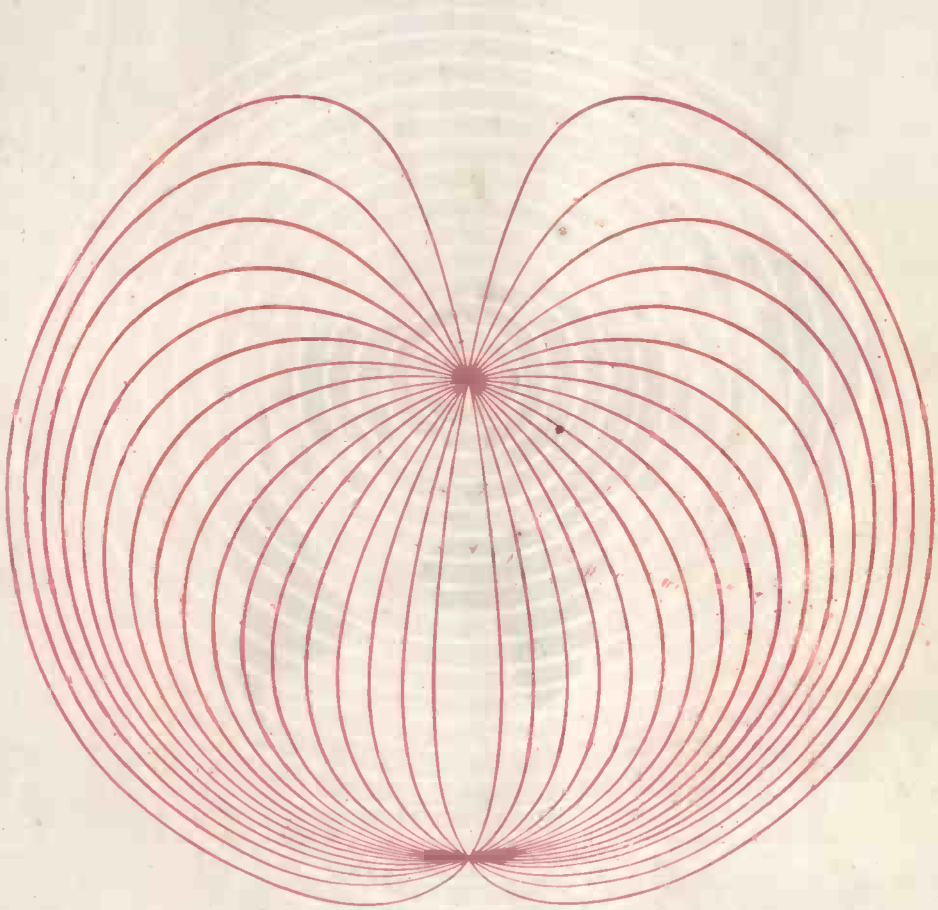
Wireless World

JULY 1954 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

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Wireless World

RADIO, TELEVISION AND ELECTRONICS

44th YEAR OF PUBLICATION

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

JULY 1954

In This Issue

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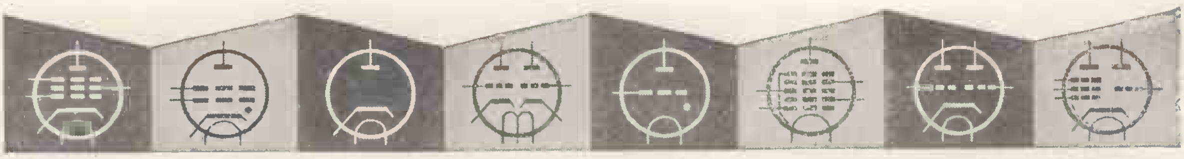


