

TUNERS
for BAND III
COMMERCIAL TELEVISION

Specially developed for incorporating into new T.V. receivers, or for tuning standard receivers for reception of Band III. Price £6.

ABOUT 2½ MILLION T.V. SETS WILL PROBABLY BE TUNED FOR BAND III RECEPTION. MAKE SURE THAT YOU ARE UP TO DATE. WRITE TO US TODAY FOR FULLEST DETAILS

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Now in dust-proof heavy gauge anodised aluminium can and with miniature 5 or 9-pin base for plugging in. (Original version still available.)

BOTH TYPES FITTED WITH PLATINUM POINTS IF SPECIFIED

Data—A Sensitivity of 25 milli-watts and capable of handling mains voltage on the contacts with alternating currents up to 0.25 amps. Being polarised it has the advantage that the Armature contact can be biased to lock in either direction by suitable adjustment of the contact screws which provides a useful facility where pulse operation is required. Speed of operation is high and the Relay will follow frequencies appreciably higher than 50 c.p.s. Resistance up to 7,000 ohms which is acceptable for Anode circuits. Alternatives to specification if required Sole Concessionnaires.

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3,000 & 600 RELAYS TO SPECIFICATION

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POWER SUPPLY UNITS No. 5, complete except for the 6-v. accumulator, consists of the 6-v. 5-amp. hand generator, with cut-out, 6-v. input vibrator pack, provides all L.T. and H.T. outputs for the 18 and 38 sets, spare Mallory vibrator, bakelite accumulator box, etc., etc., in metal back carrying case, complete with belt and shoulder webbing, new in sealed cartons, 40/-, carriage 6/-; Scot. 7/6; N.I. 10/-.

ELECTROLYTIC CONDENSERS, 32-mfd. 450-v. D.C., by Zenith, Micamold, etc., new and guaranteed, cartons of 12 condensers, 10/-, post paid.

PROJECTION UNITS, consists of an optical mount, fitted with a bloomed f/2.2 Achromatic lens, 3¼in. focal length, at one end, also a convex/concave ground glass at the other, attached to an enclosed lamphouse, fitted with a 24-v. 15-watt lamp, and polished reflector, fraction of original cost, 10/-, post 1/-.

SELSYN TRANSMITTERS (Magslips), 3in. type, pure synchro x-y-1-2-3, suitable as master or slave, 50-v. 50-cycle single phase A.C. operated. When two or more of these are wired up, the rotation by hand (or other means) of one, will result in a 100 per cent. follow in the other(s), both clockwise or anti-clockwise, supplied brand new with test report, in tropicalised sealed cartons. Value, £8 each, our price 25/-, post 2/-, 2 for 50/-, post paid with wiring diagram.

TELEPHONE SETS, consists of 2 combined receivers and microphones, connected by 20ft. twin flexible, provides perfect 2-way communication (up to 1 mile with extra flex), self-energised, no battery required, complete ready for use, new, boxed, 12/6, post 1/-.

"NELCO" ROTARY TRANSFORMERS (matched), brand new latest manufacture, receiver type, 6in. long, 2¼in. dia., input 6-v., output 170-v. at 60-m/A., 15/-, post 1/6, ditto transmitter type, 7½in. long, 2¾in. dia., input 6-v., output 350-v. at 170-m/A., 20/-, post 1/10.

G.E.C. POWER UNITS, intended for 100-watt R.F. amplifiers, input A.C. 200/220/240-v. plus 10-v. 45/120-c.p.s., output 550-v. at 300-m/A. D.C., and 6.3-v. r.m.s., consists of eight U52 rectifiers, separate heater and H.T. transformers, 2 Dubilier nitrogol 8-mfd. 1,200-v. capacitors, 2 heavy smoothing chokes, resistors, fuses, switches, etc., etc., for 19in. rack mounting, weight 104lb., new and unused, £7/10/-, carriage and crate, 15/-; Scot. 20/- extra.

WIRE STRIPPERS, strips the insulation from flexes and cables up to ⅜in. dia., micrometer adjustment, brand new boxed, usual toolshop price 15/-, our price 3/6, post 6d., 3 for 10/-, post paid.

ARROW SWITCHES, 250-v. 25-amp. rotary 4-position, 3-heat and off, series parallel, panel mounting, complete with pointer knob, brand new, 2/6, post 1/3, ditto smaller Diamond H., 250-v. 15-amp., 2/6, post 9d.

VENNER 24-VOLT TIME DELAY SWITCHES, consists of high-grade clockwork motor with external press wind, 2 electro-magnets, 5-pole cam-operated contacts, in smart metal cases fitted 4-way terminal block, new boxed, 7/6, post 1/-.

G.E.C. MINIATURE RELAYS, 40-ohm., 4-pole changeover platinum contacts, brand new boxed, 8/-, post 6d., 90/- doz., post paid.

ELECTRO-MAGNETIC COUNTERS, G.P.O. subscribers pattern, 3-ohm. coil. 0-9999 repeating, size 4½ × 1¼ × 1⅛in., 5/-, post 1/-.

ELECTRIC BELLS, 12-v. D.C., single dome 3in. dia., 1¾in high, very superior, worth 20/-, our price, brand new boxed, 3/6, post 9d.

Many other bargains; send 3d. with S.A.E. for current lists.

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Tel.: HAR 1308

C.R.T. ISOLATION TRANSFORMERS

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

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

Type B. Mains Input 220/240 volts. Multi Output 0-2-4-6.3-7.3-10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for most Cathode Ray Tubes. The MOST versatile Low Capacity C.R. Transformer with Universal Output. With Tag Panel and Solder Tags. **21/-** each.
Type C. A most useful low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 230/240 volts. Output 2-2½-2¾-2¾-3 volts at 2 amps. With Tag Panel and Solder Tags **17/6** each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.

Volume Controls

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

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

COAXIAL PLUGS	1/2
SOCKETS	1/-
LINE CONNECTOR	1/2
OUTLET BOXES	4/6

80 ohm CABLE COAXIAL

STANDARD ¼in. diam. Coaxial GRADE "A" **8d.** yd.

SPECIAL
Semi-air spaced Polythene insulated. ¼in. diameter. Stranded core. Losses cut 50%. **9d.** yd.

BALANCED TWIN FEEDER per yd. 6d. { 80 ohms
TWIN SCREENED BALANCED FEEDER 1/- yd.
50 OHM COAXIAL CABLE, 8d. per yd. ¼in. dia.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf., 1/3; 250 pf., 1/6; 600 pf., 750 pf., 1/9.
RESISTORS.—All values: 10 ohms to 10 meg., ¼ w., 4d.; ½ w., 6d.; 1 w. 8d.; 2 w. 1/-.
HIGH STABILITY, ½ w. 1% 2/-. Preferred values 100 ohms to 10 Meg.
WIRE-WOUND RESISTORS—Best Makes Miniature Ceramic Type—5 w., 15 ohm to 4 K., 1/9; 10 w., 20 ohm to 6 K., 2/3; 15 w., 30 ohms to 10 K., 2/9; 5 w. Vitreous, 12 K. to 25 K., 3/-.
WIRE-WOUND POTS. 3 WATT LAB. COLVERN, ETC.
Pre-Set Min. TV Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 meg., 3/-.
Standard Size Pots, 2¼in. Spindle High Grade. All Values. 100 ohms to 50 K., 5/6; 100 K., 6/6. W/W EXT. SPEAKER CONTROL 10Ω, 3/-.
O/P TRANSFORMERS.—Heavy Duty 70 mA., 4/6. Ditto tapped primary, 4/9. Multiratio, QPP, push pull 6/6. Tapped small pentode, 3/9.
L.F. CHOKES. 15/10 H. 60/65 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H. 120/150 mA., 12/6. MAINS TRANS. 350-0-350, 80 mA., 6.3 v., 4 a., 5 v., 2 a., ditto 250-0-250, 21/-. AMPLIFIER TRANS. 250-0-250 v. 50 mA. 6.3 v. 2 a., 17/6. MAINS HEATER TRANS. 6.3 v. 1½ a., 7/6; 6.3 v. 3 a., 10/6.

ELECTRODYNAMIC MIKE INSERT.—U.S.A. make, precision engineered. Size only 1in., diam. by ½in. Bargain Price 3/9. Matching Trans. 3/9.

SPEAKER FRET.—Expanded anodised metal, 12in. × 12in., 4/-. EXT. L.S.—Switched Socket, on-off and parallel switching, complete with plug, 2/-.
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NEW SOLON MIDGET IRON.—25 w., 19/6. IDEAL FOR RADIO CONSTRUCTORS. 200/220 v. or 230/250 v.
MIKE TRANSF.—Ratio 50:1, 3/9 ea., new and boxed.
V'HOLDERS.—Pax: Int. Oct., 4d.; EF50, EA50, 6d.; B12A CRT, 1/3. Moulded: Int. Oct. 6d.; B7G, 9d.; with screening can, 1/6; B8A, B9G, B9A, 1/-; VCR97, 2/6. Ceramic: EF50, B7G, 1/-. Paxolin ENG. and AMER. 5-, 7- and 9-pin, etc., 1/-.
Nuts, Bolts and Washers, 12 of ea. 1/- packets, 2 4 or 6 B.A
TAG STRIPS.—2- or 3-way, 2d.; 4- or 5-way, 3d.; 6-way, 4d.; 9- or 10-way, 6d. etc.
TOGGLE SWITCHES EX-GOVT.—"On-Off," 9d. Ersin M'core solder 60/40, 16 g. or 18 g., 5/6; ½ lb., 4d. yd. T.C. wire, 18 to 22 s.w.g., 2/-; ¼ lb. P.V.C. Connecting wire, 8 colours. Single or Stranded, 2d. yd. 2 K. 5 w. H.D. w/w Pots, 4/6. 10 K., 25 K., Colvern w/w Pot. 1in spindle, 3/6.
SCREENED GRID CAPS I. Oct. or Mazda, 6d. ea.
BULGIN HIGH VOLTAGE VALVE CAPS, I. Oct., 1/-.
FUSES.—1¼in. all values 60 mA. to 10 a., 6d.
ALADDIN FORMERS and cores, ¼in., 8d.: ⅜in. 10d.
SLOW MOTION DRIVES.—Epicyclic ratio 6:1 2/3.
INT. OCTAL CABLE PLUG (8-pin), with cover, 1/3.
200-250 Volt SELECTOR SOCKET (2in. × 1in.) with Plug 1/-. PILOT LAMPS.—6.3 v. .3 a., 8d.
MAINS DROPPERS. 3in. × 1½in. Adj. Sliders, .3 amp. 750 ohms. 4/3, .2 amp., 1,000 ohms, 4/3.
LINE CORD.—.3 amp., 60 ohms per foot, .2 amp., 100 ohms per foot, 2 way, 1/6 a yard; 3 -way, 1/8 a yard.

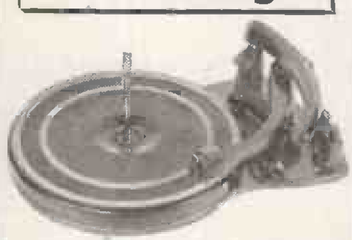
ALL WAVE RADIOGRAM CHASSIS

THREE WAVEBANDS	FIVE VALVES
S.W. 16 m.—50 m.	LATEST MULLARD
M.W. 200 m.—550 m.	ECH 42, EF41.
L.W. 800 m.—2,000 m.	EBC 41, EL 41, EZ40

Brand New and Guaranteed, with 10in. P.M. Speaker, A.C. 200/250 v. Four position Wavechange Switch. Short-Medium-Long-Gram. Slow Motion Tuning. Speaker and Pick-up connections. High Q iron-dust cored coils, 465 kc/s I.F. Latest circuit technique delayed. A.V.C. and Negative feedback. Output 4.2 watts. 3 ohms output transformer on chassis. Chassis size 13½ × 5½ × 2¼in., Glass Dial—10in. × 4½in., horizontal or vertical type available, lit by 2 Pilot Lamps. Colour Black Station names, L.W. Green, M.W. Red, S.W. White. Four Knobs supplied. Walnut or Ivory to choice, aligned and calibrated. Chassis isolated from mains. PRICE £10/15/-. Carriage and Insurance, 4/6. (Without 10in. Speaker, £9/15/-. Carr. & Ins., 4/6.) A.C.-D.C. 10/- extra.

RECOMMENDED FOR ABOVE CHASSIS

Plessey *Multi Speed* Changer



PRICE Carriage Paid **£9 . 19 . 6**

GREAT REDUCTION

Brand New Plessey 3-speed Autochanger Mixer Unit for 7, 10 and 12in. Records. Twin Hi-Fi Xtal Head with Duopoint sapphire stylus. Plays 4,000 records sprung mounting. Superb Quality. Bargain offer.
This Changer will play:—
8 mixed 78 r.p.m. 10" and 12" records.
8 45 r.p.m. 7" records
10 33⅓ r.p.m. 7" records.
10 33⅓ r.p.m. mixed 10" & 12" records
Baseboard required 15½ × 12½in.
Height required 5½in.
Depth required 2in.

★ MIXER TYPE MECHANISM
★ DUAL POINT TURNOVER HEAD

Similar model 3 speed single record unit with Acos 37 turnover head, each sapphire stylus will play 2,000 records. Starting switch automatically places pick-up on records. 7in., 10in. or 12in. auto-stop. Baseplate size 12 × 8½in. Height required 2½in., depth 1¾in.
Price carriage paid **£7 . 15 . 6**

EXCLUSIVE BARGAIN

RECORDING TAPE

1,200 ft. on standard fitting 7" reels. Brand new boxed High tensile strength, sensitivity and coercivity.

ONLY **17/6** REEL

Covered by our usual money back guarantee.

T/V PRE-AMP.—Channel 1. Easily modified for other Channels or Converter use. Midget Chassis, 4¾ × 2½ × 1½. Complete with EF42 valve, coaxial lead and plug. Ready for use. Brand new Mfrs. Surplus. Listed £3/15/-. Special Clearance Price, 21/- Buy Yours Now.

PYE Aerial Plug and Socket, 1/6 pr.
5in. RADIO SCREWDRIVERS.—Sheffield made blade 2½in. × ⅛in. Ins. handle 5,000 v. 4½d. each.
CONDENSERS.—New Stock .001 mfd. 6 kV. T.C.C., 5/6. Ditto, 12.5 kV., 9/6; 2 pf. to 500 pf. Mica, 6d.; .001. Mica or Tub. 500 v. .01 Sprague 500 v., .02 500 v., .1 mfd. 350 v. Tub., 9d.; Hunts Moldseal 500 v. .005, 9d.; .05 mfd. and .1 mfd., 1/-. .25 mfd., 1/6. .1 mfd., 600 v., 1/3; Tubular .5 mfd. 500 v., 1/9.
SILVER MICA CONDENSERS.—10%.
5 pf. to 500 pf., 1/-. 600 pf. to 3,000 pf., 1/3.
DITTO 1% (ex. stock).
1.5 pf. to 500 pf., 1/9. 515 pf. to 1,000 pf., 2/-.

ELECTROLYTICS ALL TYPES NEW STOCK.

