Designers of medium power transmitters will want to know more about the Ediswan ESA.2500. The Ediswan ESA.2500 is a forced air cooled triode designed for use as an R.F. Amplifier or Oscillator. The design of the valve is such that lead inductance is minimised and the valve is, therefore, particularly suitable for H.F. application.

**RATING**

- Filament Voltage (volts) $V_f$: 8.0
- Filament Current (amps) $I_f$: 80.0
- Maximum Anode Voltage (volts) $V_a(max)$: 7,500
- Average Maximum Filament Emission (amps) $F_{em}$: 4.5
- Maximum Anode Dissipation (kW) $W_a(max)$: 2.5
- Mutual Conductance (mA/V) $g_m$: *5.5
- Amplification Factor $\mu$: *55.0
- Anode Impedance (ohms) $r_a$: *10,000
- Maximum Operating Frequency at full rating $f$: 40 Mc/s

* Taken at $V_a=7,000$V; $I_a=400$ mA

* At higher frequencies the maximum permissible anode voltages and inputs must be reduced.

**REDIFON G.41. SHORT WAVE TRANSMITTER USES THE ESA. 2500 IN MODULATOR AND OUTPUT STAGES**

This medium power short wave Transmitter can be used for Telegraphy, Telephony or Broadcast services in any part of the world. Power output is 5.75kW on Telegraphy. Frequency range 2 to 23 Mc/s.
Wireless World
RADIO, ELECTRONICS, TELEVISION

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

Editor:
H. F. SMITH

SEPTEMBER 1955

In This Issue

Editorial Comment .................................. 405
Rocket Sounding in the Upper Air. By Sir Edward Appleton .... 406
Differentiating Speech and Music ....................... 407
World of Wireless .................................... 408
National Radio Show .................................. 412
Guide to the Stands ................................... 414
Letters to the Editor .................................. 427
Neon F.M. Tuning Indicator. By John D. Collinson .... 428
Toronto Audio Show. By P. G. A. H. Voigt ............... 430
Language Translation by Electronics. By J. P. Cleave and B. Zacharov ................................. 433
Etched Foil Printed Circuits. By H. G. Manfield ........ 436
American Oscilloscope Technique. By A. J. Reynolds .... 441
Transistor Equivalent Circuits—3. By W. T. Cocking ...... 444
Books Received ........................................ 448
Design of Tchebycheff Filters. By G. H. Burchill .......... 449
Simplified G.C.A. ...................................... 451
Vertical Pattern of V.H.F. Aerials. By E. G. Hamer .......... 452
Fourier—Fact or Fiction? By "Cathode Ray" ................. 455
Ultrasonic Fish Detection .............................. 458
Standard Chassis. By T. K. Cowell ........................ 459
Short-wave Conditions .................................. 460
Aerial Circuit Magnification. By S. Kannan ................ 461
Rugby Radio Extension ................................ 463
Random Radiations. By "Diallist" .......................... 464
Unbiased. By "Free Grid" ................................ 466

VOLUME 61 NO. 9
PRICE: TWO SHILLINGS

REASONS FOR 90° SCANNING

The screen size of direct-viewing picture tubes has grown rapidly since the television service was restarted after the war. The 9-inch circular tube of 1946 has been supplanted by progressively larger tubes, the latest of which has a rectangular face with a 21-inch diagonal. If these larger tubes had been merely expanded versions of the 9-inch tube, the problem of cabinet depth, which was present even in 1946, would have been very much aggravated. Tube lengths, however, have been kept within reasonable limits by the introduction of greater scanning angles. If, for a given screen size, the scanning angle of the electron beam is increased, it follows that the gun and the deflection coils will be moved in towards the screen, and the overall length of the tube will be reduced. The effectiveness of this solution to the problem is shown by the fact that a 21-inch tube with the same scanning angle as a 9-inch tube would be half as long again as it actually is. The new Mullard 21-inch, 90° tube type MW53-80, which is shown in the photograph, is, in fact, about three inches shorter than a 70° tube of the same screen size.

CIRCUIT AND TUBE PROBLEMS

Wide angle scanning eases cabinet design, but it brings problems of its own. The most serious is the disproportionate increase in the deflection coil power requirements. If the scanning angle is changed from 70° to 90°, the power which must be supplied by the line timebase output transformer is increased by 50 per cent. A second complication is that the beam at maximum deflection is liable to be intercepted by the envelope of the tube, producing corner cutting of the picture. Thirdly, in tubes with approximately flat faces, the deflected beam strikes the screen at increasingly acute angles, and the spot may be markedly defocused at the edges of the screen.

These difficulties have been countered by improving the efficiency of the scanning system and its associated circuits, so that the increase in power drain is not out of proportion to the gain in useful picture size. A practical line scanning circuit, in which the efficiency is improved by the use of the full h.t. line potential in conjunction with tuning of the leakage inductance of the output transformer, will be described in a further advertisement in this series.

Deflection defocusing and corner cutting are overcome by careful tube and deflection unit design. In particular, the scanning coils and the front of the yoke are shaped to fit the cone of the picture tube—giving optimum sensitivity.

A NEW PICTURE TUBE

The Mullard MW53-80 is an indirectly heated direct-viewing tube with a 90° deflection angle and a rectangular screen with a 21-inch diagonal. The metal-backed grey glass screen, with white fluorescence, has a useful area of 378mm by 482mm. The tube incorporates an ion trap, and the electron gun is designed to give uniform focus over the whole screen. Magnetic focusing and double magnetic deflection are used. The capacitance formed by the external conductive coating and the final anode may be used to provide smoothing for the e.h.t. supply. The 6.3V, 300mA heater is suitable for parallel or series connection. The overall length of the tube is 507 ± 10mm.

Operating data for the MW53-80 will be included in the reprint of this advertisement.
**B.B.C. Report**

The past year has been one of great technical development in British broadcasting, and so it is not surprising that the engineering section of the B.B.C.'s Annual Report for 1954-55 provides some interesting sidelights on the Corporation’s activities. Only in one place is gloom apparent; that is in dealing with the present position on the medium-wave band. Here, it is evident that things are likely to become worse rather than better, in spite of many efforts to improve the service. “It would appear that the point is now being approached at which little or no improvement in medium-wave reception can be gained by means of additional stations, so long as they must share a wavelength with an existing station.”

An enterprising piece of research into v.h.f. propagation at long range over water has been undertaken by installing at Scheveningen in Holland a Band II transmitter which works in conjunction with five receiving stations on the East coast. Apparently the main purpose of this experiment is to collect data on the possibilities of long-distance interference.

A commendably realistic approach is disclosed towards the allied problems of studio acoustics and monitoring control. The Report says: “Improvements in correlating acoustic quality, as assessed by experienced listeners, with the results of laboratory measurements helped towards the improvement of studio acoustics generally. A study was also made of the effect of the acoustics of listeners’ living rooms upon the quality given by a particular studio. This study led to a comparison between the conditions under which programmes are heard by listeners and the conditions under which they are heard by the B.B.C. staff in the control cubicles attached to the studios; as a result, further attention will be given to the improvement of the listening conditions in the cubicles.”

That last sentence gives food for thought and may well provoke controversy. It might even be argued that the conditions in the control cubicles should be degraded rather than improved. In these matters there are two schools of thought. One contends that the monitoring loudspeaker should match the average listener's mediocre receiving equipment, so that he may be given a signal that “sounds nice” to him. The other point of view, of course, is that the output should allow full justice to be done to it by the best receiver and loudspeaker used under the best conditions.

**Velvet Glove or Mailed Fist?**

For well over a quarter-century, there has been talk of compulsory interference suppression. As long ago as 1949 the Postmaster was given the necessary legal powers but, so far, has done little to put them into effect. Up to the present, no user of interfering electrical equipment has been bound to fit suppressors; compulsion has so far been applied only to makers of internal combustion engines.

A big change takes place on September 1st. On that day the P.M.G.'s regulation, laid before Parliament in March, comes into force. The new order imposes an obligation on all users of small electric motors to keep radiated and conducted interference within specified limits on the bands of frequencies used for television Band I and for medium- and long-wave sound broadcasting. A second regulation (No. 292) imposes similar obligations on manufacturers and sellers of refrigerators. It should be noted that manufacturers of motors are not yet affected; this matter is still under review.

What will be the effect of the regulations just coming into force? Much depends, we believe, on the way they are administered. When they were first issued, an official statement said the Post Office would not use its new powers except when it is necessary “to insist on an appliance being put right because it causes interference and the owner will not voluntarily have a suppressor fitted.” A policy of too much velvet glove and not enough mailed fist would, we believe, fail to achieve a significant reduction in the present intolerably high level of interference.

---

*Cmd. 9533; H.M.S.O., 4s 6d.

Rocket Sounding in the Upper Air

Confirmation of Results Inferred from Radio Measurements

Recent official announcements have made clear that rocket investigations of the upper atmosphere will be conducted by at least four countries during the International Geophysical Year 1957-58. Indeed, it is evident that rocket work will provide the main new technique to be used during this year of intensive geophysical investigation, just as the radio sounding of the ionosphere was the novel technical feature introduced in the work of its predecessor, the International Polar Year of 1932-33.

American workers, with their ten years of experience with rockets, have already amply demonstrated their great value for upper air measurements in situ—measurements which have confirmed and extended results previously inferred from atmospheric soundings by sound and radio waves. For example, the study of the propagation of sound waves to great distances led to the conclusion that there must be a warm layer of air in the middle atmosphere; while all readers of Wireless World are aware that the ionosphere was discovered by experiments on radio wave reflection. Both the layer of warm air at medium levels, and the ionosphere at still higher levels have been detected in rocket soundings; and in this article I propose to deal with the underlying theory of the types of measurements in the two cases.

We naturally wonder how it is possible to measure any atmospheric characteristic during a rocket flight, since the projectile is only at rest at the top of its trajectory. The most obvious air characteristics of interest are the temperatures and pressures at various heights. But clearly the rocket compresses and heats the air through which it hurls. However, careful experiments have shown that, just ahead of the tail fin of the rocket, there is a place where the pressure is the same as that of the undisturbed air. The recording barometer to measure air pressure can thus be placed there. The first, and basic, relation which has been the object of study by rocket sounding is, therefore, the air pressure as a function of height above sea level. Work of this kind has given a precision to this relationship which could not be expected from previous theoretical speculation about atmospheric characteristics. Fortunately, from the pressure-height curve, it is possible also to make a fairly accurate estimate of the temperature-height relationship in the atmosphere. By contrast, direct measurements of temperature are difficult, if not impossible, because of the heating up of the rocket skin by air friction.

The deduction of air temperature must be made from the values of the pressures observed at two heights which are fairly close together. For example, if \( \Delta p \) is the pressure change over a small range of \( \Delta h \), then it can be shown that:

\[
\frac{1}{p} \frac{\Delta p}{\Delta h} = \frac{1}{H}
\]

(1)

where \( p \) is the average pressure and \( H \) is the scale height of the atmosphere at the average level in question. It is the quantity \( H \) which leads to a determination of atmospheric temperature, since, by definition,

\[
H = \frac{kT}{mg}
\]

(2)

where \( k \) is Boltzmann's constant, \( T \) the absolute temperature, \( m \) the mean molecular mass of the atmospheric constituents and \( g \) the acceleration due to gravity at the height in question. It will therefore be seen that to determine the temperature by this method, we have to make assumptions concerning the nature of the atmospheric gas constituents and their relative proportions.

As mentioned above, rocket soundings, made by American scientists since 1946, have confirmed the existence of the warm belt in the atmosphere, immediately above the stratosphere, the enhanced temperature of which is due to the absorption of solar ultra-violet light by atmospheric ozone. The atmospheric temperature has been shown to start to rise at a level of 30 km above the ground, reaching a maximum at a level of 50 km, thereafter falling to a minimum at 80 to 85 km, above which it rises again.

I now turn to the subject of the rocket exploration of the ionosphere, which is undoubtedly the most spectacular aspect of this fascinating field of enquiry. The ionosphere was discovered in 1924 by the method of radio sounding. One advantage of such a technique is, of course, that the phenomena investigated by radio means are not appreciably altered by the sounding mechanism. There are, it is true, two effects of such a nature, but they are trifling in practice. The beam of exploring radio waves exerts a small pressure—the pressure of radiation—on the ionosphere and pushes it upwards; also, when the radio waves travel into the ionosphere itself, they tend to warm the ionosphere (as in the Luxembourgeois effect). The magnitude of radio power used normally in ionospheric radio sounding is, however, so small that these two effects are inappreciable.

We can therefore claim to measure things in the ionosphere by radio without changing sensibly the things we measure! I now turn to consider the nature of the ionospheric quantities which can be measured in rocket sounding. The American method of measuring the electron density at a given height, which is, of course, the basic quantity of ionospheric interest, depends on a very elegant application of the Doppler effect. Let us assume that a radio set in the rocket is emitting a constant frequency \( f \) as the rocket climbs upwards. Then it is easy to show that the radio frequency received at ground level will be less than \( f \) by the quantity \( df \) where

\[
df = \frac{fv}{V}
\]

(3)

where \( v \) is the mechanical upward velocity of the rocket and \( V \) is the phase velocity of the radio waves in the air.

Wireless World, September 1955
The electron density in the ionosphere is a measure for radio waves. When the ionization is substantial, the wave frequency is appreciably increased. It is so enhanced that the signal is used not only to ionize the region which is the origin of the reflecting power of the ionosphere for radio waves.

If a very high radio frequency is employed in the vicinity of the rocket emitter, the phase of the velocity of the radio waves is a measure for the change in mass and height of the rocket. In this case, the phase velocity is found to be higher, when the rocket is closer to the ionosphere.

Various elegant methods of measuring the Doppler effect have been developed by American scientists. By means of which the relation between electron density N and height h, has been estimated. The N values obtained are of the same order of magnitude as previously measured by radio sounding, but it is already clear that the new technique can supplement, in various important ways, the older radio technique. For example, in the case of the rocket experiments, it is possible to measure directly the value of N in the upper part of an ionospheric layer, whereas this quantity can only be inferred in the case of radio sounding. A word of caution should, however, be added concerning the effect of the rocket itself on measurements of ionization density in the ionosphere. These are based on the assumption that neither the rocket nor the exuded gases affect the ionosphere over a range of one radio wavelength in the ionospheric medium.

American rocket scientists feel that this condition is likely to be fulfilled in the lower part of the ionosphere—e.g., below 140 km—but, at high levels, it is considered likely that gaseous products may spread out to a considerable distance from the rocket itself and so vitiate the accuracy of N determinations.

It is now known that rocket explorations of the upper air will be conducted by the United States, France, Russia, Great Britain, and possibly Australia, during the International Geophysical Year. So far such exploration has been pursued mainly at one site, White Sands in New Mexico. It is therefore most gratifying to learn of the extension of the same technique to other latitudes and longitudes.

Broadcasting Stations of the World

Many hundreds of additions and amendments have been included in the operating details of the 2700 broadcasting stations of the world given in the latest edition of our book "Guide to Broadcasting Stations." To ensure as high a degree of accuracy as possible the tabulated information, secured from many sources, was checked against frequency measurements made at the B.B.C. receiving station at Tatsfield.

Short-wave broadcasting stations throughout the world are listed both geographically and in order of frequency (with power and call sign). The long- and medium-wave lists include only stations operating in Europe.

Details of European v.h.f. broadcasting stations and television transmitters are again included. The growth in both these spheres is shown by the fact that there are now over 300 and 130 stations respectively, compared with 160 and 40 when the last edition was prepared two years ago. Completely revised and in a new format, the 8th edition is obtainable from booksellers, price 2s 6d, or by post from this office, price 2s 8d.
WORLD OF WIRELESS

Marine V.H.F. Modulation • Import-Export Ratio • The T.A.C.

F.M. at Sea

TUCKED AWAY in a written reply in Hansard of July 28th is the announcement by the Postmaster-General that "it is the Government's intention that the United Kingdom should adopt frequency modulation for these [v.h.f. international maritime radio] services."

Dr. Hill stated that other maritime countries in Europe and in the Commonwealth had agreed that in the interest of world-wide standardization f.m. should be used as is already done in North and South America. He added that the majority of the interested parties in this country, including all the shipping interests, are prepared to accept the change which will be made gradually.

Balance of Trade

IT WILL be seen from the following table of radio equipment exported and imported during the first six months of this year and last year that the balance of trade is becoming less favourable. Whereas exports increased by about £0.5M, imports increased by well over £2M, bringing the total imports to nearly 40% of the value of our present exports. Although these figures, extracted from the Board of Trade accounts, do not agree entirely with those issued by the Radio Industry Council, they do give a general picture of the Industry's overseas trade.

<table>
<thead>
<tr>
<th></th>
<th>Exports 1954 (Jan.-June)</th>
<th>Imports 1954 (Jan.-June)</th>
<th>Exports 1955 (Jan.-June)</th>
<th>Imports 1955 (Jan.-June)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valves &amp; c.r. tubes</td>
<td>1,040,860</td>
<td>1,247,740</td>
<td>1,776,353</td>
<td>1,664,494</td>
</tr>
<tr>
<td>Transmitters &amp; nav. aids</td>
<td>6,733,705</td>
<td>6,322,315</td>
<td>919,792</td>
<td>801,483</td>
</tr>
<tr>
<td>Broadcast receivers:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(sound)</td>
<td>1,376,410</td>
<td>1,393,147</td>
<td>1,161,643</td>
<td>3,553,258</td>
</tr>
<tr>
<td>(radiograms)</td>
<td>216,648</td>
<td>283,401</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(television)</td>
<td>101,019</td>
<td>53,773</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound reproducing gear</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Components</td>
<td>489,351</td>
<td>610,263</td>
<td>1,970,000</td>
<td>1,776,353</td>
</tr>
<tr>
<td>Batteries</td>
<td>879,867</td>
<td>1,010,371</td>
<td>3,857,788</td>
<td>6,019,235</td>
</tr>
</tbody>
</table>

Television Advisory Committee

THERE have been a number of changes recently in the membership of the technical sub-committee of the Television Advisory Committee. The chair is occupied by the Post Office engineer-in-chief, now Brigadier L. H. Harris. The Post Office representative is Captain C. F. Booth (assistant engineer-in-chief), in place of H. Faulkner, and A. B. Howe, assistant head of the B.B.C. research department, now represents the Corporation in place of R. T. B. Wynn. Dr. Willis Jackson has resigned.

Three additional members have been appointed, they are L. H. Bedford (Marconi's), T. M. C. Lance (Cinema-Television) and E. P. Wethey (Kolster-Brandes). The inclusion of Mr. Lance may be a pointer to the subject at present being studied; the terms of reference of the T.A.C. included the phrase "television for public showing in cinemas and elsewhere."

Germanium from Coal

AT THE present time one of the main sources of germanium is the flue dust from coal-fired furnaces. Only a small proportion of the available germanium is deposited and the remainder is lost to the atmosphere as fine dust.

A programme has been initiated by the Fuel Research Station of the Department of Scientific and Industrial Research to survey all possible sources and to investigate the distribution of germanium in the coke, tar and liquor by-products of coal carbonization processes. This, according to the "Report of the Fuel Research Board" (published by H.M. Stationery Office, price three shillings), will lead to the discovery of ways of modifying these processes to increase the proportion of germanium recovered.

PERSONALITIES

Sir George Nelson, Bart., is to be president of the I.E.E. for the 1955-56 session. Sir George is chairman and managing director of the English Electric group of companies, which includes Marconi's W.T., Marconi Marine, Marconi Instruments, English Electric Valve and Scanners. He was recently appointed a governor of the Imperial College of Science and Technology.

H. Stanesby, the new chairman of the Radio and Telecommunication Section of the I.E.E., has been closely associated with radio work in the Post Office since he entered the Dollis Hill laboratory as a "youth in training" in 1924. For two years he was responsible for the direction of the radio laboratory at Dollis Hill. Now staff engineer in the Radio Planning and Provision Branch, he has specialized in the development of crystal filters and cable and radio links for television. He has frequently represented this country at international conferences and is chairman of the C.C.I.R. Study Group IX concerned with general technical questions.
Sir Gordon Radley, a deputy director general of the Post Office since last October and before that engineer-in-chief for three years, has been appointed director general and so becomes the first engineer to fill the post. Sir Gordon, who is 57, joined the Post Office as a temporary inspector in the research branch in 1920. He received his Ph.D. from London University in 1934 for his thesis on radio interference from power lines and a knighthood in 1954.

The position of deputy director general, vacated by Sir Gordon Radley, is to be filled by R. J. P. Harvey, who has been director of radio and accommodation for the past 18 months. Mr. Harvey, who is 50, is chairman of the Radio Research Committee set up by the P.M.G. to investigate the problems of clearing mobile radio users from Band III.

Captain K. H. T. Peard, who was captain of H.M.S. Collingwood, the naval electrical school, from 1953 until a few months ago, has been promoted Rear-Admiral and appointed director of the Naval Electrical Department at the Admiralty. He is 53. He succeeds Rear-Admiral Sir Philip Clarke who had held the position from 1951. Sir Philip has been president of the British Institution of Radio Engineers since last October.

Captain G. C. Turner has been appointed assistant Captain Superintendent, Admiralty Signal and Radar Establishment. He was fleet radar officer, British Pacific Fleet, at one time during the war and has since served in the radio equipment and electrical departments of the Admiralty and as executive officer at the electrical school (H.M.S. Collingwood).

Commander J. Forrest, who has recently been appointed to the radio equipment department of the Admiralty, has specialized in air radio matters during his naval career and it is in this field that he will be mainly concerned in his new post.

P. L. Taylor, M.A., A.M.I.E.E., has been head of the electrical section of the College of Aeronautics, Cranfield, Bucks., since its foundation in 1946, has left the College to join the research department of Metropolitan-Vickers, at Trafford Park, Manchester. His article on servo-mechanisms appeared in our January 1952 issue.

M. R. Gavin, M.A., D.Sc., F.Inst.P., M.I.E.E., vice-principal and head of the department of physics and mathematics in the College of Technology, Birmingham, for the past five years, has been appointed professor of applied electricity at the University College of North Wales (Wrexham) going to Birmingham. Dr. Gavin, who received his doctorate from Glasgow University for work on valves for decimetre waves, was for eleven years at the G.E.C. research laboratories, Wembley. Dr. Gavin, who has contributed several articles to our sister journal, Wireless Engineer, was appointed an M.B.E. in 1946.

E. Lawson, M.A., has been appointed chief engineer of the Wireless Telephone Company, Limited, of Sheffield, a member of the Plessey group. He joined the company last year, having previously been senior engineer in the advanced development laboratory of Standard Telephones & Cables.

A. V. Krause, Grad.I.E.E., recently appointed by 30th Century Electronics, Limited, head of cathode-ray tube development at the 30th Century Television, Limited. He had previously been on the staffs of Standard Telephones & Cables and Mullards.

OUR AUTHORS

Professor G. H. Burchill, contributor of the article on the design of Tchebycheff filters, was a designer of synchronous machinery with the Canadian General Electric Company for five years before joining the staff of the Nova Scotia Technical College. He has been teaching for twenty-six years and since 1953 has been professor of electrical engineering at the college.

H. G. Manfield, who described methods of making printed circuits on page 436, has been a member of the P.M.G. (now R.E.) Malvern, since 1946 where for the major part of his service he has been working on printed and potted circuits. During the war he was for some time resident maintenance engineer at several radar stations.

T. K. Cowell, development engineer in the recently formed electronic development division of R. B. Pullin and Company, instrument makers of Brentford, Middlesex, describes in this issue a multi-purpose chassis for experimental work. After six years at the G.P.O. Radio Branch at Dollis Hill, which he entered as a trainee in 1948, he was with Furzehill Laboratories for a few months before joining Pullin in January this year.

S. Kamani, who discusses aerial circuit magnification on page 461, graduated from the University of Madras (India) in 1943 and joined National Ekco Radio and Engineering Company, of Bombay, as development engineer in 1948. Five years later he joined E. K. Cole, Ltd. (Southend), where he is now concerned with the design and development of broadcast receivers.

OBITUARY

Richards W. Cotton, who died recently in Portland, Maine, U.S.A., was well known in the British radio industry, having been controller of signals (communications) at the Ministry of Aircraft Production for some time during his residence in this country from 1943 to 1946. He was at one time chairman of British Rola and was a director of Philco (Overseas), Ltd. In 1952 he was appointed director of the electronics division of the American Defence Production Administration.

IN BRIEF

Television licences in the United Kingdom increased by 52,505 during June (the latest figures available). The number of Broadcast Receiving Licences current in Great Britain and Northern Ireland at the end of June was 14,035,567, including 4,676,422 for television and 275,910 for car radio.

Extended Band III Tests.—Since August 2nd the transmission times of the Bellstra-Lee (G9AED) at Croydon have been extended by 17 hours a week. The times are now Monday to Friday, 9.30 to 12.30, 2.0 to 5.30 and 7.30 to 8.30; Saturday 10.0 to 1.0. Transmissions from G9AED will cease at one o’clock on September 3rd when test transmissions from the temporary I.T.A. transmitter at Croydon (opening on September 22nd) are due to start.

The Monopolies Commission has now appointed nine investigators to consider and report on the supply of valves and cathode-ray tubes, which was referred to the Commission last December. Written and oral evidence is now being taken and any offers to give assistance should be addressed to the Monopolies and Restrictive Practices Commission at 8, Cornwall Terrace, Regents Park, London, N.W.1.

"Inexpensive Wave Analysts." In Fig. 2 of this article (p. 361, August issue) the value of R7 should be 75kΩ, not 33kΩ.

I.E.E. Council.—Among those elected to fill the vacancies on the council of the I.E.E. at the end of September are: Sir George Nelson, president (see "Personalities"), T. E. Goldup, director of Mullards, a vice-president for the second time, Sir Hamish MacLaren, Director of Electrical Engineering, Admiralty, a vice-

WIRELESS WORLD, SEPTEMBER 1955 409
president, and Professors H. E. M. Barlow (University College, London) and J. Greig (King's College, London) ordinary members.

The new committee of the I.E.E. Radio and Telecommunication Section (note the new title), which takes office at the end of September, will be under the chairmanship of H. Stanesby (see "Personalities") with Dr. H. S. McPetrice, who is head of the Radio Department at R.A.E., Farnborough, as vice-chairman. The five vacancies among the ordinary members of the committee will be filled by F. S. Barton (principal director, electronics research and development, M.o.S.), Dr. A. J. Biggs (G.E.C. research laboratories), W. Ross (R.A.E., Farnborough), T. B. D. Terroni (manager and chief engineer, transmission division, A. T. & E.) and F. Williams (senior superintendent engineer, B.B.C.).

An Exhibition of Electrical Standards has been opened at the Science Museum, South Kensington, and will remain open until October 31st. One of the objects is to show the origin and derivation of the various electrical units. The complete set of the original B.A. Units of Resistance, which were made in 1864 for the British Association and constitutes the oldest set of accurate electrical standards now in existence, are to be seen. The Museum is open on weekdays from 10.00 to 6.00 and on Sundays from 2.30 to 6.00.

A new observatory, to be known as the Mullard Radio-Astronomy Observatory, is to be set up by the University of Cambridge as a result of an offer from the Mullard Company to provide £100,000 over a period of ten years for radio-astronomy research.

Brit. I.R.E.—The first meeting of the session will be held at 6.30 on September 28th, at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, when G. I. Hitchcox will deliver a paper on "Extending the limits of resistance measurement using electronic techniques."
An acoustical advisory service has been established by Tannoy, of West Norwood, London, S.E.27, to deal with problems of sound treatment of existing buildings and collaboration with architects in planning new premises are the main functions of this department.

The design and manufacture of filters with Ferroxcube pot cores to customers' specifications is now undertaken by Mullard Components Division.

Magnetic and Electrical Alloys, Ltd., of Burnbank, Hamilton, Scotland, producers of laminations, cores and stampings, have been acquired by the Telegraph Construction and Maintenance Co. J. Ancel Holden is continuing as chairman and W. Randall, a director of Tannoy, has been appointed as vice-chairman and managing director. Tannoy have recently formed a metals group which embraces Tannoy-Magnetic Cores, Ltd., at Chapelhall, Lanarkshire, Temco, Ltd., at Lydbrook, Gloucestershire, Sankey-Telcon, Ltd., at Crawley, and Magnetic and Electrical Alloys.

Bakelite, Ltd., is to market polyethylene under an agreement with Union Carbide, Ltd., who are setting up a plant at Grangemouth, Scotland. Until the new factory comes into operation in 1957, polyethylene imported from the Union Carbide and Carbon Corporation, of America, will be available from Bakelite.

The merchandising division of the Solartron Electronic Group, Ltd., of Thames Ditton, Surrey (new telephone number Emberbrook 5522), has been appointed agent for the United Kingdom, Eire and certain parts of the British Commonwealth for the Consolidated Engineering Corporation, of Pasadena, California, and its associated companies. The Corporation manufactures a wide range of electronic and other industrial equipment.

To enable the audience to see both the live and televised performance of "The Barber of Seville" from Glyndebourne recently, 17 H.M.V. and Marconiphone receivers were installed in various parts of the theatre. The signal was taken from the B.B.C. at video frequency, passed through an amplifier and then distributed to the receivers on the vision frequency of Channel 4.

Kelvin and Hughes, Ltd., announce that they have entered the component market. Among the components listed are a magnetic record/reproduce head and sine-cosine potentiometers.

The sound reproduction equipment in the new Edinburgh Playhouse has been supplied by Pye Marconi. In addition to the 150 loudspeakers used for the entertainment of passengers and crew, there are 35 loudspeakers associated with an emergency system with "talk-back" facilities at each speaker position.

For the demonstration of Pye underwater television at the recent international trade fair in Toronto, a microwave link was used to convey the underwater scenes from the ship stationed some two miles outside Toronto harbour to the receivers in the fair.

Reproducers and Amplifiers, Ltd., the well-known loudspeaker manufacturers of Wolverhampton, celebrated their silver jubilee in July. To mark the occasion a presentation was made to the founder and managing director, H. C. Willson.

Telerection, Ltd., aerial manufacturers, of Cheltenham, Glos., announce the formation of Telerection Developments, Ltd., "to co-ordinate and develop the large expansion plan on hand by the group of nine companies" which includes installation companies in six provincial centres.

Raymond E. Cooke, B.Sc. (Eng.), Grad. I.E.E., joined Wharfedale Wireless Works, Ltd., of Idle, Bradford, at the beginning of August as technical manager and head of the research department.


Telcon Africa (pty.), Ltd., a subsidiary of the Telegraph Construction and Maintenance Company, Greenwhich, has opened a new factory at Wadeville, Germiston, Transvaal.

Hivic Limited, manufacturers of sub-miniature valves, have transferred their registered office from Harrow to their new factory in Stonefield Way, Victoria Road, South Ruislip, Middlesex (Tel.: Ruislip 3366).

Permanoid, Ltd., formerly Associated Technical Manufacturers, Ltd., cable manufacturers, of New Islington, Manchester, have opened a Midlands branch at 558, Wolverhampton Road East, Fighting Cock, Wolverhampton, Staffs. (Tel.: Wolverhampton 38367).

The telephone number of the British Electric Resistance Co., Ltd., and the British Power Transformer Co., Ltd., of Queensway, Enfield, Middlesex, is now Howard 2411.

The new telephone number of Eric's Great Yarmouth factories is Great Yarmouth 4911.

OVERSEAS TRADE

A further substantial order for equipment for transmitting and receiving stations of the Canadian Overseas Telecommunications Corporation has been received by Marconi's W.T. Company through its Canadian associate. The contract provides for the supply of six Marconi-Siemens R/T terminal equipments and ancillary gear.

Decca airfield control radar (Type 424) is being installed at Dum Dum civil airport, Calcutta, where there is already a Type 41 long-range storm warning radar.

A new overseas radio-telephone and telegraph centre for Burma is to be equipped by Standard Telephones and Cables, Ltd., with single-sided transmitters (4 to 40KW), receivers, terminal equipment and beam aerials.

Another contract has been placed with Marconi's by the Gold Coast Posts and Telecommunications Department for the supply of radio-telephone equipment for the country's internal communication system. It provides for the installation of a twin-path, 24-channel (per path) radio communications service from Kumasi to Takoradi, via Mpraeso, Koforidua, Mampong (Akwapim), Accra, Winneba and Cape Coast. The new circuit will eventually link with one already being installed by Marconi's between Kumasi and Tamale in the north.

The New Zealand Post and Telegraph Department is calling for tenders for the supply of some 3,500 valves and cathode-ray tubes of various types. Particulars are obtainable from the Export Services Branch, B.O.T., Lacom House, Theobalds Road, London, W.C.1 (Ref. ES15177/55). Closing date for tenders is September 15th.

Television in Uruguay.—The commercial department of the British Embassy in Montevideo draws the attention of U.K. manufacturers to the potential market for British receivers which will exist when the first television station in Uruguay opens shortly. It is understood that the Sindicato Oficial de Difusion Radio-electrica is contemplating calling for tenders for the supply of 10,000 receivers to introduce the television service to the public. Interested manufacturers not already represented in Uruguay are invited to write to the Embassy in Montevideo.

South African Representatives.—Joseph Teer and Son (Pty.), Ltd., 5 Ulster House, Krui Street, Johannesburgh (P.O. Box 1630), wish to represent United Kingdom manufacturers of trimmer capacitors.

Saudi Arabian Market.—The firm of Suleiman Bakshin, of Medina, have informed the British Embassy at Jidda that they are interested in receiving offers from United Kingdom suppliers of battery receivers and batteries.
National Radio Show

Stand-to-Stand Preview of Technical Exhibits

ON Wednesday, August 24th, Dr. Charles Hill, the Postmaster-General, will open the 22nd National Radio Exhibition at Earls Court; overseas visitors and invited guests are having a preview the day before.

In the following pages we give a brief stand-to-stand survey of the technical exhibits prepared from information given to us by the 121 exhibitors. Although there are bound to be some last-minute releases by manufacturers, we feel that this preview will provide visitors with a useful guide to the show and readers unable to visit Earls Court will, we hope, find the survey valuable.

Visitors will have a foretaste of commercial television for the Radio Industry Council has offered time for short films backed by advertisements to be distributed on the network for the demonstration of Band III receivers. In Television Avenue on the first floor 28 manufacturers will be demonstrating 82 receivers, but they will operate on Band I only; Band III demonstrations are confined to the exhibitors’ stands and demonstration rooms.

Instead of the collective displays of electronic equipment being set up in various odd corners of the show, as happened last year, they are this year being combined with the training display to form a large “electronics and careers” section on the first floor. It will comprise “Electronics of To-day,” including examples of electronics in air and sea transport, medicine, communications, industry, etc., “Electronics of the Future” and a section devoted to careers in which visitors will have the opportunity of seeing the new I.E.E. training film “The Inquiring Mind.”

ALPHABETICAL LIST OF EXHIBITORS

<table>
<thead>
<tr>
<th>Aco...</th>
<th>Acros</th>
<th>Stand</th>
<th>English Electric</th>
<th>Stand</th>
<th>31 (D23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aco...</td>
<td>Electrical</td>
<td>201</td>
<td>Aco...</td>
<td>33</td>
<td>Acros</td>
</tr>
<tr>
<td>Aco...</td>
<td>E.K.</td>
<td>21</td>
<td>Antiference</td>
<td>64</td>
<td>Antiference</td>
</tr>
<tr>
<td>Aco...</td>
<td>Argus</td>
<td>35</td>
<td>Army</td>
<td>388</td>
<td>Army</td>
</tr>
<tr>
<td>Aco...</td>
<td>Assimil</td>
<td>312</td>
<td>Avo...</td>
<td>116</td>
<td>Avo...</td>
</tr>
<tr>
<td>B.B.C.</td>
<td>British Radio &amp; Television</td>
<td>109</td>
<td>British Railways</td>
<td>21</td>
<td>British Railways</td>
</tr>
<tr>
<td>B.B.C.</td>
<td>Brown Bros.</td>
<td>9</td>
<td>Bulgin</td>
<td>59</td>
<td>Bulgin</td>
</tr>
<tr>
<td>Champion</td>
<td>Champion</td>
<td>62</td>
<td>Channel</td>
<td>213</td>
<td>Channel</td>
</tr>
<tr>
<td>Collaro</td>
<td>Collaro</td>
<td>39 (D29)</td>
<td>Cossor</td>
<td>23 (D8)</td>
<td>Cossor</td>
</tr>
<tr>
<td>Cossor Instruments</td>
<td>Cossor Instruments</td>
<td>114</td>
<td>Decca</td>
<td>32 (D2)</td>
<td>Decca</td>
</tr>
<tr>
<td>DeLuxe</td>
<td>DeLuxe</td>
<td>305</td>
<td>Dubl...</td>
<td>221</td>
<td>Dubl...</td>
</tr>
<tr>
<td>Dynatron</td>
<td>Dynatron</td>
<td>24</td>
<td>E.A.P.</td>
<td>303</td>
<td>E.A.P.</td>
</tr>
<tr>
<td>E.M.I.</td>
<td>E.M.I.</td>
<td>215 (D26, D28)</td>
<td>E.M.I. Institutes</td>
<td>31</td>
<td>E.M.I. Institutes</td>
</tr>
<tr>
<td>E.M.I.</td>
<td>E.M.I.</td>
<td>215 (D26, D28)</td>
<td>E.M.I. Institutes</td>
<td>31</td>
<td>E.M.I. Institutes</td>
</tr>
<tr>
<td>Ed...</td>
<td>Ed...</td>
<td>58 (D21)</td>
<td>Eko</td>
<td>12, 121 (D7)</td>
<td>Eko</td>
</tr>
<tr>
<td>Electrical &amp; Radio Trading</td>
<td>Electrical &amp; Radio Trading</td>
<td>102</td>
<td>* Demonstration rooms and offices are prefixed with “D.”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wireless World, September 1955
With this plan and the list opposite of 121 exhibitors (arranged alphabetically under their trade names or abbreviated titles) visitors will readily be able to locate a particular stand. Demonstration rooms and offices are prefixed with "D."

DATES:
August 24th to September 3rd

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

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

ADMISSION:
2s. 6d. (children 1s.)
National Radio Show

Guide to the Stands

ACOS (201)
Piezoelectric (crystal) pickups and microphones for every purpose are made by this firm, and attention is directed to the recently developed GP59 series of pickups for high-quality radio-gramophones and record players.

The GP59-1 is a turnover cartridge of wide frequency range and medium output, and the GP59-3 has a high output with amplifiers having a low overall gain. Both types are fitted with an easily replaceable cantilever stylus.

Microphones range from inexpensive hand type to models suitable for studio work.

Cosmocord Ltd., 700 Great Cambridge Road, Enfield, Middlesex.

AERIALITE (33)
Folded dipoles are used in all the Band III aerials shown by this firm; they include indoor and outdoor types with from three elements upwards. Metal strip is used in many of the indoor models. There is a selection of adaptors for converting Band III aerials into dual-band systems and provision is made for orientating the Band III parasitic element, or elements, to meet the requirements where the B.B.C. and T.T.A. stations are differently sited.

There is also a use made of choice of f.m. aerials, aerial fittings and a range of Band III convertors.

Aerialite Ltd., Castle Works, Stalybridge, Cheshire.

AIRMEC (198)
The Televent Type 877 is a comprehensive television test set in portable form, but mains operated. It enables alignment adjustment of receivers to be carried out in the absence of a "live" broadcast on Bands I and III; a built-in wobbulator and oscilloscope (2-in tube) facilitate visual adjustment.

The coverage is 8 to 70 Mc/s and 168 to 230 Mc/s in two ranges with a crystal-check oscillator for ensuring accuracy. The wobbulator gives a variable sweep at 50/c/s and up to 12 Mc/s bandwidth.

Airmecc Ltd., High Wycombe, Bucks.

ALBA (21)
In addition to a range of 14in, 17in and 21in table model and console television receivers with multi-band turret tuners, a Band III tuning adapter is available for use of the older ALBA models.

Two new sound broadcast receivers have been developed, both with provision for v.h.f. reception. The table Model 3211AC covers short, medium and long waves in addition to the v.h.f. range, for which a built-in aerial is provided. A high-quality output stage feeds an 8in x 5in elliptical loudspeaker. Model 6221 is a radio-gramophone version with a 10-in loudspeaker and 3-speed record changer.


ANTIFERENCE (64)
The "Snapactor" principle of fixing the various elements or rods of a television aerial is one of the principal features of all this firm's Bands I, II and III aerials. It eliminates actual metallic connection between the elements and the feeder, or elements and structure, and is said to eliminate most of the troubles that arise from corrosion. Greatest prominence is given to Band III aerials, both as separate items and as adaptors for existing Band I systems. The range includes indoor and outdoor types. The "Extast" anti-interference aerial now employs high-efficiency ferrite-cored transformers.

Antiferece Ltd., Bicester Road, Aylesbury, Bucks.

ARGOSY (35)
The present range of sound and vision broadcast receivers includes two recently introduced radio-gramophones with 6-watt push-pull output stages which cover four wavebands, including v.h.f. Built-in compressed dipoles are provided, but provision for external aerials for both a.m. and f.m. reception is made. There is also a table-model broadcast set covering the same ranges, with a ferrite rod aerial for long- and medium-wave reception. A new 12in table-model television receiver is being introduced.

Argosy Radiovision Ltd., Hertford Road, Barking, Essex.

ARMY (308)
Both the Royal Corps of Signals, which operates the Army communication network, and the Royal Electrical and Mechanical Engineers, responsible for the maintenance of the equipment, are participating in the Army's exhibit. Examples of the latest telecommunications equipment, test gear and electronic devices used by the Army are to be seen.


ARRELL (111)
This firm specializes in the production of television aerials and associated fittings. They have no fewer than 16 different models of Band I aerials for indoor and outdoor use and a dozen Band III models. A feature of the designs is the use of low-loss polythene insulators on all aerials.

Arrell Electrical Accessories Ltd., New Islington, Manchester, 4.

ASSIMIL (312)
This company—a division of E.M.I. Institutes—has introduced a system of language instruction by gramophone records, based on a method which was originated on the Continent many years ago. For English-speaking people, courses are offered in French, German, Italian and Russian.


AVO (165)
Two new signal generators covering Bands I, II and III make their debut this year. One, the "Mark III," is a moderately-priced instrument covering 150 kc/s to 220 Mc/s in six bands; while the "Wide-Band AM/FM" model provides amplitude-modulated signals over the band 5 to 225 Mc/s, and a frequency-modulated output over 60 to 120 Mc/s. The modulating frequency is 400 c/s and the deviation ±150 kc/s. Other features include high accuracy of adjustment of the oscillator and provision for either sine wave or square-wave modulation.

Another interesting Avo product is the Type 160 valve tester. A full range of Voltmeters is also shown.


B.B.C. (301)
The advantages of v.h.f. broadcasting is the theme of the B.B.C. stand which is situated under the Royal Corps of Signals demonstration theatre, seating about a hundred people. In the theatre complementary tape recordings of reception on a v.h.f. receiver and a medium-wave set, made under varying conditions of interference, will be played over. At each demonstration an engineer will be present to answer questions.


B.B.C. (317)
This firm manufactures v.h.f. radio-telephone equipment for mobile, portable and fixed-station uses. Mobile equipments are generally of 5 watts r.f. output; fixed station sets are of 5 watts and 25 watts output while portable, or pack sets, give about 120 mW output. The latest addition is a motor-cycle installation with selective calling facilities.

British Communications Corporation Ltd., Second Way, Exhibition Grounds, Wembley, Middlesex.

Wireless World, September 1955
Television receivers with 14in and 17in tubes are shown in both table models and consoles. An unusual feature is the use of electromagnetic focus. A 12-channel tuner is included in which two channels only are initially operative.

As a console model there is a new set with a 21in tube.

Hartley Baird, Ltd., Princess Works, Brighouse, Yorks.

**BELLING-LEE (46)**

Combined aerials, separate aerials and adaptors for existing aerials are shown in profusion on this stand. An unusual combination is a Band I-Band II aerial (t.v./f.m.) which should be very satisfactory in areas of relatively high signal strength. It consists of one vertical and one horizontal dipole fitted to a single insulator and sharing a common downlead.

They have a diplexer combining unit for coupling two different (i.e. Band I and Band III) aerials into a single feeder without measurable loss in efficiency of either, or it could be used to split the output from a dual-band aerial designed for a common feeder into two output channels for separate Band I and Band III inputs at the receiver. Their display of aerials, while physically overshadowing their other items, should not be allowed to attract all the visitors' attention. The firm makes a wide range of plugs and sockets, fuse holders, connectors and interference suppressors. They are specialists in the latter business.

Belling and Lee Ltd., Cambridge Arterial Road, Enfield, Middlesex.

**BRIMAR (1)**

So far as valves for domestic applications are concerned, this year's exhibit concentrates attention on types introduced to meet present-day demands in the design of sets for broadcast reception in Bands II and III. Brimar television tubes are now fitted with an improved tetrode gun. A special display of transistors is to be made.

"Special quality" valves figure more prominently than in previous years. The cost of these valves has been considerably reduced, thus attracting designers to their use in wider fields of application.

New "Brimistors" include special types for insertion in valve-heater chains and for the suppression of switching surges. A miniature pattern is made for the protection of filaments in mains/battery portables.

Standard Telephones and Cables, Ltd., Footscray, Sidcup, Kent.

**BULGIN (59)**

The design and manufacture of micro-switches have been an important activity of this firm in recent years; one of the newest additions to their range takes the form of a sub-micro-switch comparable in size to a sixpence, yet which will handle 1.5 A peak current at up to 250 V a.c. or 50 V d.c. Micro-switches can be used either singly or banked for operation by a single multi-cam spindle.

The present range of miniature and standard toggle switches is very wide and most of the numerous types are available with or without insulated operating dollies.

Another important activity is the
BUSH (22, 57)

Television sets with 12in, 14in, 17in and 21in tubes are made by this firm and all cover Bands I and III. Except in the 12in models, the tuning system comprises cam-operated slug-tuned coils, with band-switching, controlled by a multi-position knob and a clicker mechanism. A fine tuning control is provided. These sets also have a.g.c. circuitry on the latter being derived from the sync separator.

Several sound broadcast receivers equipped for f.m. reception will be on view, including a radio-gramophone, the VHIF54, has a magic-eye tuning indicator.

CHAMPION (62)

Four new sound broadcast receivers with v.h.f. ranges form the basis of this season’s programme. Another model, the Model 836 “Fidelio,” is for 88-95 Mc/s only, works from a.c. or d.c. mains, gives 3 watts output into a 6in elliptical loudspeaker and costs £19 19s (including tax).

In the Model 840 console and 841 table model, two electrostatic loudspeakers are used in conjunction with a moving coil unit. Internal dipoles for v.h.f. and ferrite rod aerials for other wavebands are provided in addition to sockets for external aerials. These sets are for a.c. mains only and have three wave-bands—88-95 Mc/s, 200-550 metres and 800-2,000 metres.

An additional short-wave range (200-550 metres) has been included in the Model 880 table model and Model 856 radio-gramophone.

COSSOR (23)

All this season’s television receivers are tunable for alternative programmes: a typical specification is that of the 17in Model 937 with 21 valves. Features include turrett tuning, flywheel sync, and automatic contrast control. There is also a “three-in-one” equipment embodying television, all-wave sound broadcasting and an automatic record changer.

Emphasis is placed upon a.m./f.m. sound sets, of which there are three models, including a radio-gramophone.

COSSOR INSTRUMENTS (AND EXPORT) (114)

This year’s exhibit is concentrated largely on equipment for test and alignment of sound and vision broadcast receivers, both for use in production and maintenance. A typical instrument is the Telecheck and Marker Generator which, when connected to a standard oscilloscope, will present the overall response curve of a television receiver. There is also an alignment generator for f.m. receivers which will be demonstrated at work.

There is also to be a comprehensive display of oscilloscopes ranging from a miniature single-beam instrument to specialized double-beam wide-band models.

A range of export receivers is to be shown.

DOMAIN (305)

This exhibit comprises display stands, tables and trucks. There are 10 models of tables for television sets. They are of tubular metal construction with a shelf.

DE LA RUE (214)

The many plastic materials shown by this firm will include a range of improved insulating boards, and “Delaron Copper Glad,” a composite board specially produced for the making of “printed” circuits by offset litho, screen or photographic processes. This laminate is made to withstand the etching process and subsequent dip soldering and also has good electrical characteristics for the punching of holes.

DEFIANT (69)

A feature of the 17in television set is an electrical shift control; the 14in retains the more usual mechanical arrangement. In other respects the sets are similar. Bands I and III are covered with switch selection and trimmer aerial feeders are used for the two bands.

A radio-gramophone, the RGSH-756, has a push-pull output stage and covers Band II as well as short, medium and long waves. There is a built-in Band II aerial and an internal ferrite-rod aerial for medium and long waves. This can be rotated by hand.

DUBLER (221)

The wide range of capacitors and resistors required by the radio and electronics industry today is well exemplified by the many different types displayed on this stand. Prominence is given to two types of high-voltage capacitors for use in fly-back e.h.t. circuits and types with screw terminals or soldering...
lugs are available. The maximum working d.c. voltage is 20 kV for a ceramic- and 30 kV for a plastic-tube type.

For v.h.f. circuitry Dubilier have a range of miniature silvered ceramic capacitors in normal, feed-through and bushing patterns. Resistors also cover a wide field of application; one of their latest additions is a dual "Q" type with concentric spindles and mains switch. Interference suppression is a speciality of this firm and they now have a wide range of suppressors for domestic and industrial apparatus. One example of this range of equipment being represented is that of the latest model of the "Elizabethan" magnetic tape recorder. It has a response on playback which conforms to C.C.I.R. standards and can be used for the reproduction of E.M.I. and other tape records made to these standards. The amplifier may be used independently for other purposes with a level response from 30 c/s to 15 kc/s.

A new console model and two new portable versions will also be shown.

**E.A.P. (Tape Recorders) Ltd., 546 Kingsland Road, London, E.B.**

**E.A.R. (216)**

Record reproducing equipment is the principal concern of this firm. Portable and console models range from the "Mascot Miniature" to a "High Fidelity F.M.-Gram." The "Armchair Consolette" is provided with a special stand, or it can be used as a table model.

Equipment for the demonstration of gramophone records will also be exhibited.

**Electric Audio Reproducers Ltd., 17, Little St. Leonards, London, S.W.14.**

**E.M.I. (215)**

Equipment for tape recording at a "professional" level is to be a prominent feature of the E.M.I. exhibit. In this category is the high-quality recorder Type BTR/2, designed for record-making companies and broadcasting organizations. Different models provide for choice of tape speeds up to 30in/sec. Other recorders include a portable battery-operated model weighing only 14½ lb. Other E.M.I. activities are also represented in the exhibit. The design and installation of relay distribution systems for both sound and vision broadcasting is undertaken, while another department deals with sound amplification for public build-

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**DYNATRON (24)**

One example of the range of elaborate apparatus being shown on this stand is the Ether Pathfinder a.m./f.m. chassis. It is a tuner covering two s.w. bands, medium and long waves and the v.h.f. band. It has an r.f. stage, frequency-changer and two i.f. stages on all bands. The output is 0.2 V r.m.s. for 40 per cent modulation and the tuner is intended for use with the (separate) LF10 a.f. amplifier. This is a four-valve amplifier with push-pull output giving 12 W for under 0.1 per cent distortion.

A television set, the Condor, has a 21in tube and a 13-channel tuner. Flywheel sync is fitted and a.g.c. is provided on both sound and vision. Dynatron Radio Ltd., The Firs, Castle Hill, Maidenhead, Berks.

**E.A.P. (303)**

The portable "Elizabethan" magnetic tape recorder has a response on playback which conforms to C.C.I.R. standards and can be used for the reproduction of E.M.I. and other tape records made to these standards. The amplifier may be used independently for other purposes with a level response from 30 c/s to 15 kc/s.

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**Left: Collaro "Tape Transcriber."**

**Right: Dynatron a.m./f.m. tuner of Ether Pathfinder.**

**Above: Cossor instruments f.m. signal generator.**

**Decca RG100 radio-gramophone with v.h.f. range.**

**Left: Bush VHF54 covering long, medium and v.h.f. bands.**

*Wireless World, September 1955*
ings, hotels, factories and similar places.

E.M.I. Sales & Service, Ltd., Hayes, Middx.

E.M.I. INSTITUTES (311)
This institute offers home training in the various branches of applied electronics. Emphasis is on the practical side, and students are provided with experimental outfits on which to work. However, there are also courses on theoretical principles.


EDISWAN (58)
Broadcast receiver valves include recently introduced types for Bands II and III; among the latest productions are earthing grid triodes for both parallel and series connection. A new 12in cathode-ray tube, Type CRM124, has an ion trap tetrode gun fitted as standard. Industrial transmitting and special-purpose valves include the "Vapotron" with a novel cooling system; the valve is cooled by water vapour. Air cooling is used in a new 1-kW valve for r.f. heaters.

Among the many components and accessories shown by Ediswan will be a 12-channel turret turner for television receivers. A new co-axial television feeder has cellular polythene insulation; attenuation at 200 Mc/s is given as 3 and 3.2 dB per 100ft for the rigid and flexible types respectively. Components include a number of parts moulded in high-performance fluorocarbon resins.


EKCO (12, 121)
Tube sizes in the television sets shown on this stand are 14in, 17in and 21in. Turret tuning is used for the two bands and some models also include provision for f.m. reception on Band II. One of these, the TC267, with a 17in tube, has spot wobble, flywheel sync and a.c./d.c. The 21in model (TC220) also has these features.

Quite a large number of the sound broadcast sets are now provided with facilities for Band II reception. The smallest is the U243 for a.c./d.c. operation; it has built-in aerials and a tuning indicator. The largest is a radio-gramophone, ARG256, which covers long, medium and short waves as well as Band II. There are a push-pull output stage feeding a pair of loudspeakers, a three-speed automatic record changer, bass and treble tone controls, while provision is made for feeding the radio output to a tape recorder.

Car radio sets are also on view, on stand 121.


ENGLISH ELECTRIC (31)
The television sets shown on this stand are available in two forms—with and without provision for the reception of the three f.m. Band II stations. The vision side is switched off in the Band II positions of the selector switch. All sets cover Bands I and III. There are 17in table and console models and a 21in console in which the tube operates at 15 kV. Permanent-magnet focusing is used with electromagnetic deflection and flyback e.h.t. The set is designed for a.c./d.c. operation and a control barreter is fitted. The power consumption is 170 W.


EVER READY (54)
Though dry batteries for every conceivable application in the radio and allied field comprise the main Ever Ready exhibit, there is also a range of six battery-operated broadcast receivers. These comprise light- and medium-weight portables and transceivers and two table models.

The Ever Ready Company (Great Britain) Ltd., Hercules Place, Holloway, London, N.7.

FERGUSON (14, 102)
A large range of television and sound broadcast receivers is being shown. The "nine-star" television sets are fringe-area models and include an a.c. circuit in which the user has a choice of two time constants. The "new standard" sets are for normal reception (Continued on page 419)
reception conditions. In each range there are 14-in, 17-in and 21-in tube models, and an earlier 12-in design is retained in table-model form.

The sound receivers include the model 329A, for a.c. operation, which includes Band II f.m. reception. There is a range of radio-gramophones, some of which cover Band II. An adaptor to enable f.m. to be received with any existing Ferguson a.c.-d.c. having pick-up sockets is shown.

**Ferranti (13 & 120)**

Broadcast receiving valves specially designed for operating at around 200 Mc/s have recently been added to the Ferranti range. Cathode-ray tubes up to 21in will also be shown.

A series of silicon junction diodes have recently been introduced. These are of the hermetically sealed type with very low reverse currents, designed to withstand high operating temperatures. An important part of the exhibit comprises industrial valves such as trigger tubes, miniature stabilizers, thyratrons and high-voltage rectifiers. Specialized c.r. tubes for industrial use include flying spot scanners.

A demonstration unit will present a picture on a long-afterglow c.r. tube by means of a flying spot scanner system.

**Ferranti, Ltd., Hollinwood, Lancs.**

**G.E.C. (37)**

Among the latest Osram valves is the KT55, a relatively high-power output valve for a.c./d.c. operation on restricted h.t. voltages. A range of recently introduced miniature receiver valves has been designed for operation at around 200 Mc/s. There is a new 21-in cathode-ray tube with a 90° scan angle.

Three new p-n-p junction transistors, Types EW53, EW58 and EW59 cover many different applications, including use in r.f. circuits up to about 0.5 Mc/s. Both germanium and silicon diodes are to be shown, as well as photo-electric devices and cold-cathode trigger tubes.

The present G.E.C. range of television receivers is very wide; all have switch selection of alternative programmes and fully automatic gain control. Fringe-area models are produced. Sound receivers for the present season include a table model and a radio-gramophone with provision for v.h.f. reception.

An interesting 25-watt general-purpose amplifier just produced has a wide range of application. Flexibility of control is a feature.


**Garrard (47)**

Principal interest centres on the 3-speed record changers and record players which form the foundation of many propriety radio-gramophones. For the connoisseur there is the Model 301 "transcription" motor with minimum "wow" and flutter, and a wide range of alternative pickups and record-playing accessories.

**Garrard Engineering and Manufacturing Co. Ltd., Swindon, Wilts.**

**Gibbs (209)**

Television and radio tables and other furniture are exhibited here. Record cabinets are shown in sizes up to the U568, holding 340 records.

**Goodmans (20)**

Once again this stand will take the form of a demonstration theatre—this year with a seating capacity of eighty. The "Axiom" and "Audiom" high-quality loud-speakers will be shown working in a new range of enclosures (types Axiom 180, 280, 480 and 172) which have been designed to give good transient response and a smooth bass in cabinets of comparatively small size.

The Axiom 80 loudspeaker unit, which has hitherto been made for export, is now available in this country, and will be demonstrated. It has a free-edged cone with cantilever suspension, and has a fundamental resonance of 20 c/s.