VALVES, TUBES & CIRCUITS

19. ECC85: COMBINED R.F. AMPLIFIER AND MIXER FOR BAND II F.M. RECEPTION

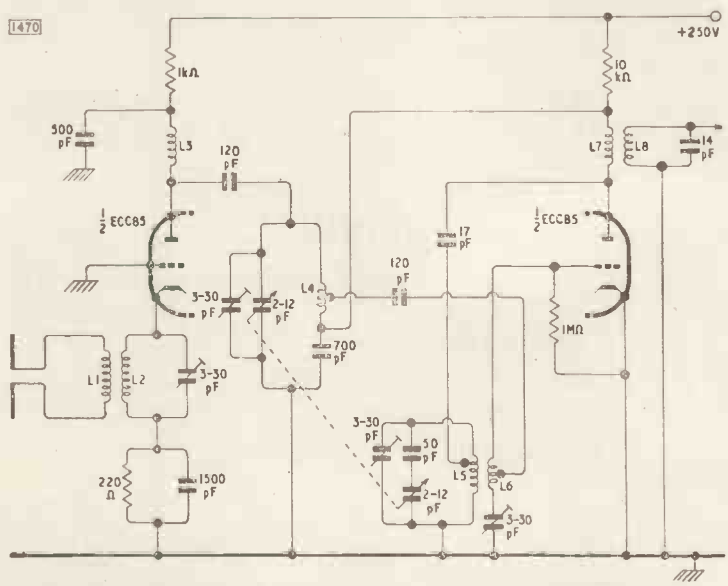
Preliminary Valve Data

HEATER		
Vh	6.3	V
Ih	0.435	A
CAPACITANCES		
*ca—g	1.5	pF
*cg—(k+h+s)	3.0	pF
*ca—k	0.17	pF
*ca—(k+h+s)	1.2	pF
**ca′—(k′+h+s)	1.9	pF
**ca″—(k″+h+s)	1.8	pF
ca′—a″	<0.04	pF
**ca′—a″	<0.008	pF
ca′—k″	<0.008	pF
cg′—g″	<0.003	pF
ca′—g″	<0.008	pF
ca″—g′	<0.008	pF
ca″—k′	<0.008	pF
cg′—k″	<0.003	pF
cg″—k′	<0.003	pF
*Each section		
**Measured with an external shield		
CHARACTERISTICS		
Va	250	V
Ia	10	mA
Vg	−2.3	V
gm	6.0	mA/V
µ	57	
OPERATING CONDITIONS		
R.F. Amplifier		
Vb	250	V
Va	230	V
Ia	10	mA
Vg	−2.0	V
gm	6.0	mA/V
ra	9.0	kΩ
Self-Oscillating Mixer		
Vb	250	V
Ra	12	kΩ
Rg—k	1.0	MΩ
Ia	5.2	mA
Vosc(r.m.s.)	3.0	V
gc	2.3	mA/V
ra	20	kΩ
LIMITING VALUES (each section)		
Va(b) max.	550	V
Va max.	300	V
pa max.	2.5	W
pa′+pa″ max.	4.5	W
Ik max.	15	mA
−Vg max.	100	V
Rg—k max.	1.0	MΩ
Vh—k max.	90	V
Rh—k max.	20	kΩ
BASE	B9A	

It is essential when designing F.M. receivers for operation at V.H.F. to reduce noise in the input stages and radiation from the local oscillator by including an R.F. amplifier before the frequency changer. A triode is preferred for the R.F. stage because it has better noise properties than a pentode. The Mullard double triode type ECC85 has been specially designed for the 'front-end' stages in F.M. reception. One triode section is used as the low-noise amplifier and the other triode section follows it as a self-oscillating additive mixer. With this arrangement both oscillator radiation and noise are reduced by feeding the signal from the R.F. stage to a null point on the oscillator coil.

The outstanding feature of the ECC85 is that extensive internal screening has been provided to reduce the capacitance between the anodes to less than 0.04 pF, so that in a suitable circuit the oscillator radiation can be made lower than with any double triode previously available. This capacitance can be reduced to less than 0.008 pF by surrounding the valve with a screening can 22.5 mm in diameter. The front-end stages are thus separated effectively without the cost of using two separate triodes. These measures are completely satisfactory in reducing oscillator radiation to an acceptable value, since only a relatively low oscillator voltage is required to drive the mixer. In addition to having high slope and input resistance, the ECC85 has an amplification factor of 57.