Tubular Wire Ends		Can Types, Clips, 3d. ea.	
16+16/500 v.	6/-	32+32/350 v.	4/6
1/275 v.	2/-	32+32/275 v.	4/6
2/450 v.	2/3	16/450 v.	3/6
4/350 v.	1/6	32/350 v.	4/-
4/500 v.	2/-	60/350 v.	6/6
8/450 v.	2/3	250/350 v.	8/6
8/500 v.	2/9	8+16/450 v.	5/-
10/500 v.	2/6	8+16/500 v.	5/6
16/500 v.	4/-	16+16/450 v.	5/6
8+8/500 v.	4/6	16+16/500 v.	6/-
32/500 v.	5/-	32+32/450 v.	6/6
32+32/350 v.	5/6	60+100/350 v.	11/6
32+32/500 v.	7/6	100+200/275 v.	12/6
25/25 v.	1/9		
50/25 v.	1/9		
50/50 v.	2/-		

SPECIALS. Can Types. 500 mfd. 12 v., 3/-; 1,000 mfd. + 1,000 mfd., 6 v., 6/6: 1,500 mfd. 6 v., 4/6; .1 mfd. 1.5 kV. T.C.C., 3/6. Type 512 screw base, 8 mfd. 500 v., 3/-: 16 mfd. 500 v., 4/-.
SENTERCEL RECTIFIERS. E.H.T. TYPE FLY-BACK VOLTAGES. K3/25 2 kV., 4/3; K3/40 3.2 kV., 6/-; K3/45, 3.6 kV., 6/6; K3/50 4 kV., 7/3; K3/100 8 kV., 12/6; K3/160 14 kV., 18/-. MAINS TYPE.—RM1, 125 v., 60 mA 4/-; RM2, 100 mA., 4/9; RM3, 120 mA., 5/9; RM4 250 v. 275 mA., 16/-.
TV. AERIALS. Aerialite, all channels in stock. Indoor loft type Inv. T., 13/6.

KNOBS, GOLD ENGRAVED.—Walnut or Ivory, 1¼in. diam., 1/6 each. "Focus," "Contrast," "Brilliant," "Brilliance—On-Off," "On-Off," "Volume," "Vol.-On-Off," "Tone," "Tuning," "Treble," "Bass," "Wavechange," "Radio-Gram," "S., M., L., Gram.," "Record-Play," "Brightness." Ditto not engraved, 1/- each. Size "B" 1in. engraved, 1/2, plain 8d.

POINTER KNOBS.—Brown with white marking line, small 9d., large 1/-.
COILS — "P" type, 2/6 each. Midget "Q" Type adj. dust core, 3/6 each. All ranges in stock.
REACTION. COND—.0001, .0003, .0005 md., 3/6 ea.

ALUMINIUM CHASSIS.—18 s.w.g. Plain, undrilled, folded 4 sides and riveted corners lattice fixing holes. Strong and soundly constructed with 2½in. sides. 7in. × 4in., 4/6; 11in. × 7in., 6/9; 13in. × 9in., 8/6; 14in. × 11in., 10/6; and 18 × 16in. × 3in., 16/6

FULL WAVE BRIDGE SELENIUM RECTIFIERS.—2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6 F.W. only 6 v., 1 a. (9 v.-0-9 v. A.C.), 5/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ amp., 13/6, 4 amp., 21/-.
ACID HYDROMETER.—New ex-Govt. Unbreakable. Packed in metal case, 7in. × 1½in., dia., 4/6.
H. F. MIDGET CHOKES.—14 M.H., 2/6 each.
BRIMISTORS.—CZ1 for 3 a. heater chains, 3/6. CZ2 for .15 a., or .2 a., 2/6. CZ3, 1/6.
COPPER ENAMEL WIRE.—½ lb. 16 to 20 s.w.g., 2/-; 22 to 28 s.w.g., 2/6; 30 to 40 s.w.g., 3/6.
SWITCH CLEANER Fluid, squirt spout, 3/9 tin.
TWIN GANG TUNING CONDENSERS.—.0005 mfd. midget with trimmers, 8/6; 375 pf. midget less trimmers, 6/6; .0005 Standard size with trimmers and feet, 9/-; less trimmers, 8/-; ditto, soiled, 2/6.
SLEEVING.—Various colours, 1, 2 mm., 2d.; 3, 4 mm., 3d. yd.; 6 mm., 5d. yd.
LOUDSPEAKERS P.M. 3 OHM. 5in. 16/6, 6½in., 17/6. 8in., 19/6. 10in., 25/-. 6½in. Goodmans with trans., 21/-. Famous make 10 in., 10 watt heavy duty speakers, 3 ohm, Aluminium voice coil., 39/6
CRYSTAL DIODE —Very Sensitive. G.E.C., 3/6.
H.R. PHONES.—(Hi-grade Amer.), 15/6 pr.
S. G. BROWN'S. 4,000 ohms. 15/6 pr.

VCR97 £2
TESTED FULL PICTURE

I. F. TRANSFORMERS

WEARITE TYPE 500. 465 Kc/s., adjustable 450-470 Kc/s., size 3½" × 1½" × 1½". Q value 110. BRAND NEW.

HALF PRICE. 10/6 PAIR

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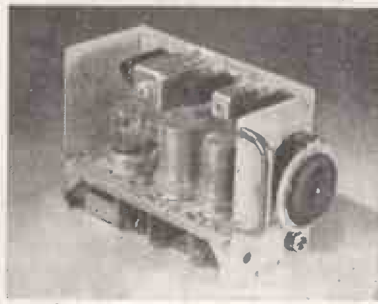
SEND STAMPS FOR NEW 1955 28-PAGE CATALOGUE

"R.F. 26" F.M. CONVERTOR UNIT—88/100 Mc/s.



We can now offer this self-contained Unit comprising 6 Valves—2-6BA6, EB91, VR137, EF54, EF54. Two I.F. stages and separate local oscillator, also Muirhead graduated vernier drive assuring easy tuning.

COMPONENTS OFFERED TO COMPLETE F.M. UNIT

- New RF26 Unit with 3 valves VR137, EF54, EF54, £1/15/-.
- Complete set of all components for conversion including 2 6BA6 and EB91, tuning condenser, I.F.T.'s Osc. and coils. Resistors and fixed condensers, plus wire and tag strips, £4/12/6.
- Instruction Book with technical circuit and complete lay-out diagrams, 2/-.
- Voltage required 250 v. 50 mA. 6.3 2 amps.
- Special offer of all above items and RF26, including circuit, £6/5/-, postage 3/-.

ALL ITEMS SOLD SEPARATELY

- Charge for alignment when completed 7 6
- Assembled, aligned and ready for use £8 10 0

Call for demonstration.

RADIO-GRAM CHASSIS

3 Wave-band Superhet. Med., long and short.
5 Latest Type MULLARD Valves.
4 Position Switching Gram., med., long, and short.
Provision for Extension Speaker. A.C. Mains. 110/250 volts.
Chassis 11in. x 7in. x 2½in. Scale 8in. Square. Or Chassis 13½in. x 6½in. x 2½in. Dial 10in. x 5½in. PRICE £10/5/-.
BRAND NEW AND GUARANTEED.
CARR. PACKING AND INS. 10/-.

G.E.C. RECORDING TAPE

600ft. Reels 10/-

EF50 (VR91A)

The selected EF50, Red Sylvania, original boxes 10/- each, 90/- for ten.

PYE 45 Mc/s STRIP TYPE 3583 UNITS

Size 15in. x 8in. x 2in. Complete with 45 Mc/s. Pye Strip, 12 valves 10 EF50, EB34 and EA50, volume controls, and hosts of Resistors and Condensers. Sound and vision can be incorporated on this chassis with minimum space. New condition. Modification data supplied. Price £5. Carriage paid.

3 SPEED RECORD CHANGER

Plays mixed records. Well-known manufacturer (list price £16/10/-). £9/19/6. carr. 5/-.

14 WATT HIGH FIDELITY F.M. AND RECORD AMPLIFIER

200/250 volt A.C. First Quality Components only. Stewart Transformers and Chokes. Partridge Output Transformer. Bass and Treble Controls (Boost and Cut). Supply Socket for Tuner Unit. Ideal for Denco F.M. Feeder. 5 valves—6SN7, 6SL7, 6L6, 6L6, 5Z4. Complete ready for use.
BARGAIN PRICE £17/10/-.

T.C.C. .1 mfd. 5/7,000 v. wkg., type CP58QO, Bakelite case, 7/6 each. B.I. .1 2,500 v. wkg., 4/-.

COMMUNICATION RECEIVER TYPE P.C.R.3.

Brand new, in original cartons: 6 valves. EF39, R.F. stage. X61, Freq. Changer. EF39, 1st I.F. stage. EF39, 2nd I.F. stage. EBC33, Det. and L.F. amp. 6V6G, Output. Ranges: 12-41 metres; 41-120 metres; 200-560 metres. Aerial Trimmer control. Volume control and tone control.
*Power Supply Unit for 12 volt operation £2/15/-
*Power Supply Parts to convert to A.C. mains £1/17/6
Limited quantity. £10/10/-. P. & P. 7/6.

TR1196 RECEIVER

Receiver 27/73. 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 OFFER, 27/6, plus 2/6 carriage.

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Complete with buzzer, morse tapper and battery compartment on baseboard, 6/-, post paid.

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Finest Audio available. Complete kit of parts, including drilled chassis. 5 valves: types 6AM6, 12AH8, EB91 and 2 6AB6. Also complete circuit and wiring diagram. £6/7/6. Or assembled and aligned, £8/10/-. Alignment only 10/-.

TUNING CONDENSERS

.0005 Midget 2¼ x 1½ x 1¾in.	5/-
.0005 Midget 2¼ x 1½ x 1¾in., with trimmers	6/6
.0005 Standard Size, with trimmers	7/6
.0005 with 4-way push-button assembly	7/6

NEON INDICATOR LAMP

Siemens type V1132. Diameter 1¼ x ½in. Striking volts 80 v. S.P.B.C. 2/6 post free.

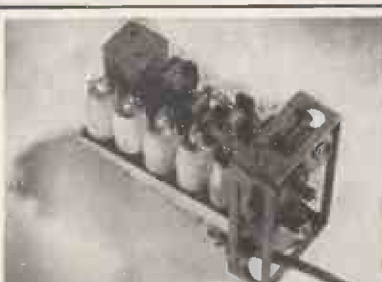
INDICATOR UNIT TYPE 182A

Unit contains VCR517 Cathode Ray 6in. tube complete with Mu-metal screen, 3 EF50, 4 SP61 and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for basis of television (full picture guaranteed) or Oscilloscope. Offered BRAND NEW (less relay) in original packing cases at 67/6. Plus 7/6 carr. "Radio-Constructor" 'scope circuit included.

R.F. UNITS

R.F.24 20/30 Mc/s	15/-
R.F.25 40/50 Mc/s.	19/6
R.F.26 50/65 Mc/s.	35/-
R.F.27 60/80 Mc/s.	35/-

Brand new. carr. free.



(CASE REMOVED FOR ILLUSTRATION)

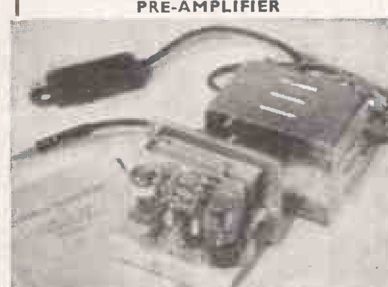
TRANSMITTER/RECEIVER

"38" WALKIE TALKIE SETS

We have purchased large quantity of the above "38" Sets, and can now offer same complete in case with 5 valves 4-VP23 and ATP4, Throat Microphone, Headphones, Junction Box and Collapsible Aerial in absolutely new condition and guaranteed Air Tested. Freq. range 7.4 to 9 Mc/s. Range approx. 5 miles. Voltage 150 v. and 3 v. L.T. Set of batteries, leads and canvas carrying bag 25/-.

59/6 CARR. 5/-.

U.S.A. PACKARD-BELL PRE-AMPLIFIER



Complete with 6L7GT-28D7GT, relay, plugs, condensers, etc. Instruction booklet. Brand new 12/6, p.p. 2/-.

CRYSTALS

200 kc/s, 2 pin, U.S.A.	10/-
465 kc/s, 2 pin, U.S.A.	10/-
500 kc/s, 2-pin British	15/-

Holders for U.S.A. Types 1/6.

STROBE UNITS

Brand new in sealed cartons, these contain 6 EF50's, 5 EA50's, 1 SP61, a host of condensers, resistors, transformers, chokes, relays, switches, 7 pots and 5 smoothing condensers. Size 18 x 8½ x 7½in. Only 59/6, carriage free.

RCA 931A PHOTO-ELECTRIC CELL AND MULTIPLIER

For facsimile transmission, flying spot telecine transmission and research involving low light-levels, 9-stage multiplier. Brand new and guaranteed, only £2/10/-. Special 11-pin base, 2/-. Data sheets supplied. Replacements for Mazda 27M1 and 27M2.

T/V. PRE-AMPLIFIER FOR LONDON AND BIRMINGHAM

45 meg. pre-amp unit complete with 2-VR91 (slight modification necessary) 17/6, p.p. 2/6.

CRYSTAL MICROPHONE INSERTS

8/6 POST FREE

8/6 POST FREE

Ideal for tape recording and amplifiers. No matching transformer required.

CATHODE RAY TUBES

VCR139A. 2½in. C/R Tube. Brand new in original cartons (carr. free)	£1 15 0
VCR97. Guaranteed full T/V picture (carr. 2/-).	£2 0 0
VCR517C. Guaranteed full T/V picture ..	£1 15 0
MU-METAL SCREENS for VCR97 or 517. P.P. 1/6.	10 0
6in. ENLARGER for VCR97 or 517. P.P. 1/6	17 6
VCR97. Brand new and crated—slight cut-off—Ideal for 'Scopes. Limited quantity. Carr. 2/-.	15 0

PHOTO CELLS G.S.18. Brand new, 25/-.

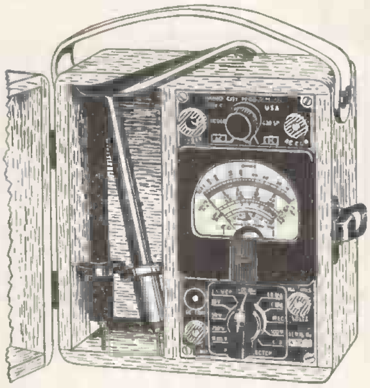
PLEASE ADD POSTAGE. ARTICLES UP TO 10/-, 1/-. £1, 1/6. £2, 2/-.

PROOPS BROS. LTD. *The Walk-around Shop*

now offer you

A MULTIRANGE AC/DC TESTMETER

of well known American manufacture



This testmeter has a basic movement of 400 microamps and is calibrated for use on the following ranges :—

A.C. and D.C. Volts 0 to 5,000 V. in 6 switched ranges.

D.C. Current ranges 0-1mA, 1-10mA, 10-100mA and 100mA-1 Amp.

Use as an OHMMETER (Resistance Measurements) .1 ohm to 1 megohm.

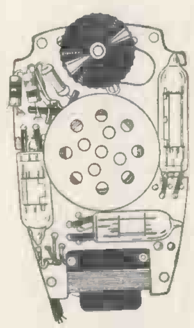
Decibels from – 10db to + 15db. For line load impedances from 5 to 1,000 ohms (directly calibrated for 500 ohm line).

This instrument is contained in a well finished polished wood case with leather carrying handle. Leads and test probes are housed in the case which measures 6½in. x 6½in. x 4½in.

All meters fully tested before despatch. Supplied complete with moulded test probes, full operating instructions and circuit diagram.

£4.19.0

(Packing & postage 3/-)



Miniature POCKET RADIO

incorporating high "Q" technique using the New Ferrite rod. Made possible by simple conversion of the "Medresco" Deaf Aid.

RADIO MINDED AMATEURS will at once grasp the interesting possibilities of this unique unit. Good reception (without using a trailing aerial) of broadcast programmes in home, office, cycling or hiking, etc.