**Goodmans Industries Ltd., Axiom Works, Wembley, Middlesex.**

**H.M.V. (48, 49)**

High sensitivity and ease of tuning are design features of the new H.M.V. television receivers, which have all main controls at the front. Electrostatic focusing is used; the line scan and e.h.t. unit is completely sealed.

There is a range of sound receivers covering the long, medium and v.h.f. broadcasting bands. The Model 1252 tuner for connection to the pick-up terminals of a receiver provides reception of v.h.f. transmissions; the unit is self-contained, with its own power supply.

Equipment for the "Stereosonic" twin-channel sound reproduction system, described in Wireless World last May, can be heard working in the H.M.V. demonstration room. This equipment can also be used as a

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**Wireless World, September 1955**
single-channel high-quality reproducer of tape records or discs of all characteristics.
E.M.I. Sales & Service Ltd., Hoyes, Middx.

HART (210)
On this stand is to be found a wide range of record cabinets and television tables. The last arc of wood construction and have shelves and castors.

HUNT (8)
With the addition of ceramics and capacitors designed especially for use in printed circuits, the range of capacitors now produced by Hunt is most comprehensive. It includes electrolytics in a wide variety of types, metallized paper, of which the W97 (Thermetic) midget has a nominal working temperature range of -100°C to +100°C, metal foil and paper types, silvered mica, stacked foil and mica and ceramics.
A capacitor test set is also produced; it covers resistance measurements as well.
Printed circuits is another activity of this firm.

INVICTA (53)
The new Type 126 television receiver with a 14-in tube, like all this year's Invicta models, has a 13-channel tuner. There is also a convertor unit for adapting Band I sets for reception of Band III.

A range of table model sound receivers and radio-gramophones providing both a.m. and f.m. reception will also be shown.

J.B. CABINETS (219)
The production of radio and radio-gramophone cabinets for the trade comprises the main activities of this firm and their exhibit consists of a selection of the more interesting models produced recently.
J.B. Manufacturing Co. (Cabinets) Ltd., 86 Palmerston Road, Walthamstow, London, E.17.

J-BEAM AERIALS (104)
The television aerials made by J-Beam have always followed a very distinctive pattern, the feeder being joined, via a suitable matching section to the end of the dipole in place of the more general centre connection. They have recently evolved an even more novel aerial for Band III fringe areas. It consists of a skeleton slot combined with twin yagis.
J-Beam Aerials Ltd., Cleveland Works, Weedon Road Industrial Estate, Northampton.

Left: Twin-channel reproducers for H.M.V. "Stereosonic" system.

Through the addition of the Windom elements and it has wide spacing between elements and it is claimed this provides a somewhat better signal than usual. A broadside array consisting of two wide-spaced 4-element yagis is said to be found for fringe areas.
Labgear (Cambridge) Ltd., Willow Place, Cambridge.

LINGUAPHONE (207)
This company provides courses of instruction in a great number of languages; teaching is through the medium of gramophone records. Various kinds of reproducing equipment are available, including a headphone attachment enabling the student to listen without disturbance.
Linguaphone Institute, Ltd., 207-209 Regent Street, London, W.1.

HCMICHAEL (40)
Particular attention is paid in this season's television receivers to inter-
lace so as to ensure high-quality definition under all conditions of reception. Another feature of the new sets is the omission of a line output transformer; one reason is to eliminate one potential cause of breakdown, another is to restrict temperature rise in the set. In the absence of an output transformer e.h.t. is derived from a separate generator.

Table and console television sets with from 14-in to 17-in tubes are shown and are available with or without a radio chassis. Twelve-channel turret tuners are used throughout the McMichael range. Sound radio sets include a standard chassis for fitting to television sets and several table models, consoles and radio-gramophones.


MARCONIPHONE (50)

Four new television receivers have been introduced; these give the choice between 14-in and 17-in tubes, and table or console cabinets. All are for a.c./d.c. supplies and embody switched coil tuning for 13 channels. Automatic vision gain control is fitted and a wide-range tunable filter is provided for mitigating the effects of diathermy or similar kinds of interference. An 8-channel Band III converter unit for fitting to earlier Marconiphone sets is to be shown.

Most of the new sound receivers provide for v.h.f. reception as well as for medium and long waves, and are also available as radio-gramophones. There will be a comprehensive display of cathode-ray tubes and valves.

The Marconiphone Company, Ltd., Hayes, Middx.

MASTERADIO (36)

Without exception all Masteradio television receivers provide 13-channel tuning, embody an ion trap and are housed in cabinets designed especially for wide-angle viewing. All are superhets and, with the exception of Model TE21C, which is for a.c. mains, they operate on either a.c. or d.c. supplies. Tube sizes range from 14in to 21in.

One of this season's sound broadcast sets is an a.m./f.m. model covering four wavebands; it is known as the “Elstree” and is a table model.


MULLARD (18)

This year's exhibit aims at providing visitors with easily assimilated explanations of the functioning of various electronic devices, particularly of valves, cathode-ray tubes and transistors. There will also be a demonstration showing the advantages of f.m. broadcasting.

In one of the demonstration rooms a specimen 20-W amplifier built around the new EL34 pentode valve will be working. The design of this amplifier was discussed in detail in Wireless World for May and June this year. Another demonstration room will show the uses of devices intended primarily for the equipment manufactured, including picture tubes and components for 90° scanning, transistors for hearing aids, Ferroxcube ferro-magnetic cores and a new grade of Ticonal permanent magnets for loudspeakers. Some of the newer applications of transistors are also demonstrated.


MULTICORE (63)

The main exhibit here will show by practical demonstration how Erisin Multicore wire solder is used in the manufacture of radio receivers.
Though most radio needs are met by six different tin-lead alloys in nine gauges, it is interesting to know that as many as 400 different specifications are available with, for example, melting points ranging from 145°C to 296°C. Another Multicore exhibit shows a complete soldering process that has been developed for printed circuit techniques of manufacture.

The Bib splicer for magnetic recording tape is now being produced in the modified form described in our February issue.

Multicore Solders, Ltd., Maylands Avenue, Hemel Hempstead, Herts.

MURPHY (29)

One of the features of this exhibit is a range of broadcast receivers which include Band II in their frequency ranges. The sets all cover medium and long waves and one short waveband and have a double-triode v.h.f. tuner in which one section acts as an earthed-grid r.f. amplifier and the other as a mixer-oscillator. There is an internal dipole for Band II and this also functions as a plate aerial on the other bands. One model, the A242R, is a radio-gramophone.

Television sets are of 14-in and 17-in types and have turret tuners with a cascode r.f. stage to cover Bands I and III. A direct-drive scanning circuit is used and the sets are available both as table models and as consoles. Band III converters for older Murphy sets are available.

Murphy Radio Ltd., Welwyn Garden City, Herts.

NAVY (107)

Among the examples of marine radio-communication equipment and electronic aids to navigation to be seen on this stand are the transmitter-receiver supplied to members of the Royal Naval Volunteer (Wireless) Reserve for use in their own homes and equipment for the facsimile transmission of weather maps. The trend of progress in marine radio equipment is exemplified by replicas of the W/T office in a small

ship of the 1920's and in its modern counterpart.


PAM (61)

Three table-models and one console comprise the television receiver range. The 17in Model 752DL is notable for its use of twin loud-speakers. All models are for a.c./d.c. operation with provision for 13 channels on Bands I and III.

The new a.m./f.m. sound receivers will be shown: Model 701 with c.r.t. tuning indicator in a table cabinet and Model 702RG, a radio-gramophone in a bureau cabinet.

The Pamco tuner is made by the printed circuit technique.


PAMPHONIC (34)

High-quality amplifiers, loudspeakers and microphones for both p.a. work and domestic sound reproduction will be shown, as well as magnetic tape sound delay mechanisms for sound reinforcement in large auditoriums.

One of the principal items is the "1002" 25-watt amplifier for which only 0.05% distortion at 15 watts (1kc/s) is claimed. The pre-amplifier, in addition to a wide range of variable tone controls, gives compensation for the main groups of recording characteristics and has provision also for radio, microphone and magnetic tape inputs. The frequency range of the equipment is 2c/s to 100kc/s with 28 dB of negative feedback.

Among the p.a. equipment an all-weather "Loud Hailer" with self-contained rotary converter designed to run from 12-volt accumulators is well worth close inspection.


PERMANOID (111)

Two low-loss coaxial cables suitable for use in Bands I and II fringe areas and in most areas of Band III are now manufactured by Permanoid. One, the Type 308, is largely airspaced with a spiral of polythene cord surrounding the centre conductor. It has a loss 3.5 dB at 200 Mc/s. An even better performance is exhibited by the Type 308EP with an attenuation of only 3.3 dB at 200 Mc/s; for 100ft in every case.

Permanoid Ltd., New Islington, Manchester, 4.

PETO SCOTT (55)

Television receivers are shown on this stand in both 14-in and 17-in models, the sets being otherwise substantially the same. A turret-tuner is fitted and a form of a.g.c. is used on both sound and vision. The video amplifier has a cathode-follower output stage. The c.r.t. tube is operated at 14 kV.

The sets are for a.c. only and both table and console models are listed.

Peto Scott Electrical Instruments Ltd., Addlestone Road, Weybridge, Surrey.

PHILCO (15)

The range of Philco receivers for this season is wide, including as it does a.m. two- and three-band sets, portable and transportables and a.m./f.m. models. All the Philco television receivers have 13-channel tuners. Car radio receivers with push-button control are also produced.

Emphasis is placed on the comprehensive series of fully tropicalized sound receivers and car radio sets for export.

Electronic training units are also to be shown.

Philco (Overseas) Ltd., Romford Road, Chigwell, Essex.

PHILIPS (27, 42, 43)

Broadcast and sound-reproducing equipment to be shown for the first time includes a car radio receiver, a table model television set, a portable record player with built-in amplifier and automatic changer and a new record changer unit. There is also a new range of high-quality sound reproducing units.

The new television receiver has a 17-in tube and is fitted with an all-channel turret tuner. Flywheel sync and a.g.c. are included.

Among the sound receivers is an a.m./f.m. model embodying a rotatable ferrite rod aerial for long and medium wave reception and a dipole for v.h.f. Push-button controls are provided.

The new Philips car set is a two-unit model with separate speaker and is permeability tuned.


PILOT (56)

This exhibit includes a new range of television receivers with 13-channel turret tuners to which coils are ready fitted for four channels in Band I and three in Band III. Automatic gain control and flywheel sync are embodied in all sets.

The range of sound receivers (Continued on page 423)

Wireless World, September 1955
includes a mains portable with ferrite
rod built-in aerial and a battery-
mains set. There are also two new
receivers and one radio-gramophone
which cover the v.h.f. band.
Pilot Radio, Ltd., Park Royal Road,

PLESSEY (122)
This firm manufacture a very wide
range of components and accessories
exclusively for the radio and elec-
tronics industries. Their exhibit con-
sists of a selection of components and
parts illustrating the vast scope of
their activities. Many new items are
in evidence and particular attention
has been given to meeting the re-
quirements of overseas visitors.
The Plessey Co. Ltd., Vicarage Lane,
Ilford, Essex.

PORTOGRAM (65)
Record reproducers of the portable
type have for many years been the
speciality of this firm, and a wide
choice of specifications is offered.
In addition, two interesting new
console reproducers have been de-
veloped. The HF65 is for record
reproduction and incorporates a high
quality amplifier and twin loud-
speakers arranged to radiate from the
sides of the cabinet to give wide
sound diffusion. There is ample
record storage space and provision
for the addition of an f.m. feeder
unit. Model TR100 is primarily a
console tape recorder and reproducer
with provision for the inclusion of a
gramophone turntable or record
changer and an f.m. feeder unit.
In this model a large bass-reflex
enclosure is associated with the loud-
speakers.
Portogram Radio Electrical Industries
Ltd., Preil Works, St. Rule Street,
London, S.W.8.

PYE (39)
Details of the Pye exhibit were not
available at the time of going to press.
In addition to the normal
range of television and sound broad-
cast receivers a special display of
high-quality sound reproducing
equipment is to be staged.

R.A.F. (306)
Amongst the equipment being shown
by the R.A.F. is the “Sonobuoy”
used by aircraft for the detection of
submarines. The cylindrical buoy,
6 inches in diameter, houses a trans-
mitter which is automatically
switched on when dropped into the
sea. All underwater noises in the
vicinity of the buoy are picked up by
a microphone and radiated by the
aerial which is automatically actuated
when the transmitter is switched on.
Examples of air traffic control
equipment, ground and air-borne
transmitters and a pictorial display of
telemetry as used in guided missiles
will also be seen on this first-floor
stand.
Air Ministry, Whitehall Gardens,
London, S.W.1.

RCA PHOTOPHONE (110)
Inputs for magnetic and crystal
pickups, radio, tape and micro-
phone are provided in the control
stages of the RCA “High Fidelity”
12-watt amplifier. The microphone
input can be mixed with the radio/
tape input.
Disc playback characteristics con-
form to the 1955 R.I.A.A. recom-
mandations, and are supplemented by
a high-pass filter (cut-off 20 c/s)
and optional low-pass cut-offs at 10,
7 and 5 kc/s with slopes variable
up to 35 db/octave. Variable bass
and treble controls give up to
15 db at 30 c/s and 15 kc/s.
The main amplifier is stated to be
flat within 0.2 db between 20 and
25,000 c/s, to have total harmonic
distortion less than 0.1 per cent at
10 W., 700 c/s, and a noise level
85 db below the rated output of 12
watts.
RCA Photophone Ltd., 36 Woodstock

R.G.D. (11)
Two new television receivers (1756T
and 1756C) employ “Synchrolock”
circuits for line timebase stability
under adverse conditions of recep-
tion.
The new “Three-Fifteen” radio-
gramophone includes a v.h.f. band,
and this feature is also provided in
the “One-Twelve” table-model
receiver.
Other new models to be seen are the
“Three-Twelve” console auto-
matic radio-gramophone with 24-
watt output, and the “Five-O-Five”
automatic record reproducer.
Radio Gramophone Development Co.
Ltd., Eastern Avenue West, Mawnneys,
Romford, Essex.

R.S.G.B. (310)
Amateur television transmission,
demonstrated on a closed circuit,
a low-power portable transmitter,
typical of those used for field days,
and an automatic morse sender are
features of the Society’s stand.
The “R.S.G.B. Amateur Radio
Call Book” and “A Guide to Ama-
teur Radio” are among the Society’s
publications available on this stand.
Radio Society of Great Britain, New
Ruskin House, Little Russell Street,

R.T.R.A. (302)
As would be expected this stand is
devoted exclusively to the require-
ments of the dealer. On it will be
found details of the various services
offered by the Association to its
members; in particular the receiver
maintenance-insurance scheme oper-
Ated by Telesurance through R.T.R.A. dealers.

REFLECTOGRAPH (20)
In the tape mechanisms which form the basis of this firm’s magnetic recorders and reproducers, a unique continuously variable speed control is employed. Models are available for industrial and scientific applications as well as for domestic high-quality sound reproduction.

The latest development is the Model RR100 which has separate amplifiers with facilities for monitoring during recording. Four transistors are employed in the playback amplifier with the object of reducing residual hum below the level possible with valves.

Rudman, Darlington (Electronics) Ltd., Wednesfield, Stoffs.

REGENTONE (38)
A new table-model sound receiver (A155FM) and two radio-gramophones (ARG79FM and ARG89FM) provide facilities for v.h.f. as well as long, medium and short waves. These will be supported by a wide choice of popular models, including the ARG77 and the Multi 99 table radio-gramophone.

The established television range of five models, two table, two console and a combined television-radio-gramophone, continues unchanged.

Regentone Radio and Television Ltd., Eastern Avenue West, Romford, Essex.

ROBERTS (117)
Efficient circuitry and meticulous attention to finish and external appearance characterize the portable sound receivers made by this firm.

There is a choice of types for battery, mains or mains/battery operation and more recent models are fitted with “Ferroxcube” aerials.

Roberts’ Radio Co. Ltd., Creek Road, East Molesey, Surrey.

ROLA CELESTION (17)
In addition to representative examples of loudspeakers for set manufacturers, a number of special types will be shown to illustrate the versatility of the company’s manufacturing resources. P.A. units for covering large areas, sources for underwater communication and flame-proof types for use in mines and oil refineries will be included in the display.

Rola Celestion Ltd., Ferry Works, Summer Road, Thames Ditton, Surrey.

S.T.C. (119)
A range of selenium rectifiers, including h.f. types, is to be shown. There will also be a series of rectifiers for sound and vision broadcast receivers as well as e.h.t. tubular rectifiers and “Q” type unistors. Three groups of high-voltage light-weight aluminium rectifiers, including types for aircraft and other uses, will also be shown, as will germanium junction power rectifiers and photo-electric cells.

A demonstration is to show the manufacture of tubular rectifiers, including electronic counting of the components used in assembly. Other displays will illustrate the use of germanium power rectifiers and servo-motor control through a photo-electric cell.


SAPPHIRE BEARINGS (304)
As one of the industry’s principal manufacturers of gramophone reproducing styli, this firm will be showing examples of “flame-fashioned” surface finish under the microscope. A modern type of shadowgraph will also demonstrate the method of checking the radius of the point to 0.0001in.

Sapphire Bearings Ltd., 96a Mount Street, London, W.1.

SIMON (10)
Magnetic tape recorders for domestic and professional use are represented by the recently introduced portable Model SP/2 and by a replica of the long-duration tape monitoring equipment installed in the control tower at the Royal Aircraft Establishment, Farnborough.

The Model SP/2 is notable, among other things, for the ready accessibility provided by the redesigned case, and for the fact that it includes an independently available 10-watt reproducing amplifier.


SOBELL (19)
The range of sound broadcast sets includes models covering the f.m. Band II and radio-gramophones.

WIRELESS WORLD, SEPTEMBER 1955
Television models include 14-in and 17-in types and are for a.c./d.c. operation covering Bands I and III with turret tuning.

Radio & Allied Industries Ltd., Longley Park, Slough, Bucks.

SPECTO (206)
This firm is showing a magnetic tape reproducer for tape records having the C.C.I.R. characteristic. The output has 15 W output with a response within +0.5 dB from 10 c/s to 20 kc/s. The harmonic distortion at 10-W output is claimed to be under 0.4% at 40 c/s and less at higher frequencies. Treble and bass tone controls are provided. The reproducer and amplifier are available together or separately.

Specto Ltd., Vale Road, Windsor, Berks.

SPENCER-WEST (211)
In addition to pre-amplifiers for television and distribution amplifiers for Bands I, II and III, this firm is showing a range of converters. The Type 30 is a simple model to permit reception of one station in Band I and one in Band III, while the Type 33 provides two channels in Band III. This has a neutralized-triode r.f. stage with a pentode mixer and triode oscillator. A feature of the unit is that remote switching for station selection is provided.

The "Adder" is a more elaborate converter for 13 channels and provides an output at intermediate frequency.

Spencer-West Ltd., Quay Works, Great Yarmouth.

TELEQUIPMENT (105)
The WG44 television pattern generator made by this firm covers both the Band I and Band III television frequencies and gives an accurate picture of several combinations of horizontal and vertical bars for testing a receiver in an absence of a "live" broadcast. They make, also, factor, test equipment and a high-grade oscilloscope.

Telequipment Ltd., 1319a High Road, Whetstone, London, N.20.

TELERECTION (7)
A distinctive feature of this firm's multi-element Band I television and f.m. aerials is that a "delta" matching system is employed for the feeder. Some aerials are also given a slight upward tilt; this is particularly noticeable in the "Multimus" series of 4-element fringe area types, which incidentally now includes one for f.m. broadcasting.

Between the fringe area types and single dipoles comes a considerable number of intermediate types for all three v.h.f. bands for use at various distances from the transmitters. Indoor and outdoor types are included. Fringe area

A new development is a sub-miniature electrolytic of high capacitance and low-voltage rating for use in transistor circuits.

Printed circuits are becoming an important activity of T.C.C., and the many different specimens shown exemplify the various applications now found for these components in radio and electronic equipments.

Telegraph Condenser Co. Ltd., Wales Farm Road, North Acton, London, W.3.

TAPE RECORDERS (66)
The "Editor" and "Playtime" series of tape recorders have been augmented by the "Editor Super Hi-Fi" and the "Playtime Plus." In the former a large-diameter loudspeaker is mounted in the detachable lid, and in the "Playtime Plus" a playback amplifier has been included. The "Editor" "Playtime Plus" was only 20 lb.


TAYLOR (4)
Prominent among the new pieces of test equipment introduced this year is a versatile valve tester known as the Model 45C. Valveholders to accommodate all valves in current use, English, Continental and American, are disposed about the top with the controls on the front. Charts give test conditions for over 4,000 valves.

Other items of particular interest at the present time are signal generators covering Band III television wavelengths, a 20-kHz V.V.O. meter and a television/f.m. receiver alignment frequency-modulated oscillator; the range is 5 to 250 Mc/s.

Taylor Electrical Instruments Ltd., 419-424 Montrose Avenue, Slough, Bucks.

STELLA (51)
Models making their first appearance include a portable mains/battery broadcast receivers in a plastics case; a ferrite rod aerial is fitted. A new console radio-gramophone includes provision for v.h.f. reception, for which a built-in dipole is provided.

A new table-model television receiver, fitted with a 17-in tube, is designed for use within the service areas. It embodies a.g.c. on both sound and vision and is fitted with a turret tuner.

A record player with a built-in three-valve amplifier has been introduced; this is additional to the model ST50A portable record player for use with existing amplifiers.


T.C.C. (45)
A special feature is made this year of capacitors designed especially for television receivers covering Band III and, with an eye to the future, Band IV also (470-585 Mc/s). These are all ceramics and consist of lead-through and stand-off bypass capacitors constructed from "Hi-k" (high dielectric constant) ceramic and small pre-set trimmers made from "Low-k" ceramic.

For circuits where high capacitance couplings are wanted in a reasonably small physical size T.C.C. have a range of "Superlectics"; these are electrolytics with leakage resistances comparable to many paper types.

Wireless World, September 1955
Band III aerials are now available with six or more elements, and in general folded dipoles are used. Telecetion Ltd., Antenna Works, St. Paul's, Cheltenham, Gloucester.

TELEVISION SOCIETY (315)
In addition to providing a rendezvous for members and visitors, the stand of the Television Society also serves as an information bureau. Reprints of some of the papers read before the Society during the past year or so, including Gouriet’s “Introduction to Colour Television,” will be available.


TRIX (38)
A wide variety of sound reproducing equipment for high-quality domestic and public address applications is made by this firm. The “Recital” console gramophone, which incorporates the Model T41 amplifier, has been improved in detail finish, and a new series of cases and improved amplifier performance are to be found in the “Trixette” range of portable gramophones.

For p.a. work a new 150-watt amplifier (Model T152D) has been developed which can be duplicated and operated from a single drive unit (Model T152TD) to give 300 watts for large installations. A new moving-coil microphone (Model G7871) and general-purpose p.a. loudspeaker (Model G7073) are available, and for motor coaches a small, simplified battery-operated amplifier (Model B65/MX) provides an output of 5 watts.

Trix Electrical Co. Ltd., 1-5 Maple Place, London, W.1.

ULTRA (41)
Television receivers with tubes of 14in, 15in and 17in are shown by this firm and all provide for reception in Bands I and III. The

ULTRA Twin,” an a.c./d.c./battery portable, is now available in a cabinet with sliding doors.

Ultra Electric Ltd., Western Avenue, Acton, London, W.3.

UNITED APPEAL FOR THE BLIND (316)
At the invitation of the Radio Industry Council, the “United Appeal,” which acts on behalf of a number of associations for the blind, is again staging a live demonstration to show how blind people can take their place in the radio industry side-by-side with their sighted colleagues. The equipment for the demonstration is provided by Philips Electrical.


VALRADIO (118)
The tuner produced by this firm, and used in their television receivers, provides for sound reception in Band II as well as for television in Bands I and III. It covers the range 40-100 Mc/s in four steps and 170-225 Mc/s in two steps. Continuous tuning between the steps is effected by the permeability method.

Vidar Ltd., New Chapel Road, High Street, Feltham, Middx.

VIDOR (28)
Two new 12-channel table-model television receivers have been introduced this year; they are the Models CN-3230 and CN-4231, both embody the same receiver chassis, but the former has a 14-in tube and the latter a 17-in. A small but important point is that the tube protecting glass is easily removable for cleaning.

Among the many portables is a new 4-valve, 2-waveband model, the CN-328. It is a very small “up-right” style, all-dry battery operated with low-consumption valves, a 5-in loudspeaker and a ferrite rod aerial. The display of receivers is supported by a full range of dry batteries, including hearing-aid types.

Vidar Ltd., Erith, Kent.

WEARITE (218)
One of the pioneers in this country in the design of tape mechanisms for magnetic recording, this firm will be showing the versatility of their “Tape Deck” as applied in industrial and Service equipment as well as in the “Perrograph” portables for sound recording and reproduction.

The Wearite range of audio and radio components is supplemented by new coils and transformers for v.h.f./i.m. receivers.

Wright and Wearie Ltd., 131 Sloane Street, London, S.W.1.

WESTINGHOUSE (191)
Contact-cooled rectifier units in a wide choice of ratings have recently been introduced for use in television and sound broadcast receivers. These units are designed for mounting in close contact with a metal chassis, and, by dissipating their heat through it, allow a reduction in bulk, cooling fins being no longer

Wireless World, September 1955
required. The emphasis of the Westinghouse exhibit will be on the more specialized types of receivers such as germanium crystal, copper-oxide units for measuring instruments, "Westcorders" and some miniature high-voltage units.

Scaled tubular rectifiers with quadruple-voltage elements are shown for providing e.h.t. for cathode-ray tubes.

Westinghouse Brake & Signal Co.,

WHITELEY ELECTRICAL (25)
The new W&B12 high-quality amplifier and feeder unit makes use of the "ultra-linear" method of connection in the output stage and has switched selection of pickup matching. A new f.m. tuner has also been developed.

A 15-in concentric duplex unit and a ready-to-assemble corner reflex cabinet kit for 10-in and 12-in units have been added to the loudspeaker range, which includes cambric cone types from 2½ in to 18 in diameter.

Representative examples of the wide range of components supplied to industry and the Government departments will be shown.

Whiteley Electrical Radio Co. Ltd.,
Victoria Street, Mansfield, Notts.

WOLSEY (5)
This year a special feature of Wolsey Band-III television aerials is that the insulators on the aerials are made of polythene specially moulded to provide a good waterproof junction between the dipoles and the insulator.

The range of aerials has been greatly extended and, while the main emphasis is on Band-III types, both existing television requirements and v.h.f. sound are fully provided for.

Pre-assembly in the factory is still one of the main features of this firm's products.

Wolsey Television Ltd., 43-45, Knight's Hill, West Norwood, London, S.E.27.

LETTERS TO THE EDITOR

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

"Tape Bookmark"

A METHOD I have been using for "finding the place" on magnetic tapes is to impose a large amplitude subsonic on the tape—about 2c/s from a dippy oscillator into 30 sec. I find about 20V into the recording amplifier, which normally requires 50mV mean, is ample. Where the recording head is fed from an output pentode via a high resistance, shunting the resistance with a 4/F paper capacitor should be effective.

On fast wind or rewind, although the tape is about ½ in from the playback head, a loud note is heard in the 100-400c/s range, according to the tape speed. By counting these markers, which are placed between each item, I can find the right place on the tape.

A simple switching circuit could be made to operate a device like the selector shown in the article by Price and Frewer in your April, 1955, issue.

The only drawback is that the indexing can only be done on one track, as, although it does not affect the adjacent track in any way, it comes through on fast rewind whichever track is in use. If difficulty is found with erasure, a permanent magnet can be used to remove the last traces of the subsonic.

Coventry.

R. G. WICKER.

FOR office dictation and telephone recording, where it is only necessary to mark the interval between messages, I have found it useful to inject into the head for a second or two a small voltage at 50c/s, derived from the filament circuit, which gives a recognizable signal on fast wind.

Manchester.

E. S. RUSHTON.

Magnetic Tape Characteristics

IT is refreshing to read the article "Does the tape characteristic matter?" in your March issue and still more to note the conclusions you reach. The fact that "it depends on the machine" is only too well known to tape manufacturers but not all machine manufacturers realize it as yet and very few of the users.

It is perhaps going too far to suggest that, if a tape has, in its own right, a characteristic, then so has a mic-metal stamping but the underlying idea is quite logical. There are one or two factors, in addition to those mentioned in the article, which may possibly have influenced some of the characteristics shown, such as optimum bias current (query: were all the runs on any one machine carried out with a fixed bias current?), surface smoothness and tape thickness, although this last factor is perhaps implied at the end of the first paragraph. Differences in top response between machines could, of course, be due in part to different air-gap width of the playback head.

As regards the one specific anomaly you mention, tape No. 4 may be of lower coercivity than tapes 5 and 7 and the bias field strength may be lower on machine (C) than on the other two. As a result the bias value may be nearer the optimum on machine (C) for tape 4 but too low for tapes 5 and 7. At the same time tapes 5 and 7 show good top response on machine (C) as might be expected if they were of higher coercivity and underbiased.

What is puzzling is the pair of curves on machine (C) for tape 6. Were they taken with the tape running in opposite directions or—horrible thought—with the coating in contact and remote from the head?

Slough, Bucks.

H. G. M. SPRATT.

The Cascode

"CATHODE RAY'S" statement on page 399 of your August issue that a.g.c. would be ineffective if applied to Fig. 1 is incorrect. In fact, the required voltage for any given control is roughly one half that required by Fig. 2. When the valve is used as in Fig. 1, the characteristics approach that of a "straight-mu" type and in Fig. 2 that of a "variable-mu" type.

The circuit shown in Fig. 2 is usually preferred since its cross-modulation characteristic is superior. This point is fully discussed in RCA Review, March, 1951, in an article "Use of new low-noise triode valve in television tuners."

G. R. WOODVILLE.

M.O. Valve Company.

Cathode Ray writes—My apology to readers for my misstatement about the cascode, and thanks to Mr. Woodville for correcting it.

Battery-mains Short-circuits

I HAVE had in for repair many battery-mains receivers, and in several cases filament and/or dropping resistor breakdowns have been the result of partial short-circuits due to the battery leads, where batteries are not in situ and mains operation is used, contacting with the metal chassis or components underneath.

Surely it would be a simple matter for manufacturers of these sets to provide dummy sockets in the cabinet material to take these leads, and thereby prevent many unnecessary breakdowns and other complaints?

Stowe, Buckingham.

W. H. JARVIS.
To the listener interested in high-quality sound reproduction a frequency-modulated v.h.f. broadcast system approaches the ideal. In contrast to the medium-wave a.m. service, it is difficult to design an f.m. receiver with a poor audio-frequency response. A wide frequency response in itself, however, is of little value if impulse noise is allowed to obtrude on the programme, or if non-linearity distortion in the receiver mangles the signal before application to a "D_{01} < 0.01%" high-fidelity amplifier.

Both noise and distortion can be kept to low values in well designed and aligned receivers, but the user must play his part in getting the best performance from any given set by tuning it in correctly.

If a receiver is correctly designed and aligned so that the i.f. passband and the discriminator characteristic are symmetrical, and the i.f. signal produced by the received unmodulated carrier is exactly in the middle of the passband, impulse noise will be fully rejected.

The phase-modulated components of the noise, being evenly distributed throughout the passband, correspond to a signal whose mean frequency is that of the midpoint of the passband, so that the discriminator output is zero. If the carrier is mistuned a standing d.c. will appear at the discriminator output which reduces to zero for the duration of the noise. Thus an audio signal will appear proportional to the amount of standing d.c., which in turn is proportional to the amount by which the carrier is mistuned.

Sources of Distortion

Non-linearity distortion can arise both in the i.f. amplifier and the discriminator. If the carrier is mistuned, large deviations can swing the signal past one side of the flat top of the i.f. amplifier passband. Amplitude variations are removed in the limiter stage, but phase changes occur at the same time. When demodulated the audio signal will be asymmetrical, showing the presence of added even harmonics. The discriminator will add its quota of distortion as it is only linear over a limited range on either side of zero output, so that if the carrier is mistuned it must deviate more into the non-linear region.

From the foregoing we may conclude that in the absence of a tuning indicator, the user may resort to two stratagems:— (a) await the passage of an unsuppressed motor-car, then hurriedly tune out its ignition noise, or, (b) tune for minimum intermodulation during loud passages in the programme. With either method, the correct tuning point tends to be elusive, and some form of indicator is essential, if only to stop doubt gnawing at the mind of the technical purist.

As the negative voltage at the limiter grid is proportional to the signal strength, it would appear that it might be applied to a "Magic Eye" in the same manner as the a.g.c. voltage in an amplitude modulation receiver. Tuning for minimum shadow angle should then give the correct tuning point. However, the main requirement of an i.f. amplifier in a

Figure 1. Complete circuit diagram of neon tuning indicator. V3 and V4 are miniature uncapped neon (Hivac, type CC11L). These are also available with M.E.S. cap and designated CC10L.

* The Acoustical Manufacturing Co., Ltd.
A flat frequency-modulation receiver is characterized by a flat frequency response over some 200 kc/s bandwidth; thus the mid-point is indeterminate. Any attempt to get a well-defined peak at the limiter grid will degrade the phase response of the i.f. amplifier, which introduces odd-order distortion in the audio signal. It is therefore necessary to provide a separate high-Q circuit, tuned exactly to the middle of the i.f. passband, to rectify the resultant signal and to feed that to the indicator. This throws a heavy responsibility on the stability of the auxiliary tuned circuit, and such an indicator approach seems unwise.

A better method is to indicate zero d.c. output from the discriminator. Indicating nothing, however, presents its own problems. One of the best solutions is to use a centre-zero meter. This not only shows the correct tuning point, but whether the set is off-tune, and the direction in which it is off-tune, without having to alter the tuning control. It has the disadvantage that as the demodulator currents are small, a valve voltmeter circuit has to be used, which together with the cost of the meter movement itself is uneconomical, not to speak of the difficulties of finding a meter which "blends with the décor of one's home."

A simple and reliable circuit has been developed (Fig. 1) that gives a visual indication of the correct tuning point which may be interpreted in the same manner as a meter. It consists basically of a cathode-coupled amplifier in which one grid is taken to a reference potential, in this case zero d.c. or earth. The other grid is taken to the output of a Foster-Seeley discriminator. If both potentials are equal, then equal currents flow in both valves. If the potentials are not equal, e.g. V1 grid is positive to earth, then I₁ increases, making the common cathodes more positive. The negative potential between V2 grid and its cathode is increased, and I₂ decreases. The current flowing in each valve is indicated by the brilliance of the two miniature neon lamps in series with each anode. With the type of neon specified, the light output is approximately 0.25 lumens per mA.

The human eye is not particularly good at estimating absolute light output, but it is very much better at estimating the relative output between two lights closely spaced. This ability is aided in the circuit arrangement used, as the eye has no trouble in comparing the brilliances in light against a fixed reference, but against one varying in the opposite direction (Fig. 2). Thus, by tuning the receiver until both neon lamps are of equal brilliance, a very sensitive indication is given of zero output from the discriminator. In practice the sensitivity of the system can be such that provided both neon lamps are obviously alight, the tuning error has negligible effect on the receiver performance.

The indication given by the plain neon lamps is not ideal as the glow surrounds only one of the parallel electrodes on d.c., and when viewed from the side, the random change of glow position is distracting. For this reason it has been found better to view the neon end-on via a low-loss diffusing screen. A suitable material is a 1/6 in opal Perspex (I.C.I. Colour No. 060). When mounted close together the glow from one neon may be screened from the other by a light-coloured opaque sleeve over the body of the bulb; the light colour helps to reflect the light forward through the diffusing screen. The performance is determined by the choice of valve, the common cathode resistor, and the h.t. supply. The standing bias on the valve grids must be chosen so that the current through the neon is limited to about 0.7 mA in the unbalanced condition. The cathode load resistor determines the see-saw action which takes place when the receiver is mistuned. With finite values of R₆ and R₅, the anode current changes will not be equal and opposite, but unbalance is immaterial as it reduces to zero at the working point.

In practice the small current demand allows a high value of R₆ to be used and this performs the dual function of bias and cathode load resistor.

The components C₃R₁₁, whose time constant is comparable to the period of the lowest frequency likely to be encountered, are used to filter the audio signal from the discriminator output. Without this filtering both neon lamps will appear to brighten simultaneously with a heavily modulated signal, thus obscuring the d.c. component.

With the typical circuit shown in Fig. 1 connected to the output of a Foster-Seeley discriminator, there is a clear indication of the correct tuning point within ±3 kc/s. The only difficulty anticipated was the fact that as the indicators show equal brilliance in the absence of a carrier, it was thought that steps would have to be taken to suppress the indicators when the limiter grid current was low. However, this proved unnecessary as one or other indicator is extinguished before the wanted carrier is heard.

There is no reason why this indicator should not be used with a ratio detector provided that it is of the balanced type, but the d.c. output per kc/s of deviation will be considerably less than that of a Foster-Seeley discriminator.

**"Band II F.M. Tuner Unit"**

ALL the coils specified on p. 374 of this article in last month's issue can also be supplied by Wright and Wearie Ltd. The "Wearite" type numbers are:

- **Aerial coil** L₃₁, L₇
- **R.F. choke** L₄
- **R.F. coil** L₅
- **Oscillator coil** L₆, L₇
- 1st i.f. coil L₇, L₈
- 2nd i.f. coil L₉, L₁₀
- **Ratio detector transformer** L₁₃, L₁₄, L₁₅
- I.F. traps L₁₆, L₁₇

The escutcheon for the EM80 tuning indicator can be supplied by McMichael Radio Ltd.

**Wireless World, September 1955**
Toronto Audio Show

Some Personal Impressions

ON the North American continent, audio fairs tend to run to a pattern. The recipe appears to be quite simple. Take one or more floors of a suitable hotel. Give the inmates of any of the rooms accommodation elsewhere. Remove the beds and some of the other furniture. Collect several dozen manufacturers, agents, importers, distributors, wholesalers, retailers and others commercially interested in "hi-fi," and persuade them that taking space would be to their advantage. Prepare a catalogue with all appropriate information you can lay hands on, including information which the above manufacturers' agents, etc., will supply. Have a few tons printed and on hand. Advertise on the radio (including television), in the Press and by every other publicity method you can think of, and then, by opening day, you will find that you have an Audio Show on your hands.

It is a fairly safe bet that something unexpected is sure to happen, so it is well to have all routine matters under control well in advance. The Toronto Audio Show was no exception to the general rule.

That part of Canada which includes Toronto looks like the foot of Italy and sticks down into the U.S., is supplied with "the Hydro"—a rather special type of alternating-current at 25 c/s which was adopted when the hydraulic power stations were built at Niagara Falls in the early days of electricity. New sources at 60 c/s are being built rapidly, but are claimed for new outlets in an expanding economy, with the result that many parts of Toronto, including the Prince George Hotel, where the Show was held, are still on 25 cycles.

The problem was tackled by disconnecting the wiring of the two floors used for the Show at the distributing box, and connecting temporary leads to a large frequency converter hired for the purpose. Excellent, all set and the Show ready to open.

Naturally each exhibitor had to be rationed as regards the power he could draw, for every converter has its limits. For some unknown reason, however, the total demand exceeded the safe loading of the converter. Perhaps it was that some exhibitors did not count their illumination as part of the load, or their equipment took more watts than it should, according to its specification. We shall never know exactly what the cause was, but it did not take that converter long to become very hot. The result was that after running for a while, the power would shut off, stay off for five minutes or so and then come on again. The matter was coped with by the second day, but on the first one's most vivid recollection was of waiting in the dark for the power to come on again and give the equipment a chance to continue its performance!

The test of the value and success of an exhibition is measured in terms of how many paid for admission, and even if some of the approximately 4,700 paid admissions represent repeat visits, it seems that on average over 1,000 new visitors came to the Show each day. For many, there can be little question but that this was the first occasion on which they heard reproduced sound of vastly better quality than that from the average radio. From this point of view alone, namely educating the public, the show must be counted a success. What the balance sheet worked out at is none of our business, what matters is that at the first such show in Toronto the public showed a lively interest.

Canadian "Hi-Fi"

Canada, with its population of less than 1/10th that of the U.S., has, by comparison, only a small market without crossing frontiers and getting tangled up in customs complications, etc. The number of truly Canadian firms on the manufacturing side of the "hi-fi" game is consequently very small. McCurdy Radio Industries do custom work, manufacturing and installing broadcast studio control equipment, etc. Microlab Devices make transcription-type turntables for 25 and 60 c/s supplies, originally for broadcast stations, and now increasingly for "hi-fi" addicts. Dominion Electrohome Industries and the Kelton Company are attacking the domestic "hi-fi" market.

The Kelton speaker system is out of the usual rut and is described as using an acoustic bandpass at low frequencies. The low-frequency speaker has a completely enclosed cavity behind, and another cavity in front from which the sound is radiated via a number of spaced holes. The design is based on a development of the method described by J. J. Baruch and H. C. Lang of the Massachusetts Institute of Technology at a meeting of the Radio Club of America on May 22nd, 1952, and reported on page 30 of the Radio-Electronic Engineering section of Radio and Television News for

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"Isometric" tape drive mechanism in the magnetic recorder designed by the International Scientific Industries Corporation. The sketch on the right indicates the principle of operation.

July 1952. Both the front cavity and the speaker are tuned to the same resonant frequency, and are over-coupled so as to obtain a bandpass effect. Quite a surprising amount of bass was obtained from a small volume, but it is noteworthy that in their best reproducer two of these were used together, two more speakers were used for the middle and also a tweeter, making five in all.

There is no need to discuss the many British components displayed, for W.W. readers will know about these already. Practically all the "hi-fi" household names, Goodmans, Wharfedale, Acoustical (Quad), Leak, Ferranti, Garrard, Connoisseur, etc., are effectively represented here. Williamson-type amplifiers, too, either according to the original circuit, or with the Hafer & Keroes Ultra Linear modification are very popular.

Those readers familiar with U.S. magazines would also recognize the many U.S. "hi-fi" products which were being demonstrated. There are in Canada no currency exchange regulations which make the purchase of U.S. goods difficult: all you need is money!

The majority of U.S. manufacturers still tackle the problem of quality speakers for home use on the same basis as one tackles it for high-power p.a., namely to use different speakers for different frequency ranges. The various possible combinations of "tweeters," "woofers" and mid-range speakers that can now be put together could only be calculated with an electronic computing machine. Since, in most of the 50 or so rooms used for demonstrations, there was a variety of combinations to listen to, it will be understood that the writer came away with no very clear picture. He still remains convinced that there is more in loudspeaker design than just getting the widest possible frequency response.

The biggest speaker at the show was undoubtedly the U.S. Electro-Voice "Patrician IV." The writer cannot really quarrel with the idea that a speaker should be 62in high, for he designed one of exactly that height two decades ago, but this "Patrician" is 39in wide across the front! It uses one "woofers" driving a folded horn, two speakers for the next range, one for the next, and then a "tweeter," i.e., a total of five, all horn loaded. There is much that can be done with about 35 cu ft in hand. The writer can vouch for the floor-shaking ability of this speaker with suitable organ music, for he was on duty in the room at the disposal of the Society of Music Enthusiasts, while a firm demonstrating a tape machine with organ music had one of these speakers operating in the room immediately below! Incidentally the price here, allowing for customs duties, 10 per cent sales tax, etc., is just over $1,000 or about £364 at the present rate of exchange.

There were speakers in all kinds of cabinets and enclosures. In some cases panel resonances were killed by damping and in some by rigidity of construction. In one case, this rigidity was achieved in a very simple manner indeed, by using a barrel with the speaker set in the side, and some internal damping material to diminish air resonances. The fact that the name of the distributor of this item is Mr. Bier is purely coincidental!

Amplifiers and pre-amps. of all kinds and with varying numbers of knobs were to be seen. In some cases, notably Quad (British), Philips (Dutch, branch plant in Toronto), National, and Fairchild (U.S.), considerable trouble had been taken to make their product look attractive and not like some piece of experimental equipment out of the lab. The Fairchild pre-amp. used a exceedingly neat way of disguising two of the knobs. Part of the decorative trim is a transparent horizontal strip divided into three parts. The two ends are attached to the bass and treble tone control spindles and the recommended procedure is to find by experiment the preferred setting for these controls, then to withdraw the levers and replace them so that they are in line with the horizontal strip. If for any reason the controls are altered, this is obvious, for they are then no longer in line, and in fact indicate the change in the response curve.

On the Philips amplifier there was also an indicator of response. It consisted of a horizontal white line behind a transparent panel. As the bass and treble control knobs were turned, the appropriate end of the line curved up or down to show how the response had changed.

New Tape Drive

Tape machines were there in great variety. With but one exception, they seemed to be along the orthodox lines. The exception, by International Scientific Industries Corporation, a U.S. organization, was not then in commercial production. The designer of this machine must, at some time, have said to himself, "I don't like the mechanics of ordinary tape machines, let us throw the book away and start again."

Most tape machines also have something which slips
in the drive to the take-up reel though when this "slip" occurs in an electric motor it may not be obvious. Fundamentally the take-up reel needs a low torque, higher speed drive when empty and a higher torque, lower speed drive when full, with a smooth automatic transition from one to the other as the reel fills up. At the time when the take-up reel is empty, and the supply reel is full, the pull of the tape there acts well away from the reel axis and so exerts maximum torque. The brake also has to be stronger at this stage than later on when the reel is not so full. As the supply reel unwinds its speed increases, while the torque due to the tape tension drops. The ideal brake should adjust itself to suit these continuously varying conditions.

The "Isometric" drive provides both the varying torque and the varying brake action in an elegantly simple way. The primary drive is a toothed permanent magnet rotor, driven from the main capstan motor. The magnet is enclosed by two "drag cups" which are coupled to the spool turntables by driving belts. Eddy currents induced in the cups tend to make them follow the rotation of the magnet, and the torque exerted depends upon the degree of overlap between cups and magnet. The position of the magnet relative to the two cups is controlled by "sensing fingers" which take up positions depending on the angle at which the tape leaves and enters the supply and take-up spools.

An additional manual control puts in extra motional "bias" of the magnet position, so that when both reels are half full one reel, the take-up reel, has more torque than that on the braked reel. To reverse the tape direction the bias is applied in the opposite direction. Torque is thus maintained all the time on both reels, but superiority of torque can be transferred from one reel to the other by moving the control. Very rapid reversals of tape direction are therefore possible without "spilling" tape all over the place; this should please those who need this facility for editing work. They will also appreciate the control over the tape by operating with the bias knob in a nearly balanced position when the tape can be made to move very slowly, the instant reversal feature still being retained.

A separate motor is used to drive the capstan, and is of "inside out" construction, in that the inner part is stationary while the outer part rotates. The motor thus acts as its own flywheel. These are the main features, but other minor ones have been worked on with equal care, in fact the writer was told that the last year has been spent on simplifying the machine. It is most certainly out of the rut, and we may wish those responsible the best of luck, for there are not enough enterprising people in this world.

A book has now been produced containing a selection of over forty of "Cathode Ray's" articles—and many of our readers will say it has been long overdue. It constitutes an entertaining textbook for the beginner in radio and a first-class refresher course for others. The selected articles are mostly on elementary topics dealing with basic electrical ideas, circuit element and techniques and circuit calculations; but, as the author himself says, the more elementary the subject—all the more important—there is to get clear ideas or them. Any errors or obscurities in the original articles have been removed and there are additional summaries, diagrams, cross-references, questions to work out and, of course, an index—making in all a total of 409 pages and 266 illustrations.

"Second Thoughts on Radio Theory" can be obtained from any bookseller at 25s or direct from our publishers at 25s 8d by post.

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**CLUB NEWS**

**Birmingham.**—"High Fidelity Sound Equipment" is the subject of the talk to be given by C. H. Young (GJ2AK) to members of the Slade Radio Society on September 2ist. At the next meeting (16th), which will be held at the Aston Technical College, Edington Road, Birmingham, 6, and for which tickets must be obtained from the secretary, the Osrn 912 amplifier will be demonstrated. On September 30th Dr. F. D. Whitaker, of Birmingham University, will speak on "The Application of Electronics to Research in Nuclear Physics." Except where otherwise stated the meetings are held at 7.45 at Church House, High Street, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

**Bradford.**—A joint meeting of the Bradford, Leeds and Spen Valley clubs will be held on September 27th at Cambridge House, High Street, Erdington, where Dr. M. J. Heavyvise (GQ2Q) will speak on aerials for short spaces and short-waves.

**Coventry.**—The annual general meeting of the Coventry Amateur Radio Society will be held at 7.30 on September 26th at the Society's H.Q. at 9, Queens Road, Coventry. Sec.: J. H. Whiteby (G3HDC), 24, Thornby Avenue, Kenilworth, Warwicks.

**Edgware.**—Meetings of the Edgware and District Radio Society are held on Wednesdays at 8 o'clock at 22, Goodwyn Avenue, Mill Hill. The next session's programme includes talks on a variety of subjects and practical evenings especially for beginners. Sec.: E. W. Taylor (G3GRT), 99, Portland Crescent, Stanmore, Middlesex.

**Edinburgh.**—The opening meeting of the 1955/1956 session of the Lothians Radio Society will be held at 7.30 on September 8th at 25, Charlotte Square, Edinburgh, 2. Meetings are held on alternate Thursdays. Sec.: J. Good (GM3EWL), 21, Mansionhouse Road, Edinburgh, 9.

**Glasgow.**—An effort is being made to start a group of the British Amateur in Glasgow. Interested readers should communicate with J. W. Bruce, 15, Downhill Street, Partick, Glasgow, W.1.

**B.A.T.C.**—As already announced, the British Amateur Television Club is holding a convention at the Bedford Corner Hotel, Tottenham Court Road, London, W.1, on October Ist. Admission is 5s. Particulars are obtainable from D. Reid, 4, Bishops Road, Chelmsford, Essex.

**QRP.**—The closing date for entries for the portable equipment contest, organized by the QRP Society, is September 30th. Details of the contest, which is open to non-members, are obtainable from John Whitehead, 92, Rydens Avenue, Walton-on-Thames, Surrey.

**WIRELESS WORLD, SEPTEMBER 1955**

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"Second Thoughts on Radio Theory"

OUR contributor "Cathode Ray" needs no introduction to regular readers of Wireless World, for he has been writing in the journal now for over twenty years. To others it should be explained that he is an author who adopts a sympathetic and informal approach to radio theory, expounding in his own way the sort of things the textbooks either miss out altogether or deal with in a dry and stereotyped manner.
Language Translation by Electronics

Novel Application of Digital Computing Machines


The idea of using digital computing machines for the translation of languages was first suggested by Dr. A. D. Booth of Birkbeck College in 1946. An automatic translation project is now under way at the college research laboratory, and this article discusses the problem in the light of the experience gained so far. It illustrates the present trend towards the use of computers more for processing information than for straightforward calculation alone.

With the advent of mechanical calculating machines it became possible to obtain solutions of problems other than mathematical in an automatic fashion. One such problem was the automatic translation of language—the general idea being to code the words into numerical form and cause the machine to operate on these numbers in a certain routine to which the translation process can be reduced. It was only with the development of electronic digital computers, however, that results could be obtained in a reasonably short time and without excessive reference to data stored externally to the machine. In principle a computing machine is capable of automatically translating languages to any required degree of refinement, although at present there are severe limitations owing to the small amount of internal storage space for information that is generally available in the machine.

The obstacles that limit the scope and refinement of electronic translation are not, however, insurmountable. We can, for example, by employing a human agent to edit the material passing into and out of the machine, obtain results which could only have been obtained automatically with a more complex mode of operation or on a computer of more advanced kind than exists at the present time.

The aim of electronic translation is not to produce a literary masterpiece (though this is theoretically possible with a large enough machine) but to give a more or less semantically and syntactically correct translation of the input text, and in particular to render the vast amount of foreign scientific literature now available intelligible to the scientist. Even very rough translations can be of value here, since they allow the specialist to examine briefly the documents in his particular field of study and to pick out those of special interest. These can then be submitted to a human translator for a more exact rendering.

Restricting the aim of electronic translation to the provision of scientific information simplifies the process by removing questions of style (and so reducing the difficulties of idiom) and by limiting the size of vocabulary. The practicability of the scheme depends, first, on the extent to which the process of translation can be formalized, and secondly, on whether the formalized translation process can be adequately expressed in terms of the "orders" available for controlling the computing machine. It is necessary, in fact, to compile a complete "program" of machine instructions that will carry out sentence analysis and selection of words.

To translate a foreign language it is necessary to have a knowledge of the syntax of the foreign language, a dictionary, and a knowledge of the syntax of the "target" language (meaning, of course, English in this country). The dictionary is a list of foreign...

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Essential features of the Birkbeck College computer to be used for translation. Containing some 400 valves, it works on the serial principle and has a basic p.s.f. of 80 kc. s. Operations equivalent to addition and subtraction are done in about 400 microseconds.

Wireless World, September 1955
language words and their "target" language equivalents, together with grammatical notes indicating possible syntactical functions of the foreign language words. It should also contain a list of contexts in which the foreign language word has a special meaning; for example, the German "unter" is entered in a standard German-English dictionary as follows:

unter (1) preposition: under, below.
(2) adjective: lower, under, inferior.
(3) prefix: under, among.

A knowledge of the foreign language syntax enables one to decide what are the grammatical functions of the foreign words (whether nouns, verbs, prepositions or what) and hence which blocks of words function as subject, direct object, indirect object, etc. in a sentence or clause. The knowledge of the "target" language syntax permits the rearrangement of the translated foreign words blocks into the appropriate "target" language order and the appending of necessary syntactical word endings.

Mechanized Translation Procedure

With these basic sources of information, then, it is possible to lay down in outline a definite procedure for the translation in terms of mechanical operations. First, it is necessary to determine the grammatical functions of the foreign language words. This is done by reference to the dictionary and is easy to systematize in a computer. The dictionary information about the possible grammatical functions of the word under consideration can be made to initiate an examination of a small context, say one word on either side, to resolve the ambiguity. For example, suppose "unter" (see above) occurs in a German sentence and we wish to decide whether it is an adjective or a preposition, then the words immediately following will settle the point. Thus, if following "unter" there is a group comprising an article or possessive adjective, an adjective, and a noun, with accusative or dative case endings, the "unter" is used here as a preposition.

The second part of the translation procedure is to determine the meanings of the words. Here we meet the problem of ambiguity in its largest form. It is closely connected with the problem of idiomatic usage, but this narrower difficulty is more easily disposed of, for a note in the dictionary can indicate that there is an idiomatic use of the word and thus lead to a set of operations for searching the context to see whether the conditions for the idiomatic use are present.

The next step is to identify groups of words which behave as one unit in a sentence. For instance, a noun together with its modifiers behaves as one unit. To determine these blocks of words the context of each word of the foreign language must be examined for grammatical patterns, and two blocks in juxtaposition will have to be distinguished by considering case endings. Then, with the word blocks found it is relatively simple to decide which are the clauses of the sentence on the basis of the occurrence of punctuation marks, conjunctions, etc. and also by the order of the word blocks.

Finally, the last stage of the procedure is to give the "target" language equivalents of the foreign language words in accordance with the analysis described above. This involves two things. First, adding the correct word-endings. This is a simple procedure according to the rules of the "target" language since the sentence structure and grammatical function of each foreign language word have already been determined. Secondly, arranging the "target" language word equivalents in the conventional word order of that language. This is an entirely mechanical operation once the clauses of the sentences have been identified.

Computer Facilities

To summarize all this briefly, the basic operation involved in translation can be reduced to: (a) comparing incoming words with the dictionary entries, (b) recognizing patterns of words or characters (as in idioms, word blocks, etc.) and (c) transferring information to and from a store (as required in the operation of searching the context of a word to find the presence of the other words used in the idiom). The next question to consider is how these operations can be achieved with the facilities available in a computing machine.

Despite variations in detail, all electronic computers have the following three main types of facility: (1) information manipulation (such as the ability to shift information to and from the various storage systems), (2) arithmetic operations (such as, addition and subtraction) and (3) what is known as "conditional transfer" (to be described below). These facilities are quite adequate to perform the basic operations of translation. In terms of actual "hardware," the digital computer has, in general, four distinct sections: a "memory" in which information can be stored; an arithmetic section in which operations are performed on the stored information; a control section which specifies what operation is to be performed (and, just as important, when); and terminal devices which enable data to be fed into the machine and by which the machine can display the results of its operations.

The first problem is how to code the words to be translated into numerical form and feed them into the machine. One convenient way is to deal with each letter of the words separately. It is then possible to use a teletypewriter as the input device, for as each letter key is depressed it produces a pattern of holes and spaces in a paper tape corresponding to the "0" and "1" digits of a number in binary notation. The paper tape can then be fed through a "reading" device which converts the holes and spaces into corresponding sequences of pulses and blank periods suitable for use in the computer. Decoding the translated text from the output of the machine is simply the reverse of this process, and here it is possible for a "receiving" teleprinter to be operated directly from the emerging sequences of pulses.

Once having decided how the words are to be coded in numerical form it is easy to see that they can be stored as groups of binary digits in the computer "memory" system, for example as states of magnetization on oxide media or as states of operation in flip-flop devices. This "memory" can be a magnetic drum, a system of acoustic delay lines, an electrostatic store or any other device, but the major requirement is large capacity; very quick access to any word is not necessary. At the moment only one type of store, bearing in mind the question of cost, fulfils these requirements. It is the magnetic drum, and this in fact used on the digital computer in Birkbeck College Electronic Computer Laboratory. Here approximately 8,000 words may be stored, and clearly several such
drums could be used. It is this "memory" system of the computer which contains the dictionary used in translation. All the foreign language words likely to be required are stored in one set of positions on the drum while their "target" language (for English) equivalents are stored in another related set of positions. The "memory" also contains the complete set of instructions (known as the "program") for the translation process, each instruction being represented by a group of 32 digits recorded on the drum.