A typical circuit for the ECC85 is given below in which the R.F. section is operated with a grounded grid and the mixer with a grounded cathode. A grounded-grid circuit has the advantage of being more easily adjusted than one which requires special measures to neutralise the anode-to-grid capacitance. Any additional gain which might be obtained from more complex circuits is not necessary, and in fact the input coils L1, L2 can be matched for minimum noise rather than maximum power. The frequency changer input is taken from a tap on the R.F. coil, L4, in order to increase the R.F. gain and also to ensure that the required frequency range is covered by the 2-12 pF tuning capacitor. The oscillator circuit is anode-tuned and is coupled to the anode by a 17 pF capacitor which because it presents a low impedance to an intermediate frequency of, say, 10.7 Mc/s also tunes the I.F. transformer. Internal anode-to-grid capacitance in the mixer triode, which might reduce the amplification, is neutralised by applying an I.F. feedback voltage to the grid.



Wireless World

JULY 1954 VOL. 60 No. 7

Radio Licences

LAST month we entered a mild protest about the new G.P.O. radio licence regulations, drawing attention to certain anomalies and irrelevancies. In particular, we complained that the licence fees charged for broadcast sound and vision reception in guest rooms of hotels were excessively high. According to the regulations, the full domestic fee is to be paid for each room equipped.

We are now told, in effect, that the "Statutory Instrument" under which these regulations were made must not be taken too literally. The wording of the Post Office official statement on this subject is somewhat vague, but apparently the regulation applies only to "permanent" residents; most transient occupants of hotel rooms may be assumed to have already a licence for their home installations. And, anyway, the onus of seeing that his set (or extension loudspeaker) is licensed is apparently on the guest; not on the hotel proprietor.

What is a "permanent" guest? A person normally resident abroad is, we believe, liable to be caught up in the U.K. tax net after a stay of six months in this country. It sounds reasonable, therefore, to suggest that, after the same period, the hotel guest, whether British or foreign, might he held liable to pay for a broadcast licence. But how many people stay in the same hotel for six months or longer? Not enough, we should guess, to justify this rigmarole of the so-called Comprehensive Hotels Licence. The comparatively rare case of the "permanent" hotel guest could easily, and administratively much more simply, have been covered by adding a few words to the regulations covering ordinary domestic licences.

We are forced to the conclusion that the Post Office, over-anxious to regularize its position with regard to the whole question of licences, has rushed through the new regulations without sufficient thought. Not only has the hotel licence already become virtually a dead letter; it has been found necessary to alter the conditions under which apparatus for the radio control of models may be operated. Further, it appears that the terms of the licence appropriate for this purpose were framed without consultation with the bodies concerned. Indeed, it would seem that the only body of radio users to express satisfaction with the new licence regulations are the transmitting amateurs, who, as reported last month, have been granted some small concessions.

Television for Posterity

IT is being increasingly borne home to all of us that in choosing standards for a public television service we are acting as trustees for posterity. When a system is once firmly established it becomes, almost inevitably, a standard for all times. At the least, it will have a profound influence on technical developments for many decades ahead. All progress tends to be handicapped by the need for "compatibility"; the new system must be able to work with the old.

Even to hint at the possibility of a non-compatible successor to the present British system has, until recently, been considered unrealistic, idealistic or "starry-eyed." But now there are faint signs of a revolt against the dogma of compatibility, and a correspondent whose letter is published elsewhere in this issue does not hesitate to say "it may tie a weight round the neck of every receiver designer for the next century." He refers to compatibility in relation to colour television.

Wireless World has often been impatient when artificial barriers are put in the way of progress in the various branches of our art. But, in this matter, we are on the side of those who believe in making haste slowly. To start colour television before a really practical solution of the many technical difficulties has been found would be foolish. A policy of "anything so long as it is colour" is to be deplored; so are irresponsible statements that the public may expect colour television within a year or two.

In the meanwhile, no effort should be spared in exploring all the technical possibilities for the future and in planning, with all the wisdom we can command, for orderly development of the service.

SHIPS' LIFEBOAT RADIO

On the left is shown the kite just after launching: at its normal working height the aerial wire is more nearly vertical. The fixed inverted-V aerial is carried by a resin-bonded fibre-glass mast. Above is the SOLAS lifeboat set, with front cover removed.