FOR DEAF PEOPLE. The "Medresco" Deaf Aid in perfect working order is also available with miniature earphone and moulded ear insert for **ONLY 35/9**, post 1/-. Batteries 5/- extra. See details opposite.

For technical Information, see whole page advertisement in MAY issue.

THE COMPLETE KIT OF PARTS includes a Type OL10 Deaf Aid (with Crystal Microphone) **in perfect working order** and miniature earphone with moulded ear insert attached; Ferrite rod 4in. x 5/16in. dia., germanium diode, components. Conversion details, circuit diagram and full instructions free with every Kit.

£2.6.0 Post Paid

Batteries extra:
1.5v. L.T. (Type D 18) 8d.
30 v. H.T. (Type B 119) 4/3.

3¾" x 2½" x 1"

24-VOLT D.C. MOTORS. 0.4 A. Size 2in. x 2in. x 2½in. 5/32in. spindle extending ⅜in. 4-pole field. Brushes at 90°. External connections to field and armature. Will run on A.C., 6/6, plus 1/6 postage.

AMPLIFIER UNIT Ex-TR1143A.—A 3-stage transformer coupled amplifier. Push pull VT52s output to modulate push pull VT501s. Circuit diagram free. Price, less valves, 4/6 post paid.

TRANSMITTER UNIT Ex-TR1143A. Suitable for conversion to 2 metres. Circuit diagram and coil conversion details supplied free. Price, less valves, 5/-, post paid.

RECEIVER UNIT Ex-TR1143A.

Suitable for conversion to 2 metres and F.M. Wrotham. Circuit diagram free.

Price—less valves, 9/-, post paid.

70 cm. UNIT. Brand New consisting of pair of tuned lines. 2 acorn valve holders, coarse and fine tuning. Suitable for mixer or oscillator unit. Size 5in. x 3½in. x ⅞in. 6/6 post paid.

CONDENSERS. U.S.A. Manufacture. 10 mfd. 600 v. wkg. (Solar) size 5in. x 4in. x 1½in. with Stand-off Insulators 8/6. 4 mfd. 1,000 v. wkg. (Cornell Dubilier) 2½in. x 4½in. x 1in. Stand-off Insulators 5/6. 1 mfd. 1,000 v. wkg. (Aerovox) 2in. x 2in. x 1in. 2/6. 1 mfd. 600 v. wkg. (Cornell Dubilier) 1¾in. x 1½in. x ⅞in. 2/-. 8 x 8 mfd. 475 v. wkg. (Sprague) electrolytic 1½in. tubular 3/-. **NOTE: Prices include postage.**

SPECIAL PURPOSE VALVES: 713A VHF triode (Door knob type) 9/-. GL446A Disc Sealed triode (Lighthouse Tube) 25/-. 6SN7 6/9, 6SL7 6/9, 6SQ7 7/-, 807 (American) 6/6, VT 52. (EL32) 7/-, TT.11 (VT 501) 5/-. **NOTE: Prices include postage.**

AMERICAN CAMERA DRIVE MECHANISM. with 24 volt D.C. motor 5in. x 3in. dia. Shaft 1½in. x ⅛in. dia., metal box 5½in. x 4in. x 2in. containing a number of useful gears. 24 v. solenoid, overload trip, micro switch, etc. 15/- post paid.

BATTERY HYDROMETER. Ball type No. 1. 1/6 post paid.

TEST SET 87 *Made by famous instrument maker.*

Available complete including:—

POWER PACK. 200/250 v. 50 cycle Power Pack. Fully smoothed, 250 v. 50 mA., with 6.3 v. 4½ A., L.T.

R.F. OSCILLATOR. RL18 oscillator 150-300 Mc/s; easily altered to TV or FM Bands with the use of 4 inches of tinned copper wire.

MODULATOR AMPLIFIER. Two-valve Modulator/Amplifier for RL18.

PULSE AMPLIFIER. Six-valve Pulse Amplifier using VR65s.

TEST SET 87 can easily be altered to **TV PATTERN GENERATOR** or to **WIDE RANGE RC AUDIO OSCILLATOR** as fully described in M. G. Scroggie's articles in "*Wireless World*" issues dated August and September 1949. **Circuit diagrams available at 2/6 each.**

TEST SET 87 is housed in a robust steel cabinet 23in. x 8½in. x 10in. high, copper plated and stove enamelled; fitted with chrome handles.

An exceptionally fine bargain.

PRICE, Complete with 10 valves (5Z4G, RL18 and 8 VR65s) **£5.0.0** *Carriage 10/-*

VHF AERIALS (Sword type). Mounted on Bakelite Base 3in. dia. Ref. 110BB/879. 2ft. overall length, 7/6 post paid.

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52 TOTTENHAM COURT ROAD · LONDON · W.1 *Telephone: LANgham 0141*

Best Buy at Britain's

COMMUNICATIONS RECEIVER ADMIRALTY TYPE B.28 (MARCONI CR.100). Valve line up 2 RF, F.C. separate local Osc., 3 I.F.s, 2nd Det., Output, B.F.O. and rectifier. Self contained power supply 200/250 volts A.C. 50 c/s. Variable selectivity (crystal filter). 6,000, 3,000, 1,200, 300 and 100 cycles. Frequency coverage 60 kc/s to 30 Mc/s in six ranges, continuous except for gap between 420 to 500 kc/s. Size 16in. × 13½in. × 12in. Weight 82 lb. The set for the serious operator. Thoroughly overhauled in superb condition, complete with new valves and air tested prior to despatch. A real bargain at only £30 plus £1 carriage.

TRANSMITTER TYPE 12 Frequency coverage 1.2 to 17.5 Mc/s in four bands. M.O., Buffer, P.A., 2 stage Modulator, built-in stabilised A.C. mains power pack, P.A. Anode current meter M.C.W., C.W., and R.T. operation. V.F.O. or crystal controlled. Super "Table Topper" size 24in. × 12½in. × 17½in. Weight 134lb. Complete with all valves ready for operation. In first-class condition and tested before despatch, with circuit and full instructions. Only £20 plus £1 carriage. Can be demonstrated to callers.

COMMUNICATIONS RECEIVER R1155 BRAND NEW "MINT" condition, in ORIGINAL MAKERS' TRANSIT CASES. R1155A. **£11/19/6** R1155B with super slow-motion drive, **£12/10/-** R1155A, shop soiled models, as new, **£9/19/6** Used models **£7/19/6** "L" and "N" MODELS. Cover trawler and shipping bands. Excellent condition **£17/19/6** Carriage on all models 10/6 extra. All receivers supplied with FREE BOOKLET giving circuit data and details of the power pack required for A.C. mains. Full re-aligned and aerial-tested before despatch and gladly demonstrated to callers. Send S.A.E. for full details of power packs and receivers or **1/3** for booklet. D/F. Loops and Visual Indicator Meters available.

A C MAINS POWER PACKS AND OUTPUT STAGE. Enable the R.1155 to be used to operate speaker from 200/250 volts A.C. without ANY MODIFICATION WHATEVER. All our power packs have heavy duty transformers, are complete with leads and Jones plugs and are guaranteed for 6 months.
Type A In smart black metal case, size 8½in. × 4½in. × 6½in. less speaker, price **£4/10/-** plus 3/6 carriage.
Type B With built-in 5in. speaker in black metal case size 13½in. × 5½in. × 7½in. Price **£5/5/-** plus 3/6 carriage.
Type C. With an 8in. speaker in specially designed beautiful black crackle cabinet speaker to match receiver, size 11½in. × 10½in. × 6in. A de Luxe job. Price **£6/10/-** plus 3/6 carriage.
NOTE: 10/- REDUCTION WHEN PURCHASING ANY OF THE ABOVE POWER PACKS WITH RECEIVER.

ERIE HI-K CERAMICONS. 1,000 pfd. 4 B.A. chassis mtg. Particularly suitable for V.H.F. decoupling, etc. Price **10/6** dozen.

SYLVANIA STANDARD OSCILLOSCOPES Type 112. For 115 or 230 v. 50 or 60 c/s. A.C. Mains. Controls:—Focus, Brilliance, X and Y Shift, X and Y Amp. Gain. Sync. Selector, Sync Phase, Time Base Coarse and Vernier, 15 c/s. to 30 Kc/s., X and Y.. plates direct or attenuated. Push-pull deflection 5in. green trace C.R.T. Stabilised H.T. supplies, no electrolytic capacitors. Contained in handsome black crackled case, size 15½ × 10 × 19½in. In first class working order and condition. Price £30

COSSOR GANGING OSCILLATORS. A.M./F.M. Sig. Gen. covering 70 Kc/s. to 20 Mc/s. in five ranges. Standard A.C. mains input. In good condition. For callers, (only few available). Price **£4/19/6**

U.H.F. SIGNAL GENERATORS by R.C.A. TYPE 710A. Cover 370 to 560 Mc/s. Large directly calibrated dial. Carrier level and 400 c/s. modulation monitored by large 200 micro-amp. meter. Precision piston attenuator. For A.C. mains operation 117 volts 50/60 c/s. Complete with instruction manual. BRAND NEW. **£35.**

OSCILLATOR BEAT FREQUENCY No. 5 manufactured by Furzehill for the Admiralty. Range 0-10,000 cycles. Complete with seven valves—push-pull 6V6 output giving 2 watts into 600 or 10 ohms. The output is monitored by moving coil meter. For operation on A.C. mains 100-250 volts. Contained in handsome metal instrument case, size 17½in. × 9in. × 11in. With circuit diagram and operating instructions. In perfect condition and tested prior to despatch. A laboratory instrument for ONLY **£12/10/-**, plus 10/- carriage.

E.M.I. OUTPUT METER. Desk type incorporating a 2½in. 1 mA. meter together with instrument rectifier, etc. 2 ranges 0-500 milliwatts and 0-5 watts and decibel scale. Brand new in original manufacturers' boxes with instructions. Price **35/-**, post 1/6.

METER BARGAINS, ALL BRAND NEW

15 v. (50~) mov. iron 2½in. pnl. mtg.	8/6
3,500 volts moving coil 3½in. projection	10/–
150 milli-amp. 2in. sq. pnl. mtg.	7/6
5 milli-amp. moving coil 2in. sq. pnl. mtg.	7/6
20 amp. moving coil 2½in. dia.	7/6
1 mA. 2½in. barrel flush pnl. mtg.	22/6
1 milli-amp. 2½in. barrel desk type	25/–
100 micro-amps. barrel pnl. mtg. scaled 0-1,500 in 15 clear divisions. Only	42/6
500 mA. Thermo Couple 2in. sq. pnl. mtg.	5/–

METER RECTIFIERS. 1 mA. Salord Instruments, **8/9** 5 mA. Salford Instruments, **6/9** 2 mA., S.T.C. as used in E.M.I. Output Meter, **5/6** All are full wave bridge and brand new.

HOUR METERS. 200-250 volts 50 c/s. 4½in. diam. Direct reading 1/10 to 10,000 hours in five scales. Indicates the time any A.C. mains operated apparatus has been in use. Ideal for life testing, process timing, etc. BRAND NEW and BOXED, **39/6** each.

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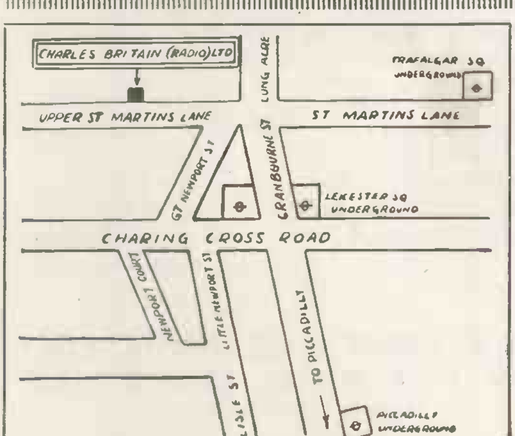

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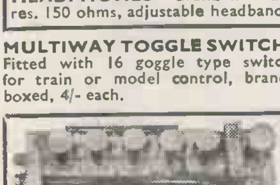

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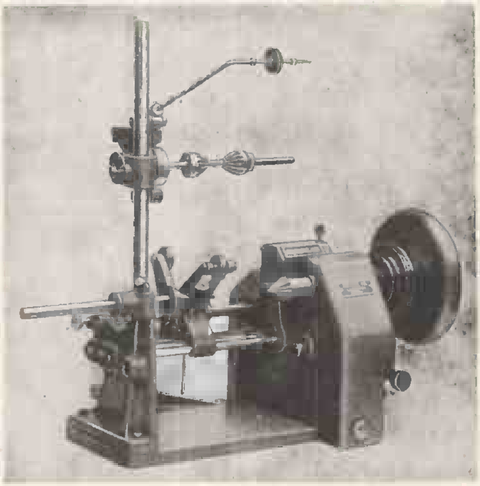

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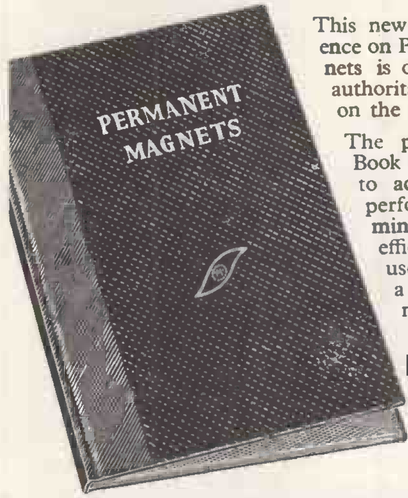

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G.E.C. B.R.T. 400 comm. rec., maker's check-over, new valves Nov., '54, condition as new; Whiteley Hi-Fi speaker; offers.—Box 3141. [4586

VORTEXION 15-watt A/C and 12-volt 20 watt A/C and 12-volt 15 watt A/C, 4 inputs; the lot £40.—130, Fairlawn Park, Sydenham, S.E.26. Syd. 5934. [4606

ZENITH super trans-oceanic portable, 7 bands —2-4, 4-8 mc/s, 31m, 25m, 19m, 16m, 550-1600 kc/s, a.c./d.c./battery, very good condition; £45.—Box 3388. [4626

R.F. units, new in original cartons, types 26-27 27/6, 25 11/6, 24 11/-, post 2/6.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [4365

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

WIRELESS WORLD 2R.F. 3-valve quality tuner, M.W. and L.W., complete with fully smoothed power supply unit, unused, ideal for use with all high fidelity amplifiers; £7, including 4 valves, approx. half original price; limited number bargain.—Box 2974, [4516

LOUDSPEAKERS—SURPLUS AND SECONDHAND

GOODMANS 12in with recommended corner cabinet; £8.—Hunt, "Casterbridge," Brooklands Park, S.E.3. [4642

WHARFEDALE W15/CS, £11; Broadcast and Acoustic 12in, 75/-; 2 high quality P.P. output transformers, 25/- each; all perfect.—68, Woodbourne Ave., S.W.16. Str. 1123. [4660

TRANSMITTING EQUIPMENT

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

NEW TEST EQUIPMENT

T.V. signal intensity meter (S.I.M.) for aerial checks and installation, etc; send for full details.—Radio-Aids, Ltd., 29, Market St., Watford. Tel. Watford 5988. [4653

TEST EQUIPMENT—SURPLUS AND SECONDHAND

VARIACS, type 80C In: 200-240v, 50c, Out: 220v, 7½amps, £5/10; type 500L-2G, In: 180v, 500c; out: 0-180v, 7+7amps, £14.
BRIDGE-MEGGERS, 250v, series 2, complete in leather case, used, tested; £12/15.
SPEEDIVAC pumps, Edwards, type 1, with 8in v-pulley, £15; motorised 230v, A.C., £21.
ADVANCE constant voltage transformers, In: 204-276c; Out: 240v, 500w, £10
VOLTAGE regulators, Ferranti 230v motor-driven moving coil, 480va, £18; 1440va, £28.
MICROAMMETERS, 2½in M.C., flush, round, centre zero, 250-0-250μa, 22/6 p.f.
P. B. CRAWSHAY, 94, Pixmore Way, Letchworth, Herts. Tel. Letchworth 1851. [0097