"Arithmetic" Operations

To see how the arithmetic unit operates in the translation process we can examine how an incoming word is compared with words stored in the dictionary incorporated in the "memory." The stored words can be fed out sequentially from the "memory" and subtracted from the incoming word. When zero is sensed from the result the incoming word is clearly coincident with the word just subtracted, and the signal so produced can be used for initiating the next part of the program, which in the simplest case is the selection of the appropriate "target" language word from the "memory" dictionary. This operation is a very easy and rapid one for a computer. Another way in which the arithmetic unit may be used is in either separating "stems" from "endings" (subtraction) or joining them. This process would be particularly useful when dealing with highly inflected languages, such as Russian and Latin, where it would be convenient to store stems and endings in the mechanized dictionary.

A very useful facility is the "conditional transfer" mentioned above. This is a control method which allows the program sequence to proceed in one of two channels, depending on whether the most significant binary digit of an incoming number is a "0" or a "1." This can be very usefully applied in translation processes in which the sequence of operations depends on recognizing any given configuration of digits in the number representing a word or part of a word. Many machines have other conditional control facilities which are similar in that they allow the sequence of operations to proceed in either of two channels provided a given condition is satisfied or not. Such a system could recognize, for example, whether a certain storage device had all "0s" or all "1s" filling it.

Specialized Dictionaries

The size of store necessary to contain the total vocabulary for a non-technical translation would be extremely large. The number of terms used in specialized branches of science, however, is considerably smaller than that required for general literature. Consequently, by limiting the automatic translation to a particular branch of science, the dictionary can be reduced to a size manageable by present techniques of storage. Besides reducing the size of vocabulary, concentration on technical literature reduces the problem of ambiguity. And by further specialization on, say, a particular branch of mathematics, ambiguity of technical terms within that branch is lessened. For technical translation, then, a mechanized dictionary must be compiled in two stages: first by collecting together the general language of mathematics, that is, the language common to all or most branches of mathematics, and secondly by assembling a glossary of all the technical words in the particular branches of mathematics. The translation of a paper, on, say, group theory would thus be preceded by feeding into a computer a dictionary of the general language of mathematics and a glossary of group-theory terms.

Not every case of ambiguity with a word can be resolved simply by reducing the vocabulary or referring to a small context. For instance "Ableitung" in German means "derivative" or "deduction." The first translation occurs so frequently in many branches of mathematics that it would be safe to consider it a general mathematical term along with the second meaning. And it will not always be possible to decide by reference to the immediately preceding word which meaning is intended, for example, "zweite Ableitung" can mean "second derivative" or "second deduction" and both these phrases could occur in mathematical literature. Resolving this type of ambiguity is difficult and could possibly be done by reference to the context of the complete sentence. Failing resolution of ambiguity, all possible meanings could be printed, leaving the specialist in that particular branch of mathematics to decide the issue.

Enough has been said now to show the nature of the problem. Various projects are under way in America and in England, notably at Birkbeck College. On the engineering side research is directed towards the construction of "memories" which are large and also permit quick access to the stored data. At the same time, devices for the automatic recognition of printed and spoken material are being developed. On the linguistic side, the problems are to construct a "program" for each language to be translated into English and to build glossaries of suitable technical terms for the various interested branches of science.
Etched Foil Printed Circuits
With Particular Reference to Photomechanical
Methods of Production

For the production of identical circuit patterns in large quantities, printed wiring is becoming increasingly popular. At the time of writing, only wiring is being attempted; the printing of component parts, with the exception of r.f. coils and low-value capacitors, is still a long way off.

The etched foil method appears to offer more advantages than other methods, and is more easily scaled down for use in laboratories and in pilot plant production. Basically, this system uses a thin copper foil, usually between 0.001 and 0.002in thick, bonded to an insulating material; this may be practically any type of laminate but, as it needs to be machined, cut and punched, synthetic resin bonded paper (s.r.b.p.) is almost universally used. Special circuits may need either a base material suitable for use at higher temperatures than s.r.b.p. or one possessing better dielectric properties (lower permittivity and power factor). The printed circuit pattern is impressed on to the copper in acid-resisting ink (the resist) and all the unwanted copper is removed by etching in a weak acid.

Methods of Printing.—The word “printing” is used in a loose way when discussing “printed” circuits. Sometimes real printing methods are used, such as the offset-litho or the silk-screen, but photography is often used to produce the same result, and, although this is hardly “printing,” the method is very similar to that used in making printing plates of the “line” or “half-tone” variety. A few words about the non-photographic methods will show the relative merits of each.

Offset-Litho Methods.—When a large quantity of printed circuits is required, the offset-litho method is probably the most suitable way of producing them. The work is done by specialist printers using a flatbed machine over which a roller travels from end to end. The printing plate is made by a method very similar to the one to be described in detail, but it is made on an aluminium sheet which has been lightly roughened or “grained.” The prepared plate is placed on the bed of the press where it is first inked and then traversed by a blanket roller, usually of rubber, which transfers its inky pattern to the copper-clad laminate. The layer of ink transferred from the printing plate to the laminate is very thin and would not in itself stand up to the acid which is later used to remove all the unwanted copper, leaving the pattern alone on the insulated base. A layer of powdered bitumen or resin is brushed or blown on to the inky pattern and adheres to it. This is fused by heat to form a reinforced layer that will resist the acid etchant.

This process is carried out by skilled printers using standard methods and equipment, as used in the quantity production of nameplates, etc. It is not possible to scale it down to laboratory proportions.

Silk-Screen Methods.—The silk-screen method of printing is extensively used for the production of large-sized prints, e.g., posters. It is attractive for printing circuits because of its general use in the radio and electronic industry for the printing of dials, scales, etc. Circuit and nameplate printing both use non-absorbent base materials—an essential difference to printing on paper. The method of production may be scaled down for use in the laboratory and it is quite economical for the making of a few prints, but several hundred may also be made in the same way.

The silk-screen consists of a fine woven material either of silk or fine wire, which is stretched tightly over a wooden or metal frame. The pattern is made into a stencil by photographic means and this is attached to the silk, leaving holes only where the pattern is required, all the rest being blanked out. The laminate is placed under the screen, ink is poured on one end and transferred to the other by means of a square-cut rubber squeegee. In this way the ink is forced through the holes in the stencil and forms a pattern on the laminate. The inks used for silk-screen work are very viscous and, as a thick layer can be applied, they are, when dry, good acid resist.

Limitations of Offset-Litho and Silk-Screen Methods.—Apart from difficulties in production which have already been mentioned, there are technical reasons why both the methods discussed are unsuitable for certain electronic circuits. The most serious limitation is in the degree of fine detail that can be obtained by their use.

In a large number of circuits, fine detail is not necessary and it should be part of the design to eliminate unduly narrow lines and spaces, but when these cannot be avoided, or when coils must be printed, photographic printing methods must be used.

Photomechanical Methods.—Printing on metals is not done by the same means as is used in portrait or landscape photography, neither are emulsions stripped from plates and transferred to metal surfaces. The process is to deposit a photo-sensitive material on to the plate, then expose and develop it.

When making printing plates or blocks, the base material is metal and is able to withstand heating, which hardens the coating material and greatly improves its acid resistance. In addition, the etching is only carried on for a fraction of a mil (thousandth of an inch)—in the trade a “deep etch” is 0.0005in. For circuit printing, the copper must be etched right through and, as it is usually about 0.0015in thick, this may take 10-15 minutes, or more, according to the density of the etchant and its temperature, and the degree of agitation.

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Wireless World, September 1955

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WIRELESS WORLD, SEPTEMBER 1955

436

www.americanradiohistory.com
Numerous ways are available for producing the image. Some are wrapped in trade secrecy, others use proprietary methods—often called "cold-tops" to distinguish them from the processes where heat is required. Many of these have been tested over a period of several years and some have proved unsatisfactory; others are temperamental and require rigid control of room humidity. Two methods will be described; neither uses proprietary materials, and both have given consistently good results over a period of time.

**Preparation of Drawings and Negatives.**—Before printing on the laminate a negative is required, and this is made from a drawing of the circuit pattern which is to be produced. A drawing in Indian ink on white cardboard has been found reasonably satisfactory. It is made four times the size as this allows the draughtsman to draw thick lines and when working to his normal tolerance of ±0.005in, the final result will be within ±0.00125in, which is sufficiently accurate for all but the most intricate designs.

To avoid work in the drawing office a novel method of producing master prints has been developed, which is only applicable when the circuit is to be printed on a standard-sized board with terminations in fixed places. When used it enables the circuit designer to lay up a master in a short time, knowing that when photographed it will be precisely to size and that the terminations will be correctly placed. With the double-sided board, registration between opposite sides is very important and is quite difficult when using drawings, as paper and cardboards are dimensionally unstable.

The circuit layout is made on a sheet of paper on which a standard basic pattern is printed by a duplicator. The lines are pencilled in, either in different colours for each side or in solid and broken lines (Fig. 1).

The system is to use engraving sheet, a three-ply laminate of a black sheet between two white or a white sheet between two blacks. The former is generally used and the standard terminations are engraved out, leaving dense black squares or circles on a white background. Surface shine is eliminated by rubbing down with fine glass paper to a matt finish. A grid pattern is marked on the surface to guide the tapes which are used to produce the wiring pattern (see Fig. 2 (a)). The whole sheet is marked out and engraved on a milling machine; the work can be done very accurately. The pattern is four times full size.

When completed, the pattern is transferred to the engraved sheet by means of adhesive cotton tape, known as photographic masking tape. This has a dull, unglazed finish that prevents shine on the photograph. It is obtained one inch wide and slit to 0.2in as the wiring is of 0.05in width, four times up in size. This tape adheres well to the engraving sheet and can be used over and over again as it retains its adhesive properties. The engraved sheet complete with its pattern of wiring is shown in Fig. 2 (b).

A circuit made by the method described is shown in Fig. 3. It consists of a double-sided laminate on which the standard components are assembled and held in turret lugs. Two double-triode wire-ended valves are fixed to the board with special clips. The whole sub-unit has been designed especially so that it can be made by semi-automatic means, and all the
Photography.—The drawing on engraved sheet, when completed and checked, is mounted on an easel and photographed to correct size. This is easily done with a process or studio camera as the image is projected on to the ground glass focusing screen and measured with a ruler. If a special process camera is not available and a studio type is used, it will be important to ensure that the drawing, lens and focusing screen are all perfectly square and parallel to each other or the pattern will be distorted.

The choice of negative is limited by the need of a very “contrasty” picture giving complete transparency of the pattern on a completely opaque background. Two photographic suppliers have recently introduced a range of extremely contrasty negatives which are available in various sizes both on film and on glass. These negatives (Kodak “Kodalith” and Ilford “Formalith”) are developed in special developers (known by the same name as the plates). They require a long exposure as the emulsion is very slow, but the result is ideal for photomechanical purposes as the whites are transparent and the black very dense, needing no reduction or intensifying as do most process plates and films.

The choice of plates or films is governed by the final requirements and the available equipment. For maximum stability and the maintenance of close tolerances, glass plates are preferred, but these often fail to make intimate contact with the laminate, when making the contact print. Films can be backed up close to the base and if a vacuum printing frame is available, intimate contact is made, giving the finest reproduction of the original pattern.

We will assume that the plate or film negative has been made and has been retouched where necessary to fill in any pinholes.

Printing on the Laminate.—The copper-clad laminate is usually made of paper impregnated and bonded with phenol-formaldehyde (s.r.b.p.) but it may be of glass cloth impregnated with polyester, epoxy or silicone resins. In any case, the copper foil is bonded to one or both faces by various proprietary methods, some patented by the laminators.

The poorness of the bond was largely responsible for the long delay in realizing the initial basic ideas behind etched foil. Modern materials have the copper foil bonded well enough to withstand a peel test on a 1-in strip of up to 25 lb at room temperature, and stable enough to withstand dipping for 3 or 4 seconds in a bath of solder heated to 250°C.

When received from the manufacturers the copper faces are greasy and oxidized. They are cleaned either by wet abrasion with a brush, water and pumice powder or, if the surface is not pitted or porous, by chemical means with or without the passage of current (cathodic etching). The surface must be clean enough to maintain an unbroken film of water when wetted. When thoroughly clean and degreased, the board is ready for the application of the photo-sensitive coating.

Coating Solutions.—Two types of photo-sensitive coatings will be discussed. On a single coating, requires reinforcing with ink before it becomes a sufficiently strong acid resist. The other, a double coating, stands up to the etching bath without reinforcement. Each has its advantages and disadvantages, which will be discussed later.

Single Coating Method.—The solution, which is water soluble, is made as follows: Take 70 grams of egg albumen and dissolve in 250 c.c. of warm, distilled water at about 35°C. When dissolved, add 111.5 grams of ammonium dichromate followed by 7 grams of ammonia, 0.88 specific gravity. Make up mixture with distilled water to 560 c.c. Filter through a No. 41 filter paper to remove particles.

The filtered solution is poured on to the clean copper face of the laminate and whirled until dry. The whirling may be done with a hand-operated tool like a hand drill with a rubber suction cup instead of a chuck, or on a modified gramophone motor and turntable, rotating at about 100-120 r.p.m. Commercial whirling machines are available for production quantities. The motor-driven types are best as the rotation is at a controlled and repeatable speed. If it is required to speed up the process, slightly warmed air may be applied from a hair-dryer or by other means, but it is important that the coating should not be overheated at this stage.

As there is a build-up of the coating at the edges of the plate an oversized plate is used; in other words, the pattern is smaller in size than that of the board which is being coated.

When dry the coating presents the appearance of a glossy yellow film that is even and non-tacky. It is not sensitive to any normal lighting except strong sunlight and to ultra-violet light, so the coating may be made in a well-lit room excluding sunlight.

The plate is placed in contact with the negative, emulsion to coating. Both are put in a printing frame—preferably of the vacuum type, but good work has been done with the ordinary type used to make contact prints. The exposure is made to ultra-violet light from either an arc-lamp or a high pressure mercury vapour lamp. If the negative is really opaque it is impossible to over-expose it, but as lamps produce heat, it is possible to overheat it. Four to six minutes with an arc lamp and 10 to 12 with a mercury vapour lamp are generally correct. Under-exposure must be avoided or the image will peel off during development.

On removal from the frame, the image will be seen as a dark pattern where the light has hardened the coating in those places not covered by the lines in the negative. The laminate is placed face upwards...
on a flat surface and a small pool of lithographic developer ink (a black, oily liquid) is poured on its centre. The ink is swabbed over the surface as quickly as possible with cotton-wool several pieces of which could be used in order to get a very thin film of ink remaining on the copper surface. The object is to remove as much ink as possible in the shortest time as it is quick-drying, and too thick a film will make the subsequent development very difficult.

The inky film is dried with warm air and thoroughly wetted under running water. Those parts of the image that were covered by the opaque parts of the negative will wash away leaving the pattern showing in the copper base. Sometimes, parts of the coating require light rubbing with cotton wool to clean up the surface, but when the process has been carried out satisfactorily the running water will suffice to develop out the image. When fully developed, the plate is dried by hot air; this time the heat is beneficial as it hardens the ink layer and so increases its acid-resistant properties.

As described, the ink layer will stand up to the etching solution long enough to remove all the unwanted copper, but as it never really dries and if both sides of a board are to be prepared for etching further initial treatment of the first side is necessary. This is quite simple, merely being the pouring over its surface of a powdered bitumin or resin (the latter known as Dragon's Blood). The powder adheres only to the sticky ink and by tapping smoothly on the side of a bench or by washing in water, all the surplus is removed from the copper. This layer of powder must be fused by heating. The resin requires about 2-5 minutes' treatment at 100°C, either in an oven or by the application of infra-red heat; the bitumen fuses at a higher temperature, which is found by experiment.

When the process is complete, the resist pattern is very hard and practically scratch-proof so the reverse side of the board may be coated and processed exactly as for the first side. When finished, the placing of the board edgewise into the etchant will remove the unwanted copper from both sides at once.

Circuits treated as described have withstood 4-5 hours in a bath of ferric chloride of 1.38 s.g. at 25°C.

Double Coating Method.—In the method already described, the single coating must be light-sensitive and also acid-resistant; this limits the choice of materials that can be used—most of them are based on a colloid such as albumen, fish glue, gelatin or gum arabic.

The separation of the light-sensitivity and acid-resistant properties allows a stronger base to be used, whilst the light-sensitive material has only to resist the solvent for attacking the base—in other words, the first layer is acid-resisting and the second is made into a stencil through which a solvent removes the underlayer where required. The process is carried out as follows:

A cellulose nitrate lacquer is coated on the cleaned copper face of the laminate. Whirling is unnecessary as the solution, thinned to double its volume with acetone, is poured on to the centre of the plate and allowed to flow over its entire surface. It dries quickly and as it is dyed red, the smoothness of the coating is easily checked.

When dry, the plate is coated with the albumen solution exactly as used in the single-coating method. It is exposed to the arc or ultra-violet mercury vapour lamp through the negative and is developed in water after exposure, instead of being inked up as described previously. As the albumen solution is almost colourless, it is difficult to see it on the surface of the lacquer, but as it is dried with hot air the image appears, only to disappear when it is completely dry. The albumen coating solution could be dyed but the need for this has not occurred in the experience of the author.

The lacquered plate is now covered by a stencil of albumen in the circuit pattern. If a solvent is now poured on its face, all the lacquer will be removed except where it is covered by the albumen coating. Many solvents may be used—propyl alcohol is effective but most are too quick in action and some attack the stencil. A slow acting and very effective solvent is polyethylene glycol—a liquid rather like glycerine in appearance and consistency. A small quantity of this is poured on to the plate and lightly swabbed with cotton wool. All the unwanted coating comes away, leaving the image ready for acid etching. No heating is required or is desirable, as the lacquer is easily crazed by overheating.

This method is satisfactory for single-sided circuits but it is impracticable to coat one side of the laminate without getting any of the lacquer on the reverse. It provides a stable image that is non-tacky and quite tough and so able to withstand handling without being easily damaged.

Etching the Copper.—Although nitric acid has

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**Fig. 4. Comparison of single- and double-coating photographic methods.**

**Wireless World, September 1955**

439

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www.americanradiohistory.com
been used by a few people, most use ferric chloride as an etchant. Practically all workers in the printing trade use it because it gives a slower, more easily controlled etch without bubbling. When copper is attacked by nitric acid, hydrogen is liberated; this bubbling through the liquid can lift the acid-resistant pattern.

The ferric chloride may be obtained as lumps which are dissolved in water by the user or, more conveniently, as a liquid of about 1.38 s.g. When making a new bath, some 5 per cent or so of old etching fluid should be added to it as this increases its cutting speed.

Etching machines are available for large-scale work, but for laboratory purposes a photographic developing dish made of china is adequate. The single-sided board is immersed face downwards so that the copper silt which is cut away by the etchant falls to the bottom of the bath. Double-sided boards are, as already stated, placed edgewise in the bath and in each case the dish is agitated in a similar way to that used in developing a normal photographic plate.

Warming the bath to about 30-35°C speeds up the process, which can often be completed in about 7-10 minutes. Some machines will etch through 0.001 in of copper in three minutes, but the resists that have been discussed are extremely durable and, when necessary, the boards may be left untouched, if the bath is at room temperature and unagitated, until the final cleaning of copper which may take about an hour.

After etching, the board is thoroughly washed in warm water to remove all traces of acid and then the resist pattern may be removed with a solvent—turpentine or white spirit for the bitumen or resin, acetone for the cellulose lacquers. Where the bitumen or resin has been well fused, abrasion of its surface, with water and scouring powder, may be necessary to clean up the exposed copper circuit. It is advisable to dry the laminate in an oven for about half an hour at 100°C to remove any water that has been absorbed during processing. This is particularly important when low-grade punching materials have been used as a base for the copper foil.

Comparison of Single- and Double-coated Methods.—It has already been stated that the double coating would be difficult to apply to double-sided boards, but apart from this fact, the following points should enable a choice to be made between the two methods.

There are more operations when using the single than when using the double coating (see Fig. 4) and it requires less manipulative skill to carry out the latter. The application of the cellulose lacquer is very simple and the albumen coating is applied in each case, so the process is common to both methods. A certain dexterity is required when inking up the albumen-coated plate; too thin a layer makes a poor acid resist and too thick a layer makes the development of the image difficult. Following up with powdered bitumen or resin is probably best done by dipping the board into the powder and washing away the surplus under a tap which, although simple, requires practice to perfect it.

On the other hand, the thinners and solvents for the ink—white spirit or turpentine—are pleasant to use, whereas acetone as the solvent for the cellulose lacquer is unpleasant, also the red cellulose is much more difficult to remove from the skin and from clothing than the simple oily liquids.

With a little practice, the single coating with its reinforcing materials gives consistently good results under all conditions of temperature and humidity. It produces a resist pattern which is very much more durable than most cold top enamels, it is made up by the user from harmless chemicals, easily obtained. The solution, when kept in a well-stoppered coloured bottle (so that it is unaffected by light) has been used over a period of three months without deterioration.

Given a good negative, thorough cleaning of the copper, adequate exposure followed by development in cold, running water, and careful inking up of the image, very satisfactory results can be achieved with a definition that is good enough for the finest detail such as is needed on miniature circuits and coils.

Acknowledgement is made to the Printing and Allied Trades Research Association, Leatherhead, and to Kodak, Ltd., Kingsway, London, for help and advice on circuit printing over a period of five years.

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Glassware for C.R. Tubes

Cathode-ray tube glass parts (cones and face-plates) are turned out at the rate of one every six seconds by a new automatic plant put into operation by Pilkington Brothers at St. Helens this year. The firm came into the business at the Government's request in 1948 and now, with the new equipment, are able to produce at least two million components a year. In this machine, large blobs of molten glass from a furnace are fed into moulds on a rotating table, and this passes under a plunger which descends and presses out the glass to the required shape. Annealing follows, then inspection, and grinding and polishing where necessary.

Wireless World, September 1955
American Oscilloscope Technique

With Some Remarks on Anglo-American Divergencies

By A. J. REYNOLDS*

THOSE readers who were in the radio industry in pre-war days will remember the very high regard in which instruments by such American companies as General Radio, Boonton, Ferris and Measurements Corporation were held. In the early and mid thirties the British Instrument as we know it today hardly existed. We had, of course, famous companies such as Cambridge, Muirhead, Sullivan and Tinsley, but they were fully occupied making what can be regarded as laboratory standards, bridges of extreme precision, potentiometers and variable air capacitors of exquisite workmanship. Little was then available, British made, for those awkward characters who required to generate few microvolts at many megacycles or who cherish a notion to measure the Q of the Litz-wound glass-inductor in their super short-waver.

The founder member of the new brigade of instrument firms was undoubtedly Marconi-Ekco who, in the late thirties, began to make American-style instruments in this country. Having a relatively clear field they expanded rapidly, but when war broke out most of the serious work in British laboratories was still being done with instruments of American manufacture. During the war few American instruments found their way into the country and the small British industry expanded enormously. It had to; in pre-war days the Standard Signal Generator was an object of awe and veneration enshrined amongst the polished teak and lacquered brass binding-posts of the standards room, one per factory being about the number required. In the Services thousands were necessary, and such old favourites as the Marconi TF144 were bounced across the desert in 15-cwt trucks and dragged across the gooey mud of forward airstrips by sodden “erks.”

After the war Britain found herself with a new industry—electronic instruments. New names appeared: Advance, Airmec, Cintel, Dawe, Solartron, Wayne Kerr and a whole host of others. The well-publicized dollar shortage precluded the entry of American instruments and as a result the styling, electrical and mechanical design of the products of the two countries have moved steadily apart. A somewhat similar state of affairs exists to that in the motor industries of the two countries.

Across in the States conditions were very similar to those at home. The war gave the instrument industry a tremendous fillip and while the old-established companies grew enormously, and along lines that could have been fairly easily predicted, a horde of new companies shot up overnight. (Some of them also shot down again pretty quickly.) Amongst these were two destined to become the giants of the industry. They are Hewlett-Packard, born in the garage of one Dave Packard just before the war and now the largest instrument company in the world in terms of turnover, and our heroes on this occasion Tektronix.

Company Organization
Tektronix Inc. was organized as an Oregon corporation in January, 1946, for the purpose of developing

Front panel of Tektronix oscilloscope Type 535, giving some idea of the facilities available.

* Livingston Laboratories.

WIRELESS WORLD, SEPTEMBER 1955
and manufacturing cathode-ray oscilloscopes. The owners all had extensive wartime electronic experience in either military or civilian capacities. The president, Howard Vollum, actually worked in this country on radar development during the war.

The company and its products form a useful guinea pig for a miniature study of current American thought in light current engineering. It is a successful company; from small beginnings as late as 1946 it now dominates the American wide-band oscilloscope market and is by far the largest producer of these instruments in the world. Before going on to the instruments let us look at a few points concerning the general organization and see how they tie up with your own conception of an American company and normal British practice.

First, the president, Howard Vollum, is a distinguished engineer, completely au fait with the performance of his company's oscilloscopes and the designer of some of them. This is a theme constantly reiterated in the new generation of U.S. instrument companies. Bill Hewlett and Dave Packard designed all of their company's original products. Rarely is the accountant-cum-financier type of director found over there. On enquiry you will be told "You can always take an engineer and train him as a business man, but rarely does the converse apply."

Secondly, at Tektronix they are more nearly self-sufficient than any other comparable company in the world. The only bought-out components are those such as valves and resistors. When the commercially available article is not good enough there is no hesitation in setting up a department to improve on current practice. Commercial capacitors could not be bought that were sufficiently good for use in their time bases, so they wind their own to ±0.25%. Bought-out c.r. tubes were insufficiently linear for the sort of accuracy sought---so they made their own, incidentally solving a major tube manufacturing problem in the process. The new Tektronix tube uses a helical post-deflection accelerator ring that starts at the top of the tube neck and runs helically right up the flare to the screen. This, of course, is an old idea and obviously the transatlantic factor is a secondary point concerning the general organization and space to deal with the internal appearance of the company's President, Howard Vollum, is a successful company. The company and its products form a useful guinea pig for a miniature study of current American thought in light current engineering. It is a successful company; from small beginnings as late as 1946 it now dominates the American wide-band oscilloscope market and is by far the largest producer of these instruments in the world. Before going on to the instruments let us look at a few points concerning the general organization and see how they tie up with your own conception of an American company and normal British practice.

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The last point, which I am sure has a sizeable bearing on the company's success, is its method of payment. Every month 22½% of the company profit is divided amongst the employees in the ratio of their salaries and a further 7½% added to the pension fund. A simple enough payment by results system, but one which ties an individual's earnings to the performance of the company as a whole. Under this system what matters to each employee is that he customer is satisfied. Surely all men should be working to please the customer rather than to put one over on an inspector three benches away!

Two Outstanding Models

As examples of the instruments themselves we have space to deal with but two, the fabulous type 517 and the latest of the line, the type 535.

The 517 is a wide-band high-voltage oscilloscope designed primarily for the observation and photographic recording of very fast rising waveforms having a low duty cycle. The use of 24 kV accelerating potential on a metallized cathode-ray tube permits photographic recording of single sweeps at the maximum writing speed allowed by the Y amplifier and sweep circuits. Distributed-type Y amplifiers provide a rise time of 7 millimicroseconds with a maximum sensitivity of 0.1 V/cm. Both amplitude and time stabilizers are provided. Sufficient time delay is incorporated in the Y amplifier to permit viewing the leading edge of the waveform which triggers the sweep.

In order to provide sufficient vertical deflection voltage with a rise time as short as 7 millimicroseconds for a cathode-ray tube using 24 kV accelerating potential, a distributed amplifier is employed. This amplifier consists of five stages plus a phase inverter and trigger valve. The first two stages use six 6AK5 valves each, next a stage of seven 6CB6 valves and a phase inverter of three 6CB6s. The signal then goes to a push-pull driver stage having six 6CB6s each side and finally to the output stage with twelve 6CB6s on each side.

The performance on the X axis is just as impressive. Since many fast-rising pulses are either non-repetitive or non-uniformly spaced, it is essential to have a sweep which can be triggered by the observed pulse itself. To enable the type 517 to trigger from fast rising signals of small amplitude, a wide-band distributed amplifier is incorporated. Signals of 0.3 V amplitude with a rise time of 1 millimicrosecond will easily trigger the sweep. When using the observed signal as a trigger, any signal giving a deflection of 2 mm is adequate.

The time base on its fastest speed runs at 10 m/sec/cm, that is, a complete sweep of 8 cm in 80 m/sec. Although their invariable practice, and one well suited to the method of calibration, this style of specifying time base speed strikes me as slightly ludicrous. It is rather like saying "Poor old Charlie was nicked for failing to exceed 0.033 hours per mile in a built-up area." Come to think of it, they are in effect quoting the time base slowness rather than time base speed, which is what we care about.

That then is type 517, a slightly fabulous beast in that few of us could live up to it. Owning a 517 must be rather like owning a 4½ Ferrari or being married to Marilyn Monroe. Let us examine another model, just as outstanding in its own sphere but more applicable to everyday problems, the type 535.

WIRELESS WORLD. SEPTEMBER 1955
The 535 is a most unusual instrument for two reasons. First, it is the best example to date of that oft-attempted oscilloscope, the Y amplifier characteristics of which can be varied by means of a series of plug-in pre-amplifiers. The main ones of these are the 53B, with a frequency response of d.c. to 10 Mc/s and a sensitivity of 5 mV/cm, and the 53C, with a response of d.c. to 8.5 Mc/s and a sensitivity of 50 mV/cm. A double beam facility is provided by means of an electronic switching system. This beam switch can be triggered by alternate sweeps or allowed to run free at 100 kc/s. A d.c. and low frequency pre-amplifier is available, giving deflection sensitivities of 50 nV/cm. When these are allied to a time base having continuous coverage from 0.02 usec/cm to 12 sec/cm, it will be seen that even without any other features the 535 would still be an outstanding instrument.

The second unusual facility is one that obviously springs from the firm's association with radar, as it is a well-established radar technique applied for the first time to oscilloscopes. This is the use of two time bases, one of which strobos the other. For those not familiar with this trick a word of explanation. Consider the two time bases in Fig. 1, one of which, at (a), is pictorially quite familiar. It can be so arranged that the linear rise of voltage in (a) will trigger a second time base, running much faster, at a predetermined voltage level, as shown in (b). It will be obvious that if the first sweep is triggered by a pulse, then varying the voltage at which the second sweep fires will slide this sweep up and down the slope of the first one and so provide a variable delay between the trigger pulse and the start of the second sweep. In practice no such waveform as (b) appears in the instrument, this having been simplified to establish the general principle.

Selective Observation

Let us take a practical example. We will feed into the type 535 oscilloscope a television waveform, Test Card “C” in fact, and arrange for the first sweep to be triggered by the line pulses and to have a duration of some 100 usec. The resultant display will then consist of a jumble of all 405 lines. If, however, a rudimentary sync separator, consisting of a CR network with the correct time-constant, is included in the trigger circuit, then the time base will trigger from the frame group and permit a display on one line which looks something like Fig. 2.

Now suppose it is arranged that when the second sweep fires it applies a “bright-up” to the beam, then a portion of this display will appear brighter than the rest. The length of the bright patch can be varied by adjusting the duration of the second sweep and its position along the picture by varying the delay (point on the first sweep at which the second sweep fires). In our example we could arrange the bright portion of the trace to coincide with the 3-Mc/s bars. This done, by switching the input of the X amplifier the second sweep can be applied to the plates of the tube and a picture of the 3-Mc/s portion of one line made to occupy the whole screen, permitting detailed examination. The beauty of this system is that a complex waveform can be displayed inoto on the screen, a portion of it selected for detailed observation and that portion viewed on a greatly increased time scale with absolute certainty that it is the desired part of the waveform.

This has Perforce had to be a rather sketchy treatment of a complete range of instruments, but I hope it has at least shown that, during the years when American instruments have been absent from this country, oscilloscope design at any rate has been progressing along lines rather different from our own.

Since this article was written a further development of the 535 oscilloscope has taken place, bearing the type number 545. It is based on a new cathode-ray tube developed by Tektronix which has the fantastic deflection sensitivity of 7 V/cm with 10 kV on the p.d.a. ring. Use of this tube gives the new oscilloscope the following Y amplifier performance: frequency response, d.c. to 30 Mc/s; rise time, 12 µsec; sensitivity at full bandwidth, 50 mV/cm. The amplifier is 6 dB down at 45 Mc/s and 12 dB down at 60 Mc/s.

* Although this example deals with the use of the type 535 as a line selecting monitor, this function is performed equally well by the similar type 524, an oscilloscope that has been a standard instrument in American television circles for over four years.

**AMATEUR COURSES**

IN preparation for next year's radio amateur examination, to be held by the City & Guilds in May, a large number of educational establishments up and down the country are arranging evening courses of instruction. Among those from which we have received specific details are:

Bradford Technical College; classes are being arranged by the Bradford Amateur Radio Society (Sec. F. J. Davies, 39, Pullan Avenue, Eccleshill, Bradford, 2).

Brenford (Middlesex) Evening Institute; Wednesdays (fee 10s).

Glasgow, Allan Glen's School; theory will be taken on Tuesdays and morse on Thursdays (fee 10s.)

Huddersfield Technical College, where the lecturer will be C. W. Oakley (G31PD).

Holloway, Grafton School; theory on Mondays and practice on Wednesdays with morse instruction after each evening's class (fee 10s).

Ilford (Essex) Literary Institute; both theory and practical courses on Wednesdays (fees 10s per course).

South-East London Technical College; theory Wednesdays, Wembley Evening Institute; Mondays, morse 7 to 8, theory 8 to 10.

Wireless World, September 1955
Transistor Equivalent Circuits

3.—Earthed-Base Transistors

By W. T. COCKING, M.I.E.E.

SUMMARY:—Equivalent circuits for the earthed-base transistor are derived from the earthed emitter circuits of Part 2. The different forms of transistor constants are discussed and the relations between the more common ones are tabulated for easy reference.

So far, transistors have been considered only in the earthed-emitter form of connection. The published characteristics of transistors, however, are usually for the earthed-base connection rather than for the earthed-emitter. The constants of transistors are also usually quoted for the earthed-base connection.

It might be thought, therefore, that it would have been better to start in Part 2 with this arrangement and so to follow the customary practice in transistor literature. We have here deliberately avoided this, however, in order to bring out the basic similarity of the transistor and the thermionic valve, so far as external matters are concerned. If it were not for certain difficulties with the point-contact transistor, we might even take the view that the earthed-emitter circuit should be regarded as the fundamental one, just as the earthed-cathode circuit is so regarded for the valve.

A difficulty arises with the point-contact transistor, however, for it can have negative input and output resistances when its emitter is earthed. These negative resistances cause certain difficulties of measurement which can make it awkward to obtain the characteristic curves and constants. Because of this, it is much more convenient to make measurements on the point-contact transistor in the earthed-base condition than in the earthed-emitter and, for uniformity, it is

Fig. 1. Amplifier stage using an earthed-base n-p-n transistor.

Fig. 2. An earthed-emitter equivalent circuit is shown at (a) and, with its connections altered for an earthed base, at (b). The successive transformations to an earthed-base equivalent circuit are shown at (c), (d) and (e). A two-generator form appears at (f).

WIRELESS WORLD, SEPTEMBER 1955
customary to measure junction transistors in the
circuit of the transistor constants should be ones based on this
circuit. It should not be thought that the earthed-emitter
equivalent circuit developed in Part 2 has been wasted, however. So far from that, we regard it as an essential stepping-stone from the valve to the earthed-base
transistor. Further, the earthed-emitter circuit is being increasingly used with junction transistors and all that is necessary to employ the equivalent circuits of Part 2 with transistor constants for the earthed-base
connection is to have some conversion formulae so that $p_{00}$, $p_{01}$ and $p_{11}$ or $P_{00}$, $P_{01}$ and $P_{11}$ can be derived from them.

Our next step must be to develop an equivalent circuit for the earthed-base transistor. The circuit has the form shown in Fig. 1 for an n-p-n transistor. Let us first of all derive an equivalent circuit from the one for the earthed-emitter circuit Fig. 5(b) of Part 2. This is repeated in Fig. 2(a). For the earthed-base connection it becomes Fig. 2(b) which can be re-drawn as in (c). The essential change is that the collector voltage is measured between collector and base instead of between collector and emitter. There is, therefore, a change in the meaning of $V_c$ between (a) and the other diagrams.

Fig. 2(c) can be changed to (d) by removing $i_{b1}$ from the $p_0$ and arm and inserting it in both the $p_0$ and $p_2$ arms. In (b), (c) and (d), $V_0$ has become $V_e$. The two are numerically equal but of opposite polarity, when measured from earth. In (c) and (d), too, $I_e$ has disappeared and the path of $I_e$ has been changed. It is plain from (a) that $I_e = I_b + I_e$, so that the currents in all the resistances are unchanged by this re-distribution and re-naming.

We now require this equivalent circuit to be brought to the form of Fig. 2(e) in which the quantities are derived from the earthed-base characteristics instead of the earthed-emitter. The relations between (d) and (e) are easily established by comparing their mesh equations. For the emitter loop

$$V_e = I_e(p_b + p_0) - I_e p_b - I_e p_{01} = I_e(r_e + r_0) - I_e r_0 - E_e - I_e p_{01},$$

which gives us $r_e = p_{03}$, $r_0 = p_b$ and $E_e = I_b p_{11}$.

For the collector loop we have

$$V_c = I_c(p_b + p_0) - I_c p_b - I_c p_{01} - I_c r_{11} - I_c p_m = I_c(r_c + r_0) - I_c r_0 - E_r - I_c r_{11},$$

Substituting $I_b = I_c + I_e$ for the coefficient of $r_m$ the second part

$$V_c = I_e(r_e + r_0 - r_m) - I_e r_0 - E_e - I_b p_m.$$

### TABLE 1

<table>
<thead>
<tr>
<th>Given $r_{11}$, $r_{22}$, $a$, $b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_e = r_{11}$, $r_{22}$, $a$, $b$</td>
</tr>
<tr>
<td>$p_b = p_{11}$, $p_{22}$, $1 - \alpha$</td>
</tr>
<tr>
<td>$r_0 = r_{11}$, $1 - \beta$</td>
</tr>
<tr>
<td>$r_m = r_{22}$, $\alpha r_{22} - 1 - \beta$</td>
</tr>
<tr>
<td>$\alpha = r_m + a, a = \frac{r_{22} - 1 - \beta}{r_0}$</td>
</tr>
<tr>
<td>$b = \frac{r_m}{r_0 + r_0}$</td>
</tr>
</tbody>
</table>

### TABLE 2

<table>
<thead>
<tr>
<th>Given $r_{11}$, $r_{22}$, $a$, $b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_{11} = r_0 + r_e$</td>
</tr>
<tr>
<td>$p_{01} = p_{11}$, $p_{22}$, $a = \frac{r_{22} - 1 - \beta}{r_0}$</td>
</tr>
<tr>
<td>$p_b = r_e$</td>
</tr>
<tr>
<td>$r_e = r_0 + r_e$</td>
</tr>
</tbody>
</table>

**Comparing the first and last equations for $V_e$, we have**

$$r_e = p_{03} + p_{01} r_m = p_{03} + a$$

and $E'_e = V'_e = I'_e p_{22} - I'_b p_{11}$.

We can now go a stage further and transform Fig. 2(e) to the form (f), which is like the equivalent circuit that we first derived for the earthed-emitter transistor. For this we have

$$V_e = I_e r_{11} - \beta I_e r_{11} - E'_e$$

and

$$V_c = I_e r_{22} - a I_e r_{22} - E'_e$$

Comparing these with the forms for Fig. 2(e) we get

$$r_{11} = r_e + r_0, r_{22} = r_0, (c) = r_e + r_0$$

and

$$\alpha = r_0 + r_m, \beta = r_0 + r_e$$

If we remember how we derived the corresponding terms of the earthed-emitter circuit from the transistor characteristic, it is now plain that these terms have similar meanings for the earthed-base characteristics. We can say therefore, that $r_{11}$ is the emitter a.c. resistance

$$r_{11} = \frac{8V_e}{r_1}$$

for $I_e$ constant. Also $r_{22}$ is the collector a.c. resistance

$$r_{22} = \frac{8V_c}{r_1}$$

for $I_c$ constant.

The other terms are the current amplification factors $\alpha$ and $\beta$, and

$$\alpha = \frac{8E'_e}{r_1}$$

and

$$\beta = \frac{8E'_c}{r_1}$$

for $V_e$ constant.

The characteristics for the earthed-base connection are shown in Fig. 3. We could have started with these and derived $r_{11}$, $r_{22}$, $\alpha$ and $\beta$ from them in accordance with the above definitions and in exactly the same way as we did for the earthed-emitter transistor in Part 2.

We should now have obtained Fig. 2(b) directly and found $E'_e = V_e$ and $E'_c = V_c$, where $I'_e$ and $I'_c$ are the zero-current intercepts as in Fig. 3.

Following the same argument as in Part 2 we could have found Fig. 2(e) and then established the relations with the earthed-emitter circuit (d).

The relations between the values for the equivalent circuits are summarized in Table 1.

The complete equivalent circuit can be reduced to its a.c. form by omitting the d.c. parts as we did before. The result is Fig. 4. One great advantage of this form of circuit is that three of the elements $r_e$, $r_0$ and $r_0$ have the same values as their earthed-emitter...
countercouples \( \rho_0 \rho_0 \) and \( \rho_m \). It is only \( r_e \) that differs from \( \rho_e \).

At this stage it is desirable to consider what four constants should be used to represent the transistor. So far, we have based everything upon a pair of a.c. resistances and a pair of current amplification factors because they are somewhat analogous to valve constants and are easily determined from the transistor characteristics. There are quite a lot of alternatives, however. We have already met \( a, b, p_{11} \) and \( p_m \) with the derived quantities \( \rho_o, \rho_x, \rho_e \) and \( \rho_m \) for the earthed-emitter connection and \( a, b, r_{11}, \) and \( r_{22} \) with the derived quantities \( r_o, r_e, r_0, \) and \( r_m \) for the earthed-base.

**Choice of Constants**

The thermionic valve operating with a negative grid requires only one family of curves to describe its characteristics and two constants, derivable from these characteristics, to describe it in an a.c. equivalent circuit. Because the transistor passes current at all its three electrodes, two families of curves are needed to describe it and four constants are needed for an equivalent circuit. This raises difficulties, because neither the two families of curves nor the four constants are unique. There are four possible families of curves and twelve possible constants!

This applies to the earthed-emitter connection and there are the same number again for the earthed-base arrangement. We need only four constants out of twenty-four possible ones! In the valve we have only three—amplification factor \( \mu \), a.c. resistance \( r_{oo} \), and mutual conductance \( g_m \) they are related since \( \mu = g_m r_o \); so we need two only out of a possible three and, if we ever want the third, the relation is a very simple one.

In the case of the transistor, the relations between the twenty-four possible constants are much more complex and are not readily performed mentally. It is rather important, therefore, to choose the best four constants. Unfortunately, opinions differ about which are the best and different writers use different ones. This accounts for much of the difficulty of transistor literature.

We regard it as essential that whatever four constants are chosen they should be determinable from the transistor characteristics which are most readily available. This at once rules out earthed-emitter constants, for the usual characteristics are the earthed-base type. We have, therefore, to choose four out of twelve possible ones.

There are three groups of four which are particularly common in the literature and which are defined in Table 2. The symbols following the square brackets indicate which voltage or current is to be regarded as constant. The twelve constants listed are not all distinct; for example, \( y_{11} = \frac{1}{y_{11}}, \; r_{22} = \frac{1}{y_{22}}, \; h_{22} = y_{22} r_{22}, \; h_{11} = y_{11} y_{11}. \) There are more possibilities than are shown in Table 2, therefore.

According to Shea\(^1\) the \( h \) group is the most suitable, because the constants are the easiest to measure and vary less with temperature and operating point than the others. However, \( h_{11} \) and \( h_{22} \) are not obtainable readily from the ordinary characteristic curves. In fact, no single group is!

There is one serious objection to the nomenclature of the \( h \) group, which is that the same letter serves sometimes for a resistance, sometimes for a conductance and sometimes for a ratio. This is very bad practice, because it prevents the ready dimensional checking of equations. It is likely to cause errors. In this respect, both the \( r \) and \( y \) groups are satisfactory, because all the \( r \) constants are resistances and all the \( y \) constants are conductances.

**Measurement of Constants**

When the constants are obtained by measurements on an actual transistor, some are easier to measure than others. The output resistance of a junction transistor is usually rather high, 1–2 M\( \Omega \), and it is difficult to employ a high enough external impedance to obtain constant-current conditions. It is much easier to make the impedance low and so to operate under constant-voltage conditions. It is, therefore, easier to measure quantities which need \( V_e \) kept constant than those which require \( I_e \) to be constant.

At the input, the reverse applies. If the input resistance is very low, it is difficult to obtain a voltage supply of low enough internal resistance to operate under constant-voltage conditions, but it is quite easy to operate at constant current. Thus it is easier to measure quantities which need \( I_e \) kept constant than those which must have constant \( V_e \).

The \( h \) group constants of Table 2 are thus admirably suited to the requirements of measurement.

When one wants to derive the constants from the characteristic curves, however, the \( h \) group is quite unsuitable. The most convenient ones are \( r_{11}, r_{22}, \alpha \), and \( \beta \), that we have used hitherto. They are all easily determined from the characteristic curves, which is why we selected them in the first place.

It does not seem practicable, therefore, to have a single set of primary constants which is suitable both for evaluation by measurement and from the characteristic curves. It seems best, therefore, to adopt one set for measurement purposes and another for derivation from the valve.

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\(^1\) "Transistor Audio Amplifiers," by Richard F. Shea. (Chapman & Hall.)
characteristics. The $h$ group seems best for the first and, for the second, the $r_{11}$, $r_{22}$, $x$, and $y$ groups that we have used hitherto.

Whichever is adopted, it can be transformed to the other or to the $r_p$ or $r_e$ and $r_{11}$ group if it is desired to use this type of equivalent circuit. This circuit is very commonly used in the literature and its outstanding advantage is that three of the four resistances are the same for both the earthed-base and the earthed-emitter connection. Only one needs to have its value altered.

Transformation of Constants

For general use in circuit work, no single equivalent circuit is necessarily always the best. Often, a particular form best suits a given problem. It is, therefore, very necessary to be able to pass readily from one form to another and Table 1 enables this to be done. Sometimes, the transistor constants are quoted somewhat differently; instead of having $r_{11}$, $r_{22}$, $x$, $y$, and $r_{11}$, for instance, one might have $r_{32}$, $r_{21}$, $r_{31}$, and $x$. The quickest way of finding $r_{11}$ is then to find $r_{11}$, $r_{22}$ and $x$ from the relations in the first column of the second group of transformations in Table 1 and then to find the $r_{11}$ from the equations in the first group. It works out at $r_{11} = \alpha (r_{22} + r_e) - r_p$.

Table 2 gives the definitions of the $r$, $y$, and $h$ groups of constants which are found in the literature. In addition, it gives a transformation from the $h$ group to the $r_{11}$, $r_{22}$, $r_e$, and $r_p$ form so that, with the aid of Table 1, a transformation to any other group can be effected. The transformation from the $h$ group to the $r_{11}$, $r_{22}$, $r_e$, and $r_p$ form is also included, since this is also commonly found in the literature. The derivation of the $r$ group is treated in the Appendix.

One or two comments on the relations of Table 1 may be helpful. In the first place, some of the relations can be simplified in practice with negligible error; for example, $r_p$ is often very small compared with $r_e$ and can be neglected in comparison. Secondly, the relation for $x$, the current amplification factor for the earthed-emitter transistor, is different from the one usually quoted, which is $\alpha = \alpha (1 - \beta)$. The equation given reduces to this simple form when $r_{11} = r_{22}$ and $r_{11} (1 - \beta) = r_{22} (1 - \alpha)$, which is usually the case.

Before we conclude this part, it may be helpful to quote some actual figures for transistors to get an idea of the order of magnitude of the quantities involved and how the transformations are effected. Turning to the Wireless World "Radio Valve Data", we find the Mullard OC70 listed as having $r_e = 750 \Omega$, $r_m = 35 \Omega$, and $\alpha = 0.97$, so

$$r_{11} = 0.97 \times 1.5 = 1.455 \text{ M} \Omega$$

since $r_p$ is negligibly small in comparison with $r_e$. For the earthed-base connection we have (see Table 1):

$r_{11} = 750 \Omega$, $r_{22} = 35 \Omega$, $\alpha = 0.97$, and

$$r_{11} = 1.5 - 1.455 = 0.045 \text{ M} \Omega$$

and

$$r_{11} = 1.5 \Omega$$

For the two-generator earthed-base equivalent circuit we have:

$$r_{11} = 750 + 35 = 785 \Omega$$

$$r_{22} = 1.5 \text{ M} \Omega$$

$$\alpha = 0.97$$

while for the two-generator earthed-emitter circuit we get:

$$r_{11} = 785 \Omega$$

$$r_{22} = 1.5 - 1.455 = 0.045 \text{ M} \Omega$$

Using Table 2, we can evaluate the quantities in terms of the $r$ and $h$ group and we get:

$$r_{11} = r_e + r_m - r_{11} = 35 + 750 \times 0.045 = 750 \frac{0.045}{1.5}$$

$$h_{11} = r_e + r_m = 750 \times 0.045 + 750 = 8.0005$$

$$h_{21} = \frac{r_{11}}{r_e} = \frac{750}{1.5} = 0.97$$

$$h_{22} = \frac{1}{r_e} = \frac{1}{1.5 \times 10^6} = 0.66 \times 10^{-6} \text{ mhos}$$

Point-contact Transistor

For a point-contact transistor, the values are quite different. Krugman 2 quotes: $r_{11} = 250 \Omega$, $r_{22} = 100 \Omega$, $r_{11} = 24 \text{ k} \Omega$, $r_{22} = 12 \text{ k} \Omega$. From Table 2 we then have:

$$r_b = 100 \Omega$$

$$r_e = 11.9 \text{ k} \Omega$$

$$r_m = 150 \Omega$$

$$r_p = 23.9 \text{ k} \Omega$$

From Table 1, $r_{11} = 250 \Omega$, $r_{22} = 12 \text{ k} \Omega$, $\alpha = 24/12 = 2$ and $\beta = 100/250 = 0.4$. Notice particularly that $\alpha$ is greater than unity. This is typical of a point-contact transistor; with the junction type, $\alpha$ is always less than unity. Proceeding, we have $r_{11} = 250 \Omega$, $r_{22} = 10.85 \text{ k} \Omega$, $\alpha = (23.9 - 0.15)/(10.85) = 2.18$, $b = 150/250 = 0.4$. Notice that $p_{22}$ and $a$ are both negative for the point-contact transistor in the earthed-emitter circuit. Taking the remaining form we have,

$$p_b = 100 \Omega$$

$$p_e = 11.9 - 23.9 = -10.85 \text{ k} \Omega$$

What is the meaning of $\alpha$ greater than unity? In terms of $\pi$, we have defined it as $i_\pi/i_x$, and we have $i_x = i_e + i_r$. If $\alpha$ is greater than unity, it means that the collector current is greater than the sum of the base and collector currents and, in turn, this means that the base current must be in the opposite direction to the collector current. We derived our equivalent circuit for the junction transistor and took the positive directions of current flow as the actual directions. With the point-contact transistor, however, one of these is reversed. We cannot yet say which.

However, we find $p_{22}$ is negative and this means that $i_\pi$ is reversed compared with the junction transistor.


(Chapman & Hall.)

Wireless World, September 1955

447

www.americanradiohistory.com
We can say, therefore, that in the two types $i_1$ flows in the same direction but $i_2$ in the opposite and we have the curious result that the emitter current of a point-contact transistor is smaller than the collector current.

*(To be concluded)*

**APPENDIX**

In American literature, the equivalent circuit of a transistor is usually derived from the arrangement of Fig. 5. The transistor is represented as a box with four terminals $1$, $1'$ and $2$, $2'$, two of which are internally joined. The voltages $v_1$ and $v_2$ are applied externally and, as a result, the currents $i_1$ and $i_2$ flow with the directions shown. Four resistances are named arbitrarily $r_{11}$, $r_{12}$, $r_{21}$, $r_{22}$ and the following equations are written:

$$v_1 = i_1 r_{11} + i_2 r_{12}$$

$$v_2 = i_2 r_{22} + i_1 r_{21}$$

(A1)

The meaning of the four resistances is then determined by putting the currents each in turn equal to zero. Thus, $r_{11} = v_1 / i_1$ for $i_2 = 0$ and $r_{22} = v_2 / i_2$ for $i_1 = 0$.

(A2)

The equivalent circuit of Fig. 6 is then drawn with $v_e = v_1$, $i_e = i_1$, $v_c = v_2$, $i_c = i_2$ for the earthed-base transistor and the same current directions as for Fig. 5.

The equations for Fig. 6 are:

$$v_e = i_e (r_e + r_m) + i_m$$

$$v_c = i_c (r_c + r_m) + i_m$$

(A3)

Comparing these with (A1), we have:

$$r_{11} = r_e + r_m$$

$$r_{22} = r_c + r_m$$

(A4)

If we write $v_e = 0$ in (A3) any current in the collector circuit flows as a result of $v_e$. Then

$$i_e = - i_m r_e + r_m$$

and the minus sign indicates that the current $i_e$ flows in the opposite direction to that shown in Figs. 5 and 6. In our derivation in the text, we assumed this opposite direction of current flow from the start and our $v_e$ was a voltage developed by $i_1$ in a load resistance even if this was not always specifically shown. Here $v_e$ is an externally applied voltage.

The current amplification factor is:

$$
\alpha = \frac{r_m}{r_e + r_m}
$$

We defined $\alpha$ in relation to the static characteristics of the valve as $\alpha_1/\alpha_e$, which is equivalent to $i_1/i_e$, in terms of alternating current. The minus sign arises in the American definition because they have assumed $i_1$ to flow the other way round. There is no real difference in the meaning of $\alpha$.

The backward current amplification factor, which we are calling $\beta$, is defined in American literature as:

$$
\beta = - i_1/i_e \text{ for } v_e = 0
$$

from (A3).

We originally defined $\beta$ as $- \alpha_1/\alpha_e$, and later obtained $\beta$ as $1 - \alpha$ or $1 + \alpha_1/\alpha_e = (\alpha_1 + \alpha_e)/\alpha_e = \alpha_1/\alpha_e$ which is $i_1/i_e$ in terms of alternating current. Again, there is a difference of sign in the definition which is again brought about by the different direction of current flow assumed initially. Again, there is no difference in the real meaning of $\beta$.

The American derivation of the equivalent circuit is simpler than ours and leads to the same result, but it is intellectually less satisfying, because the initial constants $r_{11}$, $r_{12}$, $r_{21}$, $r_{22}$ are obtained in an apparently arbitrary manner. Our constants $r_{11}$, $r_{22}$, $\alpha$, $\beta$ are derived directly from the characteristic curves and have an obvious physical meaning.

**BOOKS RECEIVED**


Design of Tchebycheff Filters

Experimental Verification of the Basic Formulae

By G. H. BURCHILL, B.Sc.

The following notes are offered as a corollary to the series of articles on filter design by Thomas Roddam (Wireless World, Aug., Sept., Nov., Dec. 1954). Filters of the third order will be discussed and the results given of measurements on experimental filters.

Data for constructing Tchebycheff third-order (π-section) filters are given by Fig. 1, and the configurations and characteristics of these filters are shown by Fig. 2. Curves are plotted for the case where source and load resistances \( R_1 \) and \( R_2 \) are equal, and for the case where \( R_2 \) is infinite. The curves were calculated on the assumption that losses in the filter components could be neglected.

These filters have relatively high insertion loss beyond cut-off, but they also have appreciable loss at certain frequencies in the pass band. The loss is to some extent under the control of the designer, and depends on the value chosen for the factor "\( t \)" in the Tchebycheff polynomial which describes the insertion loss characteristic. As indicated by Fig. 1, the greater the value of \( t \) the greater the loss beyond cut-off; but also the greater the loss at some frequencies in the pass band. Thus with reference to Fig. 2, the greater the value of \( t \) the greater the slope of the insertion loss curve beyond cut-off, and also the more pronounced the "ripple" in the pass band.

To design a filter it is first necessary to choose a value of \( t \). The choice may be made either by consideration of the allowable loss in the pass band, or of the desirable loss beyond cut-off. The lower "db"

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**Wireless World, September 1955**
curve is used in the first case, the upper "db" curve in the second. When a value of \( t \) has been chosen the corresponding values of \( a_1, a_2 \) and \( a_3 \) are read from their respective curves for the specified termination, \( R_2 = R_3 \) or \( R_2 = \infty \). The filter components are then calculated as follows:

For a low-pass filter with cut-off angular frequency \( \omega_0 \)

\[
C_1 = a_1/\omega_0 R_1 \quad L = a_2 R_1/\omega_0 \quad C_2 = a_3/\omega_0 R_1
\]

For a high-pass filter with cut-off angular frequency \( \omega_0 \)

\[
L_1 = R_1/\omega_0 \quad C_1 = 1/\omega_0 R_1 \quad L_2 = R_1/\omega_0 R_0
\]

For a band-pass filter of bandwidth \( \omega_0 \) and mean angular frequency \( \omega_m \)

\[
C_{1p} = a_1/\omega_0 R_1 \quad L_p = a_2 R_1/\omega_0 \quad C_{2p} = a_3/\omega_0 R_1
\]

\[
L_{1p} = 11 \omega_m^2 C_{1p} \quad C_p = 1/\omega_m^2 L_p \quad L_{3p} = 1/\omega_m^2 C_{2p}
\]

The curves were plotted after a number of filters had been designed and tested. The method of design was based on the articles "Filters without Fears" by Thomas Roddam in the August and September 1954 issues of Wireless World. The filter components were determined from cut-and-try solutions of the Tchebycheff filter equations, for which Mr. Roddam did not give a solution. Following Mr. Roddam's method, but in more general form, the desired insertion loss characteristic for the low-pass case, based on the appropriate Tchebycheff polynomial, is:

\[
db = 10 \log \left[ 1 + 18t(\omega/\omega_0)^2 - 48t(\omega/\omega_0)^4 + 32t(\omega/\omega_0)^6 \right]
\]

The expression in brackets may also be derived in terms of the filter components, as explained by Roddam. When \( R_1 = R_0 \) it is:

\[
1 + \omega^6 \left\{ \left( C_1 + C_p \right) R_1^2 + \left( 2 L_1 \right) \right\} - \left( C_1 + C_p \right)
\]

\[
+ \omega^4 \left[ \frac{L^2 C_1 + C_p}{4} - 2 L_1 C_2 \left[ \frac{C_1 + C_p R_1 + L \, L_1}{R_1} \right] \right]
\]

Writing \( C_1 = a_1/\omega_0 R_1 \quad L = a_2 R_1/\omega_0 \quad C_2 = a_3/\omega_0 R_1 \) and equating the two expressions term by term gives:

\[
\frac{(a_1 + a_2 + a_3)^2}{4} - a_2(a_1 + a_3) = 18t
\]

\[
a_1^2 a_2 a_3 = 128 t
\]

The first equation may be simplified to \( a_2 + a_3 = \sqrt{72t} + a_1 \) and the third to \( a_2 a_3 = \sqrt{128t} \).