AN improved kind of kite is one of the accessories of a transmitter-receiver for ships' lifeboats, recently type-approved by the G.P.O. and Ministry of Transport, which has been produced by the International Marine Radio Company. Kites have been used for raising wireless aerials ever since Marconi's transatlantic experiments of 1902, but have been generally considered unreliable: the new design produced by I.M.R.C. seems to represent a distinct advance, and is easily launched from the restricted platform provided by a ship's lifeboat. The kite flies well in winds of five or six miles an hour, and, by lifting an aerial wire to a height of about 200ft, provides a radio-communication range vastly greater than that attainable with any practicable mast-supported lifeboat aerial. During recent tests, daylight ranges of over 500 miles were achieved with average radiated power as low as 4 watts—a rather remarkable performance, considering the tests were carried out in Southampton Water, where heavy interference prevails.

The I.M.R.C. "SOLAS" (Safety Of Life At Sea) set transmits on the international distress frequencies of 500 kc/s and 8.634 Mc/s. There is clockwork-driven automatic keying for the alarm signal, SOS, and direction-finding dash, with hand-keying as an alternative. Telephone modulation is also provided. Reception is on 500 kc/s only. The set is powered entirely by a hand-turned generator; an extra crank is provided so that the work may be shared by two men.

For transmission, the three valves work as master oscillator, power amplifier and modulator; modulation for m.c.w. telegraphy is square-wave, giving the wide-band characteristics desirable for distress calls. The note is distinctive and readable through interference. There is a tuning indicator as an aid to adjusting the aerial circuit; this is needed for obtaining maximum radiation under all conditions, as a fixed aerial supported by an 18ft mast is used as an alternative to the kite aerial.

For reception, two of the valves become r.f. amplifiers and the third an a.f. amplifier; there is a germanium diode detector. An external crystal receiver can be provided; this permits listening without turning the generator.

The set is contained within a completely waterproof light alloy case which can withstand rough handling. The spindles of the controls work in waterproof sleeves, so the gear can be operated in bad weather with the front cover removed.

TRANSISTORS FOR HIGH FREQUENCIES

AN inherent limitation of the first junction transistors was the comparatively low frequency at which a sudden deterioration of current gain sets in (the so-called alpha cut-off). The physical cause of this cut-off is complex, but is generally accepted as being related, among other things, to the transit time of current carriers at the base-collector junction.

In practice the frequency at which cut-off occurs can be increased by reducing the width of the centre base section of the junction, but this involves expensive manufacturing techniques and may have adverse effects on other desirable parameters of the transistor.

An alternative method of construction is described by J. M. Early in the May, 1954, issue of *The Bell System Technical Journal*. Essentially it involves the interposition of a layer of high-purity germanium between base and collector, which is described as a depletion layer and has the attributes of a space charge. In addition to reducing the effective base-collector capacitance and increasing the reverse breakdown voltage, it also results in an increase in the mobility of current carriers through this region. The germanium in this layer is said to have intrinsic conductivity, that is to say, the available current carriers are not supplemented by donor impurities (giving negative electrons, *n*) or acceptor impurities (creating positive holes, *p*). Hence the description *p-n-i-p* or its converse *n-p-i-n*.

Experimental transistors, constructed on this principle with 0.002-in thick *i*-type layers, have oscillated up to a frequency of 95 Mc/s. Theoretically, with improved materials and geometrical forms, it is stated that there is a prospect that they may be made to work up to 3,000 Mc/s.

WORLD OF WIRELESS

B.B.C. in Band III • More V.H.F. Transmitters Ordered • Television for Jersey • Electronics Convention and Show

Band III Television

BOTH the component and receiver manufacturing sections of the industry (represented by R.E.C.M.F. and B.R.E.M.A.) have recommended the standardized use of a single input of 75 ohms for both Bands I and III. This is a long-term policy to which both receiver and aerial manufacturers will work, but it is pointed out that in the interim there will be some installations for which two inputs will be necessary.

It is understood that pulsed test signals in Channel 8 (186-191 Mc/s) are already being radiated by the B.B.C. from Sutton Coldfield. Sir Ian Jacob has said that the B.B.C. is ready to put into operation its scheme for a second programme as soon as frequencies become available.