AVO valve characteristic meter; £30.—Apply, The House of Toomer Ltd., Newbury, Berks. Tel. Newbury 814. [4656

MULLARD TV optical unit, complete with C.R. tube, in excellent condition, £11; Avo wide-range signal generator, £20.—Cosmic Radio, 129, Oxton Rd., Birkenhead. [4661

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

10 Cossor double beam oscilloscopes, model 3339; all in working order; £275 or £30 each plus carriage and insurance.—Cox Radio, 39, West St., Bognor Regis. [4581

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

SPECIAL television rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb, d.c. input 12v 200va, out, 24v, 32v, 110v, 230v, d.c., to 230v out, 250va £28/10 del., also converters for radiogram and general use, inputs, outputs and price as above; the above also supplied without smoothing, £25 del. immediate despatch; trade supplied.
AT a purchaser's home 60 mls. S.W. of Sutton Coldfield a 24v.
TELEVISION converter was tested on Ekco television 12in tube, stated consumption 135 watts d.c. current from battery only 9¼ amps, picture and sound were perfect and completely free of interference or flutter.
THE above is the latest product of British manufacture, and is guaranteed for one year.
J.A.P. No. 2A 1.2hp petrol engine, air-cooled, 4-stroke, starting rope, tools; £17/10 delivered.
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P. B. CRAWSHAY, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0096

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NEW portable tape recorder, Truvox deck Mk. 3; £40.—Box 3328. [4620

M.S.S. LED/3 disc recorder, 3-speed; £76.—J. Bryant, West St., Cromer. [4658

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PLEASE write for details to K.T.S., Ltd., "Coplow," Park Rd., Braunton, N. Devon. Tel. Braunton 224. Callers by appointment only. [0209

FOR SALE AND WANTED ADVERTISEMENT FORM TURN TO PAGE NO. 171

NEW GRAMOPHONE AND SOUNO EQUIPMENT

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

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

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECOND-HAND

GRUNDIG 700C Consul recorder with mike, as new; quick sale, £58.—Box 3590. [4646

LOWTHER DT4 tuner, perfect; £22.—18, Hawkhurst Way, West Wickham. Spring Park 3398. [4672

TRIX T41 Home Music amplifier, as new, unwanted gift; £10/10.—Hay, 3, Primley Gdns., Moortown, Leeds. [4644

VORTEXION 30-watt gramophone reproducer, as new, cost £30, sell £22/10; 130 Fairlawn Park, Sydenham S.E.26. Syd. 5934. [4606

UNUSED Decca ffrr pick-up, 30/-; Wharfedale 3,000 c/s crossover 7/16 ohms 30/-.—Whittaker, 12, Rochester Drive, West Timperley, Cheshire. [4523

H.M.V. disc recorder 2300, complete, all latest modifications, checked by E.M.I. last month; £130.—J. Bryant, West St., Cromer. [4659

FOR sale, Minifon pocket size wire recorder, perfect condition, with all accessories, nine hours' recording wire; £130 value for £70.—Call Ful. 0389. London. [4582

GRUNDIG TK9, as new, Golden mike, £55; Truvox Mk. III deck, £15; Truvox amp., unused, new, £13.—Taylor, 191, Ashton Rd., Denton, M/c. Den. 3182. [4387

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NEW mains transformers, fully shrouded, 210-230-250v, primaries 350-0-350 150ma. secondaries, 6.3v 4 act, 6.3v 2a, 5v 3a fly leads, 42/6; 400-0-400 200ma 6.3v 4 act, 6.3v 3act, 5v 3a, 63/-.—C. S. F. Steward, 6, Broughton Rd., Hadleigh, Essex. [3585

COMPONENTS—SURPLUS AND SECOND-HAND

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188.
ELECTROLYTICS, capacity, voltage, size, type of mounting, price post paid; 400, 6v, 1×2in, lug, 1/9; 250+250, 6v, 1×2in, lug, 2/-; 40, 150v, 1×2, clip, 2/6; 20+20, 275v, 1×2, lug, 3/3; 16+32, 275v, 1/2, lug, 3/3, 16+16, 275v, 1×2, clip, 3/3; 100, 275, 350v, 1⅛×3, clip, 3/6; 32+12, 350v, 1⅜×2, clip, 4/-; 16, 350v, ¾×2, lug, 1/9; 10, 450v, ¾×2, lug, 1/6; 16, 450v, ⅞×2, tag, 2/9; 32, 450/525v, 1⅜×2, clip, 3/9; 15+15, 450v+20mf 25v, 1⅛×3, lug, 4/6; 200, 6v ⅝×1¾, clip, 1/6; 100, 12v, ⅝×1¾, clip, 1/9; 8, 450v, 1×2, clip, 2/-; 150, 25v, ¾×1¾, clip, 2/-; 250, 12v, ¾×1¾, wire, 2/3; 40+40, 275v, 1⅜×2, clip, 3/3; 24+24+16, 350/425v, 1⅜×2, clip, 4/9; 4, 150v, ⅝×1¾, clip, 1/1; 500, 12v, 1⅜×2¾, clip, 2/-; 8, 350v, ¾×2, clip, 1/9, 32+32, 350/425v, 1⅜×2, clip, 5/-; 2, 450/525v, ¾×1¾, tag, 1/6; 8, 450v, ¾×2, clip, 1/9; 64+120, 275v, 1¾×4½, clip, 5/6; all ali cans, some with sleeves, all voltages, WKG, surge where marked, new stock guaranteed.
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P.M. focus rings, wide angle, tetrode tube, fully adjustable, 12/- post paid.
RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

VARIAC 0-270V 2K.V.A. type 100L; £12.—Taylor, 29, Muirhouse Ave., Edinburgh, 4. [4604

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 158. [0016

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

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2-POLE 2-way w/c switches; 1/- ea.
MICRO-PACK, 25mfd, 25v, bias cond—small; 1/4 ea.
ALL parts in stock for Denco F.M. unit, manual; 1/6 ea.
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WANTED, HRO coils, Rxs, etc., A.R.88s, BS348s, S27s, etc.—Details to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

WANTED, B.C.610 Hallicrafters, E.T.4336 transmitters and spare parts for same; best prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

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ALL U.S.A. V.H.F. test and communication equipment; TS174, TS175, TS47, B.C.221 freq. meters; receivers 1294, 1359, Hallicrafters S.27, S 27CA, U.S.A.; APR4 and tuning units TN16, 17, 18 and 19, RCA AR88D-LF, Hallicrafters SX28; valves 707A-707B, 2K28, 2K39, 2K33, 2K41; highest offers given by return.—Ger. 8410 and 4447. Universal Electronics, 22, Lisle St., Leicester Sq., London, W.C.2. [0229

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YOUR own tape recording transferred to disc.—Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio recordings, tape recording service. [4662

BUILD your own TV and learn about its operation, maintenance and servicing; qualified engineer-tutor available whilst you are learning and building.—Free brochure from E.M.I. Institutes, Dept. WW.58, London, W.4. (Associated with H.M.V.) [0180

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

NOTICES

BRITISH SOUND RECORDING ASSOCIATION. Details of membership, open to the professional sound recording engineer and all others interested in recording high quality reproduction and other branches of audio engineering, together with details of the London lecture programme and the Manchester, Portsmouth and Cardiff Centres, may be obtained from the Hon. Membership Secretary, H. J. Houlgate, A.M.I.E.E., 12, Strongbow Rd., Eltham, S.E.9. [0031

PUBLIC ANNOUNCEMENTS

NATIONAL College of Horology and Instrument Technology.
THE Minister of Education, in consultation with the Board of Governors, proposes to fill a vacancy, as from September 1st, 1955, for a Head of the National College of Horology and Instrument Technology.
THE College is accommodated at the Northampton Polytechnic, St. John Street, London, E.C.1. The College provides for technical education and research to the highest levels in connection with the horological and the instrument making industries. The curriculum includes a three-year Diploma Course in Horology. Advanced courses in Instrument Technology are projected for next session.
CANDIDATES for the post must have good academic qualifications and industrial experience.
SALARY scale £1,265 by increments of £50 a year to £1,415 p.a.
THE post is recognised for pension purposes under the Teachers' Superannuation Acts.
A LETTER of application to include particulars of age, academic qualifications, industrial experience, and the names of three persons to whom reference may be made, should be sent to the Secretary, National College of Horology and Instrument Technology, Northampton Polytechnic, St. John St., London, E.C.1. [4596

AGENCIES WANTED

WE intend sending one of our sales managers to Pakistan, India, Ceylon, Burma, Thailand, Malay, Indonesia, etc., during the latter part of this year; manufacturers of radios, parts and electrical equipment seeking new outlets and distributors, and prepared to enter into provisional agency agreements, are invited to communicate with us—B. Ashworth & Co. (Overseas), Ltd., King's House, 36/7, King St., London, E.C.2. [4629

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.

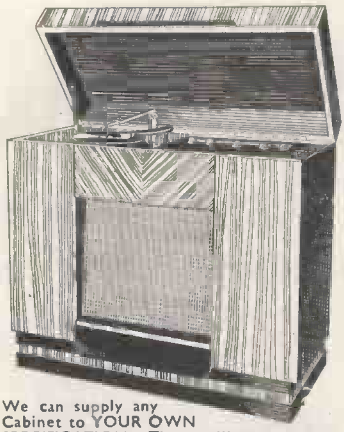
CITY of Liverpool
EDUCATION Committee.
RIVERSDALE Technical College.
PRINCIPAL: A. R. Kinsman, B.Sc. (Eng.), A.M.I.E.E., A.M.I.Mech.E.
APPLICATIONS are invited from suitably qualified persons for the undermentioned appts. (full-time)
GRADE B Assistant Teacher for Radio and Electrical Engineering; industrial experience desirable.
GRADE A Assistant Teacher to assist in full-time P.M.G. Certificate and part-time Radio Servicing Courses; industrial and/or marine experience an advantage.
SALARIES in accordance with the Burnham Technical Scale, 1954.
FURTHER particulars and form of application (returnable as soon as possible) may be obtained from H. S. Magnay, M.A., Director of Education, 14, Sir Thomas St., Liverpool, 1.
THOMAS Alker,
TOWN Clerk and Clerk to the Local Education Authority. (JA.3890.) [4645

MAINTENANCE of multi-channel demonstration links.
TWO engineers, with suitable radio experience, required for the maintenance of the above.—Apply to the Personnel Manager, Pye Telecommunications, Ltd., Ditton Works, Cambridge. [4525

COMPETENT TV and radio engineer, able to drive; excellent salary and prospects; S.W.3 district.—Box 3140. [4588

SENIOR TV engineers required; must drive, salary from £650 p.a.—Apply E. Coyne, 120, Ladbroke Grove, W.10. Bay. 1947. [0082

CABINETS



We can supply any Cabinet to YOUR OWN SPECIFICATION. The one illustrated can be obtained in walnut, oak or mahogany for £19.15.0, or as a COMPLETE RADIOGRAM incorporating:

5-VALVE SUPERHET, 3-speed Plessey Autochanger and 10in. W.B. Speaker **£48.0.3**

8-VALVE ARMSTRONG F.C.48. 3-speed Collaro Autochanger and 10in. W.B. Speaker **£60.14.8**

14-VALVE ARMSTRONG EXP 125/c, 3-speed Garrard Autochanger and 12in. Goodman speaker. **£95.5.11**

(H.P. terms can be arranged.)

Send 1/- for complete Catalogue of Cabinets, Chassis, Autochangers and Speakers (refunded on receipt of order).

LEWIS RADIO CO.
120, GREEN LANES, PALMERS GREEN, LONDON, N.13. BOWes Park 6064.

OUR NEW
GOVERNMENT SURPLUS CATALOGUE No. 12
containing over 400 items price 1/6d. post free. 2/6d. overseas seamail.

ARTHUR T. SALLIS (W.W.)
93 NORTH ROAD, BRIGHTON, SUSSEX. *Tel.: BRIGHTON 25806*

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Q.C.C

Type **B7**

The type B7 unit is mounted in the standard B7G valve envelope and is hermetically sealed and fully evacuated.

Available for the frequency ranges from 100 kc/s. to 500 kc/s. and from 3 Mc/s. to 16 Mc/s. Gold electrodes applied by cathodic sputtering give permanence of calibration. Normal adjustment accuracy 0.01% Max. adjustment accuracy 0.003%.

Early delivery can be given of some frequencies, and we will be pleased to quote for your specific requirements.

THE QUARTZ CRYSTAL Co. Ltd.
63-71 Kingston Road, NEW MALDEN, SURREY
Telephone: MALden 0334 *Cables, etc.:* QUARTZCO NEWMALDEN

SITUATIONS VACANT

SENIOR draughtsmen.

DUE to expansion of the Electronics Division of the Plessey Company, Ltd., there are several vacancies for experienced men in the following fields:
1. DESIGN of a wide range of electronic equipment, including work to Service requirements.
2. MECHANICAL design of precision mechanisms for quantity production.
THESE vacancies carry attractive salaries and long-term prospects in reward for hard work and offer good staff conditions including superannuation and insurance schemes.—Applications, which will be treated in confidence, should be addressed to:
THE Plessey Company, Ltd., Vicarage Lane, Ilford, Essex. [4474

THE PLESSEY Co., Ltd.

VACANCIES exist in new well equipped and expanding laboratories of the Chemical and Metallurgical Division. for junior and senior metallurgists, chemists and ceramists with progressive ideas; experience in any of the following an advantage.
SEMICONDUCTORS.
ELECTROLYTIC capacitors.
MAGNETIC materials.
ELECTRICAL ceramics.
POSITIONS offered are permanent and pensionable and offer considerable scope for advancement; salaries will be generous and commensurate with qualifications and experience.—Write in confidence to the Technical Manager. The Plessey Co., Ltd., Towcester, Northants. [4407

ELECTRONIC apprenticeships.

THE Ministry of Supply invites applications for electronic apprenticeships tenable for five years at the Radar Research Establishment, Malvern, Worcestershire.
APPLICANTS should be 16 and under 17 years of age on 1st September, 1955; they should be in possession of, or expect to obtain, the General Certificate of Education at Ordinary level, with passes in four subjects, including mathematics and physics (or other science subject); or be of equivalent educational standard; technical school boys are eligible to apply provided they have exemption from S.1 Stage of the Ordinary National Certificate.
FORMS of application and further particulars may be obtained from Ministry of Supply, D.T.O. (Industrial), 66-72, Gower St., London, W.C.1. The closing date for receipt of applications is 1st June, 1955. [4530

ELECTRICAL/electronic/radio engineers.

A number of vacancies exist in the design organisation of Vickers-Armstrongs, Ltd., Hursley Park, nr. Winchester.
THE work will include development, design and testing of latest specialised installations in aircraft; applicants with varying qualifications up to Degree standard are invited to apply; salary commensurate with experience and ability; recommendation may be made for housing after qualifying period.
APPLY: Personnel Department, Vickers-Armstrongs, Ltd., Hursley Park, nr. Winchester. [4607

COLLEGE OF TECHNOLOGY, Birmingham.