If these are substituted in the second equation there results:

\[
a_1^2 + 2 \sqrt{72t} a_1^2 + 72t a_1 - 8 \sqrt{32t} = 0
\]

Values of \( a_2 \) for particular values of \( t \) were obtained from this equation. The corresponding values of \( a_1 \) and \( a_2 \) were then obtained from the simplified forms of the first and third equations.

When \( R_2 = \infty \) the filter equations become:

\[
\omega^6 (C_1 + C_p) R_1^2 = 2 \omega^4 L C_1 = 18t(\omega/\omega_0)^2
\]

\[
2 \omega^4 L C_1 (C_1 + C_p) R_1^2 - \omega^4 L C_1 C_2 = 48t(\omega/\omega_0)^4
\]

\[
\omega^4 L C_2 C_p R_1^2 = 32t(\omega/\omega_0)^6
\]

Substitution of \( a_1 \) etc. gives:

\[
(a_4 + a_5 + a_6) - 2a_5 = 18t
\]

\[
2a_2 a_3 a_4(a_1 + a_3) - a_2^2 a_3^2 = 48t
\]

Further manipulation leads to:

\[
a_3 = \sqrt{32t} \quad \frac{48t}{2a_2^2} - a_1
\]

\[
a_1 = (a_1 + a_2)^2 - 18t
\]

\[
2a_2 a_3 a_4 = \sqrt{32t}
\]

These were solved for particular values of \( t \) using a slide-rule and systematic computing form, by trying values of \( a_1 \), finding the resulting values of \( a_2 \) and \( a_3 \), and comparing \( a_2 a_3 a_4 \) with \( \sqrt{32t} \). About six trials usually gave the solution.

In Wireless World, December 1954, Mr. Roddam explained the transformations which give high-pass and band-pass filter designs from low-pass calculations. The examples he gave were second-order filters, but the expressions he derived were general, and apply also to third-order filters. The high-pass and band-pass design formulas given above were obtained by writing these expressions in terms of \( R_1, a_1, a_2 \) and \( a_3 \).

A comparison with other types of filter is interesting. Mr. Roddam gives the solution for Butterworth response, low-pass, with \( R_2 = \infty \). For our purpose it may be written:

\[
C_1 = 1/2\omega_0 R_1 \quad L = 4R_2/3\omega_0 \quad C_2 = 3/2\omega_0 R_1.
\]

Evidently in this case \( a_1 = 0.5, a_2 = 1.33, a_3 = 1.5 \). The insertion loss at \( \omega = \omega_0 \) \( 3 \) db, is the same as that of a Tchebycheff filter having \( t = 0.5 \), but the Butterworth filter does not have the 3-db loss at \( \omega = \omega_0 \) and it has about 10 db less insertion loss at \( \omega = 2\omega_0 \). If \( R_1 = R_2 \), a Butterworth filter has \( a_1 = 1, a_2 = 2 \), and \( a_3 = 1 \), giving the same component values as the conventional impedance-method filter.

When \( R_2 = R_0 \), \( a_1 = 1 \) and \( a_2 \) is therefore no obvious difference between the proportions of Tchebycheff and Butterworth filters. It is therefore instructive to determine the conditions that lead to these different types of response. If the low-pass design equations are multiplied together, there results:

\[
LC = a_2 R_1 \quad \frac{a_1}{\omega_0 \omega R_1} \quad \frac{a_2 a_3}{\omega_0 \omega^2}
\]

or \( \omega^2 = \frac{a_1 a_2}{LC} \)

and if they are divided:

\[
\frac{L}{C} = \frac{a_1 R_1}{\omega_0} \quad \frac{\omega R_1}{\omega_0} \quad \frac{a_1}{a_3} \quad \frac{\omega R_1}{\omega} \quad \frac{R_1}{a_1}
\]

Evidently it is possible to operate a given filter, having fixed values of \( L \) and \( C \), at any value of the Tchebycheff factor \( t \), and the corresponding values of \( a_1 \) and \( a_2 \), if the resulting values of \( \omega_0 \) and \( R_1 \) are acceptable. Further, it is possible to operate with \( a_1 = 1 \) and \( a_2 = 2 \) to obtain Butterworth response. As an example, a filter made up of a 46-millihenry inductor and two 0.1-microfarad capacitors operates

(a) Butterworth, with \( f_0 = 3320 \) c/s, if \( R_1 = R_2 = 480 \) ohms.

(b) Tchebycheff, \( t = 0.125 \), with \( f_0 = 3320 \) c/s, if \( R_1 = R_2 = 960 \) ohms.

(c) Tchebycheff, \( t = 0.5 \), with \( f_0 = 3650 \) c/s, if \( R_1 = R_2 = 1460 \) ohms.

There is another mode of operation which is useful at radio frequencies. If \( t \) is chosen as 0.0185, \( a_1 = a_2 = a_3 = 1.15 \). If a filter having these proportions is operated at the frequency \( \omega = 0.866\omega_0 \) so that \( a_2 a_3 a_4 = 1 \) (etc.) the reactivities of all its components be-
come numerically equal to \( R_1 \). Then if it is terminated with an arbitrary load resistance \( R_L \), the rather complicated general expression for the input impedance becomes simply \( R_1 + R_L \). The value of \( R_1 \) may be chosen to make this input resistance any desired value, so the circuit can act as an impedance-matching network, as well as reducing harmonic radiation. The low-frequency form of the previous example operates in this fashion if \( R_1 = 680 \) ohms. When tested between a 340-ohm source and a 1360-ohm load (or vice versa) it showed a response resembling the Tchebycheff, but with insertion gain in the region near 0.866 \( \omega_0 \) (2350 c/s). The measured gain was slightly less than 1.9 db, the theoretical value for perfect matching.

Measurements have been made on a number of experimental filters, of the three types, some designed for \( R_2 = R_1 \) and some for \( R_2 = \infty \). Two r.f. filters were also set up and tested in the equivalent lattice form for matching balanced to unbalanced lines.

In general the agreement between measurements and calculations was close. The greatest discrepancy occurred in the pass band where the calculated insertion loss was zero or very small. In this region typical high- and low-pass filters showed 1- or 2-db loss, and band-pass filters (with three coils) as much as 5-db loss. The discrepancy is presumably due to the neglect of component losses in calculations. The loss has the effect of reducing the ripple in the pass band, and several band-pass filters designed with \( t = 0.5 \) showed only 1- or 2-db variation over the pass band, instead of the expected 3-db. One filter, designed for \( R_2 = \infty \) and with \( t = 0.41 \) was tested with a value of \( R_2 = 5000 \) ohms (\( R_L = 10R_2 \)). It showed about 0.6 db more insertion loss in the pass band than it had without the resistor, and no measurable difference in loss outside the pass band. Evidently \( R_2 \) need not be extremely high to be considered "infinite."

**Simplified GCA**

A new precision approach radar known as SPAR has been developed in the U.S.A. which provides all the facilities of a full-scale ground controlled approach (GCA) system for landing aircraft in poor visibility. Relevant to bring the aircraft down is ground-controlled approach radio-telephone. Relevant to bring the aircraft down is the most critical stage of the glide-down descent; just before the actual touch-down. Predetermined glide and approach paths are applied electronically to the screen of the tube and it is only necessary for the controller to keep the two elongated echoes astride these displayed paths to bring the aircraft down safely. Relevant flying instructions are passed by v.h.f. radio-telephone.

A high degree of accuracy is claimed for this system; \( \pm 20 \) ft at touch-down, just before which the pilot takes over for a visual landing, and 0.5% of the range are the figures given.

The aerial unit can be positioned either on the centre line of the runway or to one side of it, the maximum displacement of centre being 1,000 ft.

Brief technical details of the installation are as follows: operating frequency, 9,080 Mc/s; \( \pm 1 \) %; pulse width, 0.5 usec; peak power 50 kW; range, 10 nautical miles; aerial scan rate, 2 per sec azimuth and elevation. Provision is made for optional circular polarization to combat any clutter or degradation of the system by rain droplets. The power input required is 3.5 kVA at 115/230 V a.c. 50/60 c/s single phase.

The equipment is a Bendix product and is handled in the U.K. by Elliott Bros., Century Works, Lewisham, London, S.E.13, who recently demonstrated it on De Haviland's aerodrome at Hatfield.

**Aerial system of the new 3-cm SPAR GCA shown on mobile mounting.**

**SPAR control unit with elevation and azimuth information displayed on a single extra-long persistence c.r. tube.**
Vertical Pattern of V.H.F. Aerials

New Method of Measurement Dispensing with the Need for High Towers

THE increasing use of v.h.f. equipment for mobile services, both of the business radio and public utility types, has called for intensive development to improve the performance of all the various units involved. In the case of the transmitter the maximum power output is restricted by regulations laid down by the local licensing authorities, and to some extent by the economic maximum power consumption of the mobile equipment. The output signal-to-noise ratio of modern receivers is controlled mainly by the noise factor of the input circuits when the thermal noise is predominant. The noise factor varies between individual designs but is usually as low as 4 db up to 100 Mc/s, and 6 db up to 180 Mc/s. The main items which remain, and which could possibly give improved performance are the aerial systems and feeders. A small improvement say 1 to 2 db could be made by using low-loss air-spaced feeders, but this improvement would be outweighed by the large increase in initial cost of the improved feeder cable.

Many types of aerials have been used in the past both for the fixed and mobile stations, and each system designer has had his own particular favourite. The performance of several types of aerial has been suspect in the past, their failings becoming apparent during the course of trials or demonstrations. This in many cases has led to conflicting opinions on the suitability of various types of aerials for different uses, and it has not been possible to recommend on technical grounds the best aerial for various types of service. It has been thought for some time that the vertical polar diagram of the various types of aerial varied considerably, and it is possible that the diagram changes rapidly with small changes of frequency, this being of importance where double frequency working, or common aerials are in use (Ref. 1, 2). The lack of information in the past has been due to the practical difficulties involved in the measurement of the true vertical polar diagram of an aerial, as even with the use of a high tower only part of the diagram can be measured. To some extent the vertical polar diagram of an aerial will depend upon its location and method of mounting, so that any measurements made will only apply to the particular equipment used, or some idealized case, say that of free space. In most aerials used for mobile services the desirable factor of a low standing-wave ratio, and lack of energy fed back down the outside of the feeder are sacrificed in the interests of low initial cost; and a "live feeder can have a pronounced effect on a vertical polar diagram, or on the symmetry of both the horizontal and vertical diagram, usually giving a degradation of performance in the required directions.

With a view to checking this last unknown factor of system performance (i.e. the aerial) it was decided to measure the approximate vertical polar diagram of various types of aerial. It has been shown in the past that the vertical polar diagram of simple aerials comprised only of vertical elements could be obtained by laying the aerial horizontally above a large ground plane and either rotating the aerial itself, or moving the receiving test aerial around at a fixed radial distance from the aerial being measured. But this method has not been justified in the past for more complex aerials consisting of mixtures of horizontal and vertical elements. The techniques used have been discussed in a previous paper (Ref. 3) and provided certain precautions are taken reasonably accurate results will be obtained. The results obtained compare favourably with part diagrams taken when using a high tower to move the receiving aerial in a vertical direction. This to some extent may be fortuitous as the measured true vertical diagram will vary according to the height at which the aerial under test is mounted and also to the surrounding terrain.

Fig. 1 shows a block schematic diagram of the equipment used; the aerial under test was mounted on a wooden turntable which itself was set on a large metallic ground plane laid on the roof of a wooden hut. The aerial was connected by a suitable feeder to an oscillator through a long slotted line. The pick-up dipole was mounted 100 feet away and connected to a bridge rectifier, the resulting direct current being fed by a screened lead to microammeter 2. When measurements were made the radio frequency power into the aerial from the oscillator was adjusted to give a constant field strength at the pick-up dipole as measured by microammeter 2, and the power fed to the aerial measured by use of the long slotted line and microammeter 1. Fig. 2 is a sketch of the pick-up dipole head, a resonant circuit with the centre earthed was

By E. G. HAMER,* B.Sc.(Eng.) Hon., A.M.I.E.E.


Wireless World, September 1955

Fig. 1. Block schematic diagram of the equipment used for the measurements described in the text.
used to eliminate stray and unwanted pick up from powerful medium wave stations. A bridge formed of four germanium rectifiers was tapped on to the coil via isolating capacitors. A pick-up circuit of this kind, although insensitive, has the advantage of long-term stability, and requires no returning or power supplies; it was mounted at the top of a plywood telescopic mast on a level with the aerial under test. By plotting the inverse of the power fed into the aerial under test to give a constant field strength at the pick-up aerial the polar diagram of the aerial was obtained.

The product of the maximum and minimum relative voltages as measured by the long slotted line is directly proportional to the power being fed into the aerial (Ref. 9), and by obtaining this product at various positions the polar diagram is obtained. For any given aerial setting as the standing-wave ratio is constant the aerial power is proportional to $V_{max}^2$ and the field strength at the pick-up aerial to $V_{max}$ where $V_{max}$ is the relative voltage at a maximum position along the slotted line. It is convenient only to measure $V_{max}$ and $V_{min}$ at a few positions to obtain the standing-wave ratio, and at all other positions only to measure $V_{max}$. This obviates the need to keep moving the probe of the slotted line, thus reducing the time taken to make a series of measurements, which in itself tends to increase the accuracy as the effect of drift of measuring equipment is minimized.

The average time to take a complete polar diagram of an aerial with a mechanically driven turntable, and with 10-deg intervals is thus reduced to 10 to 15 min. These individual diagrams are rescaled to a basis of equal radiated power, and hence direct comparisons of the performance of various types of aerials tested may be made (Ref. 8).

Figs. 3, 4 and 5 are photographs of some of the aerials tested and Fig. 6 shows a comparison of the performance of various types of aerial when radiating the same power, and plotted on a basis of relative field strength. The Aerial Table shows the relative gain of the various types of aerial in a horizontal direction when compared with the equivalent omnidirectional source.

It will be noted that in the case of asymmetric

### AERIAL TABLE

<table>
<thead>
<tr>
<th>Type of Aerial</th>
<th>Gain over Omni-directional Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Dipole</td>
<td>2.2 db (theoretical 2.15 db)</td>
</tr>
<tr>
<td>Sleeve Dipole</td>
<td>1.5 db</td>
</tr>
<tr>
<td>Ground Plane</td>
<td>-0.5 db</td>
</tr>
<tr>
<td>Wide band Ground Plane</td>
<td>-0.4 db</td>
</tr>
<tr>
<td>Simple “J”</td>
<td>2.6 to 2.9 db depending on direction</td>
</tr>
<tr>
<td>Ground Plane “J” λ/4 rods</td>
<td>0.5 to 1.5 db depending on direction</td>
</tr>
<tr>
<td>Ground Plane “J” λ/2 rods</td>
<td>1 to 2.5 db depending on direction</td>
</tr>
</tbody>
</table>

Gain of various types of aerial in the horizontal plane.

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**Fig. 2.** Pick-up dipole head.

**Fig. 3.** Type of standard dipole used.

**Fig. 4.** Details of the wide-band ground-plane aerial.

**Fig. 5.** The ground-plane “J” aerial employed in the tests.

Wireless World, September 1955

453
The Relative Power constant and hence need only "the test, the results obtained This metric and plane are shown the ground-plane aerials. In case the comparative power at the pick-up dipole if the radiated power is kept constant is proportional to

\[ \frac{\sqrt{\text{s.w.r.}}}{V_{\text{max}}} \]

This method is of course subject to errors due to drift of the measuring equipment, and other errors of measurement.

For normal communication services it would appear that the best aerial to use is the simple "J" aerial, or dipole aerial with or without sleeve suppressor. The ground-plane "J" aerials offer little if no technical advantage despite their additional complications. Ground-plane aerials would appear definitely unsuitable for land mobile services, although they would have an advantage if used in mobile services to aircraft. These conclusions are based on tests conducted at a single frequency and where the aerials are to be used for multiple frequency working this may not be true. It is possible that an aerial which at a single frequency gives a slightly inferior performance, may hold this performance over a wide band of frequencies; whilst another initially superior aerial may have its performance seriously degraded by slight changes of frequency. This will probably be shown very markedly in special types of stacked aerials used to give omnidirectional gain in the horizontal plane.

REFERENCES
FOURIER—Fact or Fiction?

Why Sine Waves?

BY "CATHODE RAY"

YEARS ago—around 1930 if I remember rightly—there arose a great public controversy, the like of which, regrettably, never emerges nowadays to gladden our dull lives. Everybody has become too sophisticated to proclaim, with any show of authority, that mathematicians are wrong, or that the earth is flat, or television is a hallucination. But at the time I mentioned there were a number of persons well known in the radio world, including no less an authority than the late Sir Ambrose (Valve) Fleming, who said—and stuck to it—that sidebands were imaginary; a mere mathematical fiction. The dispute reached such a pitch that actually a Government-sponsored Committee was appointed to go into the thing, and the result was Special Report No. 12 of the Radio Research Board, published by H.M. Stationery Office in 1932. But by then the subject had gone cold.

The same kind of doubts about the reality of what is represented by mathematical processes must often visit the minds of students faced with the Fourier theorem—the one that says that periodic waves of any and every shape can be regarded as made up exclusively of pure sine waves having frequencies that are whole-number multiples of the fundamental frequency of the wave. It certainly is difficult to believe that waveform (a) in Fig. 1 can be constructed entirely from smooth waves of form (b). There is some excuse for the feeling that this can be no more than a "mathematical fiction"—an ingenious device to help with calculations, but not a physical reality.

Other questions may well be asked. What is it about waves of the particular shape (b) that they and they alone have only one frequency? How did they come to have the special privilege of being the sole ingredients of all other waveforms? Did Fourier confer it, or is it an immutable law of Nature? Is there any other waveform that could be substituted?

When I started looking up a few books to see what they said on such questions, I found that they didn't even ask, much less answer them. They just took for granted that a single-frequency wave must be a sine wave*, and that Fourier has no competitors. A more thorough search revealed some clues, but not much that could be considered to be crisp answers. Perhaps you would like to try answering the above questions yourself before reading on.

Fundamental Frequency

To clear the ground, I would remind you that the Fourier theorem applies only to periodic waveforms; i.e., those that repeat exactly and for ever. In practice, "for ever" can be interpreted rather freely, without making a great deal of difference, as "a considerable number of periods" (or cycles, as they are more often called). One period is the shortest time required for a showing of the complete programme, before it starts to repeat. Fig. 1 shows three identical copies of each waveform, and if what it shows occurred during one-thousandth of a second the fundamental frequency would be 3kc/s. In (a) there would be (according to Fourier) other frequencies, whole-number multiples of 3 kc/s; but (b) being a sine waveform has (it is generally assumed) no other frequency.

Look now at Fig. 2, which is the kind of thing

* Throughout here, "sine wave" includes the cosine wave, which is the same thing advanced quarter of a cycle in phase.
commonly used to demonstrate Fourier. First, at (a), is one cycle of sine waveform. Next (b), three cycles of the same form in the same time and therefore three times the frequency. If (b) is added to (a), its first and second positive half-cycles augment the lower slopes of the positive half-cycle of (a), and its first negative half-cycle flattens the positive peak of (a), so the result is something like (c). Among other things, this demonstration is supposed to convince everybody that (c) is necessarily a composite wave, made up of a fundamental (a) and third harmonic (b), both of these of course being of sine form.

But what if somebody, just to be awkward, comes along and draws Fig. 3 showing that adding together the non-sine waves (a) and (b) gives a sine wave (c), so (c) must be a composite wave, made up of a fundamental and third harmonic? Would you be able to explain why Fig. 2 must be accepted rather than Fig. 3?

**Credentials in Doubt?**

Of course, if some mathematician should chip in with a neat proof that a perfect sine wave cannot in fact be constructed in this way from any one other waveform, it would give us some ground for believing that the sine waveform had a special claim. (I have failed to find any such proof, and would be glad to receive offers.) Still more would the prestige of the sine wave be boosted if a Fourier series (of sine waves) could be shown to be the only one that can be used for constructing other wave forms. There, at least, I have authoritative mathematical guidance, and it is to the effect that waveforms can be constructed from series other than sine. So the sine wave is still, as it were, confined in our mental guardroom, unable so far to produce complete evidence of its entitlement to the very special status commonly granted to it.

Thinking over the thing, I eventually arrived at several reasons why the sine should be selected in preference to all others, but nothing to rule all other forms completely out on principle. The further book search I mentioned tended to support these reasons, so here they are.

They can be divided into two lots: mathematical and physical. Suppose we were to start absolutely from scratch to choose some function of time that would make the most suitable basis for expressing repetitive events. The simplest for this purpose would be something that goes on continuously at a steady rate and yet repeats itself identically in definite periods. Nothing that I—or apparently anybody else—can think of fits this description so simply and well as what in the physical world appears as steady rotation. Mathematically, it is change of angle at a constant rate. Suppose OA in Fig. 4 is a fixed line to mark the start of an angle, and the angle between it and OB (labelled $\theta$) increases at a constant rate. When the angle has changed by one whole revolution, or 360°, or $2\pi$ radians (all of which are the same thing), the position is exactly the same as at the start, and what happens during the next $2\pi$ radians is exactly the same as during the last. So it fits perfectly with the definition of "periodic." Call the number of periods or cycles or revolutions per second $f$. The angle traced out per cycle is $2\pi$ radians, so the angle traced out per second is $2\pi f$, written $\omega$ for short; and consequently the angle between OA and OB (i.e., $\theta$) at $t$ seconds from the start (when $t=0$) is $\omega t$. So we have

$$\theta = \omega t$$

Now for many purposes (as we shall see) the significant thing about this circular motion is the height of B above the horizontal (OA). That height, in relation to the maximum it can attain—obviously equal to the length OB—has been named the sine of the angle AOB, abbreviated to sin $\theta$. It is what the length OB has to be multiplied by to give the height of B above OA. When $\theta = 0$ (or 180°), sin $\theta$ is obviously 0; when $\theta$ is 90° it is 1, and when $\theta$ is 270° it is −1. Plotting sin $\theta$ against $\theta$ from 0 to 360° (or 2$\pi$ radians) we get the familiar curve of Fig. 2(a).

Suppose the maximum height, equal to the length of OB, is denoted by H. Then the height at any time $t$ must be $H \sin \omega t$. So if we plotted height against time we would get a curve just the same shape as Fig. 2(a), of maximum or peak height H, and with $f$ complete waves per second. Mathematically, there is nothing to equal this for simplicity and clearness in expressing uniform periodic motion or change. But from our point of view the more important thing is that it ties up perfectly with so many of the technicalities to which Wireless World is devoted.

**Elementary A.C.**

Take, for example, the generation of alternating current by the most elementary arrangement we can think of—a loop of wire rotated at constant rate in a uniform magnetic field. The vertical lines in Fig. 5 represent the direction of the field, and B is an end view of one of the two horizontal parts of a square loop of wire rotated about O. When the loop is horizontal, the wire is all moving along the field, so has no e.m.f. generated in it. When vertical, the wire B is cutting directly across the field, so e.m.f. is a maximum. At all positions, the e.m.f. is proportional to the sine of the angle, so the waveform of the e.m.f. is a sine waveform.

A still more significant thing is what happens when
Fig. 4. How a sine wave is derived from a steadily increasing angle.

Fig. 5. Side view of an elementary a.c. generator, consisting of a square loop of wire rotating about O in a uniform magnetic field.

Fig. 6. If to B rotating steadily around O is added C rotating at the same speed around B, then the angle COB remains constant, so C also rotates steadily in a circle around O. This shows that if two sine waves of equal frequency are added together the total is also a sine wave.

A Tricky Question

Even without detailing all the significant consequences of the foregoing significant facts about sine waves (which could easily take up thousands of pages) the most sceptical reader may be willing by now to concede that the sine wave has the best claim to its proud position in science. But besides the question of the realities of harmonics (which we shall have to leave till next month), we still have the question of why only sine waves have a single frequency. It would not do, however, to start a murder trial by asking the accused why he murdered his wife. His lawyer would be very quick to object that it had not been established that he had murdered his wife. We have not yet established as a fact that the waveform of a single-frequency oscillation is necessarily sine.

Your first reaction may be that this is a frivolous question—of course a sine wave has only a single frequency and is the only single-frequency waveform; if it weren’t the Fourier theorem would be complete nonsense, and so would most—anyway, a lot—of our basic theory. Yes, we may be quite sure it is true, but can we prove it? Obviously if it can be proved that a single-frequency waveform is a linear resistance is proportional to the e.m.f. across it (Ohm’s law), the current through a capacitance is proportional to the rate of change or “differential” of the e.m.f., and the current through an inductance is proportional to the opposite of the differential—the “integral”—of the e.m.f. The differential of a curve on a graph is represented by the slope of the curve, and if you draw a graph of the slope of a sine wave you find that it has exactly the same waveform as the sine wave, subject to a phase advance of quarter of a cycle. So obviously if you perform the reverse operation—draw the integral curve, the graph of whose slope is a sine wave—you get another sine wave, shifted quarter of a cycle the other way. The sine waveform is the only one of which that is true, and it accounts for the fact that the current waveform in capacitive and inductive circuits, as well as resistive, is only the same as the voltage waveform when that has the sine shape. It accounts for a lot of other things, too, such as the tendency for oscillation to have a sine waveform, the more nearly the conditions that cause it are reduced to simple inductance-and-capacitance.

Another interesting point is that the wave formed by adding together any number of sine-wave variables of equal frequency but different phase has itself a sine form. So if there are two or more sine-wave currents flowing in the same circuit, even if they are out of phase with one another, the total current has sine waveform. This may not be obvious if you draw the separate waveforms, and it is laborious to add them up point-by-point on a graph; one can much more easily see it by slightly elaborating Fig. 4—adding another “vector” line like OB, but at a different angle (Fig. 6), and then noting that the tip of it (C) performs a circular motion around O, just as if it were the tip of a single vector OC representing the total of the other two. But if you try adding together any other out-of-phase waveforms you will find that the total has a different form. So if electrical engineering (for example) were based on any other waveform, the whole thing would be unbearably complicated and difficult.
necessarily a sine waveform, it will be a still more decisive fact with which to justify our enthronement of the sine wave. But let me point out that the Fourier theorem doesn’t prove it; it only shows that any waveform can be regarded as made up of sine waves having frequencies that are 1, 2, 3, 4, etc., times the fundamental frequency. It doesn’t prove that there is no other waveform of which this is true. Of course, all hinges on what we mean by “frequency.” Are we not—perhaps unconsciously—relying on the admittedly strong status of the sine wave to define the frequency of any waveform as the frequency of the sine waves into which Fourier analyses it? Are we not, in fact, committing the logical fallacy called (don’t ask me why) “begging the question,” i.e., basing a “proof” of something on the assumption of that something? Have we any absolutely independent scientific ground for saying that if an oscillation occurs at only one frequency its waveform must be sine? Is “frequency” a basic characteristic of Nature that we are bound to accept, or is it one of those things, like “offside,” that could mean different things, and can only be made to mean one thing alone by people agreeing to accept an arbitrary definition? If we define frequency as (for example) the rate at which identical events occur, can we show why Fig. 1(b) has been chosen, rather than (a)—or any other of a variety of waveforms—as having only a single frequency? I suppose you will say at once that it can be perfectly easily demonstrated; if a transmitter puts out a pure sine waveform it can be picked up on only one frequency—the fundamental—but if it has any other waveform it can be tuned in on harmonic frequencies. What more proof could one want?

Well, I may be a bit awkward, but I must point out that the tuning-in is done by an arrangement that by its nature responds to sine waves. But in a single cycle of a pure sine wave, the variable attains 70.7% of its peak value four times, at evenly spaced intervals, and if some device responded to this condition it would respond four times per cycle and would reckon the frequency accordingly. It might be that a system could be devised that would respond to square waves only at their fundamental frequency, and would interpret sine waves as composed of an infinite series of harmonic square waves. That may sound rather fantastic, and anyway, I am not proposing that in practice our usual concept of frequency based on sine waves should be abandoned; but it is an interesting thing to consider whether we can prove that frequency is necessarily and inevitably based on sine waves, or whether that is merely a matter of convenience, because it fits in with the way tuning circuits and ears happen to work.

Next month we shall consider whether all non-sine waves are really composed of sine waves, or only mathematically; and how square waves, sawteeth, etc., are analysed, and what they contain.

Ultrasonic Fish Detection

Depth Sounding Equipment Based on Radar Technique

A NEW echo-sounding device recently introduced by Pye Marine as an aid to trawler fishing is notable for being all-electronic in operation and is claimed to be more sensitive than previous equipments of this kind. The transmitter consists of a 30-kc/s oscillator working into a magnetostriction transducer which sends pulses of ultrasonic energy from the bottom of the fishing vessel towards the sea bed. Reflections from shoals of fish and the sea bed are received by another transducer and, after amplification, are applied to the deflection plates of a c.r.t. display system. They appear on the screen as horizontal deflections on either side of a vertical timebase which represents the depth to which the equipment is sounding (see picture).

The speed of the timebase can be varied by a control knob which also moves a pointer on a calibrated scale showing the depth corresponding to the finish of the trace. (Depth, of course, determining the transit time of the ultrasonic pulse.) This ensures that as the sounded depth is decreased the trace is expanded to increase its scale. The variable timebase actually provides the means of triggering the transmitted pulse. Thus, as the timebase speed is increased for decreased sounding depth so also is the p.r.f. of the transmission, to the maximum possible for that depth. Successive echoes combine to form a steady picture as soon as the p.r.f. is high enough and in practice this occurs at depths less than 100 fathoms.

Another control knob calibrated in depth enables a marker to be moved up and down the trace. This actually deflects a portion of the trace, equivalent to a depth of seven fathoms, bodily to the right, and it can be placed over any echo that one wishes to investigate. By means of a secondary timebase the selected seven fathoms can then be expanded to fill the whole of the c.r.t. screen for the purpose of comparison. In the circuit this secondary timebase and the marker are both triggered from the start of the main timebase through a variable delay circuit, the control knob of which carries the depth calibration.

The design has taken into account the variations present in ships’ power supplies, and a 10% voltage change is permissible.
For some years, the author has been concerned with the construction and development of various small experimental units up to the prototype stage. The units usually embodied not more than half a dozen valves and their associated components and in general, the chassis, panels, etc, used for one job were not suitable for further use. Accordingly, they were either scrapped, or put in a cupboard and forgotten until the next “open day” when they would be hastily stripped of components and crushed into a bulging scrap metal bin.

It was with a view to reducing this wastage of time and material that the author set about devising a chassis that would possess the often conflicting features of simplicity and versatility.

It was felt that the chassis should provide the following facilities:

1. Be capable of assembly for a particular need from a small number of “standard parts.”
2. Be capable of accepting a circuit containing up to six valves of B7G or B9A type, a lesser number of valves with somewhat larger bases, or a mixture of any such types in any order.
3. Positions of valves, potentiometers, switches, etc, should be capable of alteration without difficulty.
4. Assembly should be capable of standing upright (i.e., with the valves base downwards) or inverted to facilitate wiring, alterations, voltage checking, etc.
5. Be possible to join one chassis to another for larger layouts, without reducing the flexibility of the system.

Dimensions of Parts

As bench supplies of h.t. and l.t. are usually available in development and research establishments, it was felt that a plug and socket connection would suffice together with simple facilities for switching and metering. The chassis described here fulfils the requirements outlined and the dimensions given in the sketches have been found to be satisfactory in practice.

* R. B. Pullin and Co., Ltd.
Only one runner is shown in Fig. 2 (c) as the two are identical. By making the component plate fixing hole spacing equal to 1/8 in, it is possible to mount long tag-strips of either the miniature type (1/8 in spacing), or the larger type with 1/4 in spacing, along the runners.

Component Plates

The plates illustrated in Fig. 3 are those found to have been most generally useful, and may be very easily fabricated. The valveholder plate, Fig. 3 (a), is capable of accepting either B7G or BOA holders in any one of four positions. Also, as the hole is positioned towards one end of the plate, the latter may be fitted to the runners in two ways.

To save time and trouble in fitting earthing tags, a pair of saw-slots are made in either side of the plate, leaving a tag that may be bent up. One 4-BA clear hole is drilled in the plate to facilitate fitting a small tag-strip, or stand-off terminal, if required.

The potentiometer plate, Fig. 3 (b) needs little explanation beyond the fact that it is slotted for easy removal of potentiometers, rotary switches, etc. The distance between adjacent shaft centres is normally 1 in, but the slot permits the vertical staggering of components whose diameter somewhat exceeds this figure.

Input and output terminations may be made on small, single screw fixing stand-off terminals, but tag-strip would do equally well. In cases where screened input and/or output leads are necessary, suitable sockets could be mounted on the appropriate component plate.

The valveholder plates are made of brass to facilitate soldering, but aluminium alloy is satisfactory for the other parts, provided that earthing points on individual valve plates are bonded together. For work usually involving large components it would probably be convenient to scale-up the whole system, but the author has found that a chassis of the size illustrated is a fair compromise for the majority of experimental applications.

**SHORT-WAVE CONDITIONS**

*Predictions for September*

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The full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during September. Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

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Frequency below which communication should be possible for 25% of the total time

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Predicted average maximum usable frequency

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Frequency below which communication should be possible on all undisturbed days

**Wireless World, September 1955**
Notes on Capacitive Bottom Coupling for Medium- and Long-wave Receivers

By S. KANNAN,* B.Sc., Assoc. Brit. I.R.E.

INPUT circuits with bottom capacitive coupling are commonly encountered in commercial broadcast receivers. A typical arrangement is that shown in Fig. 1, in which C represents the lumped capacitance (including any trimmer, gang or fixed capacitor, valve input capacitance and all strays); Cc is the coupling capacitor shunted by R whose value is chosen to be much greater than the reactance of Cc at the lowest radio frequency to which the receiver tunes and much smaller than the reactance of Cc at supply mains frequency so as to minimize any hum pick-up by the aerial; and L is the aerial coil. For medium and long waves, the equivalent circuit of Fig. 1 is given in the two commonly encountered types of aerial tuned circuits:

(a) Variable Capacitor Tuned Circuit: as shown in Fig. 4, where Cc denotes the sum of all strays and valve input capacity, Cc = tuning capacity, Cc = aerial tuning capacitance and Cc + Cc + Cc = C of Fig. 1.

Due to Cc (usually one section of a ganged condenser), the value of Cc varies over the band, and hence, as shown in equation (3), the aerial gain also varies over the band. However, in order that the disturbance of the tuning by changes in aerial capacitance (Cc) be kept at a minimum (and in some cases in order also that the aerial circuit frequency coverage be not unduly restricted), Cc is usually much greater than Cc. In a typical medium-wave circuit, with Cc = 200 pF, Cc = 4,700 pF, R = 10 kΩ, Cc + Cc = 70 pF, Cc = 13 to 528 pF, the aerial gain at the l.f. end of the band will be \( 200 \times \frac{1}{2} \), while the gain at the h.f. end will be \( 200 \times \frac{1}{4.983} \).

Hence, if the Q of the circuit remains fairly constant.

This generalized equation (3) can now be applied to

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†The terms "input circuit magnification", "aerial circuit gain" and "aerial step-up" are used synonymously to mean the ratio of \( E_0 \) to \( E_i \).
over the band, the gain at one end of the band will be 5498
\[ \text{gain} = 1.1 \times 4983 \]
intermediate frequencies falling between these limits. Thus, with such a coupling, one desired feature of aerial circuit design is achieved, viz., fairly constant aerial gain over the band. Another desired feature, viz., a high enough aerial gain, will not be achieved with this method of aerial coupling unless the Q of the circuit is fairly high. Perhaps this explains why this method of coupling was not popular with designers in the days before ferrite-cored aerials, when the Q of air-cored and dust-cored aerial coils of normal dimensions rarely exceeded 50 and consequently more aerial gain could be obtained with other forms of aerial coupling. With the advent of ferrite cores, however, Q's of the order of 180 are easily held fairly constant over the band and, even allowing for a reduction of this Q by 50\% due to valve input and other circuit damping, adequate gains are still obtainable.

Equation (3) also shows that, provided the circuit Q is constant over the band, the r.f. input sensitivity at aerial input must needs vary over the band by not more than the ratio indicated, viz.
\[ \frac{C_Q + C + C_e + C_a + C_{\text{full}}}{C_Q + C + C_e + C_a + C_{\text{full}}} \]
Hence, if in a receiver where circuit Q is nearly constant over the band, the aerial sensitivity figures vary by an abnormal ratio (e.g., 100 \(\mu\)V to 100\(\mu\)V over the band, which is not borne out by equation (3), the designer would do well to look elsewhere for the trouble, e.g., inconstant oscillator performance, wide tracking or ganging errors, etc.

**COMMERCIAL LITERATURE**

Colloidal Graphite Dispersions; a list of technical data, including solids content, density, flash point, diluent and typical applications, on 23 "dag" products arranged in convenient tabular form, from Acheson Colloids, 18, Pall Mall, London, S.W.1.

Silver Brazing Paste consisting of finely divided metal powder and flux in a liquid medium, which can be painted on the work, described in a leaflet "Easy-Flo Paint" from Johnson, Matthey & Co., 73-83, Hatton Garden, London, E.C.I.


Equipment Cases, racks, consoles, chassis, panels, etc. listed in an illustrated catalogue giving dimensions and enclosing a price list, from Alfred Imhof, 112-116 New Oxford Street, London, W.1.C.

Continuous Terminal Strip (to be cut up into pieces as required); cable clamping and strapping; sleeving; mouldings; grommets and other products described in an illustrated catalogue with tables of dimensions from Creators, Plasnel Works, Sheerwater, Woking, Surrey.

Harmonic Distortion Meter Kit for an instrument covering 20 c/s-20 kc/s with an accuracy of ± 5 per cent of i.f. reading plus 0.1 per cent distortion. Specification of this "Heathkit from Rocke International Corporation, 13 East 40th Street, New York 16, N.Y., U.S.A.

Tantalum Electrolytic Capacitors claimed to have greater reliability and longer shelf-life than conventional aluminum types. Technical bulletin giving capacitances, sizes, etc. from The Telegraph Condenser Co., North Acton, London, W.3.

Vibration Generators and power oscillators for driving them. Concise descriptions and specifications of a complete range of equipment on a leaflet from Goodmans Industries, Axiom Works, Wembley, Middlesex.

(b) Permeability-tuned Circuits: Equation (3) also shows why this coupling system is especially suited for many applications of permeability-tuned aerial input circuits. One example is a car-radio design where an efficient coupling of the rather inefficient car-aerial was carried out by this method (see Fig. 5). With \(C_e = 68 \text{pF}, C_a = 90 \text{pF}, \) and \(C = 100 \text{pF},\) and the circuit Q varying between 20 and 40 over the band, the aerial step-up over the band was between 5.35 and 7.9. Thus with permeability-tuned circuits, and especially in applications (e.g., car-aerial installations) where the designer need not provide for much possible variation in \(C_a,\) a low value of \(C_e\) can be used to obtain good aerial gains even with low-Q aerial coils. It should be noted, however, that in mobile installations the equivalent series resistance of the aerial can, in some cases, become an important limiting factor in the determination of maximum obtainable aerial circuit gain.

**V.H.F. Broadcasting Starts**

An error occurred on page 252, of our June, 1955, issue, where it was said that a transmitter fault could produce merely a 3-dB drop in signal strength. The figure should be 6dB, since if one transmitter fails one half of the aerial is also inoperative and the aerial gain is halved.
Rugby Radio Extension
Control and Supervision from a Central Point

Twenty-eight modern 30-kW transmitters have been installed in a new building on a 700-acre extension of the long-range Post Office radio station at Rugby. Eventually the new building will be surrounded by about 100 aerials of one kind or another radiating telephony and telegraphy signals to all parts of the world on frequencies between 4 and 27.5 Mc/s. About 60 aerials, mostly rhombics, are at present in use; these are multi-wire types and being non-resonant work over a wide range of frequencies. While resonant aerials employed far more than the 100 legislated for would be needed to maintain the service envisaged for the new extension.

The aerials are connected by open-wire transmission lines to switching units inside the building; these are twin coaxial systems providing complete interchange of connections between transmitters and aerials. There are two such switching units installed, each serving 14 transmitters and giving each transmitter the choice of any one of six different aerials by remote control. On the roof of the transmitting building the twin coaxial feeders are transformer-matched, by four open-wire lines, to the main twin-wire outdoor transmission line systems.

For telephony each transmitter accepts an input on about 3 Mc/s and, by mixing with an internal crystal-controlled oscillator, converts this to the required output frequency. Linear amplifiers are employed throughout with considerable negative feedback and suppression of harmonic and inter-modulation components.

When supplied with two separate telephony (or audio) inputs between 100 and 6,000 c/s, the drive equipment provides two independent sideband outputs or, if required, a double sideband output. It is also capable of providing an output of four telephony speech channels 300 to 3,000 c/s wide for operating the main transmitter as a four-channel independent sideband system.

The frequency-shift system is generally favoured for telegraphy whenever suitable facilities exist at the receiving end. The output of this drive unit is on a fixed frequency between 4 and 27.5 Mc/s and can be normal single-channel FSK, single-channel FSK with frequency modulation, two-channel FSK or on-off keying.

Control of all the 28 transmitters is effected from a central operating position taking the form of a curved control desk as shown in the illustration. On it are assembled separate control panels for each transmitter with switches for on-off, monitor, local or distant operation of the transmitters and indicating lamps to give warning of a fault in any of the transmitters.

The transmitters, drive units, aerial switching system and much of the associated equipment were supplied by Marconi’s Wireless Telegraph Company and installation was carried out in cop-operation with the Post Office.

The heart of the new extension to the G.P.O.’s station at Rugby is shown here. From it the engineers in charge can start up or close down any one of 28 transmitters, monitor their operation and change frequency and aerials by remote control. The transmitting hall is visible in the background.

Wireless World. September 1955
random radiations

by "diallist"

penny plain, tuppence coloured

a good many readers living in the service area of the alexandra palace transmitter will probably take the opportunity of seeing something of the b.b.c.'s experimental transmissions of colour television in the autumn. the vast majority of them, i imagine, will have to content themselves with the penny plain version and will only be able to make guesses about the tuppence coloured pictures. but even that is well worth while: for they will be able to discover whether or not the system being tested is genuinely compatible; whether, in other words, the colour transmission gives an acceptable monochrome picture. that's going to be a very important point. we're not far from the time when there'll be 5,000,000 monochrome sets in use in this country and, whatever happens about colour, a good service for them has to be provided for years to come. there'd be an outcry if their owners thought that they were being sacrificed on the altar of colour television.

making the change

the number of black-and-white television sets in the homes of this country may well be doubled by the time a completely satisfactory colour system has been developed. and that, i believe, is one of the reasons why neither the b.b.c. nor the i.t.a. are likely to be in any particular hurry to develop it. it's highly improbable that it will be feasible to convert or adapt existing sets for colour; those who want the tuppenny version will have to buy new receivers, which seem likely to be a good deal more costly than those of to-day. unless, in fact revolutionary new processes of transmission and reception are developed, the stage seems hardly to be set for a boom in colour television. it's much more probable that when good compatible transmissions are regularly on the air a gradual, rather than a spectacular, increase in the number of domestic colour receivers will take place. people will buy them when the time comes to replace their existing sets.

festina lente

hasten slowly is a sound watchword in such matters as the develop-

ment of colour tv. it's no use, as our good friends on the other side of the pond have found, going off at half-cock. and i don't think we're in danger of doing that. the p.m.g. won't sanction the adoption of any system until his advisers are completely satisfied that it's the goods; and i'm sure that the b.b.c. and the i.t.a. will be just as hard to please. the radio industry itself provides another staunch safeguard. it certainly wouldn't support the kind of colour television system that could be guaranteed to give passable pictures only if users were prepared to pay £300 for a receiver and to employ a whole-time resident serviceman! please don't imagine that i want the development of colour tv to be delayed: i certainly don't. but there must be no ifs or buts about the system we launch.

divis starts well

as i write, there are splendid reports of the coverage disclosed by the initial transmissions from the new belfast television station at divis. reception has been good over a larger area of northern ireland than was forecast by the b.b.c., and excellent pictures have been obtained much farther afield than that. in fact, they've left little to be desired in much of the area round dublin as well as in other parts of southern ireland. it's unlikely that southern ireland will be able, at all events in the near future, to finance a television service of its own. i don't think, though, that we need worry if some of its folk can pull in the divis programmes free, gratis and for nothing so far as licence fees are concerned. to do so they'll have to buy receivers made in this country, and that's good business for us. actually there are already quite a few enthusiasts in that part of the world who have been eager to spend money on rather chancy reception of wenvoe and holme moss. divis has also been well received in many parts of n.w. england and s.w. scotland, in which it has hitherto not been possible to rely on getting good, steady pictures from stations on the mainland. altogether a very satisfactory show, on which all concerned deserve warm congratulations.

a spot of bother

rather an interesting fault cropped up recently in my television receiver. it had been right up to the mark when previously used; but now, after the usual warming-up period, the brightness of the picture was a good deal below its normal level. as the sound was unaffected and the height and width of the picture were as they should be, it seemed that the h.t. line was beyond suspicion. the picture was clear and steady enough; just dim. tests dis-

wireless world, september 1955

wireless world "publications"

wireless world laboratory handbook. m. g. scroggie, b.sc., m.i.e.e. 4th edition

25/- 26/3

studio engineering for sound broadcasting. b.b.c. engineering training manual by members of the b.b.c. engineering division. general editor j. w. godfrey. 1st edition

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short-wave radio and the ionosphere. t. w. bennington, engineering division, b.b.c. second edition

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introduction to valves. r. w. hallows, m.a. (canterbury), m.e.e., and h. k. miward, b.sc. (london), a.m.i.e.e.

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3/- 3/9

radio interference suppression as applied to radio and television reception. g. l. stephens, a.m.i.e.e.

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sound recording and reproduction. a b.b.c. engineering training manual. j. w. godfrey and s. w. amos, b.sc. (hons.), a.m.i.e.e. 2nd edition

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foundations of wireless. m. g. scroggie, b.sc., m.i.e.e 5th edition

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television receiving equipment. w. t. cocking, m.i.e.e. 3rd edition

18/- 18/8

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closed a weak signal at the video amplifier, and, moving forward, the trouble was eventually found to be at the input to the second vision i.f. stage. The cause was, in fact, a defective i.f. transformer. When a new one had been obtained and connected up reception was again as good as ever. The reason why I describe this fault is that the symptoms were rather misleading. More often perhaps than not a poor signal from the video amplifier means an unsteady picture; with maybe line break-up and vertical rolling, the reason being that the sync pulses aren't good enough to take proper charge of the time bases.

Present Help in Time of Trouble

IT'S a bit surprising, I think, that dealers and service technicians don't make more general use of the oscilloscope. Many of them, of course, are fully cognisant of its virtues as an aid both to fault-finding and to correct alignment; but there are lots who never give it a thought. Simple oscilloscopes suitable for the jobs in question aren't all that expensive. It certainly takes a bit of practice and of common sense to use them effectively; but this instrument does so speed up the work, once its use has become familiar, that I'm sure it must quickly pay for itself in a busy repair shop. Myself, I wouldn't care to undertake the job of lining up the superhet stages of a high-quality sound or television receiver without being able to see what's going on by means of the oscilloscope screen. Perhaps the coming of v.h.f. sound broadcasting with frequency modulation will give the oscilloscope a boost, for it's the most reliable of all means of checking up f.m. receivers.

Lining 'em Up

THE South Wales Electricity Board is to spend a tidy bit of money during the next 18 months on getting rid of d.c. supplies and standardizing those that are already a.c. but with some odd voltage or frequency. I only hope that other boards will take a leaf out of their book. It's a job that should be pressed forward, for the different forms of mains power supply now still often to be found in the same town—or even on different sides of the same street—are more than a nuisance to domestic and other users. If, for instance, you come to move house, you may well find that quite a number of your existing appliances won't be of any use in the new abode.
A New Menace

WE are, I hope, all trying hard nowadays to avoid causing interference to radio reception and to that end have fitted suppressors to all electrical apparatus under our control. I have long ago put my own house in order in this respect but Mrs. Free Grid arrived home recently from one of her infernal shopping expeditions and found that somebody had been striking ANYONE taking Communal one, solution this merely converts have fitted WE are, I hope, A New UNBIASED

COMMUNAL TV AERIALS

ANYONE taking a train from any of the great London termini cannot help being struck by the large and ever-increasing number of TV aerials that adorn the chimney pots. As the train gets farther afield and passes through country towns the number of elements on each aerial steadily increases until the skyline of distant towns seems ornamented with a lot of elevated xylophones.

When taking such a journey the other day I could not help wondering whether some of the xylophone owners would not have laid out their money to better advantage if they had invested in a really tall mast instead of in a family of directors. Here and there I did notice that some people had been thinking on somewhat the same lines as myself and had put their ideas into practice; I'll warrant that such people get better reception than do their xylophonic neighbours.

However, a tall mast needs careful staying and if everybody erected one the general effect would be far from beautiful. At the same time, if TV aerials continue to grow at their present rate the skyline of a densely populated district will look even uglier than it does to-day.

I have been wondering, therefore, if it would not be possible for streets to co-operate as they did for fire-watching during the war and contribute to the erection of a really high and well-stayed mast to carry a communal aerial which would feed signals to subscribing houses by means of a coaxial cable.

An aerial pre-amplifier would, of course, be needed and possibly others at intervals along the distribution cable.

The mast could carry aerial arrays for B.B.C. and I.T.A. television and also for f.m. The advantage of such an arrangement would be increased signal strength, greater freedom from interference and greater beauty of skyline. Also the cost of maintaining the mast and aerial arrays would work out less per subscriber than the present cost of keeping individual aerials up to the mark.

I quite expect to be told that this is already done in some areas; in fact, the other day I noticed a TV mast towering above a building outside Wandsworth Town station which was such a fine piece of work that I suspect it to be a communal effort.

Hi-Fi-Li

A CORRESPONDENT has sent me a copy of the Toronto Telegram in which appears an advertisement for what is called Hi-Fi make-up. I can only suppose that the vendors of this cosmetic or the composers of their advertisement have no knowledge of feminine psychology.

Hi-Fi in radio, or anything else, virtually means "the same as the original" or at any rate a close approach to the original. Therefore the girl who uses this cosmetic may expect to look as Nature made her; a thought which would send a shudder through even the most tempting torso. Surely, the whole object of using cosmetics is to make some improvement upon Nature's handiwork, or in other words to obtain a result which is as lo-fi as possible.

Have the people responsible for this advertisement never heard that—

"A little touch of powder,
A little dab of paint,
Can make the female features
Look like what they ain't?"

AS OTHERS SEE US

DURING May I took the opportunity of visiting the "Photo Fair" not so much because of an interest in photography as to see how another great industry went to work in putting itself over to its customers, and to find out if we radio people could pick up a few valuable ideas.

I took Mrs. Free Grid along as she and people like her with their "snaps" of repulsive-looking people on the beach or in the garden and of babies in their baths are the very backbone of the photographic industry. Their cameras are only in the crystal-set class and yet they use more films and paper and so bring more grist to the mills of the big photographic manufacturers than do the owners of the lordly Leica and such-like instruments.

To my astonishment this numerically great class of prosperity-bringers was almost totally ignored by the exhibition. It made me wonder if we are making a similar mistake at the annual radio show. Honestly I don't think we are, for at Earls Court is to be found the true democratic spirit with something for all the listening and looking public. Nobody is ignored, but all the same I should like to read a photographer's criticism of the Radio Show.
Improved beam focus and picture positioning with minimum effect on scan coils and ion trap assemblies.

- Fitted with latest type dual "Magnadur" sintered Oxide Magnets.
- Magnets DO NOT ROTATE during adjustment.
- Friction damping ensures smooth positive movement without backlash.
- Rapid and easy adjustment of focus and picture position.

For wide angle tubes with 38 mm diameter necks.

RETAIL PRICES IN U.K.
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**E180F**
wide-band low-noise

16mA/V

\[ c_{in} = 8\text{pF} \quad c_{out} = 3\text{pF} \]

**PRINCIPAL CHARACTERISTICS**

<table>
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<td>(V_{g2})</td>
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<td>(V_{gl})</td>
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<td>(I_a)</td>
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<tr>
<td>Base</td>
<td>B9A</td>
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Input damping = 6kΩ (at \(f = 50\text{Mc/s}\) and with cathode connections strapped).

Mullard

The unusually high slope/capacitance ratio of this new Mullard pentode has been achieved by using very fine grid wire, the latest type of frame grid and the smallest cathode-grid clearance yet employed in large scale production. Gold plating of the base pins ensures that, when mounted in a suitable socket, the E180F makes one of the best base connections obtainable.

This new valve is eminently suitable for wide-band amplifier applications such as radar i.f. amplifiers, camera and transmission equipment for high definition television, and telephone line and transmission equipment.

For low-noise input stages the valve may be triode-connected and very favourably employed in pre-amplifiers in radar i.f. and camera equipment.

Your enquiries on the E180F will be welcomed at the address below.
The ADVANCE "Q" Meter is different! It is small, portable and has an excellent specification—a useful addition to any electronic laboratory and well suited for production testing. Furthermore, it is offered at a price to suit all applications. With the TI, RF measurements can be made of "Q" inductance, impedance, capacitance and power factor at frequencies between 100 kc/s. and 100 Mc/s.

- Direct reading of "Q" Range 10-400
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Full details in leaflet W/31 which we will be pleased to forward on your request.

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TAILORED FOR THE JOB

It is by no means accidental that the Ferrograph has achieved so high a reputation in every country to which exportation is possible, and at a price no greater than that of an ordinary home recorder.

One of the main contributory factors is that practically all component parts used in the Ferrograph are made in our own works at South Shields, having been expressly designed for the function they are to perform.

Thus, by purposeful design, adequate control during manufacture, and strict inspection, standards have been established to which all Wearite/Ferrograph components conform.

After assembly from such parts each Ferrograph is subjected to a multiplicity of tests, culminating in a pen-recorder trace of its response and wow.

Only thus has the Ferrograph set and maintained the standard by which all other recorders are judged.

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

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order them NOW!

* ALBA
The Adaptor with Accessories

* EKCO
Type TT.234 (for A.C. mains) for Models T.C.101-T.217.
Type TTD.258 (for D.C. mains).
These Converters are for the Superhet models only.

* FERGUSON
(illustrated below)

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Type BT.200. For Models: BT.4541, BT.4542.
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Type BT.206. For Models: BT.1251.
Type BT.203. For Models: BT.4541, BT.4542, BT.4543, BT.4544, BT.4643, BT.5543, BT.5642, BT.6542, BT.6641.

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Type L. For Model: 1825.
Type M. For Model: 1827.
Type N. For Model: 1829.

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Valves for Industry
R.F. Heating

The increasing use of R.F. Heating in industry has shown the need for units to provide outputs between 10 and 50 kW.

To meet this demand, the English Electric Valve Company have developed two new valves for R.F. generators of 10 kW and upwards. These new products are not modifications of valves used for communications, but are designed expressly for operation under the less favourable conditions imposed by factory use. They are rugged and will withstand severe overloads; they are low in first cost and have a long service life. Both types are available in air-cooled or water-cooled versions and a suitable range of rectifying valves for use in conjunction with them is also available.

'ENGLISH ELECTRIC'

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum Operating Frequency at Full Rating (Mc/s)</th>
<th>Cathode</th>
<th>Dimensions (maximum)</th>
<th>Filament</th>
<th>Maximum Anode Voltage (D.C.)</th>
<th>Maximum Anode Dissipation (Kilowatts)</th>
<th>Usable Rectifier (Amperes)</th>
<th>Amplification Factor</th>
<th>Mutual Conductance (mH/s)</th>
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<td>16</td>
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NOTE: CATHODE—Th. denotes THORIATED TUNGSTEN. BW. denotes WATER-COOLED.
BR. denotes AIR-COOLED.

Technical data sheets are available on request.
**APPROVED CAPACITOR KITS FOR CONVERSION TO THE OSRAM "912 PLUS"**

### PASSIVE INPUT UNIT (NO VALVE)

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Capacitance</th>
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<th>D.C. Wkg.</th>
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**Price for complete kit**  
11.10d.