B.B.C. Awaits Green Light

ALTHOUGH official approval of the B.B.C.'s plan to reinforce the present coverage of the Home, Light and Third Programme Services with v.h.f. transmissions is still awaited, the Corporation is continuing to place orders for equipment.

A further order for 14 v.h.f. frequency-modulated transmitters has been placed with Marconi's. This brings the total number of transmitters now on order to 64 (40 Marconi and 24 S.T.C.). With the exception of two, which will have a power of 10 kW, the transmitters will be rated at 4.5 kW.

Since the Government decision that f.m. should be used for the proposed v.h.f. service, both experimental transmitters at Wrotham have been employing frequency modulation. The present schedule is Mondays to Thursdays 11.15-12 noon, 1-2 p.m. and 2.45-4.30 p.m.; every day except Friday 6 p.m. until the close down of the service being radiated. The Home Service is radiated on 93.8 Mc/s and the Light Programme (until 4.30) and the Third Programme (from 6) are radiated on 91.4 Mc/s.

Tests of tone modulation with various peak deviations are radiated from 11 to 11.15 and 2.30 to 2.45 (Mondays to Thursdays) on both frequencies.

Industrial Electronics

THE five-day industrial electronics convention organized by the Brit.I.R.E., which opens at Christ Church, Oxford, on July 8th, has aroused considerable interest in many industries, including aircraft, electrical, film, glass, iron and steel, motor, oil and rubber, all of which will be represented.

Thirty-two papers will be presented and discussed during the six sessions—Industrial Applications of Electronic Computors (chairman, L. H. Bedford), Industrial Applications of X-Rays and Sonics (H. G. Foster), Nucleonic Instrumentation and Application (N. C. Robertson), Electronic Sensing Devices—Transducers (Prof. E. E. Zepler), Process Control (J. L. Thompson), Electronic Aids to Production (Sir Walter Puckey). The papers and a verbatim report of the discussions will be published by the Institution.

Channel Islands TV

DIRECT reception of the Wenvoe and Alexandra Palace transmitters will be relied upon for the television "booster" service which the B.B.C. plans to introduce in the Channel Islands within a year. The distances between these stations and the receiving centre to be set up at Torteval on the south-west coast of Guernsey, are approximately 130 and 190 miles, respectively.

The picture received in Guernsey on the alternative aerial systems directed towards the two stations will be transmitted by radio link to Les Platons on the north coast of Jersey—some 20 miles away. There a low-power transmitter working on 61.75 Mc/s vision and 58.25 Mc/s sound will re-broadcast a service to the group of islands. The transmissions will be horizontally polarized.

Rediffusion is planning to install a television wire distribution service in Jersey.

Radio Control of Models

THE LICENCE now required for the operation of radio equipment for the control of models has been criticized by the International Radio Controlled Models Society, and, as a result of meetings with the G.P.O., some concessions have been made and obscure rulings interpreted.

The maximum effective radiated power, which is the mean r.f. power multiplied by the aerial gain in the horizontal plane, was originally limited to 0.3 W. This has now been raised by the Post Office to 0.5 W when working on 465 Mc/s and 1.5 W on 27 Mc/s.

Although not permitted under the original provisions of the new licence, operation of equipment by other people under direct supervision of the licensee will now be allowed.

Earl's Court

PLANS for the National Radio Exhibition (Earl's Court, August 25th-September 4th) are going ahead and the preliminary list of exhibitors totals 107. Of this number some 40 are manufacturers of domestic sound and vision receivers.

The technical training display will be more ambitious than in past years. It will include sections devoted to machine-shop practice, components, glass manipulation, circuitry and aerials. Also the Radio Trades Examination Board has been invited to organize a section illustrating radio servicing.

Electronics Show

THE ninth annual electronics exhibition organized by the N.W. Branch of the Institution of Electronics, will be held at the College of Technology, Sackville Street, Manchester, from July 14th to 20th.

The exhibition will be divided into two main sections—research, composed of displays by universities, research organizations, hospitals, etc., and commercial, devoted to the products of over 50 manufacturers.

A programme of 40 lectures has been arranged for presentation during the exhibition, which opens at noon on the 14th and at 10 on other days and closes at 10 except on the 17th, when it closes at 7.