DEPARTMENT of Physics and Mathematics.
THERE is a vacancy for a research assistant in the department of physics and mathematics for taking part in a major electronic project; candidates should have a good honours degree, preferably of London University or of a university which awards higher degrees for external research; experience in the design of electronic circuits is essential; the successful candidate will be expected to do some teaching, but ample time will be available for research.
SALARY will be in accordance with the Burnham (Further Education) Scale for Grade "A" Assistants; basic salary (men) £510 with increments for approved training and industrial or teaching experience.
FURTHER particulars and form of application may be obtained from the Registrar, College of Technology, Suffolk Street, Birmingham, 1. on receipt of a stamped addressed foolscap envelope; completed forms should be returned not later than two weeks after the appearance of this advertisement
K. R. PILLING, Clerk to the Governing Body. [4598

PYE TELECOMMUNICATIONS, Ltd., Ditton Works, Cambridge, offer:—
EXCELLENT opportunities for junior and senior development engineers in the electronics and communications field.
DUTIES include development work on H.F., V.H.F., microwave and recording equipments.
APPLICATIONS from persons possessing B.Sc., Higher National or Ordinary National Certificates especially welcomed.
GOOD facilities available, however, to keen young men wishing to train and study in these fields.
PLEASANT working conditions in modern factory; single accommodation available.
WRITE, giving fullest details to Personnel Manager. [4622

A. H. HUNT (CAPACITORS), Ltd., require engineers for design and development of paper, mica and ceramic capacitors.
APPLICANTS should have previous training in electrical engineering at least to intermediate B.Sc. standard.—Apply to Personnel Manager, A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garratt Lane, Wandsworth, S.W.18. [0057

RADIO/RADIOGRAM CHASSIS

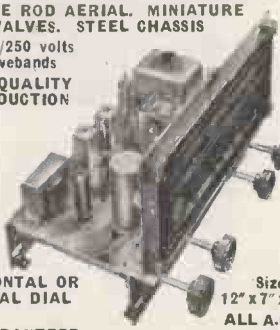
BUILT TO HIGHEST TECHNICAL STANDARDS FOR THE CONNOISSEUR OF QUALITY MUSIC REPRODUCTION

New Range of Models with Latest Features

FERRITE ROD AERIAL. MINIATURE (BVA) VALVES. STEEL CHASSIS

A/C 200/250 volts
3 wavebands

HIGH QUALITY REPRODUCTION



HORIZONTAL OR VERTICAL DIAL

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Size 12"x7"x 7½"

ALL A.C. MAINS

ASSEMBLED AND READY FOR USE.

5 VALVES chassis, 4 watt output, wide range of tone control. **£13.18.3**

7 VALVES PUSHPULL chassis, 6 watt output, separate bass and treble controls **£17.17.9**

Negative feedback applied from output transformer secondary.
Gram switching on wavechange switch.
Plug-in connections for pickup, speaker, gram motor.
Choice of horizontal or vertical dial.
Also magic eye fitment, dial escutcheon, matched 8in. and 10in. speakers.

FULL TRADE FACILITIES
DETAILED LIST AND DIMENSIONS.
DIRECT FROM THE MANUFACTURER

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MALVYN ENGINEERING WORKS

Precision Engineers

Manufacturers of: Chassis, Small Pressings, Machined Components, Wiring and Mechanical Assemblies, to specification.

Single and Production Quantities. Enquiries Invited

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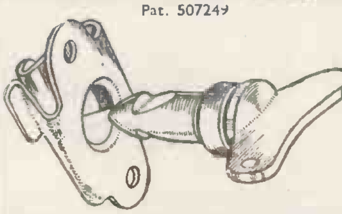

THIS FASTENER WITH ENDLESS APPLICATIONS—SIMPLE—POSITIVE SELF-LOCKING. MADE IN A VARIETY OF TYPES AND SIZES.

SPECIAL FASTENERS TO SUIT CUSTOMERS' REQUIREMENTS.

WIDELY USED IN THE RADIO INDUSTRY.

Illustrated brochure and other information will be gladly sent on request.

DEPT "W.W."

Oddie, Bradbury & Cull Ltd., Southampton
Tel.: 55883 Cables: Fasteners, Southampton

SITUATIONS VACANT

ULTRA ELECTRIC, Ltd., Western Avenue, Acton, London, W.3 ANNOUNCE the following vacancies for ENGINEERING Staff:—
(1) TELEVISION Development.
(a) SENIOR ENGINEERS required for TV receiver design; applicants should have good academic qualifications and experience of the design of radio frequency amplifiers, preferably up to frequencies of the order of 200 Mc/s.
(b) SENIOR ENGINEERS for time base development; applicants should have good academic qualifications and previous experience in the design of TV scanning circuits.
(c) JUNIOR ENGINEERS with academic qualifications or experience in TV receiver development.
(2) RADIO DEVELOPMENT
(a) SENIOR ENGINEERS required for development of radio receivers embodying the most recent AM/FM techniques, knowledge of FM receiver design desirable.
(b) JUNIOR ENGINEERS required for receiver design; experience desirable but not essential if possessing Hr. N.C. or C. & G. (Telecoms.) Final Cert.
(3) ELECTRONICS.
(a) SENIOR ELECTRONICS ENGINEER with some experience of circuit design for work in one of the following:
(i) Pulse techniques and general waveform circuitry.
(ii) Radar display.
(iii) Feedback techniques at video frequencies.
(iv) Simple servo devices.
SUCCESSFUL applicants will have opportunities of studying recent American techniques and they should be capable of accurate recording of experimental and design data and the preparation of technical servicing information.
(b) ELECTRONIC ENGINEERS for work on one or more of the above subjects.
(4) TEST EQUIPMENT DEVELOPMENT.
(a) TEST EQUIPMENT DEVELOPMENT ENGINEER for design and development of production test equipment for TV, radio or contract work; applicants should have Hr. N.C. or equivalent and good experience.
(b) JUNIOR T.E. ENGINEER with some qualifications or preferably some experience.
(c) MEASUREMENTS SECTION LABORATORY ASSISTANT (m. or f.) with some technical knowledge and experience of calibration and certification of electronic equipment.
APPLICANTS are requested to write to the Personnel Manager, stating which of the post(s) desired and giving full details (in strict confidence) including age, experience and salary expected; Saturday morning interviews can be arranged if desired. [4590

ELLIOTT BROTHERS (LONDON), Ltd., have the following openings in the Electronic section of their Process Control Division:—
(1) SENIOR ELECTRONIC ENGINEER to study present and future requirements in the field of Automatic Process Control and to act as a technical consultant on overall system design.
APPLICANTS must have the facility of providing original solutions to new problems and be in a position to advise on the use and application of new techniques. The section has its own staff of qualified Development Engineers and Physicists, and the services of divisions engaged in the fields of Computing, Servos, Radar and Nucleonics, etc., are available.
THE situation is particularly applicable to engineers who have had wide and responsible experience in the detail design of industrial electronic equipment and who desire to concentrate on the overall concept of system research and design. Candidates must possess a good engineering degree or equivalent.
(2) JUNIOR ELECTRONIC ENGINEER to assist with the work of system study and design.
APPLICANTS who may be required to organize or carry out experimental work necessary to their study must have had several years' experience in the design of electronic equipment and have an aptitude for System Analysis. Experience in the field of Industrial Instrumentation and Control will be of particular interest.
THIS position provides a valuable opportunity for entry into the rapidly expanding field of Automatic Process Control with a Company already widely experienced in these matters and having active Divisions in all branches of modern electronics. Candidates must have a good engineering degree or equivalent.
APPLICATIONS for the above positions, which will be treated in strictest confidence, giving age, qualifications and experience to Personnel Officer, Elliott Brothers (London), Ltd., Century Works, Lewisham, S.E.13. [4529

PYE TELECOMMUNICATIONS, Ltd., Ditton Works, Cambridge, invite applications for the following posts.
MARINE sales engineer to promote the selling of marine communication and associated equipment.
SALES engineer to promote the sale of communication equipment; training given to suitable applicants lacking experience.
APPLY, giving fullest details to Personnel Manager. [4623

SENIOR Technical Sales Representative with British Communications Corporation, Ltd., Exhibitions Grounds, Wembley.
A NEW appointment to meet expanding commercial activities; applicants should have sound general knowledge of V.H.F. communications equipment and have sales experience in this field; some administrative skill also desirable.—Write giving full details of personal history to the Sales Manager [4639

SITUATIONS VACANT

"THE TELEGRAPH CONSTRUCTION & MAINTENANCE Co., Ltd., cable manufacturers, wish to appoint:—

(1) TECHNICAL Assistant to be concerned primarily with the design of all types of cables. Candidates should preferably have some experience of manufacture of cables and must have a knowledge of electrical engineering to a standard of at least Inter-B.Sc. or O.N.C.

(2) TECHNICAL Assistant (Senior) to take charge of Power Cable Test Room. Comprehensive experience in electrical testing and examination of low- and high-tension cables for voltages up to 33kV or higher. Education to H.N.C. desirable.

PENSION Scheme, five-day week and all welfare facilities. Salaries in accordance with qualifications and experience.—Write details to Personnel Manager, Telcon Works, Greenwich. S.E.10. [4678

GYRO development engineers required with first-hand knowledge of development work in small gyroscopes; these vacancies fall into two categories:—

(i) Mechanical development engineer used to handling precision bearings, balancing machines, etc.

(ii) Electro-mechanical engineers with knowledge of A.C. and D.C. torque motors, voltage pick-offs and gyro motors.

WRITE in detail or send postcard for form of application, quoting Ref. 143 (i) or (ii), to the Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [4532

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY, A.W.R.E., Woolwich Common, requires Technicians, Grade I, II and III, for the following duties:—

TECHNICIAN I (620/WGE/45).

TO supervise and control several workshops engaged in the manufacture of electronic equipment and to assist a professional engineer in the investigation of new manufacturing processes and the development of prototype electronic equipment. Applicants must be familiar with modern light machine shop practice, including sheet metal work as applicable to radio and the assembly, wiring and testing of electronic equipment.

TECHNICIAN I (624/WGE/45).

TO control a department engaged in the inspection of mechanical details and assemblies and in the inspection and testing of electronic equipment. Duties will also involve the design of electronic test equipment for use on a production line. Applicants should be familiar with the testing and inspection of electronic equipment and have a good knowledge of light engineering workshop practice.

TECHNICIAN II (621/WGE/45).

TO supervise and control a small group engaged on engineering of prototype electronic equipment for small scale production. Applicants should be familiar with modern electronic components and be conversant with basic electronic design. They should have had some experience of electronic equipment manufacture and of drawing office practice.

TECHNICIAN II (622/WGE/45).

TO control a team engaged on the planning for production of electronic equipment and to liaise with sub-contractors on technical difficulties experienced during manufacture. Applicants should have had previous experience in similar duties. They should be familiar with modern electronic components and manufacturing processes. A knowledge of inspection and contracts procedure would be an advantage.

TECHNICIAN II (625/WGE/45).

TO control skilled staff engaged in the final testing of electronic equipment. To design test equipment for use on final inspection and production lines and to contribute to the production of prototype electronic equipment. Applicants should have had previous experience of similar duties. They should also be familiar with modern electronic components and manufacturing techniques.

TECHNICIAN III (623/WGE/45).

TO assist in engineering of prototype electronic equipment and to carry out planning of small scale production. Applicants should be fully conversant with modern electronic components and be familiar with basic electronic design. They should have had some experience of electronic equipment manufacture and of drawing office practice.

TECHNICIAN III (626/WGE/45).

TO control skilled staff engaged in the making of a wide range of models, formers, moulds, etc., in wood. To advise on the purchase of timber and to design instrument cases and special packing cases for shipment of apparatus. To control a paint and spray shop. Applicants should have had previous experience of the type of duties detailed.

APPLICANTS for all posts should have served a recognized engineering apprenticeship and possession of H.N.C. or O.N.C. or equivalent qualification is desirable.

SALARY:

TECHNICIAN I, £830-£1,015 (Male).

TECHNICIAN II, £710 (linked to age 30)-£830 p.a. (Male).

TECHNICIAN III, £575 (linked to age 26)-£715 p.a. (Male).

IN addition a London allowance will be payable.

THE successful applicants will be required to join the Authority's superannuation scheme.

REQUESTS for application forms by POST CARD to Senior Recruitment Officer, A.W.R.E., Aldermaston, Berks, quoting the appropriate reference number. [4667

SITUATIONS VACANT

TELEVISION engineers able to drive required by leading and progressive dealers; good salary, conditions and prospects.—Singer's, 350, Edgware Road, W.2. Pad. 7915. [4213

DEVELOPMENT Engineer required for laboratory of well-known television and radiogram manufacturer.—Write, giving experience and qualifications, to Box 3615. [4650

PARTRIDGE Transformers, Ltd., have a vacancy for an engineer experienced in transformer testing and development; to take charge of transformer testing department. WRITTEN applications giving details of past experience, qualifications and age to the Chief Engineer, Partridge Transformers, Ltd., Tolworth, Surrey. [4475

ELECTRICIANS required by The Steel Company of Wales, Ltd. (Steel Division), Port Talbot, for work on industrial electronic equipment.
CANDIDATES should have previous experience and/or technical background as basis for period of training.
THOSE wishing to apply should write stating age, experience, etc., to the Personnel Superintendent, The Steel Company of Wales, Ltd. (Steel Division), Abbey Works, Port Talbot, Glam. [4422

THE Chemical and Metallurgical Division of the Plessey Co., Ltd., is engaged in the development of interesting new products for the electronics, radio and T.V. industries.
CHEMISTS, metallurgists, and ceramists are required for development work on semiconductors, electrical ceramics, magnetic materials and electrolytic capacitors.
ATTRACTIVE posts are available for junior and senior grades in new, well equipped and expanding laboratories.
POSITIONS offered are permanent and pensionable and offer considerable scope for advancement; salaries will be generous and commensurate with qualifications and experience.—Write in confidence to the Technical Manager, The Plessey Co., Ltd., Towcester, Northants. [4406

R. B. PULLIN & Co., Ltd., invite applications for the following vacancies in their recently formed and expanding electronic development division:—
(a) SENIOR development engineer: applicants should possess an Honours Degree or equivalent qualifications and should have had several years experience of the development of electronic circuits, preferably including work on electrical servos and magnetic amplifiers.
(b) JUNIOR development engineer: qualifications to O.N.C. or H.N.C. standard together with some previous experience of valve circuit design.
THE positions are of a permanent nature; they offer excellent prospects and the opportunity to work in a newly equipped laboratory on a variety of projects requiring considerable individual technical responsibility and initiative.
A commensurate salary will be paid; contributory pension scheme, canteen and recreational facilities.—Applications will be treated as confidential and should be made to the Superintendent Electronic Development Division, R. B. Pullin & Co., Ltd., Phœnix Works, Great West Rd., Brentford, Middlesex. [4611

RADIO and/or television engineer required for bench and outside repairs, driver; references, age, experience, salary expected.—Field's Radio, Ltd., 52, Hall Gate, Doncaster. [3562

TECHNICAL writers, with experience, are required by a reputable N. London electronics company, these well-paid positions are interesting and require initiative.—Write Box 3653. [4673

G9AED experimental television transmitter, South Norwood. A full-time operator is required, capable of locating and rectifying circuit and component faults, academic qualifications not essential; training period given.
APPLICANTS should be mobile and prepared to move to the Midlands for a short period if necessary, after a few months.
ON closing down the transmitter the operator will be transferred to the company's permanent technical staff.
APPLICATIONS (in confidence), giving full details of qualifications and experience, with some indication of salary required, to The Secretary, Belling & Lee, Ltd., Great Cambridge Rd., Enfield, Middlesex. [4651

RESEARCH Engineers, preferably of degree standard, and with a sound knowledge of communications and, particularly, electronics, required for experimental work relating to underwater sound apparatus.
APPLICATIONS, giving past experience, technical qualifications, age and salary required, should be addressed to the Personnel Manager, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Ilford, Essex [4390

RADIO service mechanics required by Smiths (Radiomobile), Ltd., for many parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [0342

TWO draughtsmen required for work on interesting electronic development for small progressive company near Southampton.—Reply stating age, qualification, experience and salary expected to Box 3234. [4613

CHIEF mechanical designer for research dept. of large manufacturers of electronic equipment; prev. exp. in electronic industry essential; salary up to £1,500 p.a.; North London area.—Write Box 3419. [4632

Solder with LITESOLD

REGD. TRADE MARK

The Technical Editor of the "Wireless & Electrical Trader" in the March 5 issue on page 582 says:—

"We have had several models in constant use in our laboratory. One with an ⅛in. bit was left on continuously day and night for three weeks and then for another month all day only, and was in constant use during the day, without failure of the element."