### PRE-AMPLIFIER INPUT UNIT

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<td>C 34</td>
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<td>C 35</td>
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<td>C 36</td>
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<td>C 37</td>
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<tr>
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<td>L 430</td>
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<tr>
<td>C 39</td>
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<td>L 430</td>
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<tr>
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<td>L 433</td>
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<tr>
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<td>450</td>
<td>J F 553TS</td>
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</table>

**Price for complete kit**  
17.6d.

**APPROVED CAPACITOR KIT FOR THE OSRAM 912 High Quality Amplifier**

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Capacitance</th>
<th>Volts</th>
<th>D.C. Wkg.</th>
<th>No.</th>
<th>Price</th>
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<td>C 5</td>
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<td>C 6</td>
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<td>600</td>
<td>B 847</td>
<td>1.3</td>
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</tr>
</tbody>
</table>

**Special price for complete kit**  
£2.15.0
A NEW ADDITION TO THE RANGE OF

Hudson
RADIO-TELEPHONES

MODEL AM.102

This new HUDSON Radio-Telephone has been designed to embody the most up-to-date specifications and embrace a wide variation in methods of use, thus making it extremely suitable for every requirement.

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7 watts to 175 Mc/s amplitude modulated.

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1 microvolt gives 8 dB signal to noise ratio.

RECEIVER SELECTIVITY
60 dBs down, 50 Ke/s off tune.

A FEW OF THE MANY SPECIAL FEATURES OF THIS NEW MODEL

1. Dual vibrator system enabling operation from either 6 or 12 D.C. supply. Separate external power unit available for 220 A.C. mains operation.
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. . . And if technicalities are of little more than passing interest, the point that really counts is that, obviously, Tannoy would never release an enclosure that did not extract the last possible degree of realism from their own Speaker unit.

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For Television up to 240 Mc/s
The Colpitt's oscillator circuit used gives good frequency stability and waveform over the wide frequency range.
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Axiom

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* Absence of all resonances above 20 c/s.

* More efficient at low frequencies than bass reflex enclosures.

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* Resonant frequency of loudspeaker not critical. If cone resonance is higher than that recommended the bass extension will be reduced. Other advantages will still be maintained.

* Economical and simple to construct.

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Demonstrations daily at 12:1-2:30-4:5-6-7-8-9 p.m.

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The Telequipment Monoscope Picture Generator is the cheapest and most reliable means of producing a standard test pattern for T.V. receiver production testing and alignment.

Hitherto the price of this type of equipment has put it out of reach of all but the large Manufacturer.

By unique circuit design and simplification we have both greatly increased the reliability and brought the price to within the reach of the smaller manufacturer, Relay Companies and Trade Service Establishments.

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The illustration shows a complete installation for Factory T.V. testing. The equipment comprises the Monoscope unit, producing the standard test picture together with Vision and Sound transmitters each crystal controlled.

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★ Heats up from cold in 6 seconds—by a light thumb pressure on the switch ring.

★ When not in use, current is automatically switched off—thus greatly reducing wear of copper bit. Electricity consumption is correspondingly reduced.

★ It is 10" long, weighs 3½ ozs., can be used on 2-5 to 6-3-volt supply. 4-volt transformer normally supplied.

★ More powerful than conventional 150-watt irons and equally suitable for light wiring work or heavy soldering on chassis.

★ Simple to operate, ideal for precision work. Requires minimum maintenance at negligible cost. Shows lowest operating cost over a period.

★ Can be used from a car battery.

★ It is by far the most efficient and economical soldering iron ever designed for test bench and maintenance work.

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Designed on an entirely new principle, this light-weight, versatile iron is eminently suitable for soldering operations in the RADIO, TELEVISION, ELECTRONIC and TELECOMMUNICATION industries, particularly for all SERVICE work. For general purpose work the Superspeed Iron is the ideal stand-by soldering tool.
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These superb British made Dual Track recorders, rich in range and tonal qualities, incorporate an additional High Fidelity 10 in. GOODMANs Loudspeaker in the lid, which can be detached and used in any position desired for public meetings, concerts, dances, etc. They are powerful enough to meet any volume requirements, yet maintain crystal clear quality reproduction at all volume levels.

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**EDITOR HI-FI**
Fitted in elegant leatheryclot suitase with gilt fittings. Complete with High Fidelity desk microphone and 1200 ft. spool of tape.

49 gns.

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Fitted in padded simulated crocodile case with continuous gilt fittings and locks, with elegantly styled super tape deck. Completely automatic simple interlocked control; MIXING and MONITORING facilities. Complete with microphone and tape.

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Belcher (Radio Services) Ltd. can still accept a few more dealers' orders to erect the additional aerials and to fit tuners or convertors where practicable, but after the beginning of September there is bound to be a long queue.

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The NEW SIMON Model SP/2 Tape Recorder is designed and built to top standards. Years of specialist experience in the field of sound-recording engineering and techniques have been combined to produce an entirely new equipment which is faultless in performance and appearance. The SP/2 provides superb recording and reproduction facilities. Ask your dealer to show you the new SP/2 now...

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Ask for a copy of the new booklet — "Affairs of Tape", free of course. Brings you up to date on Tape Recording — gives you the inside story of the SP/2.

Simon is Sound recording

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Suspected or unsuspected weaknesses in materials or structures 
can be detected and analysed in detail by Cossor Oscillographs 
and testing equipment; these sensitive electronic instruments are 
saving time and money in the aircraft industry as in many others. 

A practical demonstration of an 
oscillograph in conjunction with a 
dynamic model of the Vickers 
Supermarine "Swift" can be seen 
on the Cossor Stand (No. 63) at the 
Farnborough Air Display. 

Investigation of fatigue behaviour 
in aircraft structural components is 
carried out with this pulsator. 
Steady tensile loads of up to 20 tons/ 
per sq. in. may be applied to which 
can be added oscillatory stresses of up 
to 10 tons/per sq. in. The Cossor 
Oscillograph displays the output of 
the exploring strain gauges. Photo-

graph by courtesy of Saunders-
Roe, Ltd. 

T H E  C O S S O R  G R O U P  O F  C O M P A N I E S  •  H I G H B U R Y  G R O V E  •  L O N D O N  •  N . S  
The Cossor Model 1049 Double Beam Oscillograph displays the output of the twin inverters under test at the works of Sir W. G. Armstrong-Whitworth Aircraft Ltd. Photograph by courtesy of Sir W. G. Armstrong-Whitworth Aircraft Ltd.

Transponder Surveillance Radar is a Secondary Radar system. This new Cossor development employs a ground interrogator pulse transmitter with an airborne transponder and gives greatly increased operational range.

The latest airborne equipment for reliable navigation is the Gee Mk. III produced by Cossor for use in the Gee system of hyperbolic navigation. It is used extensively by the R.A.F. and continental air forces and by Aer Lingus.

Now installed at London Airport, Zurich Airport and on Royal Dutch Air Force aerodromes, Cossor Airfield Surveillance Radar (ACR Mk. VI) gives permanent-echo cancellation, C.R.D.F. superimposition, 60 miles' range and video mapping. A full scale A.C.R. rotating Scanner, in conjunction with a Secondary Radar aerial, will be on show in the Equipment Park at the Air Display.

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5th - 11th SEPTEMBER
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SINGLE-STAGE OR PUSH-PULL
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ELECTRO METHODS LTD. 12-36 CAXTON WAY, STEVENAGE, HERTS. Phone: STEVENAGE 780
present the new R.R. (Record/Reproducer) Series 100 Magnetic Tape Recorder—an instrument of advanced circuit design and flexibility, with the following outstanding features:

FULLY TRANSISTORIZED PLAYBACK AMPLIFIER

Two Frequency Ranges:
- 60—12,000 cycles ± 3dB.
- D.C. Levels to 100 cycles (−3dB)

Separate Record and Playback Amplifiers.

Full Monitoring facilities during Recording.

Continuously Variable Tape Speed from 3.75" to 8.50" per sec.

New type Carrying Case with hinged bottom, permitting immediate access to interior of instrument for the storage of accessories and for inspection of electrical and mechanical units.

In this Recorder no output stage is fitted; instead, a separate record and playback amplifier are provided delivering an equalized output of 300mV (Peak). During recording, the instrument operates from the mains supply in the conventional manner. On playback, however, all power supplies are switched off with the exception of the mains to the tape drive mechanism. The playback amplifier then operates from a small dry battery and so permits the full advantage of low noise and "hum" to be obtained from this unit during the playback function. The record level meter is switched to read "Transistor D.C. volts," "Record head bias volts," and "Record level," while, due to the unique design of the carrying case, all preset controls, mechanical and electrical units, are immediately accessible by unlocking and swinging down the hinged bottom.

The tape rewind is electrically interlocked with the record/playback switch to avoid accidental erasure during rewind, and coloured signal lamps indicate the record and playback functions.

In the home, when recording from an F.M. transmission, this instrument permits a playback quality virtually indistinguishable from the original signal, while in industry and research with the addition of the Model "T" sub-unit which plugs into the input and output sockets of the recorder, signals of D.C. levels and up to 100 cycles (−3dB) may be recorded.

The new R.R. Series 100 may be seen, heard and demonstrated with other models in the Reflectograph range on Stand No. 208 at the National Radio Show, Earls Court.

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- **PERMALLOY 'C'** for highest initial permeability, useful for wide-band frequency transformers, current transformers, chokes, relays and magnetic shielding.
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- **V-PERMENDUR** for high permeability with a very high value of maximum flux density. Finds special application for use as high quality receiver diaphragms, also motor generators and servo-mechanisms in aircraft where weight and volume are important factors.
BASS AND TREBLE FILTER SLOPE
Compensation for the environment in which the equipment is used

FILTER SWITCH
Setting the filtering range

QUAD II CONTROL UNIT — SPECIFICATION

FREQUENCY RESPONSE:
- Cancel position.
- Radio & Tape inputs: 20-20,000 c/s within 0.3db.
- Microphone input: 20-18,000 c/s within 1db.
- Pickup Input (R.2): Within 0.5db of stated characteristics.
- Other plugs, no significant change.

Bass and Treble controls: Within 1db of published curves.
Filter frequencies (kHz): 5K/2s, 7K/2s 10K/2s ± 250 c/s.
Filter slope: Level to 50 db/Octave.

INPUT SENSITIVITIES (for 1.4 V.rms output):
- Radio and Tape: Internal impedance 100 KΩ: 100mV.
- Microphone: 100 KΩ: 1.3mV.
- Pickup: to suit pickup in use, adapted by plug-in unit.

DISTORTION (1.4 V output):
- All controls 'level', Radio input or R.2 pickup input: 0.02% approx.
- Least favourable arrangement of plugs and controls: less than 0.1%.

POWER SUPPLY: The unit takes its power from the main amplifier.
- 330 V 2 mA (plus currents taken by tuner units which may be 6.3 V 1 A), connected to sockets provided.
- Maximum power available from tuner sockets: 330 V 30 mA (each tuner) 6.3 V 2.5 A (total). The heater supply is C.T. to chassis.

VALVES: 1 x EF.86 (Z.729 or 6267), 1 x ECC.83 (12AX7) (ECC.81, 8309 or 12AT7 with changed bias resistor).

BACKGROUND:
- 70 db or where applicable, approximately 6 db above equivalent thermal noise of input impedance.

MECHANICAL:
- Front panel: Die-cast, stove finished silvered fawn, machine engraved.
- Knobs: Aluminium, stoved matt brown, machine engraved.
- Chassis and Cover: Steel, rust-proof processed, stoved steel grey.
- The complete unit, electrically and mechanically is fully tropical and suitable for all climatic conditions.

DIMENSIONS: 10" × 3½" × 6½".
WEIGHT: 7 lbs. nett. (3.15 Kg.).
HIGH FIDELITY AT
acclaimed by leading experts

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HI-FI UNITS

INCORPORATING THE PATENTED CAMBRIC
CON & UNIVERSAL IMPEDANCE SPEECH
COIL AT 3, 7.5 AND 15 OHMS

H.F. 1012 10" Die-cast unit, incorporating 12,000 gauss magnet.
Handling capacity, 10 watts. Frequency response, 30 c.p.s. -
14,000 c.p.s. Bass resonance, 35 c.p.s. £4. 17. 6 TAX PAID

H.F. 812 Die-cast 8" unit, incorporating 12,000 gauss magnet. Handling capacity, 5 watts. Frequency response, 50 c.p.s. -
12,000 c.p.s. Bass resonance, 65 c.p.s. £4. 2. 9 TAX PAID

H.F. 912 9" Die-cast unit, incorporating 12,000 gauss magnet. Handling capacity, 7 watts. Frequency response, 40 c.p.s. -
13,000 c.p.s. Bass resonance, 45 c.p.s. £4. 7. 3 TAX PAID

H.F. 1214 (15 ohms only) 12" unit, Incorporating 14,000 gauss magnet. Handling capacity, 15 watts. Frequency response, 25 c.p.s. -14,000
c.p.s. Bass resonance, 39 c.p.s. Diecast chassis. £9. 15. 6 TAX FREE

Stentorian
PRESSURE TYPE
TWEETER UNITS

Provide outstanding quality of reproduction when used
with Stentorian 10" or 12" Hi-fi units. Speech coil of aluminium
wire, wound on aluminium former which is rigidly fixed to an
aluminium diaphragm. Speech coil and diaphragm situated at the
rear of magnet centre pole hollowed out to form the commence-
ment of the Horn, in the centre of which is the phase equalizer.

T.10 Speech coil impedance: 15 or 30 ohms. Response:
2,000/14,000 c.p.s. Flux density: 14,000 gauss.
Power handling capacity: 5 watts. Dispersion angle
90°. Dimensions: 4½" long (exclusive of terminals). Distance between fixing holes: 2½" and 1½".
PRICE £4. 4. 0

T.12 Speech coil impedance: 15 ohms. Response:
3,000/17,000 c.p.s. Flux density: 16,000 gauss. Power
handling capacity: 15 watts. Dispersion Angle 90°. Dimensions: 6½" long (exclusive of terminals). Distance between fixing holes: 4" and 2½".
PRICE £12. 12. 0

A suitable cross-over network at 30/- is available.

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REALISTIC COST ★

THE WB12 HIGH FIDELITY AMPLIFIER

Thirty years’ manufacturing experience of sound reproduction equipment is embodied in the development of this amplifier — the technical details will satisfy the most critical user. Employing the most recently developed valves, it has a low noise input circuit, feeding the double triode phase splitter, and a push-pull output stage, ultra-linear connected, using a specially designed Whiteley Output Transformer. 25 db negative feed back is applied over the main amplifier. Switched pick-up matching is incorporated in an extremely flexible, compact and easily mounted pre-amplifier tone control unit. Both units are attractively styled and finished in hammered gold.

This equipment, when used in conjunction with Stentorian Speakers, provides most outstanding reproduction.

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Attractively styled, it is tunable to cover present and proposed frequencies, and will operate efficiently with any good quality audio amplifier — particularly the W.B.12, which was designed with ample spare power for this purpose.

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Price £25 complete

SPECIFICATION

CONTROL UNIT
Input Sensitivity for 10W 50mV
Hum and Noise relative to 10W —72 db
Bass Control Continuously variable from +11 db to —11 db at 30 c/s
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Switched Input for Radio Feeder, Pickup and Tape

EASILY ASSEMBLED BASS REFLEX CONSOLE CABINET

This very attractive cabinet in highly polished walnut veneer is specially designed for use with Stentorian 10” or 12” units. Takes only a few minutes to assemble, the only tool required being a screwdriver. The sub-baffle has additional provision for Tweeter Unit if required.

Size: 32 in. x 22 in. x 16 in. Supplied packed flat, complete with screws.

£10. 10. 0

CORNER CONSOLE CABINET for use with 8” HI-FI Cambric Cone Unit.

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- **WIDE RANGE**—7.5 to 250 Mc/s
- **SINE AND SQUARE WAVE MODULATION**
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The equipment illustrated comprises a complete radio terminal including Receiver, 10 watt Transmitter and an optional 50 watt Amplifier.

**Abbreviated Specification**

- **Frequency range**: 60—216 mc/s
- **Transmitter output Power**: 10 watts, or with Amplifier Unit—50 watts
- **Maximum Deviation**: 50 kc/s

**Overall Transmitter-Receiver Performance**

- **Frequency Response**: 300 c/s—6 kc/s ± 3 db
  - 6 kc/s—36 kc/s ± 1 db
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The result, in decimal notation, is presented on eight panel mounted meters each scaled from 0 to 9 and the unknown frequency is automatically remeasured every few seconds.

This new equipment presents a considerable advance in frequency measuring techniques and apart from normal laboratory applications, is ideally suited for incorporation in production testing routines.

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13½” x 10” x 7”.
34.5 x 25.4 x 17.7 cms.

**PF91A**
10½” x 3½” x 4”.
25.6 x 9.2 x 10.2 cms.

Master controls give extreme flexibility

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Six positions—tape, radio, microphone and correction for all types of records.

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10 indicated stages (5 cut, 5 boost), over 27 db range. No distortion.

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Ronette microphones can be supplied in a great variety of models and frequency response curves. Ask us for detailed description.

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This hand microphone has all round sensitivity, fine frequency response (30-13000 c/s) as well as a good “grip”. It is threaded either for international 5/8 -27 stands or for British 1/2 -26 stands, to your order. Coronation 53 microphones are supplied with a screened cable of 6'1/2 ft length. Highly polished black Polopas moulding.
Come to the
Permanent Audio Fair

After all, people do come to Classic. If you haven’t, you might wonder why they bother. There are lots of gramophone and radio dealers—good ones—yet people still come to Classic. The reason is, of course, that we’ve got something unusual.

We specialise in Hi-Fi and Tape Recording equipment. And that means that we stock all the newest and the best pieces of equipment, and we know exactly what performance they can give, and why.

More than that—we can give comparative demonstrations to help the customer appreciate the difference. A manufacturer will naturally recommend his own product, but we give our customers unbiased advice on the best equipment for the results they require. You could travel a long way, visit many manufacturers, and even then miss some of the best equipment. We’ve got it here, under one roof—an Audio Fair that stays up to date and is open all the year round.

We can send equipment anywhere in the world,

That’s why people come to Classic.

For friendly advice, and friendly H.P. terms and

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ELECTRICAL CO. LTD.
THE "HI-FI" SPECIALISTS.
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SPECIALIZE
in equipment for the DEAF
and for PHYSIOTHERAPY

AUTOMATIC
VOLUME COMPRESSION

now available in the sub-miniature 4-stage

Transistor "MINUET" Hearing Aid

Multitone were the first to introduce A.V.C. in Hearing Aids in 1936. It has proved essential for:
1. Cases of deafness with recruitment (Non-linear deafness).
2. The Quality-Conscious deaf who are unable to tolerate overload distortion.

With the Minuet, two degrees of compression can be selected by the user. In addition the instrument is adjusted during fitting to take variations in individual optimum volume requirements.

Weighs only 1½ ounces complete with battery

Inquiries should be addressed to
MULTITONE ELECTRIC CO. LTD.
PIONEERS IN SOUND AMPLIFICATION

HARTLEY-TURNER
SOUND EQUIPMENT

Introducing

THE HARTLEY-TURNER
"315" LOUDSPEAKER

Here is the latest product from H. A. HARTLEY COMPANY LIMITED. After many months of tests we are now proud to announce our new "315" Loudspeaker.

This is a 12in. diameter unit with a frequency range from 20 c/s to 15 Kc/s obtained from a special coil and cone assembly. The voice coil impedance is 4 ohms and the power handling capacity is 15 watts. The frequency response is substantially flat over the range 30 c/s—18 Kc/s.

The speaker employs a die cast frame and is manufactured to the same exacting specifications that have made Hartley-Turner products renowned throughout the world.

Modern methods of production enable us to offer this new speaker at

10 GUINEAS

Full details sent free on request to:

H. A. HARTLEY CO. LTD.
152, HAMMERSMITH ROAD,
HAMMERSMITH, LONDON, W.6.
Telephone: RIVerside 7387
2-3 kW Channelised Transmitter

The GFT.560/2 is a 2-3 kW channelised transmitter with a frequency range of 1.5-30 Mc/s. It consists of three basic cabinets—r.f. unit, modulator unit, and power supply unit—combinations of which can be used to provide multi-frequency working as well as a number of different types of emission. The wave change facilities of the transmitter are both rapid and reliable—a valuable asset when the operating frequency is changed many times each day. The GFT.560/2 is fully tropicalised, and its unit construction facilitates future expansion of the initial installation, should the need arise.

For use in conjunction with the GFT.560/2 there are ancillary units that enable the transmitter to be remotely controlled over a two wire telephone circuit: operational adjustments are dialled to the transmitter. The versatility and reliability of this new Mullard transmitter make it particularly suitable for h.f. en-route, ground-to-air services and point-to-point communication networks. A team of Mullard communication engineers is available to advise on the use of the GFT.560/2 in such applications.

**ABRIDGED DATA**

- **Frequency Range**: 1.5-30 Mc/s
- **Stability**: To Atlantic City 1947 standards
- **Power Output**: 3kW c.w., 2kW m.c.w. or r/t
- **Types of Emission**: c.w., m.c.w., telephony, frequency shift A1, A2, A3, PI
- **Output Impedance**: 600 ohms balanced twin feeder
- **Power Supply**: 400V, 50-60 c/s, 3-phase

**Mullard**

SPECIALISED ELECTRONIC EQUIPMENT
For all Stock Transformers and Chokes

see Gardners Radio catalogue

IS THE REGISTERED TRADE MARK OF AN OLD MAXI-Q ESTABLISHED HOUSE AND IS YOUR GUARANTEE OF LATEST DEVELOPMENT AND QUALITY.

If you purchased our Scanning Equipment and Coils for the “Magna-View,” “Supervisor,” “Universal,” etc., you will be pleased to know that they are still suitable and offer wonderful results with the new “Bimar” 21 inch C21HM Tube. We have seen and proved this undreamed of luxury that will turn your old receiver into a wide screen cinema.

F.M.—This advertisement isn’t large enough to print the testimonials and congratulations we have received about this equipment which was the first available to the public and which is still selling faster than we can make.

Shortly will be available a home constructors’ kit for commercial television converter, complete with power supply and cabinet at around £6 or lower.

We do not believe in offering you a free or cheap Catalogue by covering the cost in higher priced or inferior components, we therefore request 1/- in stamps, which saves you postal order poundage and covers return postage, but please don’t forget that if you live near a first-class reputable component retailer he will be a stockist of “MAXI-Q” products.

Denco (Clacton) Ltd. 357/9 Old Road, Clacton-on-Sea, Essex

Stop Press:
“OSRAM 912 PLUS AMPLIFIER” Gold finished front panel with brown control markings, 7/6.
Completely punched aluminium chassis, 14/6. Pre-Amplifier chassis, 6/-.
“Mullard Five-Ten Amplifier” Chassis and Bronze finished Front Panel, 21/-. 
Laboratory Instruments

V.H.F. Impedance Bridge Type B.801
For balanced and unbalanced measurement from 1-100 Mc/s.

Susceptance: Equivalent to $\pm 230 \text{ pF}$.
Accuracy: $\pm 2\%$, $\pm 0.5 \text{ pF}$.

Conductance: $0-100 \text{ mmho}$.
Accuracy: $\pm 2\%$, $\pm 0.1 \text{ mmho}$.

This is one of a range of bridges for use with external source and detector for the measurement of aerials, cables, feeders, and a variety of components and materials between 15 kc/s and 250 Mc/s. Bridge sources and detectors are available for use between 1-100 Mc/s and 50-250 Mc/s.

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A moderately priced 50 c/s instrument with a very wide range, capable of 3-terminal and a variety of in situ measurements.

$R: 9\Omega$ to $1000 \text{ m}\Omega$, $C: 1 \text{ pF}$ to $1000 \text{ mF}$, $L: 100 \text{ mH}$ to $10,000 \text{ H}$.

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To measure the relative levels of the components of a complex waveform over a range of 75 db between 50 c/s and 20 kc/s. Input impedance $100\text{K}\Omega$ unbalanced or $>25\text{K}\Omega$ balanced. In transportable case as shown, or for standard 19" mounting.

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**STAND 204**

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**WILLOW PLACE, CAMBRIDGE, ENG.**

Telephone: 2494. Telegrams: "Labgear, Cambridge."

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85-95 Mc/s; High Impedance Output. Magic Eye Tuning Indicator, £21.


8 Valves, incl. 2 double triodes. 8 watts output. Provision for using F.M. adaptor. Separate Bass and Treble controls. 2 short, medium and long wavebands. £23 18/6. Or £8 dep. and 29/12 monthly.

ALSO AVAILABLE FROM STOCK.

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**LEAK DYNAMIC PICK-UP with diamond stylus.**

Arm with L.P. or 78 head £11 9/6

Extra head £7 15/3

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Collaro 3155-3 sp. with Studio Pick-up £6 18 4

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Garrard 301—Transcription Unit—3 speed £25 1 6

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Keys... small, 1/6d.; medium, 1/3d.; large, 1/9.

Patent No. 519178

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PRECISION High Fidelity 4 SPEED TRANSCRIPTION UNIT
WITH VARIABLE SPEED ADJUSTMENT

Engineered by Swiss Master craftsmen for the discerning listener.

MAIN FEATURES

- Speed continuously variable from above 78 r.p.m. to below 16 r.p.m. Pre-set adjustable "click-in" positions for 78, 45, 33 1/3 and 16 r.p.m.
- These features are invaluable for:
  - Playing old celebrity discs requiring speeds above 78 r.p.m.
  - Tuning record pitch to a musical instrument.
  - Correcting for mains frequency variations.
- Accurately balanced heavy precision made turntable eliminates Wow and Flutter.
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- Large resilient 4-pole constant velocity motor.
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Type GL50-4 Four speed. Price £15'15'0
110-250 volts, 50 cycles.
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* Good appearance
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Rigidly tested
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A Woden Transformer will fulfil the most exacting specification, combining high precision and utmost reliability in service. Both research and production are centred on the manufacture of first-class equipment at the lowest possible cost consistent with quality materials and workmanship.

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This remarkable development will meet the most exacting high fidelity requirements at an extremely low price. Meticulous inspection at each stage ensures that the Spectone Mullard 5-10 Amplifier fully meets Mullards specification.

TWO INPUTS
One for radio tuner, microphone, etc., and one for pickup. The pickup input has two switch positions for equalisation—L.P. and Standard. Plug-in equalisers are available to suit various pickups.

CONTROLS
Besides the input and equalisation selection switch, volume, treble and bass controls are provided. The treble control is continuously variable from +10db to -10db and the bass +11db to -5db.

MAXIMUM OUTPUT
15 watts

HUM & NOISE
-73db referred to 10 watts.

POWER OUTLET for pre-amplifier
300 volts at 12 milli-amps. 6.3 volts at 2 amps.

OUTPUT IMPEDANCE
15 ohms

FREQUENCY RESPONSE
± 0.5db 10 c/s to 20,000 c/s.

TOTAL HARMONIC DISTORTION at 10 watts.
Less than 0.4% at 40 c/s.
Less than 0.2% at 400 c/s.
Less than 0.3% at 2,000 c/s.

OPERATING VOLTAGE
200/250 volts A.C. 110/115 volt model available to special order.

OUTPUT RESISTANCE
at 1,000 c/s is 0.9 ohm.

DAMPING FACTOR
approximately 17.

PRICE
£18 - 18 - 0
Pick-up Equaliser Plug 12/6

Manufacturers of the SPECTONE
Magnetic Tape Reproducers for playing Tape Records to the C.C.I.R. characteristic with the highest fidelity. The modern method of hearing good music faithfully reproduced.
Leaflets on request.

SPECTO LTD. Vale Rd Windsor
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For Remote Control of Electronic Equipment

- Radio Tuning
- Instrument Control
- Component Coupling

Flexible Shafts give freedom in design because they can be run between any two parts and eliminate alignment problems.

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High Class Instrument Cabinets

A unique range of extremely robust cabinets, designed by instrument engineers to give first-class appearance for a very modest outlay. Cast aluminium frames ensure that equipment is held rigidly and afford a maximum of protection against damage in transit. Any quantity supplied, carriage free in the United Kingdom.

As a result of increased production, we are now able to offer our superior instrument cabinets at greatly reduced prices (approximately 30%) with further substantial reductions for quantities of 25 or more. We shall be pleased to quote on receipt of particulars of your requirements or to send you a leaflet giving dimensions and details of this range of outstanding cabinets.

Boulton Paul Aircraft Limited, Wolverhampton
Telephone: Fordhouses 3191 (Ext. 99)
TAPE DECKS
MARK IIIU SERIES

Technically identical with the world-famous Deck supplied, in bulk, to Recorder Manufacturers. With B.S.S. sense of tracking, it is fully approved for playback of pre-recorded tapes. List Price remains at 22 gns.

Details of complete recorders incorporating the TRUVOX Tape Deck are available on request.

The full range of Truvox Tape Recorder Components and Accessories is listed below—send for fully descriptive leaflets.

TAPE DECKS  •  AMPLIFIER  •  RADIO JACKS  •  FOOT CONTROL  •  TELEPHONE ADAPTOR  •  MONOSET & STETHOSET HEADPHONES  •  CORNER DIFFUSION SPEAKER

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IMPORTANT NEWS

For the Latest News on...

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Convertors
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Come & see STAND 33
AT THE NATIONAL RADIO & T.V. EXHIBITION

AERIALITE LTD.
CASTLE WORKS, STALYBRIDGE
CHESHIRE
Depots at London, Bristol, Birmingham, Manchester, Newcastle, Glasgow.
It has been stated by experts that assuming they meet certain specifications, any amplifier would sound much like any other amplifier. Now by and large we agree with this statement—although we know that hundreds of people who have heard the A10 stoutly maintain that it sounds much better than X or Y Amplifier. We would however remark in passing that very few amplifiers at any price have all the specifications of the Armstrong A10 and we would like to draw your attention to some of its features.

- Ultra-linear output stage handles peak power outputs with the least possible distortion.
- Harmonic distortion below 0.1% at 8 watts.
- High degree of negative feedback for outstanding transient performance, clean bass, and smooth treble.

6 position filter for optimum performance.

We also manufacture AM and FM Tuner Units attractively finished in Florentine Bronze to match the A10 Control Unit.

(See page 72).

and the price? The Control Unit is £9.15.0 and the Amplifier £19.15.0

Where you can hear the A10


Imbels, 113 New Oxford St., W.1.

B.K. Partners, 220 Regent St., W.1.

Classic Electrical, 350 Lower Addiscombe Rd., Croydon.

Mooref, 50 High St., Southall.

Lancaster High Fidelity, 59 Lancaster Terrace, Manchester.

Holley, Southall, Middlesex.

ARMSTRONG WIRELESS & TELEVISION CO. LTD., WARTHURS RD., LONDON, N.7 Telephone: NORTH 3213/4

<table>
<thead>
<tr>
<th>TYPE</th>
<th>DESCRIPTION</th>
<th>U.S. EQUIVALENT</th>
<th>FILAMENT</th>
<th>Anode Volts</th>
<th>Screen Volts</th>
<th>Grid Volts</th>
<th>Anode Ma</th>
<th>Screen Ma</th>
<th>Mutual Conductance</th>
<th>Power Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>X FR1*</td>
<td>R.F. Amplifier</td>
<td>1 AD4*</td>
<td>1.25</td>
<td>100</td>
<td>45</td>
<td>45</td>
<td>0</td>
<td>3.0</td>
<td>0.9</td>
<td>2 mA/V</td>
</tr>
<tr>
<td>X FR2*</td>
<td>R.F. Amplifier</td>
<td>5678*</td>
<td>1.25</td>
<td>50</td>
<td>67.5</td>
<td>67.5</td>
<td>0</td>
<td>1.8</td>
<td>0.5</td>
<td>1.1 mA/V</td>
</tr>
<tr>
<td>X FR3</td>
<td>H.F. Triode</td>
<td>5676</td>
<td>1.25</td>
<td>120</td>
<td>135</td>
<td>---5</td>
<td>4.0</td>
<td>3.1</td>
<td>0.95</td>
<td>0.65 mA/V</td>
</tr>
<tr>
<td>X FY14</td>
<td>Output Pentode</td>
<td>5672</td>
<td>1.25</td>
<td>50</td>
<td>67.5</td>
<td>67.5</td>
<td>---6.5</td>
<td>3.1</td>
<td>0.95</td>
<td>0.65 mA/V</td>
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</table>

* Fully screened with metallized coating. † With input signal 4.55 V. A.C. and anode load 20 kΩ.
FREQUENCY RANGE 10 to 500 Mc/s

NORMAL OUTPUT: 0.1 μV to 0.5 volt, c.w. or modulated to 30% available under all conditions; 90% modulation at most carrier frequencies.

HIGH OUTPUT: up to 2 volts c.w., or 1 volt modulated, at most carrier frequencies. Sine a.m.: 1000-c/s internal or 30 c/s to 20 kc/s external. For external pulse modulation, r.f. bandwidth extends to 3 Mc/s. Output impedance: 50 ohms. A.C. mains operated.

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<table>
<thead>
<tr>
<th>AMPLIFIERS</th>
<th>LOUDSPEAKERS</th>
<th>TUNERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leak T.L.10 with point I pre-amplifier</td>
<td>Tannoy 12 inch dual concentric in corner cabinet</td>
<td>Chapman F.M.81 magic eye</td>
</tr>
<tr>
<td>Or with Vari-slope Mark 2</td>
<td>Leak T.L.10 with point I pre-amplifier</td>
<td>Chapman 5S/FM combined AM/FM</td>
</tr>
<tr>
<td>Acoustical Quad II with control unit</td>
<td>G.E.C. Octagonal Cabinet</td>
<td>Chapman 5.6 AM Tuner, 6 stages</td>
</tr>
<tr>
<td>Lowther T.P.10 with master control unit Mark I</td>
<td>Salex 12 in. corner baffle, handsomely veneered</td>
<td>Sound Sales A to Z FM unit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jason FM Tuner</td>
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<td></td>
<td></td>
<td>Dynatron pre-tuned FM Tuner with automatic frequency control</td>
</tr>
</tbody>
</table>

**SECONDHAND**

- Rogers Baby amplifier with jnr. pre-amplifier
- Charles amplifier and control unit 2 KT 66 output valves
- Decca Decola amplifier and control unit. Perfect order
- Decca P.A.6 in portable case
- Decca P.A.3 in portable case

**SECONDHAND**

- Leak U.S. Tuner, in perfect order
- Acoustical 4 station preset TRF
- Bell Sound FM Tuner
- Decca P.A.6 Variable Selectivity magic eye, handsome case
- Charles TRF/Superhet

**FREE VAN DELIVERY**

within 20 miles of our shop.

**SIMPLE EASY PAYMENTS**

arranged on goods over £10.

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Phone: FLEet St. 9391/2

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**GUIDE TO BROADCASTING STATIONS, 1955/56**

All European long- and medium-wave broadcasting stations and over 1,600 short-wave transmitters in 125 countries are listed both geographically and in order of frequency and wavelength in this enlarged edition. The information, checked against measurements made at the B.B.C. receiving station at Tatsfield, has been corrected to mid-July. Frequencies of over 300 v.h.f. broadcasting stations in Europe, operating details of European television stations and a time-conversion table are also included.

NOW ON SALE GET YOUR COPY TO-DAY 2/6net

Published for “Wireless World” Obtainable from booksellers or direct from:-

Iliffe & Sons Ltd  Dorset House  Stamford Street  London  S.E.I.
A new range of television downleads is described in this booklet. They have been developed by BICC using Cellular Polythene as the dielectric to provide minimum attenuation, and resistance to moisture ingress.

Write to-day for your copy of this Publication (No. 357)
Another LETTER FROM AMERICA!

GOOD BASS from W15/CS


The W15/CS with heavy cone and long speech coil is designed for smooth response between 25 and 2,000 c/s. It is the ideal bass speaker for 2 or 3 speaker systems.

Wharfedale
WIRELESS WORKS LTD.
Idle, Bradford, Yorkshire
Telephone: Idle 1235/6.

THE PROBLEM IS DUST

the solution is DE-STAT

DE-STAT TRADE MARK

THE ANTI-STATIC RECORD CLEANER

If you have difficulty in obtaining the "DE-STAT" from your dealer, cut out this coupon NOW.

Please send me without obligation details of the "DE-STAT" record cleaner (I enclose S.A.E.).

Please send me DE-STAT CLEANER(S) at 13/6 each.

I enclose P.O./CHEQUE for £ s. d.

NAME

ADDRESS

3101 Leeds Road, Columbus 21, Ohio, U.S.A.
June 4, 1955

Last week I had occasion to demonstrate high-fidelity equipment in a room 45ft. long, 32ft. wide, and 13ft. high; we brought along my sand-filled wall-corner cabinet with a W15/CS in it and an Altec-Lansing tweeter crossing over at 800 c/s. The crisp low bass of the Wharfedale unit put to shame all but the largest theatre horn speaker systems; even the theatre systems did not go as low. I had always suspected that the Wharfedale could hold its own against more elaborate systems in large rooms but this is the first time I have had a chance to put it to the test.

The high-fidelity dealer who sponsored the demonstration was rather unhappy as he is unable to obtain Wharfedale equipment.

The demonstration also struck a blow against the ubiquitous corner "horns" and caused many people to reappraise the values of SOLID bass-reflex cabinets. The only trouble I had was that the sand-filled is too solid, weighing about 250 lb. with bottom and back; it is quite a chore to carry it up and down stairs even with a stair climbing hand truck.

Ross F. Firestone
TIME IS RUNNING SHORT!

Independent TV begins on September 22

Round up your "unconverted" TV customers now—before this happens

Despite the success of our advertising campaign, there are still many viewers who have done nothing about conversion of their sets and aerials. Some of your customers are going to wake up on September 22nd and expect you to get their sets ready to receive the new programme that same evening—unless you round them up now! So let's make a special final effort to keep things on the move.

DEFERRED PAYMENT

The news that deferred payments can be arranged for conversion work should help you a lot. Many people who, for financial reasons, were putting off having their sets and aerials converted, will now be able to see you at once.

Then, with most of your conversion work behind you, you'll be able to sit back on September 22nd and enjoy the new programmes yourself!
DESIGNED AND BUILT BY

Britain's Leading VHF ENGINEERS

The NEW EDDYSTONE '820' V.H.F. UNIT

WEBB'S are proud to present this efficient unit built with PRECISION ENGINEERING SKILL to give highest possible quality from the B.B.C. FM stations, combined with the convenience of reception on medium and long waves. The EDDYSTONE "820" is self-powered to work from A.C. mains, a feature which makes it particularly easy to install with any amplifier.

THE TECHNICIAN WILL NOTE — with approval

ON VHF/FM All three input circuits tuned by unique 3-gang condenser, a design detail contributing to high sensitivity, whereby the "820" will often give satisfactory operation well outside the normal service area. Uses Foster Seeley discriminator for absolute minimum distortion. "Straight-through" Gram. position simplifies incorporation with amplifier.

ON MED. AND LONG WAVES Uses normal mixer-IF-detector circuit giving useful gain and Selectivity. Switch position "MW1" pre-sets any station between 960-3355 kc/s; position "MW2" 610-960 kc/s; and long waves 150-250 kc/s.

ONE FIVE-WAY MASTER CONTROL SWITCH SELECTS:

- Tuneable V.H.F.
- Medium Wave 1.
- Medium Wave 2.
- Long Wave.
- Gramophone.

WEBB'S RADIO

14 SOHO ST., LONDON, W.1.

Phone: GERrard 2089

WEBB'S are proud to present this efficient unit built with PRECISION ENGINEERING SKILL to give highest possible quality from the B.B.C. FM stations, combined with the convenience of reception on medium and long waves. The EDDYSTONE "820" is self-powered to work from A.C. mains, a feature which makes it particularly easy to install with any amplifier.

THE TECHNICIAN WILL NOTE — with approval

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Manufacturers are invited to write for further details and prices. Home-Constructors: Please send S.A.E. for recommended circuit diagram and details.

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<tr>
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<tbody>
<tr>
<td>FMC 102 Aerial Coil ...................... 7/- each</td>
</tr>
<tr>
<td>FMC 103 R.F. Inter-valve Coil ......... 5/- each</td>
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<tr>
<td>FMC 104 Oscillator Coil ................. 7/- each</td>
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<tr>
<td>FMC 101 I.F. Transformer ............... 7½ each</td>
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<td>FMC 151 Ratio Detector Transformers …… 25/- each</td>
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<th>Size</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>17in.</td>
<td>White Moulded</td>
<td>£1.00</td>
</tr>
<tr>
<td>17in.</td>
<td>Bronze Moulded, complete w/ Protective Glass</td>
<td>2/-  (pkg. &amp; post 5/-)</td>
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<td>14in.</td>
<td>Black Moulded</td>
<td>7/-   (pkg. &amp; post 1/-)</td>
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<tr>
<td></td>
<td>Dark Screen Filter suitable for 14in. Tube</td>
<td>5/-  (pkg. &amp; post 1/-)</td>
</tr>
<tr>
<td></td>
<td>Dark Screen Filter suitable for 16in. and 17in. Tubes</td>
<td>3/-  (pkg. &amp; post 1/-)</td>
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<tr>
<td></td>
<td>Polyethylene Mask for E.B.T.001</td>
<td>4/-</td>
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<td></td>
<td>Rubber Ring Anti-Corona for E.B.T.001</td>
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<tr>
<td></td>
<td>Polyethylene Shroud for E.B.T.001</td>
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**4-WATT AMPLIFIER**

* ONE KNOB DECK OPERATING
* DROP-IN TAPE LOADING
* 1,200 FT. TAPE REELS PROVIDED

Using the New Lane 2-Speed Tape Unit Mark 6

**CABINETS—PORTABLE**

- **Model PC1**
  - Power Transformer covered
  - Overall dimensions: 15 x 11
  - Clearance under lid when closed: 32

- **Model PC2**
  - Grey Lacquer Finish
  - Overall dimensions: 12 x 10 x 3 in.
  - Clearance under lid when closed: 32

- **Model PC3**
  - Realistic type covering
  - Overall dimensions: 14 x 9 x 2 1/2 in.
  - Clearance under lid when closed: 32

**SPECIFICATION**

- H.F. Tuning Unit: Type UT340 permeability tuned, coverage 86-103 Mcs, stage unit Aerial to output of 1st I.F. (110 ft. in Unit) approximately 350. Maximum frequency drift 0.20 degrees centigrade 30 kcs. Radiation less than 26 microvolts per metre price £5/5, (including Tax). Valve UCC65.

- I.F. Type U48 10 Mcs-stage, 10.7 mcs. C-110. Decoupling factor unity, price 7/-.

- **RAI NGE OF BAND 3 AND F.M. AERIALS IS NOW AVAILABLE**

- **Electric Tree Rod Aerials**
  - Medium Wave 8/9, Medium/Long Wave 12/9.

- **TELEFON FERRITE ROD AERIALS**
  - Medium Wave 8/9...

- **SPECIFICATION**

**ALUMINUM CHASSIS**

- Spontaneously made from Bright Aluminium with four sides:
  - 7 x 4 in. 3/16
  - 9 x 4 in. 3/16
  - 10 x 9 in. 3/16

**ALUMINUM PANELS**

- 7 x 4 in. 1/8
- 9 x 4 in. 1/8
- 10 x 9 in. 1/8

**FREQUENCY MODULATION**

- V.H.F. Tuning Unit type UT340 permeability tuned, coverage 86-103 Mcs, stage unit Aerial to output of 1st I.F. (110 ft. in Unit) approximately 350. Maximum frequency drift 0.20 degrees centigrade 30 kcs. Radiation less than 26 microvolts per metre price £5/5, (including Tax). Valve UCC65.

**QUALITY CRYSTAL PICK-UP ROTHERMEL TYPE U48 26/-**

**SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW:**

- Amplifier (built, wired and tested with Speaker): £14.15/6, plus postage and carriage 7/6.

**HIRE PURCHASE TERMS**

- Deposit £3/15/6 and 12 monthly payments of £1/11/6.

- New Lane 2-Speed Tape Unit Mark 6. £18/10/6, plus packing and carriage 7/6.


**SPECIAL OFFER**

- Wiring Diagrams including also details of F.M. Aerial 2/6 post free.

**LIMITED PERIOD**

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

**“PREMIER PORTABLE” TAPE RECORDER USING THE NEW LANE 2-SPEED TAPE UNIT MARK 6 COMPLETE**

- Cash: £36

(Packing & Carriage 1ln.

**H.P. Terms**: Deposit £10/8/- and 12 monthly payments of £2/16/-.

**SPECIFICATION**

- **TWO SPEEDS** 7in. AND 9in.
- **THREE SPECIALY DESIGN ED RECORDING MOTORS.**
- **1,200 FT. TAPE REELS PROVIDING PLAYING TIMES OF 1 HR. AND 2 HRS.**
- **DROP-IN TAPE LOADING.**
- **EASY FORWARD OR REVERSE WITHOUT REMOVING TAPE.**
- **ONE KNOB DECK OPERATION.**

- **RECORDING MOTORS.**
- **7-WAY 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.**
- **SPECIALY DESIGNED MICROPHONE BY A LEADING MANUFACTURER.**

- **Printed by Aylesbury Press Limited, Aylesbury.**

- **SEPTEMBER, 1955**
WIRELESS WORLD

PREMIER RADIO COMPANY

WILLIAMSON AMPLIFIER KIT 15 gns.

N.P. Terms:
Deposit £1.18.9 & 12 month’s payments of £1.1.8
This KIT is absolutely complete and all components are guaranteed exactly to author’s specification.

WILLIAMSON OUTPUT TRANSFORMER

Author’s specification 2.8 ohm impedances £4.10.0

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 £12.16.8

WILLIAMSON CHOKES

12H 100 mA. Fully shrouded £19.6

200 20 mA. Fully shrouded £11.9

Build these NEW PREMIER DESIGNS

3-BAND SUPERHET RECEIVER

TRF RECEIVER

ALL-DEY PORTABLE RADIO RECEIVER

DECCA MODEL 33A RECORD PLAYER

ADAPTABLE FOR STN. OR L.P.

Latest type Superhet Circuit using 3 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 is 6K8 freq. changers, 6K7, IF, 607, Detector AVC and first AF, 6Y6 output. The attractive cabinet to house the Receiver size 12in. long, 6in. high, 5in. 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.

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P337 £19/6

EAL-R, dia. Maine Reelraptor, 3 ohms imp. 460 ohms field with Pentode Transformer £2/6

P338 £21/6

EAL-R, dia. Maine Reelraptor, 3 ohms imp. 460 ohms field £2/6

GODMAN — 10in. dia. Moving Coil, 3 ohms imp. £2/12

VITAVOX-K310 20in. dia. Moving Coil 15 ohms imp. £11/11/6

PRICE OF 10/- PLUS PACKING & POST 1/6.

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Made for World-famous manufacturer. The Unit designed to play 10/, 10/6 and 12 in. records interspersed in any order at 33 1/3, 45 or 78 c.p.m. Capacity 16 records. New reversible dual stylus crystal Pick-Up has extended frequency range. For use on 100/200/250 volt 60 cycle A.C. mains. LIMITED QUANTITY ONLY.

Price packing and carriage £9.19.6

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DEALER INQUIRIES INVITED

WILLIAMSON CRYSTAL PICK-UPS

BARGAIN OFFER

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LATEST TYPE ELECTRONIC SCREEN CRYSTAL PICK-UP £18/10.0

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Price packing and carriage 2/-

BRAND NEW, and in manufacturers' original cases.

BARGAIN OFFER

SPECIAL OFFER

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All primaries are tapped for 200-250-250 volt mains 4-100 cycles. All primaries are armed.

MARA, PORTABLE TRANSFORMER, primary 210 v., 230 v. secondary 210 v., 240 v. £24/6.0.0

BARGAIN OFFER

BARGAIN OFFER

MAY BE BUILT.

MAY BE BUILT.

MAY BE BUILT.

BARGAIN OFFER

BARGAIN OFFER

LIST PRICE £9.19.6

BARGAIN OFFER

BARGAIN OFFER

5 v and 6A. New battery portable radio receiver £7.8.0.

MAY BE BUILT.

BARGAIN OFFER

MAY BE BUILT.

INSTRUCTION BOOK 1/6 (Post free) which includes Assembly and wiring diagrams, also a detailed Stock List of priced components.

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**PREMIER RADIO COMPANY**

**1155 RECEIVER UNIT**

**GRADE 2**

Slightly soiled complete with 10 valves. Frequency range: 15 kHz. 5 wave-bands. £91/9d. Plus 10/- packing and carriage. Hire Purchase Terms: £2/9d deposit and 10 monthly payments of £1/-.

**POWER SUPPLY UNIT**

**WITH OUTPUT STAGE FOR ABOVE**

Jones plus for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and fan, speaker is built into the unit. Price £5/5/-, plus 3/- packing and carriage. The two above units together on Hire Purchase Terms: £3/15/6 deposit and 12 monthly payments of £1/1/6 plus 15/6 pax. and carriage.

**PUSH-PULL OUTPUT TRANSFORMERS**

2 x 6V6 late 2/3 ohms, 5/6. post free.

T.1154.

BRAND NEW COMPLETE WITH VALVES. £2/19/6, post and carriage 7/6.

**METER RECTIFIERS**

Complete with Output Transformer and 6in. speaker is £219/6. plus 10/- packing. Receiver are included. The 6V6 output stage complete with Output Transformer and 6in. speaker is £219/6. plus 10/- packing. The two above units together on Hire Purchase Terms: £3/15/6 deposit and 12 monthly payments of £1/1/6 plus 15/6 pax. and carriage.

**SELECTION OF H.P. ITEMS**

**GRUNDIG TK.810.**

**GRUNDIG TK.830.**
Cash price £68/6/-, 12 monthly payments £4/13/6. Postage and packaging 1/11.

**LEAK TL.00 AMPLIFIER AND PREAMPLIFIER.**
Cash price £28/7/-, Deposit £17/11/-, 12 monthly payments £1/19/6. Post and packing 7/6.

**LEAK DYNAMIC PICKUP WITH DIAMOND STYLUS.**
(1) Cash price £1/11/6, Deposit £1/1/6, 9 monthly payments £1/1/6 (B) with Extra head. Cash price £19/5/-. Deposit £4/16/3, 12 monthly payments £1/19/6. Post and packing 7/6.

**TRUVOX MK. III DECK.**
Cash price £23/2/-, 12 monthly payments £1/15/6, plus packing and carriage 21/-.

**TRUVOX TYPE C AMPLIFIER.**
Cash price £16/16/-, Deposit £4/1/6, 12 monthly payments £1/1/6, Post and packing 8/.

**GARWOOD CHANGER TYPE RC80. A.C. /D.C.**
From turntable to Car. Cash price £8/1/6, Deposit £6/15/6, 12 monthly payments of £1/15/6, plus packing and carriage 7/6.

**COLLARD TRANSCRIPTION UNIT TYPE TD1.**

**TRUVOX TYPE C AMPLIFIER.**
From turntable to Car. Cash price £173/10/-, H.P. Terms: Deposit £18/16/6, 12 monthly payments at £1/1/6. Packing and carriage 21/-.

**SEND 2jd. STAMP FOR OUR 1955 CATALOGUE**

**PREMIER VARIABLE IMPEDANCE "MATCHMAKER" OUTPUT TRANSFORMERS**

Designed to meet the demand for an efficient variable ratio Output Transformer 11 watt from 13 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 Impedance 50 henries 15 watts audio 100 mA. Price 45/-.

**SEND 2jd. STAMP FOR OUR 1955 CATALOGUE**

**RADIOGRAM CHASSIS**

5 Valve 3-waveband superhet Receiver covering short, medium and long waves. Using the latest miniature all glass valves, overall chassis size 15in. x 7in. high x 9in. deep, dial aperture 10in. x 4in. BRAND NEW, READY FOR USE AND GUARANTEED. £10/5-0.

**PORTABLE TAPE RECORDER CABINETS**

All Rexine covered

**TAPE DECK**

Amplifier Type Price Lane Mk. VI Premier Mk. VI £6/19/6

**TRUVOX MK. III**

E.A.P. £4/4/-

**TRUVOX MK. VI**

Premier T.D. £4/4/-

**TRUVOX MK. VIII**

Premier T.D. £4/4/-

Plus Postage and Packing 5/-.

We carry a comprehensive stock of components by all leading Manufacturers.

**PREMIER RADIO COMPANY**

**1155 RECEIVER UNIT**

**GRADE 2**

Slightly soiled complete with 10 valves. Frequency range: 15 kHz. 5 wave-bands. £91/9d. Plus 10/- packing and carriage. Hire Purchase Terms: £2/9d deposit and 10 monthly payments of £1/-.

**POWER SUPPLY UNIT**

**WITH OUTPUT STAGE FOR ABOVE**

Jones plus for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and fan, speaker is built into the unit. Price £5/5/-, plus 3/- packing and carriage. The two above units together on Hire Purchase Terms: £3/15/6 deposit and 12 monthly payments of £1/1/6 plus 15/6 pax. and carriage.

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Completes a standard work for Television Engineers

**Television Receiver Servicing: Volume 2**

Receiver and Power Supply Circuits

By E. W. A. Spreadbury M.BRIT.I.R.E. Volume 2 of this unique work follows on logically where Volume 1 left off. It covers the video circuits, vision tuning and detector circuits and includes methods of multi-channel tuning, the sound channel and power-supply circuits. There is also a chapter on television aerials and another on the technique of circuit alignment.

With Volume 1 this book provides the experienced service engineer a complete picture of the problems likely to be encountered in television service work.

**NOW ON SALE - GET YOUR COPY TO-DAY**

Published for “Wireless & Electrical Trader”

From booksellers or direct from Dorset House, Stamford Street, London, S.E.1.
Who ever heard of a set designer with no headaches? We haven't. But we do know of many with considerably fewer headaches since they discovered the Monarch Automatic Record Changer.

Many manufacturers have, in fact, found the Monarch to be so completely reliable they have eliminated their own tests!

Any designer with more than his fair share of headaches would do well to examine the Monarch carefully. His critical appraisal will reveal a changer with many virtues, no vices—and no headaches.

The Monarch is now fitted as standard equipment by the majority of the world's leading set makers.

special features

- Exclusive 'Magidisk' automatically selects 7 in., 10 in. and 12 in. records, intermixed.
- Plays up to 10 records at 33\(\frac{1}{3}\), 45 or 78 r.p.m.
- High compliance crystal cartridge fitted with dual sapphire styli.
- 'Rotocam' centralized control is simple, foolproof and trouble-free.
- Independently tested Monarchs have completed equivalent of over 90 years' faultless performance.

MONARCH
world's finest autochanger

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In This Issue

Editorial Comment ............................................ 405
Rocket Sounding in the Upper Air. By Sir Edward Appleton .................. 406
Differentiating Speech and Music .................................. 407
World of Wireless .................................. 408
National Radio Show ................................ 412
Guide to the Stands ................................ 414
Letters to the Editor ................................ 427
Neon F.M. Tuning Indicator. By John D. Collinson .................. 428
Toronto Audio Show. By P. G. A. H. Voigt .................. 430
Language Translation by Electronics. By J. P. Cleave and B. Zacharov .................. 433
Etched Foil Printed Circuits. By H. G. Manfield .................. 436
American Oscilloscope Technique. By A. J. Reynolds .................. 441
Transistor Equivalent Circuits—3. By W. T. Cocking .................. 444
Books Received .................................. 448
Design of Tchebycheff Filters. By G. H. Burchill .................. 449
Simplified G.C.A. .................................. 451
Vertical Pattern of V.H.F. Aerials. By E. G. Hamer .................. 452
Fourier—Fact or Fiction? By "Cathode Ray" .................. 455
Ultrasonic Fish Detection ................................ 458
Short-wave Conditions ................................ 460
Aerial Circuit Magnification. By S. Kannan .................. 461
Rugby Radio Extension ................................ 463
Random Radiations. By "Diallist" .................. 464
Unbiased. By "Free Grid" .................. 466
33. MW53-80: A 90° TELEVISION PICTURE TUBE

REASONS FOR 90° SCANNING

The screen size of direct-viewing picture tubes has grown rapidly since the television service was restarted after the war. The 9-inch circular tube of 1946 has been supplanted by progressively larger tubes, the latest of which has a rectangular face with a 21-inch diagonal. If these larger tubes had been merely expanded versions of the 9-inch tube, the problem of cabinet depth, which was present even in 1946, would have been very much aggravated. Tube lengths, however, have been kept within reasonable limits by the introduction of greater scanning angles. If, for a given screen size, the scanning angle of the electron beam is increased, it follows that the gun and the deflection coils will be moved in towards the screen, and the overall length of the tube will be reduced. The effectiveness of this solution to the problem is shown by the fact that a 21-inch tube with the same scanning angle as a 9-inch tube would be half as long again as it actually is. The new Mullard 21-inch, 90° tube type MW53-80, which is shown in the photograph, is, in fact, about three inches shorter than a 70° tube of the same screen size.

CIRCUIT AND TUBE PROBLEMS

Wide angle scanning eases cabinet design, but it brings problems of its own. The most serious is the disproportionate increase in the deflection coil power requirements. If the scanning angle is changed from 70° to 90°, the power which must be supplied by the line timebase output transformer is increased by 50 per cent. A second complication is that the beam at maximum deflection is liable to be intercepted by the envelope of the tube, producing corner cutting of the picture. Thirdly, in tubes with approximately flat faces, the deflected beam strikes the screen at increasingly acute angles, and the spot may be markedly defocused at the edges of the screen.

These difficulties have been countered by improving the efficiency of the scanning system and its associated circuits, so that the increase in power drain is not out of proportion to the gain in useful picture size. A practical line scanning circuit, in which the efficiency is improved by the use of the full h.t. line potential in conjunction with tuning of the leakage inductance of the output transformer, will be described in a further advertisement in this series.

Deflection defocusing and corner cutting are overcome by careful tube and deflection unit design. In particular, the scanning coils and the front of the yoke are shaped to fit the cone of the picture tube—giving optimum sensitivity.