LIFE TEST

The three ⅛in. models connected to a 240-volt mains day and night since March 6, 1954, are all still functioning satisfactorily — now over 10,000 hours.

Details of full range in folder No. S.P. 5 sent on request.

Sole Manufacturers and Distributors:

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PRECISION SHEET METALWORK

We specialise in manufacturing of Chassis in all metals, large or small quantities to your own specifications.

V. W. BEAMISH

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BASS REFLEX CABINETS

Walnut, Mahogany or Oak, veneered, 30-in. high.
For 8-in. Speakers, 10-in. Speakers, 12-in. Speakers.
£9-0-0d. £9-10-0d. £10-0-0d. carriage paid.

FOR BUYERS ABROAD

We now have a collapsible Tropic Proof Model of our Standard Bass Reflex Cabinet. (Patent Pending)

GOODMANS & G.E.C.

Full range of cabinets for these speakers.

You can see your cabinet being made in our cabinet-making workshop.

Cabinets made to order.
Armstrong Chassis and Amplifiers.
The Leak TL/10 Amplifier.
LOUDSPEAKERS.

Open till 5.30 Saturdays

A. DAVIES & CO. (Cabinet Makers)

3 Parkhill Place, off Parkhill Road, London, N.W.3. GULLIVER 5775.

SITUATIONS VACANT

CHEMISTS, metallurgists and ceramists are required for the Chemical and Metallurgical Division of the Plessey Co., Ltd.; attractive posts are available for junior and senior grades.
APPLICANTS should be interested in the development of semiconductors, electrical ceramics, magnetic materials and electrolytic capacitors and experience in any of these fields would be an advantage.
POSITIONS offered are permanent and pensionable and offer considerable scope for advancement; salaries will be generous and commensurate with qualifications and experience.—Write in confidence to the Technical Manager, The Plessey Co., Ltd., Towwcestr, Northants. [4405

ROYAL AIRCRAFT ESTABLISHMENT requires radio and electronic mechanics and aircraft electrical fitters to serve as research and experimental mechanics or research and experimental mechanics (special).
RATE of pay on entry 158/10d or 158/10d+26/-, according to experience, for 44-hour 5-day week, with prospects of reassessment of rate within one to three months; any increase back-dated to date of entry.
PROSPECTS of advancement to higher rates of pay.
APPLICATION to Director, Royal Aircraft Establishment, Farnborough, Hants, giving full details of apprenticeship, training (including Forces training), qualifications and experience. [4616

RADAR Scanner Mechanics, ex-Forces tradesmen required for maintenance and repair of scanner mechanisms.—Apply stating age, experience and wages required to Personnel Manager (Ref. W.), Box 3013. [4524

WORKS MANAGER for electronic equipment factory, to take full charge of design, production and factory management; high salary and real prospects for capable and experienced man.—Write fully Box 3161. [4592

EXPERIENCED contact setters required with full knowledge of P.O. type relays; good wages and overtime, pleasant working conditions.—Apply Keyswitch Co., 126, Kensal Rd., London, W.10. Lad. 0666/4640. [4640

GENERAL manager to take control of electronic equipment factory, experienced and capable person is offered a high salary and excellent prospects.—Please write fully to Box 3329. [4621

TELEVISION Service Engineer required by A. E. Parsons, Ltd., Stephenson Place, Chesterfield; state experience and present salary, etc.; a house for living accommodation will be provided. [4631

TV and radio engineer, fully experienced; £12 p.w. to right man, and normal shop hours, able to drive.—Radio & Electrical Services, 35, Westbury Ave., Wood Green, N.22. Bow 2068. [4421

THE Edison Swan Electric Company, Ltd., have vacancies in their Special Products Development Laboratory for Engineers for Development work on a wide range of electronic instruments and apparatus for Medical, Industrial and Government use.
PLEASE write, stating experience, age and salary required, to 155, Charing Cross Road, London, W.C.2, reference SP/LAB. [0083

TECHNICAL Assistants required for development of electro-mechanical and electronic instruments (marine). Work involves initial experiments, sea-going trials, pre-production models and factory liaison. Occasional visits overseas are arranged.
QUALIFICATIONS—Practical: 5 years' workshop or drawing office experience. Academic: City & Guilds Telecommunications Final Group Certificate, or equivalent.
APPLICATIONS, stating salary required, should be addressed to the Personnel Manager, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Essex. [4508

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

TECHNICAL sales manager with sound knowledge of television; give full details education, technical qualifications, sales experience, knowledge of overseas countries and languages spoken.—Reply Ferguson Radio Corpn., Export Division, 105, Judd St., W.C.1. [4614

ELECTRONIC engineer, degree or equivalent, previous design experience of V.H.F. F.M. mobile equipment essential; small but rapidly expanding organization on south coast (near Southampton).—Write full details, age, experience and salary expected to Box 3453. [4634

DEVELOPMENT ENGINEERS to help design electronic instruments; permanent posts, salary range £550-£750 p.a. according to experience.—Taylor Electrical Instruments, Ltd., Montrose Avenue Slough. Tel. Slough 21381. Write or 'phone for appointment. [4591

MOTOR vehicle distributors require capable car radio fitter with substantial installation experience; excellent rates of pay, pension scheme, etc.—Apply Service Manager, Lamb's, Ltd., Standard House, Southend Road, Woodford. Wanstead 6666. [4594

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2(a) Senior and Intermediate Draughtsmen for design and layout of Rack Mounting Laboratory Equipment, Electronic and Electrical Instruments. Previous experience in the Radio Industry is desirable.

(b) Senior and Intermediate Draughtsmen for design of Wiring Layouts. Knowledge of components used in the Radio Industry is essential.

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SITUATIONS VACANT

SENIOR and junior electronic engineers required for high fidelity sound reproduction projects; applicants should give full details of qualifications and experience by letter to Chief Engineer, Pye, Ltd., St. Andrew's Rd., Cambridge. [4487

PROJECT engineers to control and co-ordinate electronic and mechanical projects, experience of estimating, planning, time and motion study desirable; a progressive position in expanding firm; high salaries, superannuation scheme.—Box 3088. [4580

ELECTRICAL SERVICE (EDGWARE), Ltd., 93, Edgware Rd., W.2, require urgently a senior T/V and radio service engineer; able to take complete charge of service dept.; clean licence, good refs., congenial, top salary.—Pad. 2342. [4264

McMICHAEL RADIO, Ltd., Slough, Bucks, have vacancies from time to time for electronic engineers to be engaged on Government projects; those wishing to be considered are invited to write fully to the Chief Engineer, Equipment Division. [0198

TRANSFORMER Designer required for development projects involving audio-frequency power transformers, pulse transformers, oil-filled units, etc.—Apply stating age, qualifications and experience to The Personnel Manager (Ref. R.G.), The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [0260

SENIOR Transformer Designer required to take charge of design office dealing with small transformers, power, audio, pulse, etc. Excellent prospects for an engineer with practical experience as well as academic knowledge. London area.—Box 3026. [4528

EXPERIENCED sound engineers required immediately for servicing cinema and sound reproducer equipment in Manchester area.—Write, giving details of experience, to the British Thomson-Houston Co., Ltd., Construction Department, 15, Quay St., Manchester, 3. [4587

RADIO inspectors required for service depot at London Airport; knowledge of A.R.B. procedure desirable; basic knowledge of radio theory and test equipment essential.—Write in first instance to Mr. D. Smith, Asst. Chief Inspector, Decca Navigator Co., Ltd., 244, Burlington Rd., New Malden. [4633

DESIGNER-Draughtsmen required for work on audio equipment, to produce manufacturing details from prototype information. Wide variety of work including electro-mechanical devices and casing details.—Apply Chief Engineer, Pye, Ltd., St. Andrew's Rd., Cambridge. [4522

ELECTRONIC engineer required for maintenance and construction of specialised factory equipment; final City & Guilds, Higher National or Inter B.Sc. standard; age preferably under 35; reply stating experience and salary.—Anglo-Celtic Watch Co., Ltd., Ystradgynlais, nr. Swansea. [4603

ENGINEER for long-established West End retailer dealing with high fidelity equipment, preferably sympathetic to classical music; will be required at times to demonstrate, assemble, convert and instal equipment of highest quality. —Write Box No. 8557, c/o Streets, 110, Old Broad St., E.C.2. [4641

ELECTRONICS TECHNICIAN, experienced, for interesting and varied work in teaching and research laboratories, salary £610 by £20 to £690, depending on experience and qualifications.—Apply Department of Electrical Engineering, University of Birmingham, giving particulars of experience. [4589

METALLURGICAL factory in Buckinghamshire requires male laboratory assistant with some experience of electronics for operation of direct reading spectrograph, on shifts; training on the instrument will be provided; apply, stating age and experience, to—Box 3410. [4630

COMMERCIAL bank with large expanding hire purchase business requires clerical staff, aged 22-39, pension and bonus scheme, paid holiday for applicants joining before 31.5.55, excellent prospects.—Write, giving full details, to Box W.W.251, c/o 191, Gresham House, E.C.2. [4584

TELEVISION field and bench service engineers required immediately for modern service department of leading radio retailers in East London; wages up to £14 per week or according to ability; permanent position.—Apply for interview to Leytonia Radio, Ltd. Tel. Leytonstone 1396. [4271

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APPLICANTS must be free to travel in this country; this is a monthly salaried position; it is progressive and carries entrance to the Company's contributory combined pension and life assurance scheme.—Apply Personnel Manager, Thorn Electrical Industries, Ltd., Great Cambridge Road, Enfield, Middlesex. [4597

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Your 12C arrived safely and was with much excitement fitted into its cabinet and given a thorough test. Needless to say it passed with flying colours and is all you claim it to be. Firstly an audio oscillator was used with the amplifier and the Duode given a frequency run measured by ear from 30 cps. to 16,500 cps. That in itself was amazing, but it was obvious that the response extended well beyond these limits. Using a first class pickup we then played a new RCA-Victor Toscanini record. I have never been so greatly impressed in all my life—here was in my opinion the last word in sound reproduction . . . To say that I am satisfied is a complete understatement.
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SITUATIONS VACANT

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THE G.E.C. Stanmore Laboratories invite applications for the following vacancies:—
1. CIRCUIT Engineers to fill several vacancies in our engineering development laboratories. The Group is responsible for developing production prototype models of equipment for the services, including items such as:
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(REF. WW/MW.1).
2. MICROWAVE Engineers for work on transmitter receiver equipment for guided weapons. The vacancies are in laboratory teams engaged on engineering development for production (Ref. WW/MW.2).
ALL the above posts are for experienced engineers. There are, however, a limited number of vacancies for men who are studying for H.N.C. or equivalent qualification.
3. TRIALS Staff for several posts at levels appropriate to H.N.C. and Honours degree standard for work on Radar Type Equipment. In some cases an ability to carry out theoretical assessment would be an advantage. Some interest in flying and aircraft is desirable. Service qualifications of appropriate standard considered (Ref. WW/JMCP.1).
4. ENGINEERS to fill vacancies in a recently formed Special Development Section working on:—
(a) ELECTRONIC equipment design AR/BAT. 1/WW.
(b) LIGHT electro mechanical and hydraulic servo development. AR/BAT.2/WW.
(c) GENERAL radar electronic development AR/BAT.3/WW.
APPLICANTS for senior posts should have a sound electrical or mechanical background preferably with academic qualifications in Electrical/Mechanical Engineering or Physics, and those for junior posts should have obtained H.N.C. Electrical.
5. EXPERIENCED Physicist and/or Electrical Engineer to work on circuitry and servo design aspects of radar equipment (Ref. WW/SM).
PLEASE apply in writing to the Staff Manager, G.E.C. Stanmore Laboratories, The Grove, Stanmore Common, Stanmore, Middx., quoting the appropriate ref. number. [4668

ASSISTANTS (Scientific). The Civil Service Commissioners invite applications for pensionable posts. Applications may be accepted up to December 31st, 1955, but early application is advised as an earlier closing date may be announced either for the competition as a whole or in one or more subjects. Interview Boards will sit at frequent intervals.
AGE at least 17½ and under 26 years of age on January 1st, 1955, 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 or mathematical subject. At least two years' 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 essential 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).
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INSTALLATION Engineer required by well-known manufacturers of mobile and fixed V.H.F. communications equipment; excellent opportunities for advancement; sound knowledge and experience necessary; write giving full particulars to—Sales Manager, British Communications Corporation, Ltd., Exhibition Grounds, Wembley. [4647

SENIOR electronic engineer wanted to take charge of field project for initial period of 18 months, age group 27 to 35, must be single and medically fit and prepared to take complete charge of organisation, administration and technical supervision of team in isolated situation abroad; qualifications required B.Sc. Degree or H.N.C. plus at least three years' experience in electronics or Final Cert. Five Years' Course C. & G.; good prospect of permanency in large and expanding organisation; overseas salary £1,250 to £1,400.—Box 3272. [4618

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SITUATIONS VACANT

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ELECTRONIC engineers are wanted in large Midland engineering plant, the positions are progressive and interesting requiring qualified and experienced electronic engineers, senior and junior for rapidly expanding laboratory engaged upon measurement and control problems.—State age, qualifications and experience fully, in confidence, to Box 3082. [4534

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ELECTRONIC Engineer required by London manufacturers of radio components to take charge of measurements laboratory and test gear design; experience of measurement capacitors or telecommunication cables essential; salary £750 p.a.—Write details of qualifications, experience, age and present salary: Box 2259. [4375

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HONOURS graduates in physics or electrical engineering are required for advanced work in a quartz crystal laboratory; the positions offered afford excellent opportunities for young men or women to specialize in the study of piezoelectric materials from both the theoretical and practical viewpoints; an interest in mathematics and electronics would be an advantage for this work.
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HATFIELD INSTRUMENTS, Ltd., who are now expanding their laboratories, required senior and junior electronic engineers with experience in the design and test of high grade radio and industrial laboratory equipment.—Apply in writing, in the first instance, stating age, experience and salary required, to Hatfield Instruments, Ltd., 175, Uxbridge Rd., Hanwell, W.7. [4452

MINISTRY OF SUPPLY requires electronics technician at Burghfield, near Reading, to supervise investigation of faults in radar, H.F. and pulse circuits; qualifications, British of British parents, recognised engineering apprenticeship or equivalent training in appropriate trade, detailed knowledge of radar, H.F. and pulse circuitry essential; experience in fault finding and compiling investigation reports advantageous; H.N.C. or equivalent desirable; salary within £772-£945 p.a.; not established but opportunities to compete for establishment may arise.—Application forms from M.L. & N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D150/5A. [4531

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1,000 WATT AUTO WOUND VOLTAGE CHANGER TRANSFORMER, tapped 0/110/200/230/250 volts, **£5/15/-** each, carriage 4/6. 500 watt ditto, **£7/15/-**, carriage 7/6. 350 watt **55/-**, 500 watt **75/-**, 200 watt **45/-**.
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3. TECHNICAL MAINTENANCE ENGINEER with experience of vacuum equipment and automatic and mechanical apparatus of the type used in C.R.T. production. Knowledge of electronic circuitry would be an advantage.
4. PLANT ENGINEER. A young mechanical engineer, preferably with some knowledge of vacuum or chemical techniques is required to assist in the design of automatic plant for C.R.T. and valve production.
5. CIRCUIT ENGINEER for work with new types of valves including the design of circuitry for use with them. The successful candidate would also assist the Sales Department in establishing these new types.
6. VALVE DESIGN ENGINEERS holding good hons. degrees in Physics or Electrical Engineering and preferably with previous experience of Valve design.
7. CIRCUIT ENGINEER for Ceramic Valve Laboratory, having experience of R.F. work and preferably of pulse circuitry. He would be required to determine the characteristics of advanced types of valves opening up new and interesting fields.