A NEW PICTURE TUBE

The Mullard MW53-80 is an indirectly heated direct-viewing tube with a 90° deflection angle and a rectangular screen with a 21-inch diagonal. The metal-backed grey glass screen, with white fluorescence, has a useful area of 378mm by 482mm. The tube incorporates an ion trap, and the electron gun is designed to give uniform focus over the whole screen. Magnetic focusing and double magnetic deflection are used. The capacitance formed by the external conductive coating and the final anode may be used to provide smoothing for the e.h.t. supply. The 6.3V, 300mA heater is suitable for parallel or series connection. The overall length of the tube is 507 ± 10mm.

Operating data for the MW53-80 will be included in the reprint of this advertisement.

Reprints of all the advertisements in the "Valves, Tubes, and Circuits" series, with additional notes, are available without charge from the address given below.

MULLARD LTD · TECHNICAL SERVICE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE · LONDON W.C.2

MVM 333
Get your new

BRIMAR MANUAL

Radio Valve and Teletube Manual No.6

The LATEST EDITION has

272 Pages of VALVE and TELETUBE DATA
CIRCUITRY & SPECIAL COMPONENTS

still only 5/-

SUMMARY OF CONTENTS

Valve ratings and base connection symbols.
Classified list of nearly 300 valves, teletubes and selenium rectifiers.
Germanium diode section including ratings in various circuits.
Brimistors section.

Radio engineering formulae and NEW circuits.

Send 5/- for your copy, to:

Standard Telephones and Cables Limited
Publicity Dept.: FOOTSCRAY · SIDDUP · KENT

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NEW-

QUITEXCEPTIONAL IN DEFINITION AND QUALITY OF REPRODUCTION

The HGP 59 Series

High Definition

Salient Features

Extremely smooth response with no peaks to colour or mar reproduction.

* New type stylus mounting reduces all Pick-up distortion to an absolute minimum.

* Extremely light stylus pressure.

* Very compliant stylus—superb transient response, low record and sapphire wear.

* Sapphire styli replaced very simply without any tools whatsoever.

* Positive turnover mechanism with a neutral position.

* Precision sapphires made by the finest precious stone lapidiaries. Individually inspected under 500x magnification.

* Each unit very carefully checked for sensitivity and response and finally subjected to a critical listening test before being despatched from the factory.

This new ACOS “High Definition” Series represents a most important advance in “turnover” pick-up cartridge design. There are two versions — the HGP 59-1 with a normal output which will give superb wide-range reproduction in the highest grade radiogram, and the HGP 59-3 which will load a single valve amplifier in a portable player. Both have all the features listed on the left.

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

COSMOCORD LIMITED · ENFIELD · MIDDX · TEL: ENFIELD 4022
"BELLING-LEE"  
NOTES

G9AED  
CROYDON

Within a week of publication of this issue of the "Wireless World," the "Belling-Lee" band III experimental transmitter at Croydon will have closed down. We would like to thank all those readers who have assisted us by sending in reception reports. We have also been very pleased to receive letters of appreciation from so many dealers and others in the Trade. So far as we are concerned, we are grateful to those members of our staff who have carried out the duties of station operators. Up to the time of writing the station has kept to schedule with the only a one minute breakdown from the starting date of April 1st. The only other times the station has been "off air" during scheduled hours has been due to co-operation with I.T.A. engineers testing on dummy load etc.

G9AED Croydon now closing down.

NOW CLOSING DOWN!

SEAMED v. EXTRUDED TUBES for TELEVISION and V.H.F. AERIAL ELEMENTS

Some people are rather inclined to look upon the use of all forms of seamless tube as a means to achieve cheapness, but it is significant that one prominent maker of television aerials is changing over from extruded to seamless tube as quickly as possible, and perusal of the findings of the research project into this question removes all doubt as to reasons why.

In the manufacture of a close seamed rolled tube, a strip is cut along the grain from a sheet of the correct alloy; this strip is rolled to form a tube. The grain is along the length of the tube which is work hardened during the process.

The tables showing tensile tests show the seamed tube to be superior under all headings; tons per sq. inch, 0.1% proof stress, ultimate tensile stress, elongation and Young's modulus.

Deflection tests also favour the seamed tube. The table showing Fatigue tests show the most astonishing figures. Here the elements in their normal housings were subjected to vibration tests. Both types of element being tested horizontally and vertically until fatigue cracks appeared. The advantage of the seamed tube over the extruded tube is in the region of 4:1.

 Authorities are satisfied that in general it is not high wind that causes aerial elements to snap, but fatigue.

These tests were carried out on elements manufactured from standard alloy specifications commonly used in good practice.

Drawn tube B.S.1471 HT.10WP.

Seamed tube B.S.1470 HS.10.

It is important to note that manganese is generally omitted from billets used for extrusion, as it slows down the rate, but the presence of this metal in significant quantities in the sheet from which the seamed tubes are rolled, has the effect of retarding corrosion.

There is insufficient capacity in the country to supply the requirements of the one manufacturer using this method of construction.

Finally, no claims are made for the use of seamed tube under conditions of tortuous stress, as in crossarms, booms or masts. This would definitely be a wrong application.

From careful consideration of the facts it would appear that there is quite a lot in favour of rolled seamless elements correctly manufactured. The Belling & Lee Ltd., Great Cambridge Road, Enfield, Middlesex.

NDP/BFW 15.7.55.

A NEW HIGH-GAIN 3-ELEMENT

This further addition to the "Belling-Lee" band III range was designed specifically as an inexpensive high gain aerial to cover channel 9 only. Available with various mounting arrangements and listed under L925.

Advertisement of BELLING & LEE LTD.

Great Cambridge Rd., Enfield, Middx.

Written 24th July, 1955

A range of lightweight plugs & sockets

"SCREENECTOR"

for instrumentation, etc.

These non-reversible, screened connectors accommodate cables up to 0.24 in. overall diameter and are available for 1 to 3 ways. Points to note:—A spring-loaded locking ring is now incorporated giving vibration-proof locking; resilient skirt maintains screen contact even if locking ring is left undone; contacts assembled on moisture resistant, nylon-filled, phenolic moulded insulant; rubber cable support to minimise wear at clamping point; housing designed so that the moulded inserts can be interposed, i.e. fixed or free plug, etc.; flange permits use on panels of any thickness.

New type plugs (L.788, L.789 or L.790 range) will mate with old type sockets (L.722, L.625 or L.715 range) locking as formerly, and old type plugs will mate with new type sockets but will not lock in as the ring is not spring-loaded. Apart from this both ranges are interchangeable mechanically and electrically.

Contact Resistance:—less than 2 milliohms per pole.

Working Voltage: 150 v. d.c. or a.c. peak.

Insulation Resistance:—60,000 megohms at 500 v. d.c. between contacts and from contacts to housing.

BELLING & LEE LTD

GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND
Marconi VHF
Multi-Channel Equipment

TYPE HM 181

Multi-channel radio links are not only recognised economic alternatives to line and cable routes wherever the latter are costly because of intensive urban development or the wild nature of the terrain; they are frequently preferable in their own right. The type HM 181 equipment has been designed for comparatively simple schemes using two terminals working point-to-point or with a limited number of repeaters. It operates in the frequency range 150-200 M/cs, employs frequency modulation and gives high performance with low distortion.

It provides the following facilities:—

- 8, 16 or 24 channels
- Repeaters with easy channel dropping facilities
- Unattended operation
- Engineers' order wire
- Ease of access for maintenance

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

Lifeline of communication
MARCONI
COMPLETE COMMUNICATION SYSTEMS
Surveyed, planned, installed, maintained
MARCONI'S WIRELESS TELEGRAPH CO., LTD., CHELMSFORD, ESSEX
Partners in progress with The 'ENGLISH ELECTRIC' Company Ltd.
NEW! THE PRACTICAL WAY of learning RADIO • TELEVISION • ELECTRONICS

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

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SEPTMBER/55  IC.68A
Why Ediswan Clix P.T.F.E. Valveholders are widely used in B.B.C. Television equipment

Large quantities of Ediswan Clix P.T.F.E. Valveholders are used in B.B.C. Television equipment. Only the combination of the finest insulation—P.T.F.E., the most efficient contact material—Beryllium copper—and Ediswan Clix design and manufacture can match the requirements of efficiency and reliability in this and all other stringent valveholder applications.

Ediswan Clix P.T.F.E. Valveholders are fully type approved for Services Grade 1, Class 1 conditions. Full details of these valveholders and other components in the Ediswan range are given in catalogue CR. 1681. Manufacturers and Development Groups may have a copy on request.
MARCONI-SIEMENS

Five Band Split Privacy Radio Telephone Equipment

This equipment, which may be switched in or out of use at the radio terminal, provides a very high degree of privacy for speech on a radio-telephone circuit by:

1. splitting the speech band of 250-3000 c/s into five sub-bands of 550 c/s and recombining them in different relative positions,
2. inverting the frequency range of any one or more of the sub-bands, and
3. rearranging the combination of the sub-bands simultaneously at both ends of the radio-circuit in accordance with a pre-arranged sequence at controlled intervals between 4 and 20 seconds.

The resulting speech band, which modulates the transmitter, is unintelligible and the frequent regrouping of the sub-bands, with or without inversion precludes any simple method of interception. A reversal of the process at the distant terminal restores the original speech. The processes involved are reversible, thus common channel equipment can be used for both transmission and reception. Amplifiers in the privacy path compensate for the losses in band splitting and recombining. The simultaneous switching system, operates by means of relays under the control of a synchronous motor driven by a high precision crystal oscillator, this does away with the need for a transmitter pilot tone.

THE LINK BETWEEN RADIO AND LINE COMMUNICATIONS

Full technical details of this and other Marconi-Siemens equipment, which provides completely integrated radio and line telegraph and telephone systems may be obtained from either

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX
OR SIEMENS BROTHERS AND COMPANY LIMITED, WOOLWICH, LONDON, S.E.18
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SUBJECT(S) OF INTEREST
(We shall not worry you with personal visits)

WIRELESS WORLD
SEPTEMBER, 1955
new world-beating
'SCOTCH BOY'
extra-play
magnetic recording tape
190m

THE FINEST BASE-FILM EVER MADE
The astonishing new polyester base-film for 'Scotch Boy 190M,' is so much stronger than other tape bases that it can be made 33 1/3% thinner — and still be stronger. This means you get 50% more length — and 50% EXTRA PLAYING TIME — on the same-sized reel.
Polyester film is a naturally limp and flexible material, and is little affected by temperature and humidity changes. 'Scotch Boy 190M' tape conforms snugly to recorder heads, is easy to handle, winds trimly, and tracks smoothly. It has an indefinite life in storage, and is an ideal tape for archive purposes.

NEW THIN COATING
The new and potent oxide coating of 'Scotch Boy 190M' tape gives clear, crisp reproduction of every frequency in the audible range. High-frequency response shows a specially notable improvement. Output variations from reel to reel and within each reel are remarkably small and, as with all Scotch Boy tapes, background noise is negligible.

THE WORLD'S FINEST TAPE
'Scotch Boy 190M' has been developed and produced in Britain by the 3M Company. Its appearance in Britain is its first appearance in the world. This is a landmark in the development of tape recording.
Ediswan now have available a new stabilised power supply unit which has been specially designed to feed Photo-Multipliers. It is particularly suitable as a supply unit for Ediswan Mazda Photo-Multipliers type 27.M1, 27.M2 and 27.M3.

**BRIEF SPECIFICATION TYPE RI184**

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
<th>STABILITY</th>
<th>OUTPUT RESISTANCE</th>
<th>RIPPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>200–250 v., 40–100 c.p.s.</td>
<td>High stability low ripple D.C. supply variable between 370 and 1,100 volts. Max. current 2 mA. Pos. or neg. may be earthed.</td>
<td>A 10% change in mains input voltage results in a change of less than 0.1% between 1,100 volts and 600 volts output.</td>
<td>Approximately 1,500 ohms.</td>
<td>Less than 0.01% R.M.S.</td>
</tr>
</tbody>
</table>

**MOUNTING** The Unit is suitable for standard rack mounting or for bench use. Bench Stands are available.

**PRICE — £48**

*Further information is available on request*

**EDISWAN**

**RADIO DIVISION - THE EDISON SWAN ELECTRIC COMPANY LIMITED**


*Member of the A.E.I. Group of Companies*
Both for studio and outside broadcasting of television programmes Marconi equipment is required at every stage of production and transmission. Cameras, Picture and Waveform Monitors, Vision Mixers, Telecine Equipment where film sequences are included, Microwave Links, Transmitters and Aerial must all be matched as components of a completely integrated system with a designed performance. The long experience and advanced technical knowledge of the Company's Broadcasting Division are at the disposal of all who are responsible for television, throughout the world.

Marconi Television Equipment is installed in every one of the B.B.C.'s Television stations and has been supplied to countries in North and South America, Europe and Asia. Compatible colour television was first demonstrated in Britain by Marconi's.

Shown above is the Marconi Mk. III Camera for 4½" or 3½" image orthicon tube. It combines technical excellence with optimum operating facilities. On the right is a typical Marconi Television Aerial array.

Lifeline of communication

MARCONI
Complete Broadcasting and Television Systems

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

Partners in progress with the 'ENGLISH ELECTRIC' Company Limited
WESTON ELECTRICAL INSTRUMENTS INCLUDE:
LABORATORY STANDARDS • PRECISION GRADE INSTRUMENTS • INDUSTRIAL GRADE INSTRUMENTS PORTABLE, ROUND, RECTANGULAR AND EDGewise SWITCHBOARD AND PANEL MODELS • PORTABLE TEST SETS • RELAYS • AIRCRAFT INSTRUMENTS

Supplied as D.C. moving coil, A.C. rectifier and H.F. thermocouple types; also A.C./D.C. moving iron types. Four sizes are available with scale lengths of 2.5in., 3.5in., 4.2in. and 6.25in.
Front of panel or back of panel mounting may be adopted as desired, and if the former method is used there is complete interchangeability with existing round models. The 3.2in. and 4.2in. scale instruments are available with either illuminated or non-illuminated dials; the 2.5in. and 6.25in. scale instruments being available only with non-illuminated dials.

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Why I bought a Grundig

People like myself are inveterate listeners. For us, music and other pleasures of the mind—drama, discussion, verse—are as necessary as food.
In my case I found a need to "capture and keep" the memory of things that delighted my ear—to record the peerless performance or the subtle interchange between accomplished speakers.
For this, my Grundig Tape Recorder is perfect. It has a wide range, high fidelity reproduction and simple controls with looks that match its performance.
VORTEXION TAPE RECORDER

The amplifier, speaker and case, with detachable lid, measures 8\(\frac{1}{4}\)in. x 22\(\frac{1}{2}\)in. x 15\(\frac{3}{4}\)in. and weighs 30 lb.

**PRICE, complete with WEARITE TAPE DECK**

\[ \text{£84 0 0} \]

**The total hum and noise at 7\(\frac{1}{2}\) inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.**

**The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.**

**A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.**

**The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.**

**A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.**

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

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

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

**The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.**

**POWER SUPPLY UNIT**

to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder, **PRICE £18 0 0.**

We supply and recommend the Jason F.M. Feeder Unit. **PRICE £15 17 0,** including Purchase Tax.

3-WAY MIXER AND PEAK PROGRAMME METER

FOR RECORDING AND LARGE SOUND INSTALLATIONS, ETC.

One milliwatt output on 600 ohm line (775V) for an input of 30 micro-volts on 7.5-30 ohm balanced input.

Output balanced or unbalanced by internal switch. The meter reading is obtained by a valve voltmeter with 1 second time constant, which reads programme level, and responds to transient peaks.

Calibration in 2 db steps, to plus 12 db and minus 20 db referred to zero level. Special low field internal power pack supplies 8 valves including stabilising and selenium rectifier, consumption 23 watts.

Manufactured by

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

Telephones: LiBerty 2814 and 6242-3

"Extratop"

£12-10s.
Add to the wide response already obtainable from the famous Phase Inverter Speaker by merely adding the new "Extratop" Dynamic Pressure Tweeter Unit complete with Crossover. Impedance 15 ohms. Suitable for use in conjunction with any 15 ohm speaker but even better with the Phase Inverter Speaker. Tweeter £12 10s; Phase Inverter Speaker £14 10s.

£14-10s.

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"Manufacturers of all A-Z Products ('A-Z' Regd. Trade Mark)"
Works and Acoustic Laboratories:
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Tel. Farnham 6461 (3 lines) "Grams: Sounsense Farnham"

Quartz Crystals of any shape and size cut and ground precisely to specification and coated, if required, with Gold, Silver, Aluminium or Rhodium, etc.

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Grams: Xsals, Green, London.
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S.G.Brown
SINGLE HEADSET
with BOOM MICROPHONE
for:

TELEPHONE OPERATORS
CONFERENCE INTERPRETERS
BROADCASTING TECHNICIANS

Designed with fully adjustable single earpiece and microphone. Leaves both hands free. Enables operators to listen and speak, independently.

Earpad and Microphone housings moulded from dermatitis-proof rubber. Designed to withstand very heavy wear. (Available with two earpieces if desired.)

S. G. Brown provide Headphones and associated equipment for all known purposes. Brochure 'W' sent on request.

Telephone: Watford 7341

SHAKESPEARE STREET, WATFORD, HERTS.
In the field of component assembly, 'Scotch Boy' electrical tapes have long been unrivalled for strength, ease of application, and excellent dielectric properties.

Now a new range of 'Scotch Boy' electrical tapes, with thermosetting adhesive, has been introduced. These remarkable new paper, glass cloth, and acetate cloth tapes have the same ability to stick at a touch, but the adhesive cures firm when components are subjected to the normal drying cycles.

The cured adhesive has greatly increased solvent resistance, and soft spots are eliminated. The new tapes are, therefore, ideal for use with solventless varnishes and casting resins.

HERE ARE TYPICAL APPLICATIONS:

**CENTRE RIGHT**
No. 27 Glass Cloth Tape holds the leads and insulates the lead wire splice of a lighting transformer

**TOP RIGHT**
No. 38 Paper Tape is used to anchor, start, and finish wires

**TOP LEFT**
No. 38 Paper Tape binds and insulates motor field coils

**BOTTOM RIGHT**
No. 28 Acetate Cloth Tape anchors leads in secondary windings, and No. 38 Paper Tape holds fibreglass pads of a transformer
THE LEAK DYNAMIC PICKUP

This new pickup results from five years continuous development of our first moving coil design. Reports from users during the first few months of its sales have justified our earlier belief that the pickup might earn recognition as the best in the world.

PRICES

The arm: £2/15/-, plus 19/3 Purchase Tax.
L.P. head with diamond stylus:
£5/15/-, plus £2/0/3 Purchase Tax.
78 head with diamond stylus:
£5/15/-, plus £2/0/3 Purchase Tax.
Mumetal-cased transformer: £1/15/-. 

SPECIFICATION

*THE ARM
This is of advanced design having very low inertia. Friction is kept to a minimum by using a single pivot bearing. The arm is counter-weighted and has provision for plug-in interchangeable heads. An arm-rest is provided.

*GENERATING SYSTEM
Dynamic (moving-coil). Coil impedance approximately 6 ohms, 1,000 c/s. No magnetic material is embodied in the moving parts, and the pickup is free from the inherent distortion of moving iron (magnetic variable reluctance) types. These distortions are also inherent in those dynamic pick-ups in which the moving coil is wound on a magnetic core.

*STYLUS
Material: Diamond, guaranteed unconditionally not to chip or break. Stylus sizes: L.P. 0.001 in. radius ± 0.0001 in. 78: 0.0025 in. radius ± 0.0001 in.

*PLAYING WEIGHTS
Between 2 and 3 grammes for L.P. Between 5 and 6 grammes for 78. Automatically adjusted by the weight of the head.

*RECORD AND STYLUS WEAR
These are lower than on any other pickup of which we have cognisance. Diamond has a playing life of approx. 100 times longer than sapphire, and because it will take a higher polish than any other material it therefore causes less record wear.

*OUTPUT
The shielded step-up transformer delivers an output of 8 mV for each cm/sec. r.m.s. recorded velocity. This means that an amplifier with a sensitivity of 40 mV at 1,000 c/s will be easily loaded by the pickup from commercial records.

*FREQUENCY RESPONSE
Total variation ±1 db 20,000 c/s to 40 c/s with the L.P. head, including transformer (recorded velocity 1.2 cm/sec, r.m.s., above turnover).
Low frequency resonance:
20 c/s ± 5 c/s with our very lightweight arm.
High frequency resonance:
0.001 in. radius on Vynil, 21,000 c/s ± 2,000 c/s. 0.0025 in. radius on shellac, above 27,000 c/s.
The frequency response does not change with temperature.

* SIGNAL-TO-HUM-RATIO
It is not possible to specify this important ratio without stipulating the strength of the interfering fields. These fields will, of course, vary according to the installation. However, for the purpose of comparison measurements have been taken under working conditions, i.e. with various pickups mounted normally within inches of the electric turntable motor and within two feet of a power transformer in an amplifier. The results show that the Leak Dynamic Pickup has a lower hum content than any variable reluctance (moving-iron, magnetic) pickup and a very much lower hum content than a single turn moving coil (i.e. "ribbon") pickup.

* DIMENSIONS
From the centre of the fixing stem to the front of the pickup head, 94 in.
From the centre of the fixing stem to the rear of the arm, 2 in. The height of the pickup is adjustable and it can be used with any turntable.

* MOUNTING
A template of original Leak design is supplied, enabling the pickup to be accurately located on the turntable mounting board. There is a single fixing hole and the stem contains a miniature socket which accepts the plug leading to the transformer (see illustration).

* TRANSFORMER
The transformer has a step-up ratio of 1.80 and is heavily shielded in mumetal. The primary lead is terminated in a plug and a shielded secondary lead is supplied.

* ELECTROSTATIC LOUDSPEAKERS
Reprints of "The Gramophone" article (May, 1955), by H. J. Leak, summarising his work and findings on Electrostatic and Dynamic Loudspeakers, are available on request, free of charge.

Write for illustrated leaflet 'W'.

Sole distributors for H. J. LEAK & Co. LTD.

AUDIO TRANSUDCERS LTD., PICCADILLY HOUSE, 33-37 REGENT STREET, LONDON, S.W.1
Telephone: REgent 5659
Telegrams: HIFI, PHONE, LONDON
Cables: HIFI, LONDON
On Monday, September 14th, 1934, Mr. H. J. Leak left his employment as a sound-film engineer and founded our company. The beginning was modest. The aim of the founder was to earn a living in the way which appeared to hold the best promise of a happy life; by making sound-reproducing equipment better, if possible, than anyone else. To-day, twenty-one years later, the objective is exactly the same and is approached with the same enthusiasm, but the circumstances have vastly altered. The company is known throughout the world, and owns a fine post-war factory and office buildings, designed for the most efficient production of audio products, with ample spare land for periodic expansion. The company's steady growth has been achieved without any surrender of independence, for the final direction and control, both engineering and commercial, remains with the founder, who is assisted and advised by an efficient and enthusiastic nucleus of executives each having fourteen or more years of service.

During the first eleven years of the company's life the main products were audio amplifiers of many types, the company remaining somewhat anonymous because these amplifiers, though they were of Leak design, were supplied to large organisations for sale under their own names, or to government departments. Wider recognition came in 1945 when, as the result of war-time research in our laboratories, we were able to offer audio amplifiers with a distortion content as low as 0.1%. A survey of engineering literature will confirm that we were the first manufacturers in the world to design and market amplifiers with such a small distortion content, and the magnitude of this advance can be gauged when it is remembered that the then accepted standard for laboratory amplifiers was 2½% distortion. Our figure of 0.1% was received with incredulity, but it was subsequently confirmed by the National Physical Laboratory, and this criterion is still an accepted world-wide standard.

With this clear lead on low-distortion amplifiers we were able to build up an export market much greater than the domestic one, and the increased volume of manufacture resulted in lower prices which, in turn, brought real high-fidelity amplifiers within the reach of the music lover at home. We also further popularized high-fidelity by lecturing throughout the country and giving demonstrations of comparisons between live and recorded voices and music.

During all these years we have carried out constant research and development on transducers, and our first moving-coil pickup (1948) was widely greeted as a distinct advance over the available magnetic and crystal types. This pickup is still in use all over the world in many recording studios for dubbing and play-back work. Our latest "Dynamic" pickup is a development of the earlier model and has found a ready market throughout the world among those who demand the highest quality of record reproduction.

Until very recently all our work on loudspeakers had not enabled us to offer products markedly superior and cheaper than those obtainable elsewhere, and we therefore refrained from entering this market. However, final designs are in the process of tooling, and within the next few months we shall market loudspeaker transducers giving very obvious improvements in listening quality. These loudspeaker motors will initially comprise a 15" moving-coil bass reproducer employing novel constructions and materials, resulting in an enhanced steady state and transient performance as compared with conventional loudspeakers. There will also be a balanced-push-pull electrostatic loudspeaker having astonishingly low harmonic and transient distortions. In combination these motors give an advance in listening quality comparable with the advance made by the advent of the Rice-Kellogg moving-coil loudspeaker in 1925, and with the advance made by our introduction of low-distortion amplifiers ten years ago.

Within a month or so details of the Leak "Trough-Line" FM tuner will be announced. Most of the conventional bases of present-day FM tuners have been abandoned for solutions resting on firmer engineering grounds, and many features of the tuner may well become standard practices of the future, just as happened with the original "Point One" amplifier.

Our grateful thanks are due to very many people. To our suppliers for giving us the high-quality materials and finishes on which we insist; to our agents and dealers overseas and at home for their service to our customers and ourselves; and to our customers for their support and recommendation—the basis on which the company has grown. Finally, a special word of thanks to fellow engineers for the knowledge which they spread by the written and spoken word.

It has been an exciting and happy twenty-one years. The founder, who is in his forties, is the oldest executive, so we are still a young company in outlook, with the enthusiasm of youth tempered by the experience of survival and achievement. We therefore look forward exuberantly to the future and we hope that you will share with us the pleasures resulting from the undoubted advances yet to come in the art and science of sound reproduction.
ADDITIA—BAND III CONVERTOR

Our convertor has given very satisfactory results from the experimental Beulah Hill station, and we have had many satisfying reports regarding its performance.

It is a very neat-looking unit and fits to the standard Elpreq II-B or III-B cabinet. It is designed to convert any T.V. superhet or T.R.F. and any internal modifications of any kind are required to fit it in the aerial, connect to the mains, and you have Band I or Band III at the flick of a switch. Standard models are set for London working but the unit is completely tunable for any combination of stations.

Build it Yourself

You can save at least £2 on the £10, if you build the convertor yourself. Price of all components including stove enamelled case and even transfomers for the front, is £5, (3½/- plus 2½/- post free). Mains components also required. Data is included free with the parts or available separately price 1/-.

BAND 3 AERIAL KIT

An interesting aerial, "The Folded V" was described in the July number of a T.V. magazine. We tried this and found it to be most efficient, both for interference reducing and increasing reception strength. It is portable and adjustable, therefore, offer this aerial as a constructor's kit. The kit comprises alloy elements and connectors, neat plastic centre piece with polythene insulators and saddles for mounting on railings. Cost each or in limited, window frame drain pipe, etc., 6/6. Construction data free with parts or available separately price 1/-.

W.W. (May 1954 Band I Kit)

One of the most successful kits we have ever offered is a complete kit of parts including the specified EF80 and 1S4 receiving valves, fitted chassis, etc., and everything including a copy of the parts diagram. Price only 40/6, post 2/- extra. Mains components if required 3½/- post free. Price is built into the Beulah Hill station. Aerial is 23/-, plus 2/- post, or 84/- if mains components also required. Data of all components including stove enamelled case and even transfers for the front, is included free with the parts or available separately price 1/-.

THE "ELPREQ" Band III Signal Generator

This is a very neat-looking unit and attains high performance of band III. Unit is completely tunable for any combination of wide-band or narrow-band, high-definition or regular IQ. Sensitivity and output—German miniature pentodes and EF80. DC output is 23/-, full 1V.C. adjustable and has been tuned T.R.F.—full V.C. variable—negative feedback circuit. The wipe-over switch of the wave change switch is a high-tune output—particularly fine tone especially on gram. Chassis size: 7 x 7 x 7 approx. scale size 4 x 4 x 4 approx. Tested in difficult areas, the results we have received in our own stations are very encouraging. 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 x 7 x 7 with the 14 x 41 multicoloured scale, and it is built to the same exceptional specification as the Organtone. Price £10/- including carriage and packeting. Tests E10/- deposit.

CHASSIS ASSEMBLY

Three-colour 3-waveband mains covering standard, Long, Medium, and Short wave-bands, built into cabinet, finished in standard white-surfaced plywood driving board, veneer, etc., to suit, but size 10 x 7 x 21/2. Chassis size 16 x 41 x 21. Price £12/- plus 6/- post. Note. This is the one that fits our 37/- table cabinet.

WHAT IS IT?

It is the indicator that you would make to check that the "Elpreq Band III Signal Generator" is working properly. When the loop is brought up to the output circuit the lamp lights brightly.

THE "ELPREQ" Band III SIGNAL GENERATOR is most useful. It—
1. Will provide the signal for tuning to any Band III station.
2. Can be used as a grid-leak circuit to obtain the frequency of Band III T.V. aerials, Oils, etc.
3. Can be made to give a pattern on T.V. Receiver screen.
4. Can be accurately calibrated with included equipment.
5. All the parts including valves, iron, etc., which into metal chassis are available as a kit at 21/- post free. Construction data free with kit or available separately price 1/-.

DEMONSTRATIONS OF BAND III EQUIPMENT AT ALL BRANCHES

CABINETS FOR ALL

We confidently believe we carry the best stock of cabinets in London. The size illustrated is the Bureau, a really beautiful cabinet elegantly finished in varnish and finely polished. The control board is revealed when the front is dropped. Both radio and motor board are left uncut to suit your own equipment. Price is £5 extra, carriage £2. We have many other types in stock. For a visit or a send for Cabinet List.

THE CLEVELAND ORGANTONE

Five valve 3-waveband superhet 7½ in. long, 3½ in. wide, 3½ in. deep. In standard sizes. Price £7½/- domestic, £7½/- export.

3-SPD BY MOST FAMOUS MAKER

Plays all records 7½, 10½, and 12½. Records may be mixed. 7½, 10½, and 12½. Uses famoous "Pos" HI-G turnover Sapphire e'dge. Brand new, in maker's case. Free 12 month's guarantee. Normal price E16/-/-. Huge purchase enable us to offer these at £17½/- or £4 deposit and seven convenient payments of £1 each. Non-callers please add 7½/- for carriage and insurance.

CHANGE OF A LIFETIME

Corner Consoles. A useless cabinet but being corner fitted is not out of place even in a modern small living-room. Overall dimensions: 16½ in. wide x 24 in. deep x 24½ in. high. £12½. May be cut to suit "12½" T.V. viewer. Radiet Unit, Amplifier, Tape Deck, etc., £4 10/- each. Original price £12½, now 20/- carriage.
MULLARD AMPLIFIER "$10"
A High Quality Amplifier designed by Mullard engineers. Robust high fidelity with a power output of 10 watts and a harmonic distortion less than 4%, at 10 watts from 1 kHz. It is especially designed by the Mullard engineers for theadio-phonist who must have extreme accuracy and freedom from feedback. The unit is complete and ready to work is £1/2/0. Post and carriage 10/-.

THE NEW LEAK TL-10 AMPLIFIER

...This is a complete fluorescent lighting fitting. It has built-in ballast and starter, electrodes ranilled while still in box. It is an ideal unit for the kitchen over the work-bench, or in similar locations. It uses two 50-watt lamps. Price, complete less tubes, £2/6/6, or with two tubes, £3/6/6. Post and Insurance 9/6. Does not take 20-watt tubes 7/6 each.

OTOGONAL SPEAKER CABINET
...The transmitter is a complete unit, complete with turntable—plays 33, 45, 78 and 32 r.p.m. Post and insurance 3/6.

TABLE RADIO CABINET
Due to a special purchase, we are able to offer this very fine cabinet, size approx. 18 x 9 x 4 x 46. Walnut veneered and polished, £212/-.

SPEAKERS
The latest W.B. Canton type speaker units. With 12 inch cone speakers 17/6. Extra to the amplifier 2/6.

Mains Power Pack for £11/5
With Postage paid, 2/-.

AMAZING MINI-RADIO
Uses high-frequency coils—covers long and medium wavebands and 58. Uses coils and tubes, 6J1 and 6P6, 1 11/2/6, 2/6 post. Con-structed data free with the parts, or available separately 1/10.

Valve Holders
Each is fitted with a tubular anode. For 6UG bottom base and type 2 for RGA. Price 2/6, each.

Valve Packings
Each is packed with fine valves. Special cash-only order price this month, 5/-, 10/-, 15/-.

IEEE CHASSIS
Chassis size approx. 15 x 7 x 7. Suitable for pentode and triode valves. 8-pin, 3-pin or 4-pin sockets. Lid and front, £2/6/6, 3/- post and packing.

Electronics Precision Equipment Ltd.
249-Kilburn High Road, Kilburn
42-46 Windmill Hill, Ruislip, Middlesex
29 Stroud Green Road, Fin-bury Park, N.4

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

These are of really superb construction on the line of those made in France and comparable. All have tap-changers, and have been supplied to the L.N.E.R. from America for use on the new electrification line. The makers claim a saving of 20 to 60 per cent in comparison with other transformers of similar specification. They are supplied in two sizes, Type 295, 125-265 at 300 ma. and Type 296, 125-265 at 600 ma., both costing 2½/6. Type 296, 265-200 at 150 ma., 4 v. at 2.5 a. and 6 v. at 4 a. Price 3½/6, carriage 6/6.

TYPE 295.

1540 v. 5 a.; 4 a. at 375 v. for telephones and receivers. Price 4½/6, carriage 7/6.

POTTED CHOKEs

These are in similar type cases and therefore match the above transformers. Type 294, 5 H.T. at 390 ma. Price 10/-, carriage and packing 5/-.

RELAYS P.O. 3000 TYPE

Ref. 5A3. 2,000 ohm, slow close coil plats, contacts, one break, two make. Price 1/6 each.

Ref. 5A4. 3,000 ohm, standard coil, contacts, one break, two make before break, two make, 1 break. Price 1½/- each.

Ref. 5A5. 10 ohm, standard coil plat, contacts, two make. Price 7½/6 each.

WELD TYPE WIRE JOINER

This welder melts the metal to be joined so that after the parts are accurately aligned, the metal is fused by the heat. It is used for joining thin copper bus bars, connecting small wires to larger ones, and for making joints that are not intended to replace the soldering iron but nevertheless is ideal for making joints that have, for instance, to withstand heat, vibration, chemical action, etc.

In many cases also this method is faster than soldering and there is a considerable saving of current. Price 5½/6. Complete with slow close coil transformer, 20/6.

WIRE JOINTER

This welder melts the metal of each to run together, so that after the parts are accurately aligned, the metal is fused by the heat. It is used for joining thin copper bus bars, connecting small wires to larger ones, and for making joints that are not intended to replace the soldering iron but nevertheless is ideal for making joints that have, for instance, to withstand heat, vibration, chemical action, etc.

In many cases also this method is faster than soldering and there is a considerable saving of current. Price 5½/6. Complete with slow close coil transformer, 20/6.

AUTO TRANSFORMERS

For 240 volt A.C. American equipment, etc., etc., input tapped 200-240 v. Output 150-200 v. Price 3½/6 each. Up to three additional inputs before we have special this month 110/250 volt totally enclosed in metal box with lug and output leads. Price 4/6, plus 5½/- post and packing.

TOTAL 1100 c.c. cu.

Variable Resistors Heavy Duty Type.

<table>
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<th>Ohms</th>
<th>Amps.</th>
<th>Price</th>
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<td>5/6</td>
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<td>30</td>
<td>3/-</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>4/-</td>
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</table>

These are screw adjust types.

RACKS AND RACKING EQUIPMENT

STANDARD RACK

4½ ft. high and 18 in. wide, heavy, glass construction. Holes drilled and tapped at the standardized spacings. Price 8½/-.

ENCLOSED RACK

As above but rectangular and with sheet metal enclosed sides (front and rear) fitted handle and front production lid. Price £17/10-0/- depending on condition, plus carriage.

MOUNTING PLATES

To fit above racks. Heavy 1½ in. steel plate with single square inch and 1½ cent. centres with choice mounting brackets.

2½ in. front plate with choice brackets, 17½/-

2½ in. front plate with choice brackets, 15½/-

2½ in. front plate with choice brackets, 14½/-

3½ in. front plate with choice brackets, 19½/-

SAFETY SWITCH

When fitted this switch will cut off the mains as rack door is opened. 9/6.

CHARGING SWITCHBOARD

Feed this Switchboard through a mains Transformer and Rectifier giving 54 volt D.C., up to 25 amps, and you have an excellent multi-circuit charger for simultaneously charging several batteries at different currents. This is an Government switchboard giving 25 watt 18 volts fitted in two cases. It contains one charge relay, one voltmeter, one ammeter, two secondary ammeters and three switches. All connections are made in an easily fitted case. We have these in stock, in original cases (Price £4/10-0/-, carriage £1). We can supply a 12 volt, 30 amp. Mains Transformer at £5/5-0/- plus 5/- carriage.

High Power Transformers

WIRELESS WORLD

MAINLY FOR THE INDUSTRIAL USER

For R.F. Beamers, transmitters, etc., etc.

These are open wound type for maximum cooling and have the coil wound on a primary fully screened. Type 5F2, £10-0/-, carriage and packing 2/-.

Type 5F2A, £25-0/- at 1 amp., £7-5/- at 2 a. Price 5£5, carriage and packing 7/-.

Type 5M1, 1000-1000 at 1.5 mgs., £35-0/-, carriage and packing 7/-.

Type 5F1, 1000-1000 at 500 ma. and 4 v. at 4 a. Price £17/10/-, carriage and packing 4½/-.

Type 5F2, 971-0-375, £25-0/- at 250 ma. and 4 v. at 4 a. Price 7£7/6, carriage and packing 3½/-.

Type 5M2, 500-500 at 500 ma., £6-5/- at 4 v. 45/-, carriage and packing 3½/-.

POWER FILAMENT TRANSFORMERS

Type 5M1, 4 v. at 4 a. 2-25-2 v. at 10 a. Price 1/6/-, carriage and packing 3½/-.

Type 5M2, 300-150 at 10 a., 4-6-4 at 10 a., 6-6-6 at 6 a. £2-5/- at 5 a. Price 27½/-, plus carriage and packing 2½/-.

Type 5M1, 24 v. at 2½ a., 30 v. at 2½ a., 50 v. at 10 a., £25-0/-, plus 5/- carriage and packing.

Type 5M11, 500-500 at 500 ma., 6-5/- at 6 v. 45/-, carriage and packing 3½/-.

PORCELAIN STAND-OFF INSULATORS

threaded end. Price 1½.

RELAYS

Extra light weight, extra sensitive for high speed or radio control work, weight only 2½ oz. only 2½ oz. 5 mA. solid polish ground over contacts, adjustable pressure. Price 12/-.

TELEPHONE JACK PLUGS

As illustrated. Price 7½/- each. Sold to suit, 10/- each.

AUTOMATIC MOTOR STARTER

For remote control of D.C. motors between 1 and 3 k.w., adjustment for 100v. to 600v. Unusual and in first-class condition. Complete with metal case, 800 ma. Price 5£10, carriage £5.

SEPTEMBER, 1955

110
HEAVY DUTY POWER PACKS

500 WATT 1,000 v. (VARIABLE)

The conventional circuitry may be examined throughout and all components are supplied on the power pack itself for easy handling. A master switch controls the whole unit and whenever this is off the rectifier and load are isolated. The B.T. transformer is supplied from the primary of the transformer, connection being via an off-set switch and a tapped choke. The switch controls the B.T. and the tapped choke in conjunction with its selector switch gives ten variations from "low power" to "high power." The transformer is housed in a steel case which is smoothed by a 10-amp choke and a muf, condenser. A bleeder resistor connected in series with the output coil serves as a damping condenser and also discharges the smoothing condenser which otherwise would be a source of danger to users.

The continuous rating of the power pack is 1,000 volts at 2,000 milliamp 500 watts. But the proportions of the various components are such that 100 per cent. overloading would have an output of approximately 2 kilowatts.

Price £7/10/- each, or made up ready £21/0/-

500 WATT 2,000 v. (VARIABLE)

The maximum continuous rating of this is 500 milliamp at 2,000 volts. Rectification is half wave. Specifications, otherwise as for the variable 500,000 v.

1,000 WATT 2,000 v. (VARIABLE)

The continuous power rating of this is 500 milliamp at 2,000 volts. But the tapped choke is made to effect this in the circuit. Weight approximately 100 lb., 52 x 16 in. x 15 in. Price £37/10/- in kit form, or made up ready to use £47/10/-

1,000 WATT 2,000 v. (VARIABLE)

The maximum continuous rating of this is 3 amp. at 1,000 volts. Rectification is full wave, output as before. Weight approximately 100 lb., 52 x 16 in. x 15 in. Price £37/10/- in kit form, or £47/10/- made up ready to work.

FIXED MODELS

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

- Fixed 500,000 v., 52 x 16 in. x 15 in. Price £23/10/- with rectifier unit and all necessary leads and 10/- carriage.

- Fixed 1,000 v., 52 x 16 in. x 15 in. Price £37/10/- in kit form, or £47/10/- made up ready to work.

All prices quoted ex W.ks.

CEILING FAN

This model, made by Revo, incorporates a series-wound totally enclosed ball-bearing motor of robust construction and noiseless operation. The fan has a blade diameter of 30 in., and consumes approximately 250 watts. Maximum source voltage 230 v. Price £22/10/- in kit form, or £30 made up.

TETRODE TYPE V231

This is a high-powered air-cooled tetrode. Specifications of which are as follows—

- Fixed 500,000 v., 52 x 16 in. x 15 in. Price £37/10/- in kit form, or £47/10/- made up ready to work.

- Fixed 1,000 v., 52 x 16 in. x 15 in. Price £47/10/- in kit form, or £57/10/- made up ready to work.

All prices quoted ex Wks.

SPECIAL PURPOSE VALUES

 studies in abnormal blood pressure and low blood pressure. 15-12,000, price £3 each.

NEW 5 AMP. THERMOSTAT (MINIATURE)

This thermostat is adjustable from 0-50° C. to operate over the temperature range 21-26° C. - suitable for convectors, gas-pot vulcanisers, hot plates, etc. This thermostat is adjustable to suit any temperature range 18-30° F., fitted with heavy (0.3 amp.) A.C. silver contacts 15 lb. long: 31/4 in., wide, price £1/10, post 6d. 1 amp. Type 5/5.

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

METERS

- 2Hn. Flasb metering 620 m.m. moving coil 10° £6.60 5-00 mA. moving coil 10° £7.10 5-05 amp. moving coil 11° £7.60 5-0 amp. moving coil 11° £7.80 5-0 amp. R.F. thermo. 14° £8.50 5-0 amp. R.F. thermo. 11° £8.70 5-0 m.A. moving coil 11° £8.80 5-0 amp. moving coil 11° £9.00 5-0 amp. B.F. thermo. 14° £9.20 Hot Wire Amp. Meters 14° £9.30 5-0 m.A. ins. flash. 11° £10.60 8-0 ins. m.A. ins.

PYREX AERIAL INSULATORS

Ideal for aerial connections through walls or through panels. Consists of glass discs, or cones, of a size suitable for connecting to aerials with metal fixing flanges. Price 2/- each.

PLUG AND SOCKET VALUES

- 22 in. long, price 5/- each.

High Cycle Motor Alternator

- Type 1. Has a motor 200 v., 50 cycle single phase 2,800 r.p.m., coupled to a generator output 500 v., 1,700 cycles at 24 amps. Price £3/10/- plus 7/- carriage.


SPECIAL EQUIPMENT SALES

- IMPORTANT NOTE

Owing to the bulkiness of many of the items listed on these two pages it may not be possible to keep stocks as bricb, therefore please telephone confirmation that the equipment is actually in stock before placing an order.

SPECIAL SALES DEPT., E.P.E. LTD., 121, TERMINUS ROAD, EASTBOURNE.

- Phons: Eastbourne 5055.

Phone: Eastbourne 5055
GRUBB PARSONS
A.C. STABILISER

NEW & IMPROVED MODEL

☆ Even greater constancy of output voltage than with earlier model.
☆ Increased output—up to 1 amp.
☆ Safety device incorporated to avoid any dangerous rise in output voltage in event of failure of any part of the unit.
☆ Optional provision of voltmeter and ammeter to measure input and output voltages and output current.
☆ Stabiliser can be adapted at small cost to stabilise the radiation emission from light sources such as filament lamps and Neirnst filaments.

PERFORMANCE DATA

Stability: ± 0.05% for input voltage changes of at least ± 10% at all loads and for normal frequency variations.
Regulation: Within ± 0.1% for changes from no load to full load.
Waveform: Total introduced harmonic content within 3% (Mainly 3rd and 5th) under average conditions.
Reactive Loads: Above performance maintained for loads of P.F. from 0.8 to unity, lagging or leading.
Input Volts: (Nominal) 210, 220, 230, 240, and 250, switch selected.

SIR HOWARD GRUBB, PARSONS & COMPANY
WALKER GATE, NEWCASTLE UPON TYNE 6

PROPRIETORS: C. A. PARSONS & COMPANY LIMITED

S T L

Hermetically sealed transformers for tropical conditions

STL TRANSFORMERS
incorporate sound design and are manufactured to the highest standards called for in the electronic and communication fields. Consult us for your next transformer requirements.

STEWART TRANSFORMERS Ltd.
75 KILBURN LANE, LONDON, W.10 · LADbroke 2967

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RADIO SERVICING

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T/V TECHNOLOGY & ADVANCED SHORT-WAVE RADIO & RADIO ENGINEERING & RADIO SERVICE ENGINEERING & RADAR & BASIC ELECTRONICS FREQUENCY MODULATION.

I.C.S. will also coach you for the following examinations—
B.I.R.E.; P.M.G. Certificate for Wireless Operators; Radio Servicing Certificate (R.T.E.B.); C. & G. Telecommunications, etc., etc.

DON'T DELAY—SEND COUPON TODAY for free descriptive booklet, stating which subject or examination interests you. Fees include all books needed. Examination students coached until successful.

Reduced terms for H.M. Forces.
Dept. 223D, I.C.S., 71 Kingsway, W.C.2.

INTERNATIONAL CORRESPONDENCE SCHOOLS.

Please send Booklet on subject
Name.......................... Age..........................
(Block letters, please)
Address..........................

ICS
### WESTALITE RECTIFIERS TYPE 4

**VOLTAGE RATINGS**

<table>
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<tr>
<th>Circuit</th>
<th>Half-wave, Voltage, Average maximum</th>
<th>Half-wave, Voltage, Average minimum</th>
<th>Half-wave, Voltage, Maximum</th>
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<td>91 volts</td>
<td>91 volts</td>
<td>91 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>93 volts</td>
<td>93 volts</td>
<td>93 volts</td>
<td>93 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>95 volts</td>
<td>95 volts</td>
<td>95 volts</td>
<td>95 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>97 volts</td>
<td>97 volts</td>
<td>97 volts</td>
<td>97 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>99 volts</td>
<td>99 volts</td>
<td>99 volts</td>
<td>99 volts</td>
</tr>
</tbody>
</table>

**DISTANCE BETWEEN TERMINALS**

<table>
<thead>
<tr>
<th>Type</th>
<th>Distance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 14</td>
<td>25, 50, 75, 100</td>
</tr>
<tr>
<td>Type 14C</td>
<td>25, 50, 75, 100</td>
</tr>
<tr>
<td>Type 14B</td>
<td>25, 50, 75, 100</td>
</tr>
<tr>
<td>Type 14A</td>
<td>25, 50, 75, 100</td>
</tr>
</tbody>
</table>

### WESTALITE RECTIFIERS TYPE 14

**VOLTAGE RATINGS**

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Half-wave, Voltage, Average maximum</th>
<th>Half-wave, Voltage, Average minimum</th>
<th>Half-wave, Voltage, Maximum</th>
<th>Half-wave, Voltage, Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>10 volts</td>
<td>10 volts</td>
<td>10 volts</td>
<td>10 volts</td>
</tr>
<tr>
<td>K.V.R.</td>
<td>11 volts</td>
<td>11 volts</td>
<td>11 volts</td>
<td>11 volts</td>
</tr>
<tr>
<td>T.V.</td>
<td>12 volts</td>
<td>12 volts</td>
<td>12 volts</td>
<td>12 volts</td>
</tr>
<tr>
<td>Max. Output</td>
<td>13 volts</td>
<td>13 volts</td>
<td>13 volts</td>
<td>13 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>13 volts</td>
<td>13 volts</td>
<td>13 volts</td>
<td>13 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>15 volts</td>
<td>15 volts</td>
<td>15 volts</td>
<td>15 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>17 volts</td>
<td>17 volts</td>
<td>17 volts</td>
<td>17 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>19 volts</td>
<td>19 volts</td>
<td>19 volts</td>
<td>19 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>21 volts</td>
<td>21 volts</td>
<td>21 volts</td>
<td>21 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>23 volts</td>
<td>23 volts</td>
<td>23 volts</td>
<td>23 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>25 volts</td>
<td>25 volts</td>
<td>25 volts</td>
<td>25 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>27 volts</td>
<td>27 volts</td>
<td>27 volts</td>
<td>27 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>29 volts</td>
<td>29 volts</td>
<td>29 volts</td>
<td>29 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>31 volts</td>
<td>31 volts</td>
<td>31 volts</td>
<td>31 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>33 volts</td>
<td>33 volts</td>
<td>33 volts</td>
<td>33 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>35 volts</td>
<td>35 volts</td>
<td>35 volts</td>
<td>35 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>37 volts</td>
<td>37 volts</td>
<td>37 volts</td>
<td>37 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>39 volts</td>
<td>39 volts</td>
<td>39 volts</td>
<td>39 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>41 volts</td>
<td>41 volts</td>
<td>41 volts</td>
<td>41 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>43 volts</td>
<td>43 volts</td>
<td>43 volts</td>
<td>43 volts</td>
</tr>
<tr>
<td>D.C.</td>
<td>45 volts</td>
<td>45 volts</td>
<td>45 volts</td>
<td>45 volts</td>
</tr>
</tbody>
</table>

See us on Stand 101 at the RADIO SHOW, or write, stating requirements, direct to:

**W. W. 8, WESTINGHOUSE BRAKE & SIGNAL CO. LTD.,
82 York Way, King's Cross, London, N.I. TERMINUS 6432**
9 Octave realism

The G.E.C. metal cone loudspeaker gives lifelike reproduction of any type of sound over a range of 9 octaves. This includes the whole musical fundamental range with overtones. This gives the true tonal quality and character that all music lovers demand.

from a single unit

Sound engineers will appreciate the simplification—and the improvement in performance—which has been achieved by combining these qualities in a single unit—*smooth response over a range of 9 octaves with extremely good low frequency response . . . *negligible inter-modulation . . . *unequalled transient response due to special coil and cone construction.

for only £8.15.0

This is a professional instrument but its remarkably low price makes it particularly valuable to the home constructor. It must be used under the correct conditions to obtain optimum results. Cabinets have been specially designed for use with this speaker. Home constructors are invited to write for details.

G.E.C.

Metal Cone Loudspeaker

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This book gives details of how to modernise this popular Amplifier. Stage by stage wiring instructions are included for the improved '912', and there are many additional valuable features. By purchasing this book, you can read how to bring up-to-date your existing Osram '912' or obtain full details for constructing this versatile and remarkable Amplifier for High Quality Sound Reproduction. It costs 4s. 0d. from your dealer or by post 3d. extra from Osram Valve & Electronics Dept.
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All mouldings will accept \( \frac{3}{8} \) in. spindle.

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Telephone: CROYdon 3379, 6390, 6770.

TYPE “A”
1\( \frac{1}{8} \) in. dia. x \( \frac{3}{16} \) in. deep. Large ribbed knob in walnut, ivory or black, 4 B.A. grub screw and locknut fixing. Can be engraved to suit your requirements.

TYPE “B”
1\( \frac{1}{8} \) in. dia. x \( \frac{1}{16} \) in. deep. Small ribbed knob in walnut, ivory or black, 4 B.A. grub screw and locknut fixing. A gold engraving for every purpose.

TYPE 324
1\( \frac{1}{8} \) in. dia. x \( \frac{1}{8} \) in. deep. Medium-sized fluted knob in black or white. Brass insert and one 4 B.A. grub screw for fixing.

TYPE X5/P.1325
1\( \frac{1}{8} \) in. dia. x \( \frac{1}{8} \) in. deep. Black fluted instrument knob with brass insert. Fixing: two 2 B.A. grub screws.

TYPE X9/P.1375
1\( \frac{1}{8} \) in. dia. x \( \frac{1}{8} \) in. deep. Identical to Type X5/P.1325. Ideal for test apparatus, etc.

TYPE 1322/17
Top: 1\( \frac{1}{8} \) in. dia. Flanged instrument knob with white pointer. Brass insert. Fixing: grub screws.

TYPE P.1322/X11
Top: 1\( \frac{1}{8} \) in. dia. Base 2\( \frac{1}{8} \) in. dia. Large ribbed knob in walnut, ivory or black. 4 B.A. grub screw and locknut fixing. A gold engraving for every purpose.

TYPE 15/P.1325
1\( \frac{1}{8} \) in. dia. Black fluted instrument knob with brass insert. Fixing: two 2 B.A. grub screws.

TYPE 327
1\( \frac{1}{8} \) in. long, \( \frac{1}{8} \) in. wide, \( \frac{3}{16} \) in. deep. Useful pointer control knob in black with white nose marking. Fixing: grub screw and locknut.

TYPE D.2265
1\( \frac{1}{8} \) in. long, \( \frac{1}{8} \) in. wide, \( \frac{3}{16} \) in. deep. A particularly attractive cream pointer knob with black nose marking. Positive fixing by means of one 4 B.A. grub screw.

TYPE 5060
1\( \frac{1}{8} \) in. long, \( \frac{1}{8} \) in. wide, \( \frac{1}{8} \) in. deep. Useful pointer control knob with black with white nose marking. Fixing: grub screw and locknut.

TYPE 324
1\( \frac{1}{8} \) in. long, \( \frac{1}{8} \) in. wide, \( \frac{1}{8} \) in. deep. Popular instrument knob in black or white with suitable nose marking. Moulded with brass insert. Fixing one 4 B.A. grub screw.

FREE PANEL INSTRUMENTS

INSTRUMENTS manufactured by WEIR ELECTRICAL INSTRUMENTS CO. LTD.
BRADFORD-ON-AVON · WILTSHIRE

2\( \frac{1}{8} \) in., 2\( \frac{1}{8} \) in. and 3\( \frac{1}{8} \) in. enclosed in cases of black moulded insulating material and provided with scales printed in black on matt white enamelled metal dials.

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BRADFORD-ON-AVON · WILTSHIRE
TELEPHONE 1379

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TRIANON ELECTRIC LTD.
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WILLESDEN, LONDON, N.W.10
TELEPHONE: WILLESDEN 2 1 6

(Sole Agents for Great Britain)

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TELEPHONE 1379

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Instruments manufactured in Moving Coil and rectifier types to B.S. 89-1954.

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Available as Ammeters, Voltmeters, Milliammeters and Microammeters.
Are you searching

FOR HIGH QUALITY

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Make contact with Ardente Acoustic Laboratories Limited, for details of high-quality Miniature Earphones, Transformers, Switches, Volume Controls, Plugs and Sockets; also of the widely-known ARDENTE Hearing Aids.

Sub-Miniature Transformer

Size: 0.15 x 0.25 x 0.30

Of robust construction; its unique design of laminations enables Transformer characteristics to be closely controlled, despite its small size. Weight: 0.12 ozs. Lead-out wires are colour coded for phase sense of windings applications.

Specially designed apparatus, capable of detecting one short-circuited turn of 50 SWG in 5,000 turns, is used in manufacture to safeguard against premature failure caused by electrolytic action on the fine wire at short-circuited points.

A comprehensive range is available. A typical example is a Transformer with primary inductance of 100 Henries with no D.C. in the winding. The graph shows variation of primary inductance with D.C. in a similar unit.

Special designs of Transformers are produced to meet individual requirements.

The Miniature Earphone

to be featured in a later advertisement.

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Springfield Works, Horn Lane, Acton, London W.3
Telephone: ACOm 4161-1282

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Cash Price £28/7/-, or sent for £4/10/- Deposit and 18 monthly payments of 30/-, carr. and crate free.

LEAK TL/10 AND VARISLOPE MK. II PRE-AMPLIFIER.
Cash Price £34/13/- or sent for £6 Deposit and 18 monthly payments of 35/-, carr. and crate free.

LEAK DYNAMIC PICK-UP
Complete with two detachable diamond heads and transformer. Cash Price £20/19/9 or sent for £3 Deposit and 10 monthly payments of 40/-, Post and packing paid.
Delivery of all the above is from stock. We can also supply Wharfedale, Goodmans and Tannoy loudspeakers, etc., Connoisseur Variable 3-speed Motors and all other Quality Equipment on EASY TERMS. Please let us have your requirements.

14 DAYS FREE TRIAL

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will convince you

that it really does shave quicker and smoother than any other method. The extra long shaving heads are slightly arched to fit easily into those hard-to-shave spots.

SEND DEPOSIT OF ONLY 5/- FOR IMMEDIATE DELIVERY

Brand new. Sent post paid in silk lined presentation case.

\* WE WILL ALLOW YOU FOR YOUR OLD ELECTRIC SHAVER if you decide to keep the REMINGTON after trial.

SEND FOR FREE BROCHURE

The L.R. SUPPLY Co. Ltd.
BALCOMBE : SUSSEX
Phone 254
McMURDO STANDARD CONNECTORS

Line-to-line, line-to-chassis or inter-chassis connectors. Adequate contact "float" allows for slight mis-alignment of male or female units. Sockets fitted with McMurdno No. 9 Octal valveholder contacts which have proved their reliability on many jobs. Low contact resistance with reasonable insertion and withdrawal forces. Life tests prove that low contact resistance persists through more than 5,000 insertions. AVAILABLE in 8, 12, 18 and 25 WAY ALSO COVERS WITH TOP SIDE OR END CABLE ENTRY.

For full details apply to:
THE McMURDO INSTRUMENT COMPANY LTD - VICTORIA WORKS - ASHTED - SURREY.
Tel.: ASHTED 3401

MODEL "S" FOR STRIP WINDING
ALSO MANUFACTURERS OF
AUTOMATIC AND HAND COIL WINDING MACHINES
ETA TOOL CO. (LEICESTER) LTD.
29A WELFORD ROAD, LEICESTER
Phone: 5366

VHF/FM BROADCAST RECEIVER
TYPE CB4

Constructed to VHF standards throughout. Covers the band 2 with RF, Mixer, 2-IF, and ratio detector stages. Provision is made for single or push pull output, or added Short Waveband. Although "hand built" in small quantities, an attractive price is maintained.

Model "A," FM tuner. A popular and small unit, with good sensitivity. These are in use from Bognor to Ely, and little changed since first described by Amos and Johnstone in the "Wireless World." New "hammer" finish front plate and tuning scale carries a magic eye; this and power unit are optional.

Our new Linear Amplifier is condensed to only 12 x 5in. plan with symmetrical front layout. Linear Hi-Fidelity Amplifier £14 10 0.

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB4 FM/MW feeder unit, mains driven</td>
<td>£21 0 0</td>
</tr>
<tr>
<td>CB4/2, with push pull output</td>
<td>£21 0 0</td>
</tr>
<tr>
<td>&quot;A&quot; basic tuner</td>
<td>£14 17 6</td>
</tr>
<tr>
<td>&quot;A&quot; tuning scale, magic eye</td>
<td>£2 0 0</td>
</tr>
<tr>
<td>&quot;A&quot; power unit</td>
<td>£3 0 0</td>
</tr>
</tbody>
</table>

Welcome to MARLBOROUGH YARD, N.19, evening demonstrations also arranged

BEL SOUND PRODUCTS CO. ARC 5078
A page to remember — WOOLLEYS
UNUSED RADIO & COMPONENT BARGAINS

We are offering **AS NEW, COMPLETE TR.1196 TRANSCEIVERS**, as illustrated. Outfit comprises, 6 valve Superhet, 3 Valve Transmitter, Power Unit and Relay Unit. All complete on Chassis. Present range 4-6.5 mc/s, and output 2 watts. Can be easily converted to cover 1.5 mc/s.-7 mc/s and power output up to 8 watts. It has a most versatile Receiver which can be easily adapted to cover any band of frequencies from medium broadcast to 30 mc/s. The Transmitter range can also be easily extended and by simply adding 200 pf. condenser to tank circuit will cover 1.5 mc/s. Circuit and conversion details included with each unit.

Each outfit is despatched in transit case at the amazingly low price of £3/- plus carriage 10/-.

And why not build up the complete mobile outfit, ideal for ship to shore work and convert to 1.5 mc/s to 4 mc/s.

Illustration shows converted equipment already in use and passed by P.M.G.

REMEMBER!! 9 Standard Valves, 2 Standard 460 Kc. IF's, 3 relays, a motor generator and a host of useful equipment and for breaking up we have a few with soiled cases but otherwise perfect and complete at £2 each, plus carriage 8/6.

**BRAND NEW POTS**
- POTS, 100K, ½ spindle ea. 1/-
- POTS, 1 meg., ½ spindle ea. 1/-
- POTS, 3 gang each, 70K ea. 1/-
- HUNDINGER POTS, 100 ohm. Miniature wire wound ea. 2/-
- POTS, COLVERN, 200 ohms 5 watts. Wire wound, N.P. case ea. 2/-
- 100K MINIATURE POTS ea. 1/-

**RESISTORS**
- ERIE Resistors, 47K, 2-watt, boxed in 50's and 5's. Also 150K, 70K, 1-watt. Price: 2 w., 3d. ea. 1 w., 2d. ea.
- Wire Wound Vitreous 10-watt, wire ends 500 Ω, 9d. ea.
- Voltage Regulators 110/30 ma. 4 pin base. Two in series for 230 volts. 3/6 ea.

**SLEEving**
- We are able to offer for immediate delivery Sleeveing in various grades, such as Permanoid, Micoflex Plastic and Tenaplas Silk covered. Prices are 20% below present trade.
- SLEEving various colours, 1 mm. and 1.5 mm. Permanoid, in coils of approx. 144 yds. 8/6 per coil.
- TENAPLAS SLEEPING silk covered in 1 gross reels 1.5 mm. 15/- per gross yds.
- MICOFLEX, Plastic, In 3 gross reels 1.5 mm. 13/- per gross yds.
- PERIBRAID Sleeveing 1.5 mm. 1,000 yd. reels 15/- per gross yds.
- SLEEving in 3 ft. lengths x 18 mm. dia. 6d. per length.
- SLEEving in 3 ft. lengths x 20 mm. dia. 9d. per length.

**ELECTRO-VOICE MOVING COIL MICROPHONES**
No. 600 C, with built in matching transformer for direct connection to grid of amplifier valve. These mikes are ex the famous BC.610 transmitter and have an excellent overall frequency response, they are all brand new with 9 ft. screen lead and 3 pin plug, packed in original carton. Price £2 plus 1/6 postage and packing.

**MISCELLANEOUS NEW ITEMS**
- Ferranti mc. meters boxed 0-5 m/a. flush square 2". 9/- ea.
- Valve Holders UX5 Amphenol. 5/- doz.
- Valve Holders B9 Paxolin. 4/- doz.
- Valve Holders Jumbo Giant UX boxed. 2/6 ea.
- Zenith 50 w. Bleeders 500 Ω. 2/- ea.

All above items postage extra.

Foreign orders, please verify correct amount from U.K. to destination.

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Phone: VIC 2078
**TELEVISION DOWN LEADS**

K 16 M 'Local' 50-ohm co-axial;
   attenuation 4.8 dB/100 ft. at 45 Mc/s.

K 19 M 'Local' 75-ohm co-axial;
   attenuation 3.7 dB/100 ft. at 45 Mc/s.

AS 93 M 'Fringe' area 50-ohm co-axial;
   1.7 dB/100 ft. at 45 Mc/s.

AS 60 M 'Fringe' area 75-ohm co-axial;
   1.5 dB/100 ft. at 45 Mc/s.

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Telephone: LONdon Wall 7104
Enquiries to: TELCON WORKS, GREENWICH, S E 10 Telephone: GREenwich 3291

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POST OFFICE TYPE
MAGNETIC RELAYS
3,000 and 600

H.M. GOVERNMENT AND LEADING MANUFACTURERS

COILS up to 80,000 ft.
CONTACTS up to 8 amps.
INSULATION up to 5 kV.

Specialists in Tropicalisation and inter Services Jungle Finish
Conforming to A.I.D. and C.I.E.M.E. standards

PROTOTYPE Relays made to specification.
POST OFFICE TYPE KEYS supplied to specification.
Speedy Deliveries—Enquiries Invited

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Autophoenix No. 6
A new and improved treadle operated machine for the automatic insertion and closing of eyelets in either flat or formed work in metals, plastics, fabrics, etc. The deep throat, high vertical gap and projecting base make this machine adaptable for eyeletting radio chassis, cylindrical shells, spinnings, mouldings, etc.

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Engineering, Marine & Welding Exhibition
SEPT. 1st — SEPT. 15th

**HUNTON LIMITED**

Phonix Works, 114-116, Euston Road, London, N.W.1
Tel.: EUscon 1477 (3 lines).
Emitape is used by the great recording companies - "His Master's Voice", Columbia and Parlophone - and by the world's leading broadcasting organisations, because of its fidelity, sensitivity and length of life. This easy-to-use tape is also being increasingly employed in laboratories, factories and domestically — in fact, wherever true-to-life recording is required. It is made in a variety of spool lengths wound on plastic or aluminium spools to meet the requirements of professional and domestic recorders with differing hubs.

**Special Features**
- High Sensitivity
- High Tensile Strength
- P.V.C. Base
- Anti-Static
- Freedom from Curl
- Editing Leader and Trailer Strips

**Tape Accessories**
- 7" Empty Plastic Spool in Carton AP.87 5/-
- 5" Empty Plastic Spool in Carton AP.85 4/-
- 3" Empty Plastic Spool in Carton AP.93 3/-

- Non-Magnetic Scissors AP.39 Price 16/-
- Magnetic Tape Jointing Block AP.46 Price 8/-
- P.V.C. Tape Jointing Compound AP.77 Price 4/6
- Gummed Jointing Tape AP.37 Price 6/-
- White P.V.C. Editing Tape 150 ft. Roll AP.38 Price 4/6

**Visit Stand 215 at the Radio Show, Earls Court**

Used by the leading Broadcasting Organisations and for recording the world's greatest artists on "His Master's Voice", Columbia and Parlophone Records.

Full particulars of Emitape and editing accessories together with literature are obtainable at your local dealer or from:

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Export Enquiries for products mentioned in this advertisement should be addressed to:

E.M.I. International Ltd. (also at Hayes).
The International Aeradio VHF short range radio teleprinter terminal is designed to combine the highest engineering standard with low initial cost. This equipment is especially valuable where landline facilities are unreliable or not available, as may happen between a town and its airport.

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AUTOMATIC COIL WINDING MACHINE

This machine is the most modern on the market and it possesses many exclusive refinements including:

- Dustproof construction throughout
- Provision for winding up to four coils simultaneously.
- Micrometer traverse setting.
- Wire Gauge Indicator engraved with various wire gauges to which the machine can quickly be set.
- All steel parts are either cadmium or chromium plated.
- Instantaneous re-set counter reading up to 100,000 Turns.
- Entirely new Wire Tensioning Stand to hold two reels of wire.

We will be pleased to send you an illustrated leaflet giving a full technical specification on request.

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Ealing 8322

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Valradio tuners cover all 13 British Channels, and have been specially developed for incorporating into new T.V. receivers, or for tuning standard receivers to Band III. Available for AC sets using 6·3 parallel connected valves, and AC/DC with 3 series connected valves. Price £6.0.0

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A range of other detection units are available to suit every type of vacuum system. The instrument is capable of detecting leaks of the order of 10^-4 litre microns/second.

EDWARDS HIGH VACUUM LTD.
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CRAWLEY 1500 (10 lines) EDCOMVAC CRAWLEY

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SEPTEMBER 1955

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FULLY REBUILT
TYPE 804
ULTRA HIGH FREQUENCY SIGNAL GENERATORS
Range: 75 to 330 Mc/s (in five bands) Calibrated Capacitive Attenuator
Output: 1 µV to 20 mV Output Impedance 75 ohms
Internal Modulation with modulation depth meter
Power Supplies: 115/230 V. A.C.
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22-RANGE
UNIVERSAL METERS
of well-known Canadian make.
Sensitivity 400 ohms per Volt.
AC/DC Volts: 5-25-100-500-1,500 or 3,000
DC Amps: 2.5-5-25-100-500 mA
Single Resistance Range
Dimensions: 5½in. x 5½in. x 5½in.
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AMERICAN UNIVERSAL METERS
Type ME-98/U (TS-352/U), manufactured by Phanatron Co of U.S.A. Sensitivity 1,000 and 20,000 ohms per Volt.
AC/DC Volts: 2.5-10-50-250-500-1,000 Volts; built-in multiplier extending the range to 5,000 Volts.
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Resistance Ranges: direct, x10, x100, x1,000, x10,000.
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VACUUM CONDENSDORS, 50µF, 32,000 Volts.
Brand New. Price, post free £17 6 0

The new edition of our Catalogue of Test Equipment is now ready.

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UNIVERSAL ELECTRONICS
OFFERS A COMPREHENSIVE RANGE OF QUALITY EQUIPMENT
which, whether new or used, is guaranteed to be in perfect condition.

RECEIVERS
All receivers are in good working order and condition unless stated.
Output 100 mV. Power Supplies 115 V. A.C.

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For RECEIvers AR88D-LF, AR77E, R107, Marconi CR100, S2OR, SX24, SX28, etc.
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BRITISH TEST EQUIPMENT
AVO model 7, as NEW, £15. Avo 40, £12/10/-.
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SERVICE AND REALIGNMENT
of all British and U.S.A. types
COMMUNICATIONS RECEIVERS
to makers' specifications AT LOW COST

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FULLY REBUILT
TYPE 804
ULTRA HIGH FREQUENCY SIGNAL GENERATORS
Range: 7.5 to 330 Mc/s (in five bands) Calibrated Capacitive Attenuator
Output: 1 µV to 20 mV Output Impedance 75 ohms
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Power Supplies: 115/230 V. A.C.
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U.S.A. MICROWAVE TEST GEAR
No technical manuals equivalent. Write for prices.
GENERAL RADIO 804B. 30-300 Mc/s. signal generator, £70. All laboratory equipment may be inspected by appointment.

U.S.A. FREQUENCY METERS
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125 kHz-30 Mc/s. Complete with calibration charts. Available from stock. CONDITION PERFECT.

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Hallicrafters S27, S27CA, SX28, etc. R.CA AR88, R1359 and R1294 VHF receivers.
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HI-FI SPEAKERS
The fullest range of W/B, Stentorian, Wharfdale, G.E.C., Goodmans, Baker, etc., all sizes, 3-15 ohms. We have the one to suit your purpose and pocket.

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A very large and comprehensive range. A few examples:
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“TWEETERS” Electrostatic H.F. Speakers for use with amplifiers or sets. Supplied with full data and circuit diagrams.
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12 CHANNEL T.V. TUNER
- 10.7 m/cs I.F. Trans., US376, 7½ each.
- TA.350. 6-button Coil Pack for long, med. and short waves, gram and off, together with a F.M. position which incorporates switching for change over from A.M. to F.M. Designed for use with UT.340 or UT.341. 95/-.

LATEST DESIGN
CONTINENTAL F.M. COMPONENTS
- UT.341. As above but with baseplate and 2- gang condenser incorporating 1.3 reduction drive. Supplied pre-aligned 98/5.

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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 circuits diagram, wiring instructions and component lists. 5/6 post free.

FAMOUS MAKE 3-SPD. AUTO CHANGERS
LATEST 1955 MODEL, NEW & UNUSED
Takes 10 records of all sizes (mixed) in one loading. HGP 37 crystal turnover-pick up. Handsome enamelled finish. Supplied complete in maker’s carton.

FAMOUS MANUFACTURER’S SURPLUS.
6 valve 3-wave Superhet, 13-50 m. short, 200-550 m. medium, 1,000-2,000 m. long. Brand new Mullard valves; ECH42, EF41, L63, BE41, 6V6 g.t., EZ40, and finest quality components. Gram switch, 465 Kc/s I.F. tone control, 3-colour dial. Overall size: 25 x 25 x 11½. Aperture required for dial and controls 11 x 3½. Complete with valves, output trans., knobs etc.

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6-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES
Famous Manufacturer’s Surplus.
6 valve 3-wave Superhet, 13-50 m. short, 200-550 m. medium, 1,000-2,000 m. long. Brand new Mullard valves; ECH42, EF41, L63, BE41, 6V6 g.t., EZ40, and finest quality components. Gram switch, 465 Kc/s I.F. tone control, 3-colour dial. Overall size: 25 x 25 x 11½. Aperture required for dial and controls 11 x 3½. Complete with valves, output trans., knobs etc.

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THIS TRF 3-VALVE BUILT FOR £10.0

RECEIVER CAN BE
(Carr. & Pkg. 2/6 extra)

Latest type circuit for 200/250 A.C. Mains, medium and long wave. Uses 6H7C, 6L7, 6H6, and Metal Rectifiers. Handsome Plastic Cabinet, 12 x 14 x 5½ in. deep, Walnut or Ivory finish. If preferred a Wood Cabinet is available (see lower blue). FULL DATA, wiring and circuit diagrams and price list of components, 1/- post free. CABINET only, plastic or wood 17/6. Carr. & Pkg. 2/6 extra.

THIS 4-VALVE, 3-WAVE SUPERHET CAN BE BUILT FOR £7.19.6 (Carr. & Pkg. 2/6 extra)

Very efficient Superhet Circuit for 200/250 A.C. Mains, long, medium and short wavebands. Uses 6K8 free, changer, 6K7 I.F. amp., 607 det. A.V.C., AF-amp., and 6V6 output valves. Wood cabinet, Walnut veneer, 12 x 6½ x 5½ in. deep, Walnut or Ivory finish. If preferred a Wood Cabinet is available (see lower blue). FULL DATA, wiring and circuit diagrams and price list of components, 1/- post free. CABINET only, plastic or wood 17/6. Carr. & Pkg. 2/6 extra.

ALUMINIUM CHASSIS
18 S.W.G., undrilled. 4 sides, reinforced corners. Depth 2½ in. 6 x 4½, 12 x 8½, 16 x 10 8/3, 8 x 6 ½, 14 x 9 7/6, 12 x 3 4/9, 10 x 7 6/6, 16 x 9 8½, 12 x 6 6/6 Post 1/- per chassis extra.

DRILLED CHASSIS AND DIAL ASSEMBLY
Size 13¾ x 7 x 2¼ in., drilled for five latest type miniature valves mains trans., I.F., etc. Dial 13 x 14 in., for horizontal or vertical mounting. Spin wheel tuning. All pullies and spindle supplied. POST 3/-

DULCI RADIO CHASSIS, full range 3 & 6 wave, 8½/19/6 to 21 gns. Also DULCI AM/FM CHASSIS, FM FEEDER UNIT, BAND III CONVERTER.

COMPLETE 5-VALVE RADIO CHASSIS
Brand new and unused. A.C./D.C. 200/250 volts. P.P. 45½ l/s. A.V.C.—4 watts output—3 station pre-set—frame serial—fully aligned—chassis 10 x 5½ in.—max. height 5½ in. Completely wired and ready for use, with the addition of a speaker and output transformer. Two controls—volume and station switch. Valves used: 100C1, 10F9 or UF41, 10LD11, 10P14, U404 or LV41.

LASKY’S PRICE 69/6

HIRE PURCHASE TERMS ON CERTAIN ITEMS
Please give details of your requirements.

FAMOUS AMPLIFIERS BUILT ON T.C.C. PRINTED CIRCUITS

The latest advance in Amplifier design. We can now supply from stock two famous Amplifiers, the Osram 912 and Mullard 5/10, built on the new printed circuit technique. All specified components, T.C.C. condensers, Lab. resistors, etc., are used and you have your choice of transformers and chokes by Patricios, Haddon, W/B or Elsson. Demonstrations given any time.

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The MULLARD 5/10 Amplifier, built on printed circuit, supplied fully assembled, complete with valves, ready for use. Prices from 19 gns. depending on make of transformer used.

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All Components for either Amplifier supplied separately, for printed circuit or conventional construction. Price Lists on request.

LASKY’S 4-WATT A.C. AMPLIFIER KIT
Uses 1 each 6SL7, 6V6, 5Z4. All components, chassis, valves, output trans., mains trans., £45/-. Carriage and packing 2½.

INSTRUCTION BOOK and shopping list, 1/- post free.

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**THE LATEST BRENNEL TAPE EQUIPMENT**

The DECK, 3-speed, 3 in. diam. Any number may be fitted together. Per doz. 2/6 post free.

The AMPLIFIER, 4 watts, for use with 3 ohms speakers. Magic eye, high fidelity. 16 1/2 Gns.

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Write for details.

**SPECIAL OFFER OF TAPE DECK CASES**

As illustrated. Will take Truvox Tape Deck with space for amplifier, radio feeder unit and speaker. Overall dim. with lid closed, 19 x 14 x 13 in.

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Latest model Mk. III NU twin track, 2-speed, 3 motors, press button control. £23/2/-

**SPECIAL COMBINED OFFER**

The above Tape Deck Case together with the above Truvox Tape Deck

£24/10

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Mk. VI, 2-speed, 7 in. diam. per sec. 3 high grade motors. Takes standard reel to 1200 ft. capacity. £18/10/-

LATEST GRUNDIG TAPE RECORDER in Stock.

Price 45 Gns.

**RECORDING TAPE**

Craft base, length 1,200 ft. Cyldon metal spoons. 12/11/.

All makes of Tape stocked.

£13/5/-

**PORTABLE CASES**

Solidly made of laminated wood, inside dim. 19 x 14 x 13 in. deep. Originally made for portable radio gram, with space (14 x 5 x 8 in.) for radio or amplifier and speaker. Motor board size 14 x 12 in. Takes any standard size gram unit. Resine type finish in various colours. Fitted handle and locks, 2 keys supplied.

LASKY'S PRICE 25/-

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**COLLARO 3-SPD. RECORD PLAYING UNIT**

3-speed, auto and hand change. All types in stock—Garrard, Collaro, B.S.R., etc. £18/10/6.

**SPEAKER FRET**

Large selection of materials for frets—plastic, tygan, cloth, expanded metal.

**OVER 50,000 VALVES**

Our valve stock is one of the largest in England. All makes and types, B.V.A. and ex-Govt.

**SPECIAL PURCHASE BUREAU RADIO-GRAM CABINETS**

Handmade design, solidly constructed, beautiful Walnut veneer finish, with generous record storage space. Further details and illustration on request. LASKY'S PRICE 14 gns. Carr. 17/6. Available on H.P. Terms.

**SPEAKER CABINETS**

Design for use with the G.E.C. metal cone Speaker. Exactly per specification £12/10/-

Carr. 6/6

**MINIATURE CRYSTAL DIODES**

Glass type, wire ends, each 1/6

GEX. 45 and equivalent types, various makes, 3/6.

**TRANSISTORS AND GERMANIUM DIODES**

All types available.

**SAVING POUNDS! ORDER BY POST IF YOU CANNOT CALL**

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MULTI-TEST METERS
1,000 ohms per volt. Basic movement 400 microamp. 3in. A.C./D.C. 0-1 amp. If switched ranges: 100,000 ohms and 1 meg., also decibel range, in polished wood carrying case (6 x 6 1/4 x 4in.) closed with leather handle and space for test leads.
LASKY’S PRICE
95/- Post & ins. 3/6
TEST LEADS, 3/6 extra.

MAKERS’ SURPLUS TV COMPONENT BARGAINS
WIDE ANGLE 38 mm.
Line E.H.T. Trans., Ferro-cube, core 9-16V
25/-
Scanning Coils, low imp. line and frame
25/-
Frame Output Transformer
10/6
Scanning Coils low imp. line and frame
17/6
Frame or line blocking osc. Trans 4/6
Focus Magnets, Ferro-cube
25/-
P.M. Focus Magnets, Iron Core
19/6
Duomag Focalliser
29/6
Smoothing chokes 150 mA.
Electromagnetic focus coil with combined scan coils
25/-

STANDARD 35 mm.
Line Output Trans. No E.H.T. 12/6
19/6
Scanning Coils. Low imp. line and frame
12/6
Ditto by Igranic
14/6
Frame or line blocking osc. output transformer
4/6
Frame output transformer
7/6
Focus Magnets without Vernier
12/6
With Vernier
17/6
Focus Coils, Electro-magnetic
12/6
Focus Coils, Electro-magnetic
12/6
300 mA. smoothing chokes
10/6

C.R.T. MASKS
12in. rubber, complete with armour plate glass. Dustproof. Black, 7/6, White, 10/6.

12in. MOULDED IMPLOSION GUARDS, 7/6. Post extra.

R1155 RECEIVERS now available on Easy Terms. Ask for details.
5 Frequency 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., Supplied in maker’s original wood transit case.
LASKY’S PRICE
BRAND NEW £11 19 6
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Secondhand, Grade 2 £7 19 6
Carriage 176 extra, including 10/-, returnable on packing case.

ASSEMBLED POWER PACK-OUTPUT STAGE FOR R1155 RECEIVER
For use on 200-250 v. A.C. mains. Complete with Mullard valves. In metal case, 12 x 7 x 5 1/2in.

AERIALS of all types stocked, TV, Band III, F.M.
300 ohms FEEDER, per yard, 9d.
80 ohms Co-axial, doz. yards.
Co-axial Cable, air cored, yard 9d.
Any length supplied.

E.H.T. RECTIFIERS
3/6 8/2 8/8 14/8
Post extra.

LACKY’S RADIO
HIRE PURCHASE TERMS ON CERTAIN ITEMS
Please give details of your requirements.

VALUE IN MAGNIFICENT TV CABINETS
Complete with mask, glass, castors, shelf, bearers, C.R.T. neck end protector, back, speaker fret and haffle board. Finished in beautiful figured medium light or dark walnut veneer, with high polish. Suitable for most home constructor TV Receivers, including the "View-master", "Practical Television", "Tele-King", "Magnaview", "Wireless World", etc. Supplied with cut-out for 14in., 16in. and 17in. C.R. tubes at no extra cost.
An allowance of 10/6 will be made if the mask is not required.
Inside Dim.: Depth 16 1/2in., width 21in., Height 21 1/2in. Overall height: Width 18 1/2in.

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.
H.P. Terms. Deposit £21/7/- plus carriage. Balance plus charges spread over 12 months.

THE ROTHESAY
The last word in outstanding contemporary design. Absolutely rigid construction throughout with the finest laminated woods, veneered in walnut, polished walnut, medium or dark shade. Fitted with gold anodised speaker grille. The C.R.T. aperture frames are detachable, supplied to suit any size tube to order.
NOTICE THESE GENEROUS SIZES.
Outside dim.: 34in. high, 21in. wide, 21in. deep.
Inside dim.: 18in. wide, 19in. deep.
Size of top: 22 1/2 x 21in. Thickness 4in.
LASKY’S PRICE
Carriage 15/-extra.
H.P. Terms. Deposit £3/1/-plus carriage charge. Balance plus charges spread over 12 months.

THE ROTHESAY CABINET WITH FULL-LENGTH DOORS, fastened in both sides, polished to match the cabinet and mounted with full-length piano hinges. Price £14/9/6.

LIMITED NUMBER TALLON TV CABINETS
16-17in. aperture, pre-fabricated ready for home assembly. Solidly constructed of 4in. laminated wood. Walnut veneer finish, 18in. top. Suitable for the Tele-King, Wide-angle Viewmaster and other home constructor TV sets.
LASKY’S PRICE £8/10/0
CARTRIDGE 10/-.

ARMOURED PLATE GLASS
12in., actual size 15 x 10 x 1in. 3/6
14in., actual size 17 1/2 x 10 x 1in. 5/6
17in., actual size 17 x 15 x 1 1/2in. 7/6
Post extra.

SENTERC E.H.T. RECTIFIERS
8/2 8/8 14/8
Post extra.

L.V. RECTIFIERS
12v., all types in stock. 1amp., 1-wave, 3/6 2 amp., 4-wave 4/11. 4 amp., full wave, 15/- 6 amp., full wave, 21/- Post extra.

TWO ADDRESSES FOR PERSONAL CALLERS
Open all day Saturday.
(Off opposite Paddington Hospital)
THE "TELETRON" BAND III CON-
VERTER is a dual A.F. & F.M. band
converter, comprising 250-0-250 volt.

Carrying cases in black leatherette finish. Anodised alloy cases 30 x 8 x 10 inches in size. Only £2.95. Cabinet made from selected, carefully selected veneer and chrome plated parts. All made as a single unit by craftsmen. A.C. mains units kit for using our popular combo and receiver.}


Carrying cases in black leatherette finish. Anodised alloy cases 30 x 8 x 10 inches in size. Only £2.95. Cabinet made from selected, carefully selected veneer and chrome plated parts. All made as a single unit by craftsmen. A.C. mains units kit for using our popular combo and receiver.
SEPTEMBER, 1955

WIRELESS WORLD

142

R.S.C. TRANSFORMERS

SELENIUM RECTIFIERS
L.T. Types
2/6 v. a.h.w.

.. 1/9
6/12 v. a.h.w. .. 2/9
F.W. Bridge Types
6/12 v. 1 a.
.. 5/9
6/12 v. 2 a.
.. 8/9
..15/9
6/12 v. 4 a.

H.T. Type H.W.

3/11
5/9
7/9
9/9

120 v. 40 mA...
250 v. 50 mA...
250 v. 80 mA...
250 v. 150 mA.
RM4 250 v. 250

11/9

300 v. 275 mA. 12/11

CO -AXIAL CABLE 75 ohms tin., 7d. yard.

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

DIAL BULBS. M.E.S.. 8 v. 0.15 a., 6/9 doz. ;
6.5 v. 0.3 a.. 6/9 doz. ; 4 v. 0.3 a., 6/- doz.
ELECTROLYTICS (current production).
NOT ex -Govt.
Tubular Types
Can Types
SAF 450 v.
.. 1/9
16 mfd. 350 V. .. 1/11
8 mfd. 500 V. .. 2/6
16AF. 450 v. .. 2/9

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32 mfd. 500 V. ..
8-16AF 500 v. ..
25AF 25 v.
..
50AF 12 v.
..
50AF 50 v.
..
16AF 350 v.
16AF 450 v.
16µF 500 v.
32AF 350 v.

2/3
2/9
3/9
3/9
5/9

4/11
1/3
1/3
2/3
100 mfd. 12 v. .. 1/9

100 mfd. 25 V. .. 2/3
Can Types
8 mfd. 350 V. .. 1/3
8 mfd. 450 v. .. 2/3
16 mfd. 500 V. .. 3/9

24AF 350 v.
32AF 350 v.

..

2/11
2/11

32 mfd. 450 V. .. 4/9
64 mfd. 450 V. .. 3/11
100 mfd. 450 v... 4/9
8-8AF 450 v.

..

3/6

8-8 mfd. 500 v... 4/9
8-16AF 450 v.

FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED
MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.
FULLY SHROUDED UPRIGHT MOUNTING
250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a..
_ 17/6
Midget type, 21-3-3in.
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a... 19/9
250-0-250 v. 100 mA., 6.3 v.-64 v. 4 a., c.t.,
0-4-5 v. 3 a.
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a... 23/9
250-0-250 v. 100 mA., 6.3 v. 6 a.. 5 v. 3 a.,
_
31/for R1355 conversion
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a... 23/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a.. c.t.,
0.4-5 v. 3 a.
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.. 23/9
350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t.,
0-4-5 v. 3 a.
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a... 33/9
350-0.350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a.,
33/9
5 v. 3 a.
425-0.425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v.

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4 a., c.t., 5 v. 3 a., suitable Williamson

49/9
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Amplifier, etc.
450-0.450 v. 250 mA., 6.3 v..6 a., 6.3 v. 6 a.,
69/6
5 v. 3 a.

FILAMENT TRANSFORMERS
Primaries200-250 v. 50 c/s. 0-4-6.3 v. 2 a. .. 7/9
6.3 v. 1.5 a.
0-2-4-5-6.3 v. 4 a. 16/9
5/9
17/6
8/11
6.3 v. 6 a.
6.3 v. 3 a.
12 v. 1 a.
12 v. 3 a. or 24 v.
7/9
17/6
1.5 a...
6.3 v. 2 a.
7/6
CHARGER TRANSFORMERS
a a., 11/9; 0-9-15 v. 3 a., 0-3.5-9-17 v. 4 a., 18/9.
0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.
ELIMINATOlt TRANSFORMERS
Primaries 200-250 v. 50 c/s. 120 v. 40 mA. 7/11
.. 14/9
130 v. 50 mA., 6.3 v. 3 a. ..
1491/911
120 v. 40 mA., 5-0-5 v. 1 a.
90 v. 15 mA., 6-0-6 v., 250 mA.
OUTPUT TRANSFORMERS
Midget Battery Pentode 66:1 for 3S4. etc... 3/6
.. 3/9
Small Pentode, 5.00011 to 30
.. 4/9
Standard Pentode, 5,0000 to 30
4/9
Standard Pentode, 8,000 to 30
Battery Pentode, 10,000 ohms to 3 ohms.. 4/9
Multi -ratio 40 mA. 30:1, 45:1, 60:1, 90:1,
5/6

Class B Push -Pull

TOP SHROUDED DROP. -THROUGH TYPE Push -Pull 8 Watts 6V6 to 3 ohms ..
.. 13/9 Push -Pull 10-12 Watts 6V6 to 30 to 150, 8/9
250-0-250 v. 70 mA. 6.3 v. 2.5 a. ..
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a... 16/9
16/9
sectionally wound ..
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a... 18/9 Push -Pull 10.12 Watts to match 6V6 to
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a... 22/9
.. 16/9
3-5-8 or 150
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t.,
Push -Pull 15-18 Watt, sectionally wound,
0-4-5 v. 3 a.

.. 2/11 350-0-350 v. 100 mA. 6.3 v. 4 a.. c.t., 5 v.

23/9

.. 21/9
6L6, KT66, etc., to 3 or 15 ohms..
Push -Pull 20 Watt high -quality sectionally

. 22/9
16-16AF 450v... 4/11
wound, 606, KT66, etc.. to 3 or 150 .. 47/9
16-32AF 350 v... 4/9 350-0-350v. 100 mA., 6.3 v.-4 v. 4a.. c.t.,
SMOOTHING CHOKES
0-4-5
v.
3
a.
32-32AF 350 v... 4/9 350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a.,
.. 11/9
250 mA., 3 H.. 100 ohms ..
32-32AF 450v... 5/11
.
29/11 150 mA., 7-10 H., 250 ohms
.. 11/9
5 v. 3 a.
..
..
Many others in stock.
9/9
350-0-350 v. 150 mA... 6.3 v..4 a., 5 v. 3 a... 29/9 100 mA., 10 H., 150 ohms potted ..
8/9
100 mA., 10 H., 200 ohms ..
E.H.T. TRANSFORMERS. 2,500 v. 5 mA.,
VOLUME CONTROLS with long spindles, all
5/6
80 mA., 10 H.. 350 ohms ..
2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97,
.

values, less switch, 2/9 ; with S.P. switch, 3/9.

VCR5I7

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

37/6

THE SKY FOUR T.R.F. RECEIVER


..

.1 mfd. plus 1 mfd. 8,000 v.. large blocks

3/3

A design of a 3 -valve 200-250 v. A.C. Mains 400 v. C.T. 150 mA. 4 v. 5 a., 6.3 v. 6 a..
6.3 v. 0-6 a., 4 v. 6 a., 4 v. 6 a., 4 v. 3 a.,
4 v. 3 a.. 5 v. 2 a. ..
22/9

valves 6K7, SP61, 6F6G., and is specially designed 325-0-325 v. 150 mA., 6.3 v. 46 a.. 5 v. 2-3 a. 29/9

6-6 mfd. 450 v... 5/9

..

5/9
8-8 mfd. 500 v... 5/11
4 mfd. 1.500 v... 4/9
15 mfd. 500 V. .. 7/9
4 mfd. 400 v. plus 2 mfd. 250 v.
1/11

for simplicity in wiring. Sensitivity and quality
is well up to standard. Point-to-point wiring
diagrams, instructions and parts list, 2/-. This
receiver can be built for a maximum of 1411916
including cabinet. Available in brown or cream
bakelite, or veneered walnut.

EX GOVT. VALVES. VR137 lad.. EA50. EB34, P.M. SPEAKERS. All 2-3 ohms. frlin. R.A. 13/9.
6iin. Plessy with 5,000 ohm output transformer.
12816, 9d.
16/11. Sin. Rola Heavy Magnet, 19/9. 10in. Rola
EX GOV. UNITS, type RF26 in original sealed with Trans., 29/6,
cartons 39/6, Transmitter Receivers type TR9D
complete with all valves 45/-, Carr. 6/6.
BATTERY CHARGER KITS. For mains
CONTROL PANEL with 1 six -position 3 -wafer R.S.C.
To charge 6 v. accumuYaxley switch, 1 pointer knob, 2 S.P.S.T. switches, input 200-250 v. 50 c/s. lator
at 2 amps., 25/9.

various plugs and sockets. Only 1/6.

To charge 6 v. or 12 v.

battery at 2 a., 31/6.

M.E. SPEAKERS. All 2-3 ohms, 8in. R.A. field,

600 ohms, 11/9. 10in. R.A. field, 1,000 ohms. 23/9.

MANUFACTURERS SURPLUS
TRANSFORMERS
Sec. 425-0-425 v. 150 m.a. 6.3 v. 3 a. 5 v. 3 a.
37/9.

To charge 6 v. or 12 v.

battery at 4 a., 49/9.
ABOVE KITS CONSIST
OF GREEN CRACKLE
LOUVRED
STEEL
CASE. MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER,

FUSES. FUSE -HOLDERS AND CIRCUIT.
For normal 200/250 v. A.C. mains input. To Any type assembled and tested for 6/9 extra.
HEAVY DUTY BATTERY CHARGER

charge 12 v. battery. Variable charge rate of up
to 10 amps. Fitted Meter and Fuses. Guaranteed
12 months. Carr. 101-. 16/1916.

OIL FILLED BLOCK
CONDENSERS

1

9/9
7/9

with selenium rectifier. For inclusion in
_ 9/6 receiver
either of cabinets illustrated above. It employs
5/9

EX GOVT. METAL BLOCK PAPER
8 mfd. 500 v.

EX GOVT. MAINS TRANSFORMERS

16-18-20 v. 35 a. ..
79/6
7.7 v. C.T. 7 amps., 4 times
25/9
460 v. 200 mA., 6.3 v. 5 a.
.. 27/9
300-0-300 v. 150 mA., 610-0-610 v. 150 mA.,
1,200 v. 250 mA.
29/6

4/9

.5 mfd., 3,500 v. Cans ..

CONDENSERS
2 mfd. 800 v. .. 1/9
4 mfd. 500 v. .. 2/9
4 mfd. 1.000 v... 4/3

4/11

Carriage on following types 5/- extra.
0-11-22 v. 30 a.
..
.. 72/6

EX GOV. E.H.T. SMOOTHING

(common negative isolated)
1.5 mfd., 4,000 v. Blocks

..

..

All 230 v. 50 c/s. input. 48 v. 1 a.
8.8 v. 4 a. ..
..
978 v. 200 mA.

Preset type, 1/9 each.

CONDENSERS
.25 mfd., 4,000 v. Blocks
.5 mid., 2,500 v. Blocks

60 mA. 10 H.. 400 ohms

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

H.T. ELIMINATOR AND TRICKLE CHARGER

KIT with louvred crackle finished case. Mains
input 200-250 v. Output 120 V. 40 mA., and 2 V.
Or in working order, 37/6.

R.S.C. 6 v.

EX GOVT. AUTO TRANSFORMERS
15-10-5-0-195-215-235 v. 500 Watts
.. 27/9
Double wound 10-0-200-240 v. to 10-0-275295-315 v. 1.000 watts
..
69/6
Double wound 0-110-240 v. to 0-130-140.
150-160-170 v. 1,500 watts
.. 69/6
Carriage on any of above 5/- extra.

EX GOVT. SMOOTHING CHOKES
250 mA., 10 H., 50 ohms ..
250 mA., 10 H., 100 ohms ..
250 mA., 3 H., 50 ohms
..
150 mA., 10 H., 50 ohms ..
100 mA., 10 H.. 100 ohms, Tropicalised
100 mA., S H.. 100 ohms, Tropicalised
50 mA., 50 H., 1,000 ohms, Potted
90/100 mA., 10 H., 100 ohms, Potted
50 mA., 5-10 H.
L.T. type 1 amp.
..

SPECIAL OFFER
Potted Mains Transformer. (Ex New Equip.).
Primary 0.10-80.180-200-220-240 v.. 50 c/cs.
secs. 250-0-250 v. 60 mA., 6-3 v. 2a., 5. v. 2 a.
Size approximately 3# x 3 x 41in.

CHASSIS
or 12 v. BATTERY CHARGER 18 s.w.g, undrilled alu-

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

.

14/9
14/9
8/9
10/11
6/9
3/11
8/11
8/9
2/9
2/9

minium amplifier type
(4 -sided).

141n. x 10in. x 3in. 7/11
16in. x 10In. x 3in. 8/3
18 s.w.g. aluminium receiver type.

6in. X nin. x in. 1/11
7fin. x 41in. x 2in. 2/9
10in. X 51in. X 2in. 3/3
llin. X 61n. X 2frin. 3/11

..

10/11

s.w.g. aluminium
receiver type.
121n. x 8in. x 21in. 5/3
16in. x 8in. x 2/in. 7/6
20in. x 8in. x 21in. 8/11
16 s.w.g. aluminium
16

amplifier type. 4sided.
12in. X 8in. x 21in. 7/11
16in x Sin. x
10/11
201n. X 8in. x 211n.13/6
14in. X 10in. x 31n.13/6


Brand NEW R.S.C. BASS AND TREBLE CONTROL STAGES. Includes 7 valves, sectionally wound output transformer, block-paper reservoir condenser and other parts. Complete. 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. 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.

H.P. Terms on assembled units. Deposit 26/- and 12 monthly payments of £1. Plus carr. 10/-.

Terms to include cover, mike, speakers, etc., on request. Cover as illustrated if required, price 17/- extra.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER £3/19/6. Full descriptive leaflet 6d.

HIGH SENSITIVITY, HIGHEST QUALITY for 9 Gns. Or assembled ready for use 50/- extra. Full descriptive leaflet 6d.

H.P. Terms on assembled units. Deposit 126/- and 12 monthly payments of £1. Plus carr. 10/-.

Terms to include cover, mike, speakers, etc., on request. Cover as illustrated if required, price 17/- extra.

R.S.C. BASS AND TREBLE CONTROL STAGES. Includes 7 valves, sectionally wound output transformer, block-paper reservoir condenser and other parts. Complete. 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. 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.

H.P. Terms on assembled units. Deposit 26/- and 12 monthly payments of £1. Plus carr. 10/-.

Terms to include cover, mike, speakers, etc., on request. Cover as illustrated if required, price 17/- extra.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER £3/19/6. Full descriptive leaflet 6d.

HIGH SENSITIVITY, HIGHEST QUALITY for 9 Gns. Or assembled ready for use 50/- extra. Full descriptive leaflet 6d.

H.P. Terms on assembled units. Deposit 126/- and 12 monthly payments of £1. Plus carr. 10/-.

Terms to include cover, mike, speakers, etc., on request. Cover as illustrated if required, price 17/- extra.
STERNS DESIGN FOR HOME CONSTRUCTORS

The "SUPER-SIX" compact and highly efficient superhet Radio-Radiogram chassis of outstanding quality.

Y O U  C A N  B U I L D  I T  F O R  £ 2 1 0 / 7 / 6

Including the OCTAL VALVE LINE-UP

- Incorporating the new B.V.A. Miniature Valve Line-up. This receiver is designed to the very latest specification and provision is made to incorporate either the standard Octal Valve line-up or the new B.V.A. range of miniature valves.

Great attention has been paid to the quality of the reproduction of both Radio reception and Record playback, and excellent clarity of speech and music is obtained.

A few brief details:

- Cover 3 wavebands 18-50 metres, 100-500 and 500-3000 metres.
- Employ 8 valves having PUSH-PULL for 6 watts output.
- Employ 4 extra valves for F.M. and P.M. operation.
- A position Tone Control on both Radio and Gram.
- Bass independent mains supply socket for Record.
SEPTEMBER, 1955

WHEN ORDERING PLEASE STATE WHETHER FOR 3 OR 15 ohm SPEAKER.

at If amps.

the POWER SUPPLY AVAILABLE being 200 to 250 Volts at 45 mA. and 6.3 Volts

reproduction.

above has types 625 and 6SN7.

having 625 -6E7 -two 6F6s and 5 Volt Rectifier and the separate Control Unit,

approximately 10 watts output. A total of 7 valves are employed, the main Amplifier

It is designed for really good reproduction employing two 6F6s In push-pull for

CHOKES. etc.

purchase of FARMEKO TRANSFORMERS,

an attractive price only because of a bulk

H.P. TERMS DEPOSIT 13/31- and

THE STERN'S

AMPLIFIER.

FOR ONLY £13.13'

"HIGH

A COMPLETELY ASSEMBLED

PUSH-PULL OUTPUT

A 6 VALVE 3 WAVEBAND SUPERHET

with PUSH-PULL OUTPUT.

Thousands of these successful and very popular Receiver

Chassis have been sold for £15/15/-

exch.

WE CAN NOW OFFER THEM FOR

(b) The COMPLETE AMPLIFIER WITH PRE-AMPLIFIER £23/7/-, or £7/2/-

Deposit and 12 month


(c) The " POINT ONE " PRE-AMPLIFIER ONLY: £0.01101- or £2/12/8 Deposit and 12 month

and 9 months at 19/-.

A COMPLETELY ASSEMBLED

"HIGH FIDELITY" PUSH-PULL

AMPLIFIER. Supplied Complete

with THE STERN'S DUAL CHANNEL TONE CONTROL PRE-AMPLIFIER

FOR ONLY £13/13/-

Territory deposit £23/- and 12 monthly payments at 1/-.

We are able to offer this equipment at such an astonishingly low because of a bulk

of PARMEKO TRANSFORMERS.

Chokes, etc.

It is designed for really good reproduction employing two 6PSs to pushpull for

approximately 10 watts output. A total of 7 valves are employed, the main Amplifier

having 625 -6SN7 -two 6F6s and 5 Volt Rectifier and the separate Control Unit,

which is identical to that supplied with the 12 Watt " HI FI" Amplifier described above has types 625 and 6SN7.

Joule Feedback is employed over the whole of the main Amplifier and the PARMEKO OUTPUT TRANSFORMER ensures really good reproduction.

It incorporates its own feed.

The NEW " LEAK " TL/10 AMPLIFI-

ER and "Point One" PRE-AMPLIFIER

This Amplifier has a maximum output of 30 watts and maintains in every respect the world renowned LEAK reputation for precision engineering; fine appearance and fastidious wiring. The Pre-amplifier will operate from any make of type of pic-up. A continuously variable input attenuator at the rear of the Pre-amp, permits the instantaneous use of crystal, moving iron and moving coil pic-ups.

H.T. and L.T. supplies are available for a

Radio Tuning Unit. An input attenuator is fitted. B.A.E for descriptive index.

WE HAVE BOUGHT THE ENTIRE STOCK OF THE

MODEL B3PP RADIO or RADIOGRAM

CHASSIS.

THE COMPLETE KIT IS

£7/10/-(Plus 5/- carriage & Insurance).

THE COMPLETE KIT ASSEMBLED AND READY FOR USE

H.P. Terms £14/0/- Deposit, 12 Months at £1/0/0.

PRICES :

(a) The COMPLETE AMPLIFIER WITH PRE-AMPLIFIER £28/7/- or £7/2/-

Deposit and 12 months at £1/4/9.

(b) The TL/10 MAIN AMPLIFIER ONLY: £17/17/-, or £4/7/- Deposit and 12 month

and 9 months at 19/-.

(c) The " POINT ONE " PRE-AMPLIFIER ONLY: £10/10/-, or £2/12/6 Deposit and 9 months at 19/-.

These Receiver Chassis have undoubtedly proved to be about the most popular and successful yet

offered.

They are the Ideal Replacement

for OLD RADIOPHANS.

All CHASSIS are BRAND NEW in

QUARTZTRONIC FOX 17 MONTHS (R.V.A.

VALVES 90 DAYS).

WILLIAMSON AMPLIFIERS BY GOODSELL

These Amplifiers hardly need emerging upon, being sufficient to say that they have now become the accepted standard for quality reproduction by which all others are judged. Two Models are available. BEND S.A.B. FOR ILLUSTRATED LEAFLETS.

SPECIAL PRICE REDUCTIONS

SELECT ANY TUNING UNIT (see page 147) and an assembled AMPLIFIER (or a TUNING UNIT, AMPLIFIER and RECORD PLAYER) and we will quote you a REDUCED PRICE.

H.P. TERMS ALSO QUOTED.

(a) STERN'S 8 1/2 WATT AMPLIFIER and the Model CP3G (or DENCO F.M. TUNER) all

£17/17/- (plus 10/- carriage & Insurance). H.P. Terms Deposit £28/17/- 12 months at £1/0/0.

(b) STERN'S 8 1/2 WATT AMPLIFIER and the Model CP3G (or DENCO F.M. TUNER) all

£17/17/- (plus 10/- carriage & Insurance). H.P. Terms Deposit £28/17/- 12 months at £1/0/0.

(c) STERN'S 8 1/2 WATT AMPLIFIER and the Model CP3G (or DENCO F.M. TUNER) all

£17/17/- (plus 10/- carriage & Insurance). H.P. Terms Deposit £28/17/- 12 months at £1/0/0.

(d) STERN'S 8 1/2 WATT AMPLIFIER and the Model CP3G (or DENCO F.M. TUNER) all

£17/17/- (plus 10/- carriage & Insurance). H.P. Terms Deposit £28/17/- 12 months at £1/0/0.
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.

**HANDLE CONSTRUCTORS**

**Build it for £40'!**

!! IT ONLY NEEDS CONNECTING UP !!

H.P. Terms are shown below.

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.

**Tape Recorder**

**Buy it assembled and ready for use for £43'!**

(Plus £1/10/- carriage and insurance. £1 is refunded when packing case is returned to us.)

H.P. terms. Deposit £11 and 12 monthly payments of £2/18/6.

**ACOS (CRYSTAL) 1,200 ft. REEL OF MICROPHONE SCOTCHBOY MODEL MC.311 MAGNETIC RECORDING TAPE.**

**PORTABLE ATTACHE CASE**

This, as may be judged from the illustration above, 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.

**Stern's HOME CONSTRUCTORS**

**Build it for £40'!**

!! IT ONLY NEEDS CONNECTING UP !!

H.P. Terms are shown below.

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.

**Stern's Tape Recorder**

**Buy it assembled and ready for use**

**for £43'!**

(Plus £1/10/- carriage and insurance. £1 is refunded when packing case is returned to us.)

H.P. terms. Deposit £11 and 12 monthly payments of £2/18/6.

**SEND S.A.E. FOR DESCRIPTIVE LEAFLET**

**THE NEW TRUVOX MODEL TR7U TAPE DECK**


**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.

**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/- or in two parts as follows:

<table>
<thead>
<tr>
<th>CASH</th>
<th>DEPOSIT payments of</th>
</tr>
</thead>
<tbody>
<tr>
<td>£33 10 0</td>
<td>£8 10 0</td>
</tr>
</tbody>
</table>

See note below re packing charge

**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.**

**PORTABLE ATTACHE CASE**

This, as may be judged from the illustration above, 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.

**Stern's Radio Ltd.**
!! A SELECTION OF HIGH QUALITY TUNING UNITS!!

THE DENC0 F.M. FEEDER UNIT
INCORPORATING AN R.F. STAGE

A 5 VALVE SUPERHET DESIGN having a frequency coverage of 88 to 100,000 metres. This F.M. Receiver is designed to be used with any type of Amplifier and most Radio Receivers and is complete in itself. It accommodates the Maybell and Leo 1P, Raag followed by a Radio Receiver which may be used up to 30 MHz or more. It is designed in two stages:- (i)3BSM—two 6PP6 and 6AQ5. Overall chassis dimensions 7in.x4in.x9 1/2in. 451/2 in. high including power supply and chassis. Standard Price 8/-5/-6.

WE WILL ALSO SUPPLY IT
(a) Assembled and ready for use, excluding Dial Assembly, Price 15/-6.
(b) Assembled and ready for use including Dial Assembly as (b) above. Price 20/-6.
(c) Assembled and ready for use, with Dial Assembly and " Magic Eye " indicator mounted in centre of Dial. Price 10/-6.
(d) We can also supply (a), (b) and (c) with and including an HT/LT Supply (for an additional 2/-). The Supply Unit is also available as a separate Unit, 8/-6. x 2in. x 2in. high. Provides 24 volts at 50 mA. and 6.3 volts at 2.5 amps.

THE DULCI F.M. TUNER

This unit will be available end of September. It is a completely self-contained Unit which can be accommodated either horizontally or vertically. An overall size of 9in.x 4 1/2in.x 3in. x 5in. high. Provides 250 volts at 50 mA. and 6.3 volts at 2.5 amps.

SPECIAL PRICE REDUCTION
PORTABLE AMPLIFIER

SHAFTESBURY PORTABLE AMPLIFIER

Suitable for home use and small Halls; completely self-contained and portable. Also finds use for both Record Players and Microphone. Also provides for the " mixing " and " fading " of both Gram. and Speech as required. Has matched inputs for both Record and Gram. Controls for Mike and Gram., either of which can be faded at will, and can be accommodated either on or away from the main amplifier, i.e., on the front of the amplifier, etc., is available for £21 17s 6d. The Complete Kit with easy-follow assembly instructions and parts list for £18 14s 6d. Price completely assembled excluding Power Supply £25. Carriage and Insurance 7/-6.

THE COMPLETE EQUIPMENT is all contained in the PORTABLE CARRYING CASE £18 0/0

Having been reduced from £33 13s 0d. HIRE PURCHASE TERMS Deposit £4 1/-6 and 12 monthly payments of £1 4/-6.

A DUAL-CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

Attractively finished in " Old Gold " and providing full control of Bass, Treble and Treble. In conjunction with a main volume control, it can be used with any amplifier and with any pickup. The range of frequency control provided by the unit allowing ample compensation for all types of pickup and all natures of recordings, etc., English, American, and long-distance signals without recourse to pick-up correction. The extreme flexibility of the bass and treble control is such that the level of bass and treble can be set to suit any conditions irrespective of volume output of the instrument. The controls are given in 12 watt amplifier and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price including the bass and treble control £13 10s 6d. Complete assembly data are available separately for £1 4/-6.

COMMERCIAL T/V CONVERTERS

Completely self-contained Units designed to operate with any commercially made Television Receivers. To enable the immediate reception of both the B.B.C. (Band D) and the Commercial (Band H) programmes. No aerial fitting and no alterations is required to your present receiver. It is simply a matter of connecting the mains Supply, Band D and Band H Aerials to the sockets provided on the Converter, which is then connected to your usual receiver by a lead which plugged into the receiver and thus into the T.V. Receiver aerial socket. The Controls on the Unit are:-
(a) Station Selector Switch which immediately selects either Transmitting Station.
(b) An On-Off Switch which also switches the T.V. Receiver on or off.
(c) Band III Station Tuning Control

PRICE AVAILABLE-
1. THE AERIALITE MODEL T.A.5 illustrated here. Contained in a brown crackled finished case at £15 6/-6. x 4 1/2in. x 4 1/2in. deep, Price 19/-6.
2. THE DIRECT TV CONVERTER. In polished walnut case size 9in. long x 6in. high x 4in. deep. Price £27 16/6.
3. VALRADIO TUNER. A sturdy T.V. Converter (without case) for direct incorporation into an existing T.V. receiver. In this instance it is essential that, when ordering, we are advised of either the I.F. frequency or the make and model number of the T.V. receiver. Price £15 15/-6.

YOU CAN BUILD A COMPLETE PORTABLE RECORD PLAYER for £11 9/6

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Input 12 v., output 250 v. 60 mA., 22/6.
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2 mfd. 600 v. wkg. 3/6
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EF50 (VR19A)
The selected EF50, Red Sylvania, original boxes, 10/- each, 90/- for ten.

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3-speed Auto-changer. Plays mixed records, cream Transformer Pick-up. Listed 16/-10/-. Our Price £7/19/6 CARR. PD.


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"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 6EP6 and 4TP4, 20, 35 and 15 M.C.S. price 16/-; 25 M.C.S. Price £1 15/0. Cable "Radio Constructor" 38 scope included.

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8/6 POST FREE
Ideal for tape recording and amplifiers. No matching transformer required.

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We can now offer this self-contained Unit comprising 6 Valves—2-EF14, 2-EF17, 2-EF34, 2R02. Two I.F stages and separate local oscillator also Northwood pre-glimmer vernier drive, saving easy tuning.

COMPONENTS OFFERED TO COM- PLTE F.M. UNIT

• New EF09 Unit with 3 valves
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Complete set comprising 6 & 155, 2-RF14, 2-EF34, tuning condenser, I.F.T. and Osc. and coll. Resistors and fixed condensers, plus wire and tap strips. £4/10/6.

Instruction Book with technical circuit and complete lay-out diagrams. 1/6.

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ALL ITEMS SOLD SEPARATELY

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BCN64A I.F.F.

Containing 13 valves 3-2112, 3-6387, 3-496 metal. 18 v. dynatron and tap output 600 v. 60 mA. with three speed geared motor plus 4 relays, condensers and resistors, in good condition. 35/-, Carr. 3/-

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Containing 4—Red EF50, 1-SP91, 2-SP91, 1-EB34, 2-91/61, 2-81/61, valves. 25 m/c/s., output 300 v. at 100 mA. Complete, aligned and ready for use. £1 15/0. Cable "Radio Constructor" 474 scope included.

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Unit contains VCR57 Cathode Ray Tube, complete with Mu-Metal screen, 2 EF50, 4 SP61, and 2 MAC valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for hobbyist or experimentalist. Offered BRAND NEW first relay in original packing. Complete with 6 valves. Price 7/6 Carr. 1/6.

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R.F.24 20/30 Mc/s. 12/6
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D.P.D.T. RELAYS. Operate at 200/300 volts D.C., 8/6. We can supply any type of voltage and contacts at varying prices.
NEW SLENIUM RECTIFIERS. F.W. 12/6 volts 3 amps., 14/6; 4 amp., 23/6; 5 amp., 50/6; 10 amp., 250 v., 40/6; 20 amp., 250 v., 80/6; 1 amp., 250 v., 100 ma., 10/-.
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F.W. 12/6 volts 3 amps., 14/6; 4 amp., 23/6; 5 amp., 50/6; 10 amp., 250 v., 40/6; 20 amp., 250 v., 80/6; 1 amp., 250 v., 100 ma., 10/-.
NEW BROWNS MC HEADPHONES. (Ex-W.D.) With ear-pads and 6 ft. lead and plug, list price £5 15/6. Our price 18/6.
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Behind the new RCA High Fidelity Amplifier stands nearly a quarter of a century’s skill and experience in designing professional sound reproducing equipment. This Amplifier includes several exclusive features entirely new to audio engineering, thus making it many years ahead of its time both in design and construction.