Salaries would depend on age and experience within the following ranges:
Post 1, £800-£1,000 per annum.
Posts 2, 4, 5, 6, and 7, £600-£900 per annum.
Post 3, £500-£700 per annum.
Permanent staff appointments with Pension benefits. Application forms from Mr. T. J. Lunt, Staff Manager, Ferranti Ltd., Hollinwood, Lancs. *Please quote reference* PDH1, 2, 3, 4, 5, 6 *OR* 7.

A Leading Radio and Television Manufacturing Company requires the services of a Chief Engineer. Salary up to £3,000 per annum, according to qualifications and experience. Superannuation and Insurance Schemes in operation. Please reply, in strictest confidence, giving full details to Box No. 2694.

SITUATIONS VACANT

A SENIOR Engineer is required for a responsible post on design of Communications Receivers and Low Power V.H.V. R/T Equipment. Applicants should have a good engineering or science degree, or equivalent qualifications and at least five years' experience in these fields in responsible positions.—Applications should be addressed to Personnel Department. S.E., Murphy Radio, Ltd., Welwyn Garden City. [4430

A SENIOR Communications Engineer is required for responsible post on design of Carrier Telephony Radio Links. Applicants should have a good engineering or science degree, or equivalent qualifications and at least five years' experience in a similar post.—Applications should be addressed to Personnel Department. S.C.E.. Murphy Radio. Ltd., Welwyn Garden City. [4431

SIEMENS BROTHERS & Co., Ltd., require technicians for their Research Laboratories at Blackheath, S.E.3 engaged in work on electronics and telecommunications; pensionable staff posts with good prospects of advancement. —Apply in writing to Siemens Brothers & Co., Ltd., Ref. 744/12, Woolwich, S.E.18, giving particulars of age, qualifications, experience and salary required. [4462

CRAFTSMEN for Radio and Television Service required at Shrewsbury and Ludlow districts; applicants must be fully experienced in the repair and maintenance of all types of radio and television receivers; rate of pay at present 4/1 per hour; N.J.I.C. conditions.—Apply, in writing, to Mr. W. Winwood. Sub-Area Manager, Midlands Electricity Board, Spring Gardens, Ditherington, Shrewsbury. [4463

EDISON SWAN ELECTRIC Co., Ltd., have a vacancy for an engineer to take charge of their Special Products' Development Laboratory. candidates should have an engineering degree or its equivalent, and should have experience in developing electronic equipment ready for factory production.—Please write full particulars, including age and salary required. to 155. Charing Cross Rd., London, W.C.2. Reference K. S. P. [0086

RADIO technicians required by International Aeradio, Ltd.. for overseas service; permanent and pensionable positions, inclusive salary from £894 per annum to £1,373 per annum, tax free. according to marital status; free accommodation; kit allowance; free air fares; generous U.K. leave.—Qualified candidates to whom replies only will be sent please write quoting RT to Personnel Officer. 40. Park St., W 1. [0262

DEVELOPMENT Engineers.—A leading Manufacturer of Radio and Television Receivers has vacancies in its Laboratories for Electronic Engineers with experience in the Design and Development of this tpye of equipment. Situated in the Midlands. Salaries according to qualifications and experience.—Those interested should write, giving details of career and salary expected to the Personnel Manager (Ref. GLB.) Box 2541. [4427

THE LONDON HOSPITAL MEDICAL COLLEGE, Turner St., London, E.1, requires a technician for the construction, testing and maintenance of electro-medical apparatus: O.N.C. or equivalent qualification desirable but not essential; salary, according to age and experience, on the Whitley Scales for Medical Laboratory Staff.—Applications, stating age, qualifications and experience, to the Secretary within 14 days. [4652

APPLICATIONS invited for Electronics Technician. Duties include construction of equipment for wide range of researches. Previous experience an advantage but suitable applicants having just completed National Service considered. Salary in range £340-£480, plus London Weighting. Pension scheme.—Write Professor A. R. Ubbelohde, Department of Chemical Engineering. Imperial College, S.W.7. [4666

UNIQUE opportunity for the right man; medium-sized engineering company in S.W. London requires enthusiastic electronic engineer to take charge of small development section; academic qualifications necessary, but breadth of interest even more important; products range from aircraft radio equipment and radio components to domestic appliances and tape recorders; substantial salary and assured future for the right man.—Box 3233. [4612

ESTIMATOR; Decca Radar, Ltd., invite applications for a responsible post as estimator in their laboratories; applicants must have a sound knowledge of mechanical and electronic engineering coupled with substantial suitable industrial experience; excellent starting salary with a rising scale; British nationality essential; pension scheme. —Reply, quoting RLA 84, to Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey. [0193

DECCA RADAR LIMITED invite applications from young men, preferably of H.N.C. standard or above, who would like to become microwave engineers working in the modern wide field of navigational aids; training will be given to suitable applicants to fit them for a progressive career; British nationality essential; there is a pension scheme in operation.—Write, giving full personal particulars and quoting RLA91 to Deccar Radar, Ltd., Radar Research Laboratory, 2, Tolworth Rise, Surbiton. Surrey. [0131

ENGINEERS AND DRAUGHTSMEN: Excellent opportunities for keen and enthusiastic engineers and draughtsmen for a wide variety of work associated with Radio and Machine Frequency, Resistance Heating Development, and Application problems. The posts are permanent and pensionable, and every opportunity for advancement is available. Salary will be in accordance with age, experience and qualifications.

Engineers for development and design of Radio Frequency Generators. Applicants must have had a full time electrical apprenticeship and experience in high power R.F. equipment. Qualifications—H.N.C. or full time University Degree.

Engineers for development and design of Mechanical Handling Equipment associated with Radio and Machine Frequency Heating Applications. Applicants must have had a full electrical or mechanical apprenticeship and experience in the design of Mechanical Handling Equipment, including pneumatics and hydraulics. Qualifications—H.N.C. or full time University Degree.

Technical Assistants and Junior Engineers for Experimental Laboratory work on problems related to the application of Radio, Machine Frequencies, and Resistance Heating. Candidates must have had a full time electrical or mechanical apprenticeship and reached at least O.N.C. standard.

Draughtsmen, Seniors and Juniors for circuitry layouts, mechanical and electrical equipment associated with Radio, Machine Frequency, and Resistance Heating Applications. Candidates must have had a full electrical or mechanical apprenticeship and have O.N.C. or H.N.C. in mechanical or electrical engineering.

Write for application form to: **The Personnel Manager, Metropolitan-Vickers Electrical Co., Ltd., Trafford Park, Manchester, 17, marking envelope 'R.I.'**

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The Company is a member of a major communications Group and the posts, which are available for both senior and junior applicants, are pensionable and offer scope for advancement. There is a five-day working week. Applications in writing, which will be treated in strict confidence, stating age, education, qualifications and salary expected, should be addressed to The Engineer-in-Chief, Hivac Limited, Greenhill Crescent, Harrow, Middlesex.

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SITUATIONS VACANT

(1) PHYSICISTS and Electronic Engineers are required for the Chemical and Metallurgical Division of the Plessey Co., Ltd. Attractive posts are available for junior and senior grades in new, well-equipped and expanding Physics and Electronics Laboratories. APPLICANTS should be interested in the development and application of semi-conductors, dielectric, piezoelectric or magnetic materials.
POSITIONS are permanent and pensionable and offer considerable scope for creative work; salaries will be generous and commensurate with qualifications and experience.—Write in confidence to the Technical Manager, The Plessey Co., Ltd., Towcester, Northants.
(2) THE Chemical and Metallurgical Division of the Plessey Co., Ltd., is engaged in the development of interesting new products for the electronics, radio and TV industries.
PHYSICISTS and Electronic Engineers are required for development, applications and instrumentation work on semi-conductors, ferro-electric and ferromagnetic materials.
ATTRACTIVE posts are available for junior and senior grades in new, well equipped and expanding Physics and Electronics Laboratories.
POSITIONS are permanent and pensionable and offer considerable scope for advancement. Salaries will be generous and commensurate with qualifications and experience.
WRITE in confidence to the Technical Manager, The Plessey Co., Ltd., Towcester, Northants.
(3) THE Plessey Company, Ltd.—Vacancies exist in new, well-equipped and expanding laboratories of the Chemical and Metallurgical Division for junior and senior Physicists and Electronic Engineers with progressive ideas; experience in any of the following fields an advantage:
Magnetic measurements.
Acoustics.
Piezoelectricity
Design of electronic apparatus.
Radio interference suppression.
Design of electromagnetic devices.
POSITIONS are permanent and pensionable and offer considerable scope for advancement; salaries will be generous and commensurate with qualifications and experience.—Write in confidence to the Technical Manager, The Plessey Co., Ltd., Towcester, Northants. [4260

MARCONI'S WIRELESS TELEGRAPH Co., Ltd., require draughtsmen at their Chelmsford and Acton offices; men experienced in the design of radar, radio or electronic equipment are needed to meet expanding development programmes; 5-day week, superannuation fund, social and athletic club, modern canteen.—Apply to the Secretary, Marconi's Wireless Telegraph Co., Ltd., New St., Chelmsford, stating age, training and experience. [4608

SIEMENS BROTHERS & Co., Ltd., have vacancies in their laboratories at Woolwich for assistant engineers to carry out experimental work on electronics as applied to long-distance telephony; the work covers multi-channel carrier current telephony and telegraphy over long distance open-wire lines and cables in addition to VHF and UHF radio circuits; field trials for such new equipments afford opportunities for short periods of overseas experience, and young engineers can obtain overseas installation experience.
THE laboratories are also engaged on the development of specialised carrier current terminal equipment for use with submarine cable systems employing submerged repeaters; opportunities are available for dealing with mechanical design, the physical principles of component design and the miniaturisation of equipment.
THERE are vacancies for young engineers who wish to take up sales and project engineering work involving commercial as well as technical requirements; this work necessitates a period of laboratory training before undertaking overseas travel.
APPLICANTS should have Ordinary National Certificate or higher qualification; experience in the maintenance of multi-channel carrier telephone or telegraph equipment an advantage. APPLY Siemens Brothers & Co., Ltd., Ref. 744/11, Woolwich, S.E.18. [4377

A VACANCY exists for an electronic instrument development engineer in the Telecommunications Laboratory of British Insulated Callender's Cables, Ltd., at Kirkby, nr. Liverpool; candidates should hold a degree in physics or engineering and have previous experience in the design and development of electronic instruments.—Applications, quoting reference P/60/54, should be addressed to The Staff Officer, B.I.C.C., Ltd., Prescot, Lancs. [4593

MURPHY RADIO, Ltd., have vacancies in the Electronics Division Laboratories for qualified engineers to design and develop the following: 1. V.H.F. and U.H.F. Communications equipment. 2. Airborne and Ground radar equipment. 3. Computing devices and servo systems. 4. Nucleonic equipment and measuring instruments. 5. Transistors. The salary range is £600-£1,000 per annum depending upon experience. Further posts are available to engineers of H.N.C. standard of equivalent having less experience, the salary range being £450-£650 per annum. These vacancies are at Welwyn Garden City but one or two vacancies of a similar nature are available at the Ruislip Works.—Applications, giving age, full details of qualifications, experience and salary required, should be forwarded to Personnel Department, Murphy Radio, Ltd., Welwyn Garden City. [4432

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Applications, quoting D.O.35, giving details of age, experience, and salary required, should be addressed to the Personnel Manager, Aircraft Division, BRISTOL AEROPLANE COMPANY LIMITED, Filton House, BRISTOL.

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SITUATIONS VACANT

DESIGNER (25-55 years) required by old-established firm of electrical component manufacturers in N.W. London. Applicants must possess sound knowledge of radio frequency circuits, pulse forming networks and experience in the electronic, radio and/or television industry would be an advantage. Superannuation scheme.—Write, stating age, experience and salary required, to Personnel Manager, Box 3M S4590, A.K. Advg., 212a, Shaftesbury Ave., W.C.2. [4665

DECCA RADAR LIMITED require the services of a first-class mechanical engineer for work on their microwave link systems; this post is a special appointment and a substantial starting salary is envisaged on a rising scale; British nationality essential; pension scheme in operation.—Please write, giving full particulars and quoting RLA89, to the Research Director, Decca Radar, Ltd., Radar Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [0130

I grew up in the radio components trade and my 30-year-old business is flagging for want of the right kind of help; I need someone—now—with specialized knowledge and experience like my own, who knows the business inside out, who can compile and maintain a catalogue, and who will justify high pay; technical knowledge alone insufficient, must have experience; write me fully if you think you are the man, but remember I want someone to help me, not a passenger to teach.—Box 3454. [4636

SENIOR and junior design draughtsmen required for interesting work in connection with electronic equipment, commercial radio and television and/or light electro-mechanical engineering. London area; the positions vacant offer ample scope and opportunity for future advancement to men of good ability; a high salary will be paid to the selected candidate; all recognised staff privileges available; please reply, giving full details of experience to—Box 2442. [4409

TELEPHONE engineers.—A well-known London company manufacturing Telecommunication equipment have vacancies in their sales section for (a) engineers for preparing tenders, (b) engineers for editing and writing technical publications, (c) engineers for instructing and training customers' engineers; should have good knowledge of carrier telephone and VF telegraph systems; canteen and sports club facilities; pensionable staff posts; state age, qualifications and experience.—Box 2287. [4379

DECCA RADAR, Ltd., have vacancies for radar mechanics and wiremen in their research organization; these positions carry excellent rates of pay and the possibility of promotion to staff appointments; the work is of a varied and interesting nature, concerned with the development of modern navigational aids; there are good canteen facilities; British nationality is essential.—Reply, quoting ref. RLA 78, to Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey. [0138

DECCA RADAR, Ltd., invite applications from electrical engineers and physicists of degree standard, having practical experience in microwave components, to work on advanced microwave and millimetric aerial design in a rapidly expanding group; the prospects for men of ability are considerable. British nationality essential; a pension scheme is in operation.—Please write to Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey, quoting reference RLA95. [0192

DRAUGHTSMEN.—An expanding production programme has created a number of vacancies for mechanical designers, senior daughtsmen and detail draughtsmen; situated in the Midlands; the work involves the complete engineering of electronic apparatus for Government contracts and of domestic radio and television equipment.—Applicants interested in this type of work, with or without experience, are invited to apply, giving details of career and salary expected to the Pesonnel Manager (Ref. GLB.), Box 2438. [4398

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Allesley, Coventry, requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments for work on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager, Ref. R.G. [0259

MINISTRY OF SUPPLY requires Electronics Technicians at Farnborough, Hants (and possibly at Bickley, Kent, later) to supervise, or assist in, scheduling of R.A.F. telecommunication equipment showing breakdown into sub-assemblies and components; preparing lists of spares, connectors for aircraft installations; ensuring completeness of contractors drawings. Qualifications—British of British parents. Recognized engineering apprenticeship or equivalent in electronics. Must have long workshop experience radio/allied equipments, able interpret drawings, specifications, circuit diagrams. Knowledge component standardization and R.A.F. servicing requirements advantageous. O.N.C. or City and Guilds or equivalent desirable. Vacancies in two grades at salaries within £535 (age 26)—£772. Application forms from A.B.1181, London Appointments Office, Ministry of Labour and National Service, 1-6, Tavistock Square, W.C.1. [4674

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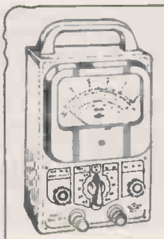

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A standard of approximately H.N.C. is desirable but lesser qualifications would be acceptable if combined with practical ability and experience of this or analogous work (e.g. in H.M. Forces). Permanent Staff appointments with Pension benefits.