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

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**PRE-AMPLIFIER**

**INPUTS—**
- Magnetic Pickup
  - B.78: 16 mv input for rated output. 300 c/s Turnover,
  - 6 DB Roll-off at 10 Kc/s.
- A.78: 14 mv input for rated output. 500 c/s Turnover,
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  - L.F. 13.5 mv input for rated output. 500 c/s Turnover,
  - 12 DB Roll-off at 10 Kc/s. Flattened LF at 50 c/s to + 13 DB.
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- Crystal Pickup. 35 volt with inbuilt equalisation from constant amplitude to constant velocity output enabling switched replaying characteristics to be accurately employed.

**Radio/Tape High Level**
- 200 mv. Flat characteristic.
- Low Level 50 mv. Flat characteristic.
- Microphone 6.5 mv for rated output. Flat characteristic.

Mixer Facilities for microphone input, with radio/tape/gramo inputs.

OUTPUT. 1.2 volts from cathode follower stage.

TAPE RECORDING OUTPUT. 1.2 volts cathode follower independent of monitoring.

BASS & TREBLE. Plus and minus 14 DB at 50 c/s and 10,000 c/s.

VOLUME. Twin ganged control giving correct gradation.

LOW-PASS FILTER. Switched 10 Kc/s, 7 Kc/s, 5 Kc/s and Flat.

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FILTER SLOPE. Variable to 35 DB per octave.

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OUTPUT. 12 watts rated. Peak in excess of 20 watts over 20-25,000 c/s.

DISTORTION. Total harmonic less than .1% at 10 watts—700 cycles.

NOISE LEVEL. 85 DB below rated output.

DAMPING FACTOR. 50—also variable from positive to negative values.

FREQUENCY RESPONSE. Within 0.2 DB 20—25,000 c/s ± 0.5 DB 10—60,000 c/s.

FEEDBACK. 40 DB total.

OUTPUT IMPEDANCES. 4 ohms, 7 ohms, 15 ohms.

INPUT VOLTAGE. 1.2 v for rated output.

ANCILLARY POWER SUPPLIES. 375 volts
- 45 milliamps, 6.3 volts 2.5 amps available for VHF Tuner, Pre-amplifier and Tape Reproducer amplifier.

POWER CONSUMPTION. 130 VA at full load.

AC Input 100/150 and 200/250 volts.

PRICE £48.0.0 COMPLETE.
BAND 3 T.V.
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(*W. World, May 15*)

Kit of parts complete to build this model.

All parts finished. Complete with 200/250 volt mains transformer, 4-position W.I.C. switch, L.M. S. and Gramophone switch. Short-wave switch and A.F. outputs. Fully shrouded and wired diagram. Fully guaranteed. £15.0.0.

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3 VALVE, SUPERHET, LATEST.

Best Ever Value in Record Players

Latest H.E. Model.


Electrolitics Leading Mark's New Stock

Tubular Can Types

50/7/5...30/1/3 250 v. 300 mA., 23/-; 125 v. 100 mA., 4/-
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Resistors

100/10 250 v. 1000 mA., 3/6; 80/80 125 v. 800 mA., 1/-

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Single wire 1000 ohms, 3/6; 2000 ohms, 5/-.

Easy Obtainable

Feeders losses cut 50%.

Coax Patches

1000 ohms, 5/-.

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inh. 6in., 8/; 12in., 12/.

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5000 ohms, 4/-.

CO Axial

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Best Ever Value in Record Players

Speaker BRT-Expanded Bronze moulded metal. 6in., 6/; 8in., 10/; 10in., 15/; 10in., 6/; 8in., 12/; 6in., 6/; 4in., 3/.

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Kit of parts to build this modern and highly popular complete unit with 4-position W.I.C. switch and J.F. dial, wound coils and terminals, 12-inch metal coaming, all necessary quality components etc. for only £15.0.0.-post free. Designed especially for sale by broadcast receiver manufacturers. £15.0.0.

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12/16 2 kv. 47/16; 20/16 3.2 kv. 67/16; 30/16 5 kv. 7/16; 40/16 8 kv. 2/6; 60/16 10 kv. 2/6; 110/16 14 kv. 2/6; 220/16 15 kv. 3/6; 330/16 15 kv. 5/6; 440/16 15 kv. 7/6; 660/16 15 kv. 9/9; 1000/16 15 kv. 11/9; 1500/16 15 kv. 13/9; 2000/16 15 kv. 15/9.

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1% Hi - Stab. 10% Tol. 10 megohms. 20% Tol. w. 3d.; Carbon Resistors

0.001, .005, .01, .02 and .1 350 v., 500 mics.

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WIRELESS WORLD

158

SEPTEMBER, 1955
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A sub-chassis 3½" x 6¼" x 2½" containing a R.F. Transmitter operating 67.42 cm. (445 Mc/s) with a bandwidth of 40 Mc/s. Modulation of its carrier is by means of a Moving Coil Transducer with a metal diaphragm. The proximity of the diaphragm effectively changes the resonant frequency of its tuned circuit, to produce frequency modulation. This transmitter utilises TWO 955 (VT 121) valves, and can quickly be converted for Radio Controlled Models; the frequency for this purpose being in the band, or for 70 cm. work.

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A sub-chassis 3½" x 6½" x 2¼" houses a Receiver tuned to the transmitting frequency. Contains TWO 9004 valves. For use in 70 cm. band.

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An Audio Frequency Amplifier in a sub-chassis 5" x 3½" x 3¼" R/C coupled, using TWO 12SH7 and ONE 12SJ7 valves; and can be used for Telephone Intercom., Pre-Amplifiers, etc.

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Easily converted to 2 metres or 70 cm. In Copper-plated metal case 3½" x 4½" x 5½" with dial calibrated 0-100 and 120V Neon Tube. Coverage approx. 190-210 Mc/s. New. 6/6 each post paid.

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Type 3 BP 1, 3" short persistence, complete with Mumetal screen and base. NEW. Post paid.

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in bakelite case fitted with small bayonet cap holder. Size 5 inches in diameter by 3 inches deep.

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Of well known manufacture. 2 volt, 10 ampere/hour. Lead Acid.

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**Miniature POCKET RADIO**
Incorporating high "Q" technique using the New Ferrite rod. Mode possible by simple conversion of an ex-Govt. Hearing Aid.

**Technical Details.** A Germanium Diode Detector circuit followed by the existing 3 valve Amplifier, giving adequate amplification throughout the medium wave band. This conversion can be carried out in approximately 30 minutes.

**PRICE** £2 6s. Od. post paid (or without crystal microphone £2 2s.). Batteries extra: 1.5v. L.T. (Type D18), 8d.; 30v. H.T. (Type B119). 4/-.

**NOTE:** As the crystal microphone is not used in the Pocket Radio, it can, if desired, be used as a general microphone and it does not require a matching transformer.

**THE COMPLETE KIT OF PARTS** includes a Type OL10 Hearing Aid (with Crystal microphone) in perfect working order with miniature ear phone and moulded ear insert attached; ferrite rod, germanium diode, components, circuit diagram and full instructions.

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**SEE and HEAR** this Miniature POCKET RADIO demonstrated.

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Manufacturers of precision Quartz Crystal in a wide variety of bases covering the complete range 40 Kc. to 18 Mc. in fundamental frequencies. All are made to extreme size tolerances, and frequency adjustment can be given up to 0.05%.

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200 or 10% cut, zero temperature coefficient of the range—50 crystals to 40.50 spectrums. Frequency adjustment 0.05%, or better. Made from silver-plated electrodes, mounted. Ruling 3½ pin spacing. Other sizes to order, £1 each.

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T. V. CABINETS. Large purchase enables us to offer new top-grade table cabinets at keenest prices, famous 1054 models complete mass, glass, glass, a great friend ! 34in. (h), 36in. (w) x 16in. (d). £107.50 Hill (ence, B4. 3). Large 1044 de luxe cabinets are made beautifully finished and flawless, mass glass, meters, 14in. or 15in. sizes. 1044 £5 (B. 3. 4. 31). ELLIPTICAL SPEAKERS. 3 x 4, 9, 000 lines, as used in above top cabinets. £16/6. (P. 1. 3. 31). 12 in. speakers, £12/6. AERIALS. 93% complete all hallings, famous make, original wrapping, listed approx. £30/6. 40% complete all hallings (Cart. 3/). AUTO CHANGE GRAMS. Set 3 speed, 2 valve, 105a, compact, 50 cts. case, 4. 4. 3. 12. DITTO RECEIVERS. 7 waveband, with 13 valves, 10. m. 4,000,000, continuous, modern monoblock, B.F.O., 8 in. meter, noise limiter, vernier dial, 4. output. £19 (Cart. 24). VALVE VOLTMETERS No. 2. Excellent condition. £12/10/0. 3314 Casser DB complete, unrestored. £13. Ditto DSB 3314 (H. 111). Microlite 3316 scope, tested. £15. Marconi TF2002, with hard box, £20. £11 (Cart. 24). B.210000 TRANSFORMERS with 16 all dry valves, basically complete. £80/10/- cart. 3/4.

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Drop thru' 360-360-360 70 ma. 6 v. 3.5 amp., 2 x 1/8.

Chassis mounted and fully shunted, 2 x 1/8. P. & P. 1/4-

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P. & P. 1/-.


Three speed automatic changer by a very famous manufacturer, current model. Will take 7in., 10in. or 12in. records mixed. Turnover crystal head. P. & P. 5/6.

CONSTRUCTOR'S PARCEL, medium and long wave A.C. mains 230/250 2-valve plus metal rectifier, beam 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 6 9/16 x 2 1/2 in., size of scale 75 x 3 1/2 in. Valve parts will complete. See description.

CONSTRUCTOR'S PARCEL, complete with scan mils and frame transformer. Input arranged for 80 ohm feeder. EF80 as RF amplifier, ECC81 as line up, 3 valves as C.T. 4 a., 4 v. C.T. 2.5 mfd. 250-0-250, 2 a., 19/6. P. & P. 1/6.; 32 x 32 mid., 4/-; bias condenser.

CONSTRUCTOR'S PARCEL, big, complete with frame transformer. Input arranged for 80 ohm feeder. EF80 as RF amplifier, ECC81 as line up, 3 valves as C.T. 4 a., 4 v. C.T. 2.5 mfd. 250-0-250, 2 a., 19/6. P. & P. 1/6.; 32 x 32 mid., 4/-; bias condenser.

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impedances to suit any Head on the market. 45 Kc/s to 50 Kc/s.

**TAPE RECORDISTS!** Are you Completely satisfied with your
recordings? Bad waveform in an oscillator cause DISTORTION
due to intermodulation, NOISY BACKGROUND due to D.C.
component in an asymmetrical waveform and INTERFERENCE
with radio due to harmonics beating with incoming signal. The
fundamental cannot do this.

COIL, complete with circuit, 1/6 post free. Patent, app. for.

**FUNDAMENTAL REJECTOR COILS**

Even a small amount of bias frequency getting into the amplifier
can cause a lot of trouble, and nearly all tape recorders need a rejector
circuit to prevent this.

COIL, complete with instructions, 1/6 post paid.

**MOTEX TAPE DECKS**

The famous K6 decks; twin track, two speed, with push buttons
and electronic braking, is a beautifully finished job at only £19/19/-.

Post free. Or £3 down and 12 monthly payments of £1/16/6.

**TAPE AMPLIFIERS**

The HATFIELD amplifier is complete with oscillator as above, and
magic eye, less speaker, at £12/15/6. Or £2/16/6 down.

**COMPLETE RECORDERS**

The HERTA recorder incorporates ALL the above items together
with a first-class crystal mike and one reel of SCOTCH BOF tape
in an attractive two-tone portable cabinet, absolutely complete at
39 gns. Or £7 down and 12 payments of £3.

Further details and H.P. forms from:

**HATFIELD RADIO**

78 STROUD GREEN RD., LONDON, N.4

---

**THE GENERAL ELECTRIC CO. LTD.**

at their Research Laboratories,
East Lane, North Wembley,
Middlesex,

have openings for young
PHYSICISTS or ELECTRICAL
ENGINEERS

The successful candidates will be given opportunities to be trained to qualify as Patent Agents. Previous experience of Patent work is desirable but not essential.

Applicants should have some background and interests in the electronic field, tele-
communications or radar.

These appointments carry excellent prospects, and a high level of remuneration can be expected on qualification. Candidates should be free of National Service commit-
ments if under 26 years of age.

Apply in writing to the Staff Manager (ref.: RLO/34) giving full particulars of experience, qualifications and age.

---

**G2AK This Month's Bargains**

**THE IDEAL POWER TRANSFORMER FOR THE TABLE TOP RIG.**

This Parmeko-made transformer has the following conservative
ratings: Primary, 230 v. 50 c/s. Secondary, 620 v. 1550/375/0/375/550/620 V.
Rated at 275 VA. It will give 620 or 550 volts at 200 mA.

Convoluted copper windings for suitable rec-
tifiers such as 5R4GY, 5Z3, 83, 5U4, etc.

for R.F. and Modulator.

Meters: 2in. Scale Round Flush 0-1 Amp. R.F.,
Ditto 0-30 mA., Ditto 0-150 mA., ditto 0-3 Amp. Thermo., ditto 0-20 V. d.c., ditto 620 V.

**G2AK**

2010, 20 Amp. d.c., 7/6 each.

6/ x 51in. high.

Condensers: 8uF 600 V. Trop. 750 V. normal condensers.

Power Transformer: This Parmeko-made transformer has
6/ x 51in. high.

Weighs 2411b.

**RADIO TUNER**

Goldring 412-15/-. Or 0/10/- down.

**GARRARD RC 60 & 90**

Output Volts 50% greater than the H.T. voltage,

COMPLETE STABILITY, LESS THAN 0.2% distortion, R.M.S.

Output must be restricted

to maintain the waveform, so say all the books. But not so with the
HATFIELD oscillator, nor is it necessary to work near the point of
insufficiency.

**COMPLETE STABILITY, LESS THAN 0.20% distortion, R.M.S.**

output voltage 50% greater than the H.T. voltage, 1 mA, coil,
simple circuit.

Sounds, incredible, but it is GUARANTEED.

Send for copy of N.P.L. report and see our ad. In April issue of
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Further details and H.P. forms from:

**HATFIELD RADIO**

78 STROUD GREEN RD., LONDON, N.4
**MISSING FREQUENCIES CAPTURED**

Now released for the first time in Great Britain

**New TSL High Fidelity ELECTROSTATIC SPEAKERS**

_Give life-like high quality reception and reproduction_

An absolute must for

1. Receiving F.M. Transmissions.
2. High quality recordings.
3. Television Sound.
4. Modernising old receivers to high fidelity standards.

TSL Electrostatic Speakers reproduce those missing frequencies beyond 8-10,000 cycles and increase the speaker response to 20,000 cycles. While it is realised that the human ear cannot, except in the rarest cases, distinguish sound beyond 15,000 cycles, it must also be remembered, that these high frequencies, even up to 20,000, combine with the audible range to produce balanced, rounded and natural reproduction. Sound, without the additional high fidelity of a TSL Electrostatic Speaker is like a salad without the dressing—it is just not complete.

<table>
<thead>
<tr>
<th>TYPE LSH 100 Electrostatic Loudspeaker</th>
<th>TYPE LSH 75 Electrostatic Loudspeaker</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td><strong>Size</strong></td>
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<td>...</td>
<td>...</td>
</tr>
<tr>
<td>3 x 3 x 3 in.</td>
<td>3 x 3 x 3 in.</td>
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<tr>
<td><strong>Speaker capacity</strong></td>
<td><strong>Speaker capacity</strong></td>
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<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>1100 pF</td>
<td>800 pF</td>
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<tr>
<td><strong>D.C. voltage</strong></td>
<td><strong>D.C. voltage</strong></td>
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<td>...</td>
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<tr>
<td>400 v. max.</td>
<td>300 v. max.</td>
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<tr>
<td><strong>Tone Frequency (A.C. voltage)</strong></td>
<td><strong>Tone Frequency (A.C. voltage)</strong></td>
</tr>
<tr>
<td>60 v. max.</td>
<td>60 v. max.</td>
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<tr>
<td><strong>Effective test voltage at 50 cycles</strong></td>
<td><strong>Effective test voltage at 50 cycles</strong></td>
</tr>
<tr>
<td>440 v.</td>
<td>440 v.</td>
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<tr>
<td><strong>Weight</strong></td>
<td><strong>Weight</strong></td>
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<td>...</td>
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<tr>
<td>3.0 oz.</td>
<td>1.6 oz.</td>
</tr>
<tr>
<td><strong>Max. Power handling capacity</strong></td>
<td><strong>Max. Power handling capacity</strong></td>
</tr>
<tr>
<td>20 watts</td>
<td>6 watts</td>
</tr>
<tr>
<td><strong>Retail at (not subject to P.T.)</strong></td>
<td><strong>Retail at (not subject to P.T.)</strong></td>
</tr>
<tr>
<td>21/-</td>
<td>12/6</td>
</tr>
</tbody>
</table>

**EASY TO FIT**

Either type may be fitted in a matter of minutes by suspending, by means of elastic rubber bands, centrally in front of the cone of the normal magnetic speaker. There is no interference between the two units. Alternatively they may be mounted separately from the main speaker. The addition of two resistors and two capacitors is necessary to the circuit but no other change is required. Full instructions with every speaker.

Ask at your local retailer or in case of difficulty write for details to:

**TECHNICAL SUPPLIERS LIMITED,**

Hudson House, 43, Goldhawk Road, London, W.12.

Telephone: S.H.F. 2581 & 4794

---

**MARCONI COLLEGE**

Applications are invited for posts on the **LECTURING STAFF** of **MARCONI COLLEGE CHELMSFORD**

The appointments will be to the radio engineering section and candidates should have had experience in modern communications techniques, although applications will be considered from engineers trained in other branches of electronics. Successful applicants will be required to instruct graduate engineers.

The posts are permanent and pensionable. 5 day week. Excellent working conditions in new building.

Please reply giving full details of age, qualifications and experience and quoting Ref. 2910 to Marconi’s Wireless Telegraph Co. Ltd., Dept. C.P.S., 336/7, Strand, W.C.2.

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**A. V. ROE & CO., LTD.**

have the following vacancies in their **WEAPONS RESEARCH DIVISION** at **WOODFORD**

**TECHNICIANS**

For design and development work in a guided weapon project. At least 3 years’ experience in electronics or H.N.C. is necessary.

**JUNIOR AND SENIOR DRAUGHTSMEN**

For design work in precision instrumention. At least 3 years’ experience in design precision engineering or H.N.C. is necessary.**GOOD SALARIES AND PROSPECTS**

**PENSIONS AND LIFE ASSURANCE SCHEME**

Application giving full particulars of age, qualifications and experience to be addressed to:

A. V. ROE & CO. LTD., WEAPONS RESEARCH DIVISION, WOODFORD, CHESHIRE.

---

**The Northern Polytechnic**

Holloway Road, London, N.7.


Department of Telecommunications Engineering**Full-time Day and Evening Courses in Telecommunications Engineering in preparation for the Full Technological Certificate of the City and Guilds of London Institute, and Graduareship of the British Institution of Radio Engineers.**

Full-time one year course in Radio Servicing and full-time one year course in Television Servicing, also part-time day release and evening classes are held in these subjects in preparation for the City and Guilds of London Institute and the Radio Trades Examination Board’s Certificates. Special short courses are available for qualified Service Engineers interested in Band III Television and Frequency Modulated Sound broadcasting. All the above courses include practical laboratory and workshop experience.

---

**Enrolment for evening classes, 5.30-7.30 p.m. 19th and 20th September, 1955. New term commences 26th September, 1955.**

PROSPECTUS FREE on application to the Secretary.
VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED, have the following vacancies in their Guided Weapons Development Department:

(x) CALIBRATION ENGINEER. An Engineer is required for work on calibration of electrical and electronic instruments and to investigate associated measurement techniques. Applicants for this position should have a degree or equivalent in engineering or physics and preferably have experience in electrical measurement and allied techniques.

(y) ENGINEER DRAUGHTSMAN (Electronic). A Draughtsman is required to engineer equipment from laboratory circuit information to prototype stage. Adequate facilities are available for the development of original techniques. A knowledge of M.O.S. requirements is desirable. The minimum academic qualification required is Higher National Certificate in Electrical Engineering or equivalent.

(z) DRAUGHTSMEN (Electrical). 2 Draughtsmen are required to engineer prototype electronic equipment under the direction of an engineer draughtsman. A knowledge of M.O.S. requirements is desirable. Minimum qualification is Ordinary National Certificate or equivalent.


Weybridge is 30 minutes from London on the main Waterloo/Portsmouth Line. Additional "buses operate to and from the Works at starting and finishing times.

Canteen facilities.

Applicants should be in a position to arrange their own housing accommodation. Assistance can only be given with individual lodgings.

Holidays already arranged by applicants this year can be taken into account.

THE MULLARD RADIO VALVE COMPANY LIMITED has a number of vacancies for Technical Assistants in the following Divisions at its Mitcham factory:

- Cathode Ray Tube Division
- Valve Making Division
- Semi-Conductor Division
- Valve Applications and Measurements Division
- Gas Discharge Valve
- Photo Electric Cell Division

In each field of work vacancies exist in the Production Development and Technical Departments. Applications are invited from persons holding the General Certificate of Education at Ordinary level in science subjects and at Advanced level, and others who possess either the Ordinary or Higher National Certificate in Electrical Engineering.

The posts give an opportunity for further training in the electronic field and there are facilities for further study leading to higher qualifications. There are, in addition, considerable opportunities for promotion in varying and expanding fields of electronic work.

Commencing salaries will be according to age, experience and qualifications and can be considered as progressive. There is a Company Pension Scheme and Long Service Holiday Plan.

Applications in writing, which will be treated with the strictest confidence, should be addressed to the Personnel Manager, The Mullard Radio Valve Co. Ltd., New Road, Mitcham Junction, Surrey, quoting reference JFC/TECH/GEN.

B.O.P.E. Ltd.

RESEARCH, DEVELOPMENT AND DESIGN ENGINEERS

British Optical and Precision Engineers Ltd., is a group of companies within the J. Arthur Rank Organisation. The B.O.P.E. group manufactures high quality precision mechanical, optical and electronic, including sound recording, equipment for the cinematograph and television industries, as well as specialised measuring instruments, radiation instruments and machine tools for industry in general. In addition, research and development work is carried out under Contract to the Government.

The three main manufacturing companies of B.O.P.E. are British Acoustic Films of London, Taylor, Taylor & Hobson of Leicester, and A. Kershaw & Sons of Leeds. The group is expanding rapidly in selected fields allied to its present work and is increasing its research, development and design staffs at all three centres. In addition, a Central Research Laboratory is being established in West London.

Vacancies are available for first-rate ENGINEERS with good qualifications and experience in the fields of servo-mechanisms of all types, small precision mechanism design, measuring instruments and associated electronics.

Some junior posts are also available for ASSISTANT ENGINEERS and RECENTLY QUALIFIED GRADUATES.

Several senior posts require to be filled and excellent salaries will be paid for good men. The planned expansion offers opportunities for advancement for all grades, and all positions are pensionable.

Please apply to the Personnel Manager, Research & Development Department:

BRITISH OPTICAL & PRECISION ENGINEERS LTD.

INTRODUCING: SHORT WAVE TRANSMITTING/RECEIVING INSTALLATIONS T/R-50 SERIES

Complete in every detail for immediate operation

Use: MARINE: MOBILE: FIXED STATIONS

The performance of these installations is of the highest order and meets the requirements of commercial telecommunication working in all climates and conditions.

Every design feature has been incorporated to ensure:
RELIABILITY — ACCESSIBILITY — EASE OF SERVICING.

Brief Specification:

TRANSMITTER
FINAL AMPLIFIER PLATE INPUT POWER
-80 WATTS.
FREQUENCY RANGE: 1,500 Kc/s. to 12,500 Kc/s.
in 3 bands: V.F.O. or CRYSTAL CONTROL with choice of five crystal positions.
EMISSIONS: (a) Radiotelephone (voice) with facilities for full press-to-talk operation.
(b) Radiotelegraph (code) with provision for full break-in keying.

RECEIVER
SUPERHETERODYNE: I.R.F., Mixer, Local Oscillator, 2-I.F.'s, 2nd Detector and 1st Audio, B.F.O., Power Output Stage with built-in Speaker and additional 500-ohm line connections.
Note: The R-50 Mark II can be provided with a muting control (full or partial) on special order.

POWER SUPPLIES
12 v. Dynamotor Unit or A.C. Mains Supply Unit (manufactured to customers' requirement).

AUTO-ALARM SYSTEM—can be supplied on special quantity orders.
ACCESSORIES & SPARE PARTS—All accessories and equipment spares for 3—5 years' operation are supplied with the equipment.

Write for catalogues of our Broadcast Transmitters M I-8167-BRS & M I-8167-BRM.

Complete in every detail for immediate operation

Use: MARINE: MOBILE: FIXED STATIONS

The performance of these installations is of the highest order and meets the requirements of commercial telecommunication working in all climates and conditions.

Every design feature has been incorporated to ensure:
RELIABILITY — ACCESSIBILITY — EASE OF SERVICING.

British Sarozal Limited
1-3 Marylebone Passage - Margaret Street - London - W.1
Cables: SAROZAL, LONDON
A.I.D. and A.R.B. Approved.

British National Radio School
Estd. 1940
Now in our fifteenth year and still
No B.N.R.S. student has ever failed
to pass his examination(s) after completing our appropriate study course.

What prospects for your C. & G. Exams?
Let us help you to pass three or four, NEXT May. We shall be doing it for lots of your colleagues.

Please note new address:

Principal, M.I.E.E., M.Brit.I.R.E.
British National Radio School
3, CANYNGE ROAD, CLIFTON, BRISTOL, 8
Tel. BRISTOL 34725

The Mullard Radio Valve Company Limited
has a number of Senior Staff vacancies in the Television Tube Production Department of its Cathode Ray Tube Division.

These posts are for
PRODUCTION ENGINEERS
who, in each case, will later be responsible for the overall efficiency of their section, including a complete range of duties within the production and management function against a highly technical background.

It is felt that these posts would have a particular appeal for young men who possess a good Honours Degree in the Physical Sciences or Engineering, coupled with a short period of industrial experience (or who may be completing National Service), and now feel they wish to further their career in the production field.

There are opportunities for promotion in this expanding field of Company activity.

The commencing salary will be according to individual age, experience and qualifications and can be considered to be progressive.

The hours of work will be forty-four in a five-day week. The Company provides a progressive Holiday Plan and Pension Scheme.

Applications in writing, which will be treated with the strictest confidence, should be addressed to the Personnel Officer, The Mullard Radio Valve Co. Ltd., New Road, Mitcham, Surrey.
NEW RECEIVERS AND AMPLIFIERS
C.R. SCOTT, ELECTRICAL, 21, ELECTRONIC DEVELOPMENT, Ltd, Rickford, Chester
PRIDEWAY, Chester, Cheshire, Tel. 6012.
SPECIALIZE in the manufacture of High Fidelity Sound Reproducing equipment, including:-
WILLIAMSON Amplifiers
McKean, 10, Oldham St., Manchester, 6.
Alderson Equipment, including:-
Fidelity Recording equipment, ideally suitable for replacing the home EMI pre recorded equipment, Professional Recording Amplifiers, Microphone Microphones suitable for use with all types of leadets.

QUINNELS LABORATORIES Ltd., Leamington Spa, Warwick, Tel. 01926.
Road, Worthing, Sussex, the precision high fidelity specialist, amplifier type CR 10, 20 watt output, response 15 to 70,000 c.p.s. b.m.t.
Leamington Spa, Warwick, 01926.

STENTOR, Birmingham, 6.

SEPTEMBER, 1955

amplifiers to order for the musical and scientific purposes making them unsuitable for use with all high fidelity amplifiers; powerpack and A.C.C. available; off e rs. 5062,-

5,000 Watts, 3-valve quality treble blankets; 2,000 Watts, 3-valve treble blankets; 1,000 Watts, 3-valve treble blankets; 500 Watts, 3-valve treble blankets.

Readers are warned that Government surplus

20W powerpack for use with all high fidelity amplifiers;

MAGSLIPS always in stock.

ROTOR converters.

SAUCEP AND SECOND-HAND WANTED

SURPLUS AND SECOND-HAND

RIVAL 140, C.F. receiving equipment; 1,000 Watts, 3-valve treble blankets; 500 Watts, 3-valve treble blankets.

K.W.B. 6 Watt amplifier, 12gns; the filter lift leaflets.

Mixing Professional Recording Amplifiers, Microphone Microphones for use with all types of leadets.

NEW DYNAMOS, MOTORS, ETC.

NEW TEST EQUIPMENT - SURPLUS AND SECOND-HAND

R. T. & I., THURSDAY, OCTOBER 25th.

Mullard BC348R, CR100, etc. - Requirements please

Wharfedale Golden C.S.B., £6; Motorised 230v AC. £21.

Grundig, Philips, Ferrograph T.R.

BARKER L/S supplied.

BARKER L/S supplied.

TAPE recording amps, 15gns, (max. eye) or 15gns (miner. ind.r., etc. p. complete 71/2", 22 Watts, P.P. burn, 64/414; others, 0/1, output, £10.

RELEVANT LITERATURE


SECOND-HAND

Goodsell, 5w £13/10, preamp £10/10.

SURPLUS AND SECOND-HAND

WEARITE tape decks and component parts.

TAPE recorders as used and pre-owned, £20 o.n.o. - Young, Fremantle 0096, London, after 6 p.m.

SECOND-HAND

FREEGRAPHO magnetic tape recorders

Amplifiers. Iron cored potentiometers, etc.

REFLECTIONS, Magnetic tape recorder, 6m. £15; Motorised 230v AC. £21.

OUR TEST EQUIPMENT is of C-core design with

The Partridge Type P.3878 is of C-core design with

design by W. A. Ferguson.

Optimum conditions are obtained in the form of output stage used in this amplifier

20W output, response 15 to 60,000 c.p.s. b.m.t.

THURSDAY, OCTOBER 25th.

Mains Transformer Type P.3877

In: 70v; Out: 50v; Ins: 190v, 50-500w, 500w.

available; offered on our co-op. terms.

Tell: Worthing 513.

TELESCOPE deposits, 12gns; with

SLJ. M.R.C.M.

NEW GRAMOPHONE AND SOUND EQUIPMENT

NEW TV COMPONENTS

FOR SALE, BROADWAY, LONDON, W.12.

2,000 Watts, 3-valve treble blankets, 500 Watts, 3-valve treble blankets, 100 Watts, 3-valve treble blankets.

Ferrograph tape recorders as used and exchange or

RELEVANT LITERATURE IS AVAILABLE ON REQUEST

SECOND-HAND

TAPE recorders for sale, exchange or hire in Greater London, good quality tape recorders wanted for sale, all types of equipment, mechanical and electronic, carried out by specialists, all accessories available we deal in TAPE recording equipments.

SONAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited Requirements:- Generators, 250va, 250va, 250va, 250va.

NEW TV COMPONENTS for sale, brand new and unused, one G.E.C. 4603 electronicon tube, surplus to requirements.


M

SPECIALIZE in the manufacture of High Fidelity Sound Reproducing equipment, including:-
WILLIAMSON Amplifiers
McKean, 10, Oldham St., Manchester, 6.

Alderson Equipment, including:-
Fidelity Recording equipment, ideally suitable for replacing the home EMI pre recorded equipment, Professional Recording Amplifiers, Microphone Microphones suitable for use with all types of leadets.

QUINNELS LABORATORIES Ltd., Leamington Spa, Warwick, Tel. 01926.
Road, Worthing, Sussex, the precision high fidelity specialist, amplifier type CR 10, 20 watt output, response 15 to 70,000 c.p.s. b.m.t.
Leamington Spa, Warwick, 01926.

STENTOR, Birmingham, 6.

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available; offered on our co-op. terms.

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TELESCOPE deposits, 12gns; with

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NEW TV COMPONENTS

FOR SALE, BROADWAY, LONDON, W.12.

2,000 Watts, 3-valve treble blankets, 500 Watts, 3-valve treble blankets, 100 Watts, 3-valve treble blankets.

Ferrograph tape recorders as used and exchange or hire in Greater London, good quality tape recorders wanted for sale, all types of equipment, mechanical and electronic, carried out by specialists, all accessories available we deal in TAPE recording equipments.

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Leamington Spa, Warwick, 01926.

STENTOR, Birmingham, 6.
THE INSTRUMENT MODEL

Specially designed for soldering operations in the compact assemblies used in present day radio, television and electronic industries.

Weight 32 oz. excluding flexible length 9 in.

25 Watts

Voltage range 12-50

24-100-240

22-6

Interesting features

1. Bit ¢45" diameter, simple replacement

2. Steel cased element, also replaceable

3. Detachable hook for suspending iron when not in use

4. Moulded two part handle, remains cool in use.

5. Six ft. flexible handle.

CABINETS

W. T. HENLEY'S TELEGRAPH WORKS LTD.
1/35, Hatton Garden, London, E.C.1

WE CAN SUPPLY ANY Cabinet TO YOUR OWN SPECIFICATION. The one illustrated can be obtained in walnut or mahogany for £19/15/-. or is a COMPLETE RADIOGRAM incorporating:

5-VALVE SUPERHET. 3-speed Plessey Autochanger and 10n. W.B. Speaker

£48.0.3

8-VALVE ARMSTRONG F.C.8. 3-speed Collaro Autochanger and 10n. W.B. Speaker

£60.14.8

14-VALVE ARMSTRONG EXP 125/6. 3-speed Garrard Autochanger and 12n. Goodman's Speaker

£95.5.11

ALTERNATIVE ARRANGEMENTS OF HORN, Speaker and Autochanger can be supplied. Send 1/- for complete Catalogue of Cabinets, Autochangers and Speakers (refund on receipt of order). H.F. can be supplied.

LEWIS RADIO COMPANY
120, GREEN LAINES, PALMERS GREEN, LONDON, N.13.

BOWES PARK 6604
To get the best possible performance from KT66 triodes in a circuit such as the Williamson use the GILSON 15-30 WATT TRIODE OUTPUT TRANSFORMER

FEATURES: A 30-WATT size of core of grain oriented laminations. Approx. 0.05% core harmonic distortion which figure will be still further reduced by the application of negative feed-back.

Level response at 160 c/s to 30 Kc/s at 0.15 w. 10% 2 c/s 20 Kg, 1 Kc 400 Kg, 30 Kc/s 22 Kg. Low winding capacitance. Ratio 10 KΩ to 8 x 0.971 or 8 x 3.71 in sections. Max. D.C. 120 mA each anode. Adequate insulation, voltage proof, 3 K v peak overall.

For unexcelled performance from your OSRAM 912 AMPLIFIER use the GILSON ULTRA LINEAR OUTPUT TRANSFORMER

specially designed for this circuit


List price £2.12.6

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MAKERS OF NEON SIGN TRANSFORMERS

Specialists in the design and manufacture of small transformers for power and audio frequencies. Contractors to Admiralty, etc., A.I.D. Approved

WANTED, EXCHANGE, ETC. WANTED, ex-stock types: TP144, TP237P, TP720, A frequency meters type TP117. TP225. TP247, TP254, etc., receivers types R1159 and R1124. Send price and details toTxted Instruments, Ltd., 142 Islington High St., Hanwell, W.7. Tel. Basing 7993 (507)


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LEWIS RADIO have the best selection and finest finish. (4025)

EXCLUSIVE sale of cabinets in bakelite for television apparatus offered to constructors for different countries.-Apply Box 4928. (1447)

WALNUT radiogram and television cabinets. Advertisement.

METERS WANTED. We urgently require meters of all types, meter components, test equipment, etc., any quantity, large or small, prompt, cash. ANDERSON ELECTRONICS, Ltd. (42) Hampstead Rd., London, N.W.1. Euston 1659.

REPAIRS AND SERVICE. MAINS transformers rewound, new transformers to any specification. MOTOR rewinding and complete overhauls; first-class worshipship; fully guaranteed. P.M. ELECTRIC, 59, Putney Bridge, Warter Gate, Nottingham. Est. 1917. Tel. 4796.

MAINS transformers, E.H.T.s, chokes, and E.H.T. coils, etc., promptly and efficiently rewound or manufactured to any specification. LABORIOUS REWINDING SERVICE, Ltd., 402a, Harrow Road, London, N.W.10. (4022)

SERVICE service for hire or sale over 2,000 models, radio and television, s.a.e. enquiries. P.R.O. Service. 13-6, W. Gilbert, 24, Prithi Gardens, London, W.12. Tel. She. 5922.


NOTICE that Melton Electronics, Ltd. (4007) Ashley Rd., Parkstone. Poole, Dorset, manufacturers of quality motors, line and frame outputs, R.F. and E.H.T. coils, and a complete range of G.I. and G.I.C. transformers.

YOUR enquiries for rewinding all Commercial Types will receive immediate attention. (4010)

REWRINDS and conversions to mains and output transformers, check chokes, etc., from A.M.P. equipment, supply all types, including wave-winding of all types.

PRESIDENT, VALVES WANTED. R. Shaw, 69, Folkestone Rd., Parkstone, Poole, tel. Ladbroke 2296.

DRILLED CHASSIS..dds, etc., supplied to specification; business heading or service card for trade prices.-Majestic Winding & Machining, 57, High Rd., Willesden Green, N.W.10. Tel. Wordsworth 7791.

24-HOUR service, 6 months' guarantee, any transformer, rewind, mains outputs and chokes, E.H.T. transformers and chokes, etc. supplied to specification; business heading or service card for trade prices.-Majestic Windings Co., 180, Windham Rd., Bournemouth.

D. C. BOULTON for repairs to any type of speaker, specialist, of heavy and P.W. for any standard, including power, accessory, pressure units, microphones, transformers and to specification; motors, etc., Lundy's, 81 Manchester Rd., Bradford. (1017)

ARMATURE rewinding service to the trade. Vacuum, d.c. generators, hood dryers, dental motors, vacuum cleaners, armatures re-placed from stock. 24 hours' service; every armature guaranteed we also specialize in complete overhauls and rebuilds of vacuum cleaners; all vacuum cleaner parts, boxes, bearings, fans, brushes for B.S.I. and Hotchkiss, E.M.I. 912, etc.

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PRESIDENT, VALVES WANTED. R. Shaw, 69, Folkestone Rd., Parkstone, Poole, tel. Ladbroke 2296.
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AUTOMATIC SELF-REGULATING CHARGERS

For 6 v/125 v. using the neutral lead: 6 v. charger, 100 mA; 125 v. charger, 2500 mA. General purpose ultra reliable. As sold for 11 years through W.W. with full data sheet and instructions. No. 1 Kit. Rainwater 3 amp. rectifier, 65 watt tapped, unregulated train, insulated lead, full set of instructions. For 12 v., 60 amp., complete unit, complete public address equipment; complete set of instructions. For 110 volts, 40 amp., complete public address equipment; complete set of instructions. For 120 volts, 60 amp., complete public address equipment; complete set of instructions.

FOOLPROOF CHARGER KITS

Gratuitous trouble free and ultra reliable. As sold for 11 years through W.W. with full data sheet and instructions. No. 1 Kit. Rainwater 3 amp. rectifier, 65 watt tapped, unregulated train, insulated lead, full set of instructions. For 12 v., 60 amp., complete public address equipment; complete set of instructions. For 110 volts, 40 amp., complete public address equipment; complete set of instructions. For 120 volts, 60 amp., complete public address equipment; complete set of instructions.

PITMAN

September 1955

AUTOMATIC 'CHARGERS' and POWER PACKS

as supplied to Ministries, Airline Co's, etc., up to 150 watts. Correct design, best materials and workmanship. Selenium rectifier stacks, 40 ms. to 10 am, with or without transformers.

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At a. l. Kit. 3 a. rectifier, 65 watt trains, tapped, insulated lead, full set of instructions. For 12 v., 60 amp., complete public address equipment; complete set of instructions. For 110 volts, 40 amp., complete public address equipment; complete set of instructions. For 120 volts, 60 amp., complete public address equipment; complete set of instructions.

120, 5 in., 1 amp. 42/6p. Output 2/60, wh. 68.

PROOFFOUR CHARGER KITS

Gratuitous trouble free and ultra reliable. As sold for 11 years through W.W. with full data sheet and instructions. No. 1 Kit. Rainwater 3 amp. rectifier, 65 watt tapped, unregulated train, insulated lead, full set of instructions. For 12 v., 60 amp., complete public address equipment; complete set of instructions. For 110 volts, 40 amp., complete public address equipment; complete set of instructions. For 120 volts, 60 amp., complete public address equipment; complete set of instructions.

PITMAN

Parker St.  - Kingsway  - London, W.C. 2

Radio and television engineer (fully experienced) required: house available for right person or persons of suitable ability. Experience, but experience in the electronics industry is not in every case essential.

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The engagement of the new stock not surp"ised, 1 v., 1/5, 2/6. 7/6, 9/6. 5/-, all p.p. 10/6.

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SITUATIONS VACANT

ELECTRONIC Engineer.
INTERESTING post in new and expanding division of a large Co., for an energetic engineer to lead a small team on design and development of pulse generators, wide band amplifiers, osciloscopes and other instruments. West London suburbs (commuting salary £1,000 per annum.—Box 5133.

M I C R O W A V E Engineer.
AEI required for Radar, Ltd., for work on advanced microwave and millimetric aerial design in a large and expanding Aerial Group. Applications are invited from Electrical Engineers and Physicists with an S.N.C. standard or above, having practical experience in microwave components; the prospects for men of ability are considerable. There is a pension scheme in operation. (M.I.R.E.M. Orally essential.—Please write, quoting reference RLA 106, Deepe Radar, Ltd., E.1. Tolworth Rise, Epsom, Surrey.)

FERRANTI, Ltd., their Physics Laboratory are engaged in a programme of electronic development of great industrial importance. The work involves the use of digital computers to monitor processes. Positions are available from £210. Readership ensures a wide and expanding field of application. A salary commensurate with the qualifications required and staff pension scheme; application form will be sent on request. (Applicants quoting reference RLA 176 apply to The Personnel Officer, Ferranti, Ltd., Perdy Rd., Edinburgh.)

TECHNICAL ASSISTANTS.
ELECTRONIC, to undertake development work on a large variety of equipment in a Missile Guidance laboratory now underway extending types of work include microwave and pulse circuitry, field work on aerials, test gear, etc. Power supplies should have electronic experience, preferably of radar, complemented by some experience in design and hold; or be studying for, H.N.C. or equivalent. Service experience an advantage. Excellent salary with bonus. Pension Scheme. Premises: Leigh. Request Information.—Apply quoting Ref. WW 15, with full details of experience, to the Assistant Manager, THE FAIRY AVIATION Co., Ltd., Weapon Systems Division, Heston Aerodrome, Hounslow, Middx.

C I N E M A TELEVISION, Ltd.
HAVE vacancies in the VACUUM Tube Development Laboratory at Lower Sydenham. Post involves technical supervision of small scale work, including cathode ray tubes, photocells and signal generating tubes; technical experience of similar vacuum work an advantage, but not essential. Applications are invited from men of suitable age, qualifications and previous experience, are invited from suitable men and women applicants should be free from National Service obligations.


LABORATORY Assistants. Qualifications: Advanced level in general science or with ordinary national certificate; successful experience will be expected to continue studies at evening classes.

LABORATORY Technicians. Qualifications: To G.O.E. ordinary level in science and mathematics; must have had some experience in careful and detailed work and have considerable general mechanical aptitude.

3. VALVE Mechanics.
For experimental and pre-production valve assembly; basic training in workshop practice essential. Experience in similar work and good manual dexterity essential.

4. SCIENCE Laboratory Assistants.
With at least 2 years experience of branch and laboratory work and some preparation of small metal to class vacuum seals.

5. FILMED Pipe Tester.
To carry out performance checks on a wide range of vacuum tube manufactured on company laboratory scale; education approaching G.O.E. advanced level in general science essential.

ITEM 1. 59 hour week; items 2-6, 44 hour week.

PENSION scheme, canteen facilities, 25 minutes Charging Charter. APPLY to Personnel Department, CINEMA-TELEVISION, Ltd., WORSLEY Bridge Road, Lower Sydenham, S.E. 26.

R A D I O and/or television engineer required for bench and outside repairs; drive; reference age, experience, salary expected.—Ajay Ltd., Radio Division, S.G. Gale, Dinsdale.

E L E C T R I C A L SERVICE (EDGWARE), Ltd.
Electrical Engineer, includes design of complete electrical circuitry and equipment for industrial services; with a background in the design and installation of electrical systems, including switchgear. Salary: £260 to £300 per annum—Box 2542.

GUARANTEE: All our models are sold under full and unconditional money-back guarantee of satisfaction, and we will refund your money if for any reason you are not satisfied after 7 DAYS TRIAL IN YOUR HOME.

W H A T is the DUODE 12C like? A very special unit, similar to the well-known 150 but now fitted with a clever outer suspension and selected cone. Its bass range extends well down to 25 cm., almost sub-sonic, and the extreme top, to over 16,000 cm.—almost ultra-sonic. The large magnets give about 17,000 gauss, which, with the Duode built-up damping, holds all transients and the bass register in the finest grip. Definition throughout the entire range is superb. We believe the Duode 12C is the finest high quality Sound Unit available at any price to-day. List price £20. Value—Full tax.

DUODE 12A
A full 12 inch unit with the famous dual drive, built-in crossover, feedback and individual care which have made the Barker and Duode names so world famous for NATURAL sound. Fitted with a magnet about 14,000 gauss. List price £10. Full value—no tax.

DUODE 12B
The same cone and drive assembly with a better magnet giving about 14,000 gauss and similar performance, fitted to the standard Duode of the past two years. List price £14. Full value—no tax.

DUODE 12C
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DUODE 12D
A full 12 inch unit similar to the Duode 12C with larger bass and greater output. Fitted with a magnet about 17,000 gauss. List price £20. Full value—no tax.
CAPACITY AVAILABLE

Due to further expansion of our works and facilities manufacturers are advised that immediate capacity is available.

FOR THE MANUFACTURE OF Transformers, Chokes and Inductances, including wave winding of all types.

HADFIELDS solventless varnish vacuum impregnation and enveloping processes to approved specifications.

MACHINE ENGRAVING on metal and plastics.

Enquiries to—

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387. ASHLEY RD., PARKSTONE, DORSET.

Telephone: Parkstone 230.
AUTOMATIC TELEPHONE & ELECTRIC COMPANY LTD. LIVERPOOL, 7.

COMMUNICATION ENGINEERS AND DRAUGHTSMEN

The Transmission Department invites applications in senior and junior categories for LINE TRANSMISSION LABORATORY ENGINEERS, and APPARATUS DESIGN ENGINEERS, and also DRAUGHTSMEN with experience in telecommunication and light current engineering. Expanding programmes offer progressive opportunities in interesting work.

Specialist experience in any branch of line transmission engineering is desirable for some of the posts.

The positions offered are on the Company staff, with contributory Pension Fund, and usual staff conditions. Assistance in establishment in the Liverpool area will be given in approved cases.

Applicants should write to the Personnel Manager, Automatic Telephone & Electric Co. Ltd., Stronger Works, Edge Lane, Liverpool, 7, giving full details of age, experience and qualifications.

Situations Vacant

E.M.I. ENGINEERING DEVELOPMENT, LTD.

Transformer design.

A VACANCY has arisen at the Feltham laboratories of this active company for an engineer to work in transformers design and development; the person we are looking for will have at least Ordinary National and preferably had some experience in the field; but this is not a pre-requisite. Application is invited in the first instance from qualified persons who are looking for a varied and interesting nature, concerned with the development of modern electronic equipment. There is no written examination, but passing a practical test of British Nationality essential—Write: Referring to RLA.110.

Electrical Wiremen and Radar Mechanics are required by Decca Radar to fill positions as Technical Assistant in their Research Division. These positions carry excellent rates of pay and the possibility of promotion to staff appointments. A varied and interesting nature, concerned with the development of modern electronic equipment. There is no written examination, but passing a practical test of British Nationality essential—Write: Referring to RLA.110.

HER MAJESTY'S OVERSEA CIVIL SERVICE

Applications are invited for the following posts—

TELECOMMUNICATIONS Engineer.

POINTS and TELEGRAPHS Department, Sierra Leone.

DUTIES cover all general branches of telecommunication engineering, maintenance and construction of all fixed and underground plant, all types of telephone exchanges, telegraph apparatus, and point-to-point radio works.

APPOINTMENT is either pensionable in the salary range £250-£1,525 p.a. gross or on contract for two tours of 15-30 months each, in the salary range £350-£1,750 p.a. gross, plus a family allowance of £45 to £95 p.a. for each consolidated 9 months satisfactory service. Free first class passages for the officer, his wife, and up to two children under 10 years of age. Government quarters are provided, if available, at reasonable rent. Leave is granted at the rate of 7 days for each month of service. CANDIDATES should be A.M.I.E.E. or have passed or be exempt from Parts A and B of the Institution's examination. A sound knowledge of the theory of telecommunication engineering is necessary and extensive experience of its application desirable.

APPLY in writing to the Director of Recruitment, A.M.I.E.E., 17 Queen Anne's Gate, London, S.W.1, giving full details of age, experience, and qualifications. Mention the reference number (B.CD.10/25/03). Closing date for receipt of initial applications—September 15th, 1955.

JUNIOR Wireless Operators required at the Feltham laboratory of the Britamer Ltd. for work on transformer design and development; the person we are looking for will have a sound knowledge of electronics, also thorough knowledge and experience of multi-channel carrier-telephony, radio, A.M. and F.M. telephony, public address equipment, all types of repeaters and automatic telephony. Some knowledge of radar and computers desirable. Amadeus qualifications essential. The commencing salary will be £1,050 per annum. Family residential and other travel concessions given. Applications should be addressed to the Personnel Manager, Britamer Ltd., Eastern Place, East Acton, London, W.1, giving full details of experience and qualifications. Letters should be marked —D.A.15/009.

Sales Engineer required with a good knowledge of the application of components and equipment in ULTRASONIC equipment, RADAR equipment, GUIDED MISSILES.

Preferably with commercial background in addition, salary in accordance with experience, excellent opportunity for progress in a rapidly expanding organisation—Box 150/2.

Electronics Engineer required who can undertake part or full time development of low frequency Final Quadruplers. In first instance 1950/51 Box 1112, 1491.


Prices include postage

Truvox Tape Deck Switch 11219/B/3 inc. postage

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(Wafer Switches to Specification)

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COILS

Output, and Special Purpose Transformers for Radio Equipment, Chokes, etc.

Solenoids for A.C. and D.C. Operation.

W. F. PARSONAGE & Co., Ltd.

INDUCTA WORKS Park Rd Bloxwich Walsall

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TRANSFORMERS of all types up to 25 KVA for Single or Three Phase operations. Phasor conversion, etc.

Mains

For Contactors, E.M. Brakes, Air Valves, etc., and Coil Windings for all purposes.

SOLENOIDS

for A.C. and D.C. Operation.

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Tel: ULVERSTON 3306

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QUARTZ CRYSTAL UNITS

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 anodic sputtering give permanence of calibration. Normal adjustment, accuracy 0.01%, adjustable to ±0.005.

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

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Prices include postage
**SITUATIONS VACANT**

**THE GENERAL ELECTRIC Co., Ltd.,** has vacancies for:

1. **TRANSFORMER DESIGNERS** for a number of development projects including guided missiles. The work involves design of a wide range of types including small power transformers. Must have knowledge of electronic components and possess H.N.C. & G. certificates of equivalent qualifications.
2. **ENGINEERS** for work on magnetic amplifier transducers.

**APPLICANTS** should have experience of the design and development of the above types of equipment and possess H.N.C. & G. certificates of equivalent qualifications. **APPLICATIONS** will also be considered from ex-Navy R.E.A., R.E. and R.A.P. radio fitters who have reached the technical standard.

**APPLY** stating age and experience to the Personnel Manager, The General Electric Co. Ltd., Brown's Lane, Allesley, Coventry, Ref. RG.

**GOLD COAST GOVERNMENT**, Broadcasting Engineers.

**APPLICATIONS** invited for one vacancy in each post of:

A. **HEAD of Engineering Training**.
B. **ASSISTANT in Engineering Training (Radio Frequency)**.
C. **ASSISTANT in Engineering Training (Audio Frequency)**.

**DUTIES**: Post A: Responsible for formulating and carrying through a training scheme in radio engineering for new entrants to the service, courses of training "on the job" for existing staff, and a course and examination approximately equal to the B.B.C.'s Grade C examination for Technical Assistants who wish to qualify for promotion into the Senior Technical Assistant Grade.

Post B: Responsible under the Head of Engineering Training for the training of pupils scattered in small groups over wide areas by lectures and post courses, up to approximately the standard of the B.B.C.'s Grade C examination with emphasis on radio frequency subjects and on the theory and operation of radio frequency equipment. Will also be required to carry out some operational duties.

Post C: Responsible under Head of Engineering Training for the training of pupils and staff scattered in small groups over wide areas by lectures and post courses, up to approximately the standard of the B.B.C.'s Grade C examination with emphasis on audio frequency and power frequency subjects; also for specialised courses on the theory and operation of radio frequency and wired broadcasting equipment used in a broadcasting organisation. Will also be required to carry out some operational duties.

**QUALIFICATIONS**: All posts. Candidates should have passed or have been exempted from Sections A and B of the Associate Membership examination of the Institution of Electrical Engineers or hold equivalent qualifications. Additionally as follows:

Post A: Have had previous teaching experience. Must be able to organise the training scheme in all its aspects, including postal courses, its inception, and must have a thorough knowledge of the requirements for the engineering division of a broadcasting service.

Post B: Candidates with exceptional experience not necessarily requiring the above qualification may be considered for appointment. Candidates should have a thorough knowledge of studio apparatus and acoustics, tape and disc recording and power equipment and should also have a sound knowledge of the fundamental theories of audio frequency and power frequency equipment and be capable of lecturing on these aspects. Previous teaching experience desirable.

Post C: Have had appropriate experience in radio engineering. Candidates not so qualified but with exceptional experience may be considered for appointment. Candidates should have a thorough knowledge of studio apparatus and acoustics, tape and disc recording and power equipment and should also have a sound knowledge of the fundamentals of the theory of audio frequency and power frequency equipment and be capable of lecturing in this subject. Previous teaching experience desirable.

**TERMS of Service**: The appointment will be on terms of contract; gratuity terms for one tour of 18 to 24 months, with extension of contract to a maximum of 5 years, a gratuity approximately equal to age, qualifications and experience. Gratuity up to £500 for each three-monthly completed satisfactory service. Free passages and accommodation for each member of family; one way for wife and up to three children under 15. Any leave with pay for each month's service. Kit allowance £100 may be paid. Battalion furnished accommodation at £90 p.a. rental. Income tax at normal rates.

**CANDIDATES** in the United Kingdom should apply to the Adjutant on Recruitment, Gold of Office, 13, Belgrave Square, London, S.W.1, for a form of application. Other candidates should send full personal details and statement of qualifications, experience, employment, etc., with approximate dates to that address.

**ELECTRONIC Development Engineers** required to be well-qualified North London company including specialist vacancy for test engineering department. Above-average salaries for experienced qualified engineers. Write Box 5114, (1965).

**TELEVISION**: Leading and progressive Murphy dealers need men with good theory background and able to drive, even if little practical experience. Good Salary, conditions and prospects. Singer's, Pad. 7915.

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**FM81**

Our FM tuners provide excellent reproduction with absence of background noise and are tunable between 87.5 Mhz—108 Mhz and will receive the proposed National B.B.C. FM Band. Modulated V.H.F. transmitters as and when installed within approximately 60 miles of the transmitter.

Using the latest valves and techniques they are available in the following types:

FM81 Illustrated above, £21 tax paid.

FM82 with pre-set station selection, output 1.2 volts, self-powered 250-350 volts, £34 tax paid.

SS/FM all waves AM and FM tuner, £33/10 tax paid.

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**SITUATIONS VACANT**

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1. **TRANSFORMER DESIGNERS** for a number of development projects including guided missiles. The work involves design of a wide range of types including small power transformers. Must have knowledge of electronic components and possess H.N.C. & G. certificates of equivalent qualifications. **APPLICATIONS** will also be considered from ex-Navy R.E.A., R.E. and R.A.P. radio fitters who have reached the technical standard.

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**DUTIES**: Post A: Responsible for formulating and carrying through a training scheme in radio engineering for new entrants to the service, courses of training "on the job" for existing staff, and a course and examination approximately equal to the B.B.C.'s Grade C examination for Technical Assistants who wish to qualify for promotion into the Senior Technical Assistant Grade.

Post B: Responsible under the Head of Engineering Training for the training of pupils scattered in small groups over wide areas by lectures and post courses, up to approximately the standard of the B.B.C.'s Grade C examination with emphasis on radio frequency subjects and on the theory and operation of radio frequency equipment. Will also be required to carry out some operational duties.

Post C: Responsible under Head of Engineering Training for the training of pupils scattered in small groups over wide areas by lectures and post courses, up to approximately the standard of the B.B.C.'s Grade C examination with emphasis on audio frequency and power frequency subjects; also for specialised courses on the theory and operation of radio frequency and wired broadcasting equipment used in a broadcasting organisation. Will also be required to carry out some operational duties.

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<table>
<thead>
<tr>
<th>Page</th>
<th>Page</th>
</tr>
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<tbody>
<tr>
<td>E.M.I. Institutes</td>
<td>25, 98, 121, 134, 150</td>
</tr>
<tr>
<td>E.M.I. Institutes</td>
<td>166</td>
</tr>
<tr>
<td>E.N.A.</td>
<td>166</td>
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It needs courage and imagination, backed by sound judgment, to be continually 'out in front' pioneering new developments. But this is how we at T.C.C. interpret the responsibility of Leadership.

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