Application forms from Mr. T. J. Lunt, Staff Manager, Ferranti Ltd., Hollinwood, Lancs.

Please quote reference HGN.

SITUATIONS VACANT

WINSTON ELECTRONICS, Ltd. have a vacancy for an engineer in their development laboratories. Applicants should have several years' experience on audio frequency circuits, in addition to general electronic circuit knowledge, and would be required to work on loudspeaking telephone equipment. A reliable man is required, who can cope both with development work, and with installation queries.—Apply in writing to Chief Engineer, Winston Electronics, Ltd., 1, Park Rd., Hampton Hill, Middlesex. [4526

THE General Post Office has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster-General's First Class Certificate of Proficiency in Radiotelegraphy; selected candidates will be considered later for permanent pensionable posts.—Application should be made to The Inspector of Wireless Telegraphy, Radio and Accommodation Department, Wireless Telegraph Section, Union House, St. Martins le Grand, London, E.C.1. [4635

RADIO (Meteorological) Technicians 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 United Kingdom and overseas. Commencing London salary £467/10 at age 25 or over, rising annually to £565, subject to deductions for each year below age 25, Provincial salary £20 to £30 lower; overtime, night duty allowance, etc.—Apply at any Employment Exchange, quoting Borough 881. [4467

BUSH RADIO Ltd., require senior and junior engineers in their laboratories at Chiswick, Kew and Plymouth; applicants should preferably hold a Higher National Certificate, B.Sc. Engineering or Physics, or equivalent qualifications; experience in the following fields of development would be an advantage; Domestic radio or television, electronic equipment for aircraft, communication receivers, pulse circuits and micro-wave techniques.—Write, giving full details and salary required, to the Chief Engineer, Power Rd., Chiswick, W.4. [4395

AN electronic or electrical engineer of degree standard is required to take charge of the engineering department in a factory which is part of a large organisation engaged in the manufacture of all branches of communications equipment. The successful applicant will be responsible for engineering development, design and specification of all new items, as well as routine engineering problems. The wide field of work to be covered offers considerable opportunity for advancement. Living accommodation for single or married persons can be made available.
BOX W., R2417, A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [4490

MANAGER required for a unit of a well-established engineering company engaged in large-scale production of radio and television; the successful candidate will have a specialised knowledge of this class of work and will be capable of advising and supervising the design laboratories, tool design, planning and machine and assembly departments; this vacancy offers ample scope and opportunity to a man with high administrative ability; salary up to £2,500 per annum; London area.—Please reply, in confidence, giving full details, to Box 3083. [4535

THE TELEGRAPH CONDENSER Co., Ltd., invite applications from engineers fully experienced in radio and television design to assist Chief Development Engineer in development of printed circuits. Qualifications at least to A.M.I.E.E. standard. This position offers scope for the right man who must be capable of initiating and following projects to finality, including contact with customers. Superannuation scheme.—Write giving full details of qualifications and experience, age and salary required, to Personnel Manager, T.C.C., Ltd., North Acton, W.3. [4312

DECCA RADAR, Ltd., have, due to the continued expansion of their research laboratories, a number of vacancies for circuit design engineers; these cover work in a wide field, embracing high and low power pulse, receiver, A.F.C. radar display, and test equipment design in standard and sub-miniature form; applicants should be of degree standard; experience is desirable but not essential; there is a pension scheme in operation; British nationality.—Please write, quoting RLA 93, to Decca Radar, Ltd., Research Laboratories, 2, Tolworth Rise, Surbiton, Surrey. [0191

TECHNICAL sales/service manager required for British West African branches of large British company distributing domestic radio receivers, V.H.F. radiotelephone equipment, intercommunication telephones, domestic and commercial refrigerators, air conditioners, and office equipment; good technical radio background essential; refrigeration experience desirable; familiarisation course arranged with U.K. manufacturers prior to departure for Africa; first-class passage sea/air, free furnished quarters, full pay on leave after approximately 18-month tours, pension scheme; apply in own handwriting stating age (preferably between 21 and 30), whether married or single, full details education, qualifications, national service and business experience; original references should not be sent.—Apply T. S. D., Box 1134. [4489

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For design and development work in a guided weapon project. At least 3 years' experience in electronics or H.N.C. is necessary.

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For design work in precision instrumentation. At least 3 years' experience in design precision engineering or H.N.C. is necessary.

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Application giving full particulars of age, qualifications and experience to be addressed to:

A. V. ROE & CO. LTD., WEAPONS RESEARCH DIVISION, WOODFORD, CHESHIRE.

Engineers required for new and expanding Research Laboratory in the Surrey/Hampshire Area. The work consists of fundamental studies in a variety of branches of Electronics. The posts offer scope for initiative, considerable freedom of action and opportunities for advancement. Vacancies exist for the following posts:—

(1) 1 Senior Engineer to take charge of a group studying initially problems of Microwaves.

(2) 1 Senior Engineer to take charge of a group engaged initially in a Mathematical and Experimental Study of Modulation.

Applicants, who should be graduates or equivalent, should have had several years' experience in research or development work, although not necessarily in the field indicated above. Commencing salary, according to qualifications and experience, in the range £800 to £1,200.

(3) 4 Engineers to work in the above groups.

Applicants should preferably possess a degree or H.N.C. and have had some experience in Electronic Development. Commencing salary according to qualifications and experience, in the range of £700 to £900.

(4) 4 Draughtsmen to work on the above projects.

(5) 3 Instrument Makers to work on the above projects.

These positions are permanent and facilities are available for Company Insurance and Superannuation. Please reply, in confidence, giving full details of qualifications and experience, to Box No. 3164.

SITUATIONS VACANT

TEST Engineers are required by a Leading Midlands manufacturer for:—(1) Testing and Fault-Finding on Radar Units and other Electronic Devices. (2) Construction and maintenance of Test Equipment. (3) Testing and Fault-Finding on domestic Radio and Television Receivers. These progressive positions cover a wide range of activities and selection will be made not only on experience but also on ability to respond to further training. Ex-Service technicians are particularly suitable.—Applicants should write, giving details of career to date and salary expected to the Personnel Manager (Ref. GLB.). Box 2540. [4426

APPLICATIONS are invited from senior project engineers with a specialised knowledge of the manufacture of electrical and mechanical products; applicants should have a good practical engineering background and a sound technical experience of tool design and planning and be capable of putting new projects on a sound production basis; these vacancies offer excellent opportunities to men seeking permanent and progressive positions; London area.—Applications, which will be treated in confidence, should give full details of experience and salary required, and be addressed to Box 3085. [4537

LABORATORY Assistants required for vacuum tube development laboratory. Education to standard of School Cert. or equivalent, preferably to Inter. B.Sc. or equivalent. Applicants can be male or female and should be interested in physics and chemistry. Previous experience of vacuum tube work desirable but not essential. Male applicants should have completed National Service, and all applicants must be of British or Commonwealth birth. 5-day week. Pension Scheme. Good canteen.—Write, stating age, experience and salary required to Cinema-Television, Ltd., Worsley Bridge Rd., Lower Sydenham, S.E.26. [4527

AIRCRAFT radio aerials.—Gloster Aircraft Co., Ltd., Gloucester, have a vacancy for an electronic engineer (H.N.C. or equivalent) to work on the development of suppressed aerials for aircraft; the work involves theoretical and practical knowledge of measurements from "H.F." to "X" bands and of the properties of different types of suppressed aerials. A SMALL laboratory is being established for the work; an elementary knowledge of aircraft design and construction would be an advantage.—Applications, stating age, previous employers and experience, etc., should be addressed to the Employment Officer. [4533

UNIVERSITY OF SOUTHAMPTON.—Research assistant with an interest in the development of electronic instruments required in the department of aeronautical engineering; the selected candidate (who should be of degree or H.N.C. standard) will be expected to apply his knowledge to the problems which occur in aerodynamic research and to co-operate directly with aerodynamicists already engaged on such problems.—Applications in writing, giving full details of education, qualifications and experience, together with names of two persons to whom reference may be made, to The Secretary and Registrar, before May 31st. [4610

THE Mullard Radio Valve Co., Ltd., has a number of vacancies for Electrical Engineers or Physicists to undertake Applied Research Work in the applications of transistors and kindred devices; the field offers opportunities for original work and at times requires considerable ingenuity; further advanced studies and publication of results is encouraged.
IT is intended that the posts will eventually carry considerable technical responsibility in an expanding organization; for this reason applicants should possess a good honours degree and some previous experience or, alternatively, a real interest in electronics would be an advantage.
COMMENCING salary will be according to individual qualifications and experience and will provide progressive remuneration for increased responsibilities; applications in writing, which will be treated in confidence, should be addressed to—Personnel Officer, The Mullard Radio Valve Co., Ltd., New Rd., Mitcham Junction, Surrey, quoting ref. JFG/H.1. [4638

JUNIOR development engineers are urgently required to assist in the development of precision electronic laboratory instruments; successful applicants will be engaged on interesting long-term projects concerned with the development of a wide range of equipment; the appointments are permanent and carry considerable technical responsibility; applicants should have had previous development experience preferably in the instrument field; academic qualifications ranging from H.N.C. to degree standard are preferable; salaries are dependent upon age, qualifications and experience.—Apply stating full details to the Personnel Manager, Furzehill Laboratories. Ltd., Boreham Wood, Herts. [4609

SENIOR methods engineer required by a large and progressive engineering company situated in the London area; applications are invited from men with good engineering qualifications and experience in the manufacture of radio, television and services equipment; the accepted candidate will have extensive experience of this class of work and will be acquainted with the most up-to-date production methods, including work study and standard costs; for a man with the required knowledge, initiative and drive, this vacancy provides excellent prospects; salary range from £800 to £1,500 per annum.—Please reply, in confidence, giving full details of previous experience, to Box 3084. [4536

First-class Design Draughtsmen required for high production press tools, jigs, fixtures, etc., for valve and cathode ray tube components. Background of practical experience and O.N.C. least qualification, but H.N.C. preferred. Experience in the use of tungsten carbide an advantage. Rates substantially above normal minimum for men of suitable experience. Five-day week, staff pension scheme, modern welfare amenities. Apply Personnel Superintendent,

The Edison Swan Electric Co., Ltd.,

Cosmos Works, Brimsdown, Enfield, Middlesex

Test Gear Design Engineers and Maintenance Engineers required with practical experience of this class of work, based on sound knowledge of electronic principles. These vacancies are permanent and progressive. A company pension scheme in operation. London Area. Please write, in confidence, giving full details of qualifications to Box No. 3447.

Special purpose machinery and equipment design draughtsmen required. O.N.C. least qualification, but H.N.C. preferred. Men with imagination and initiative to develop original ideas with minimum direction. Basic applied electrical knowledge an advantage. Rates substantially above normal minimum for men with suitable experience. Five day week, staff pensions scheme, modern welfare amenities. Apply Personnel Superintendent,

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SITUATIONS VACANT

FERGUSON RADIO CORPORATION, LTD., have a vacancy for an engineer with initiative and a sound technical background to take charge of a small, well-equipped test-gear laboratory situated at Spennymoor, Co. Durham; the post is permanent for a man with previous similar experience and able to carry responsibility in a rapidly expanding department and offers exceptional promotion and long-term prospects; the successful applicant will be eligible for the Company's pension and life assurance scheme.—Applications, in writing, giving full particulars as to age, qualifications and experience, to Personnel Manager (Quote - 0979), Ferguson Radio Corporation, Ltd., Gt. Cambridge Road, Enfield, Middlesex. [4599

MINISTRY of Transport and Civil Aviation. Radio technicians (men only) required at aerodromes and radio stations in various parts of U.K.; special training courses for keen technicians with basic quals.; interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids; prospects of permanent pensionable posts and advancement; rates of pay (London) from £342/10 at age 19, to £467/10 at 25, rising (subject to qualifying tests) to £565; rates slightly lower in provinces; shift and night duty allowances from 2/- to 5/- also payable; candidates aged 19 or over with practical experience in maintenance of radio or radar equipment should apply to any Employment Exchange, quoting Westminster 6627. [4649

A VACANCY occurs for a development engineer in a design group concerned with a wide range of small transformers and inductors of types used in radio equipment and electrical appliances. Preference will be given to applicants having experience of this class of work, but young engineers with a sound basic training and limited experience will be considered, and if successful will have the opportunity of gaining practical knowledge of design problems met in fulfilling commercial and military specifications. An attractive salary is offered together with good future prospects. The Company's extensive laboratory and production facilities are situated in the London area.—Please reply, giving details of qualifications and experience to Box 2993. [4521

D.S.I.R. require (ASSISTANT EXPERIMENTAL OFFICERS) at Mechanical Engineering Research Laboratory, East Kilbride, near Glasgow, to assist in developing electronic devices including pick-ups, amplifiers and associated equipment for precision measuring apparatus. Candidates must have two passes in G.C.E. at advanced level in mathematics and science, if over 22 would normally be expected to have pass degree, H.N.C. or equivalent in engineering or physics; general knowledge or practical experience of electronics an advantage; inclusive annual remuneration for 45½-hour week within range: (men) £297-£659, (women) £297-£570; East Kilbride is a new town with good housing prospects.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A 133/5A. Closing date June 10th. [4615

B.B.C. requires Engineering Staff (British, minimum age 20) for operations and maintenance duties at transmitter, studio, recording and television centres. Must be willing to serve anywhere in U.K. and have completed or been exempted from National Service. Experience in radio engineering desirable. Essential qualifications include university degree, Higher National Certificate or equivalent in electrical engineering, or success in examination for C. & G. Final Certificate in Telecomms. or full Technological Certificate or Graduateship of I.E.E. or Graduateship with maths. of Brit. I.R.E. Promotion prospects. Starting salary £545, rising by 5 annual increments to £755.—Requests for application forms (enclosing addressed envelope and quoting ref. EX.25, W.W.) should reach Engineering Establishment Officer, Broadcasting House, London, W.1, within 7 days [4664

WAR Department requires Technical Adviser to Director of Signals, War Office, London, for advice on all aspects of communication engineering as applied to signal projects world wide and solution of related technical problems; applicants must be British subjects, physically fit and able to travel to any part of the world; they must hold A.M.I.E.E. or University degree in electrical engineering (electronics or light current) and have sound up-to-date theoretical knowledge of radio, particularly H.F., V.H.F. and microwave, and of V.F. and carrier techniques of telegraphy, with sound practical experience of H.F. and microwave radio, including aerial techniques associated with long-distance H.F. communication and microwave radio relay; bias of work is on radio side, and successful applicant will be required to plan and design communication systems; salary according to age, qualifications and experience within range £1,035-£1,355.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D645/54A. [4637

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