Tickets are obtainable by sending a stamped-addressed envelope to W. Birtwistle, 78, Shaw Road, Thornham, Rochdale, Lancs., from whom the 100-page exhibition catalogue, which includes the time-table of lectures, is also obtainable, price 1s 6d.

BIRTHDAY HONOURS

Among those whose names appeared in the Birthday Honours List are:—

C.B.

W. A. Wolverson, director, External Telecommunications Executive, G.P.O.

K.C.M.G.

Major General L. B. Nicholls, chairman, Cable & Wireless, Ltd.

M.V.O.

Lt. T. D. Grosset, Royal Navy (Shore Wireless Service).

C.B.E.

T. E. Goldup, director of Mullard, Ltd. (see "Personalities").

O.B.E.

W. E. Cleaver, manager, Cable & Wireless Engineering School, Porthcurno, Cornwall.

F. M. Colebrook, senior principal scientific officer, National Physical Laboratory, D.S.I.R. (see "Personalities").

M.B.E.

F. N. Calver, engineer-in-charge of the Daventry transmitting station, B.B.C.

R. H. J. Cary, senior experimental officer, Radar Research Establishment, Malvern.

I. A. Dalgliesh, chief radio officer, British European Airways.

R. B. Hosking, signals officer, Ministry of Transport and Civil Aviation.

R. D. Lanser, superintendent of radio maintenance, British Overseas Airways Corporation.

S. H. Lines, general works manager, A. C. Cossor, Ltd.

A. I. F. Simpson, senior engineer, General Electric Company (see "Personalities").

PERSONALITIES

Colonel A. H. Read, C.B., O.B.E., who, as announced in our May issue, recently retired from the Post Office where he was director of Overseas Telecommunications,

Cdr. C. M. JACOB

K. SHORT

has taken up an appointment as Telecommunications Attaché at the British Embassy in Washington.

Colonel J. D. Haigh was recently appointed director of Electronics Research and Development (Defence) in the Ministry of Supply and promoted acting Brigadier. He has already served in this directorate (1946-50) when it was known as the Directorate of Telecommunications Research and Development. Since October of last year Col. Haigh has been employed on fuze design at the Armament Design Establishment, Fort Halstead.

Group Captain P. Allerston, O.B.E., M.I.E.E., recently appointed manager of the new Equipment Servicing Department of A. C. Cossor, Ltd., was concerned with the inauguration of the original Gee programme during the war. From 1946 to 1949 he was Deputy Director of Radio Engineering (Air) at the Air Ministry. In his new post he will be responsible for the installation and maintenance, both at home and overseas, of Cossor's airfield control radar, Gee ground and airborne equipment and other radio and radar gear.

Commander C. M. Jacob, D.S.C., A.M.I.E.E., R.N. (Ret.), recently appointed deputy technical manager of the Marconi International Marine Communication Company, specialized in radio and radar during the greater part of his naval career, which began in 1923. In 1939 he was appointed to the Home Fleet as fleet wireless officer and fleet radar officer. Since the end of the war he has held a number of shore appointments, including that of deputy captain-superintendent of the Admiralty Signal and Radar Establishment.

K. Short, D.L.C. (Hons.), A.M.I.E.E., who joined Truvox during the war and has been chief engineer since 1950, has been appointed technical director of the company. He studied at Loughborough College for five years, receiving a first-class honours diploma, and returned to the college for a further year in 1948.

T. E. Goldup, M.I.E.E., who has been a governor of the Ministry of Supply's School of Electronics at Malvern since 1949 and chairman of the Board of Governors for the past two years, is among the new C.B.E.s. Mr. Goldup is a director of Mullard, whom he joined in 1923. He was a member of the Radio Research Board of D.S.I.R. from 1950 until March this year, and was chairman of the Radio Communication and Electronic Engineering Association for 1953-54.

F. M. Colebrook, B.Sc., D.I.C., A.C.G.I., who is appointed an O.B.E., has been on the staff of the National Physical Laboratory, Teddington, since 1920. Since 1949 he has been officer-in-charge of the Electronics Section, prior to which he was deputy superintendent of the Radio Division. Mr. Colebrook is on the editorial board of our sister journal *Wireless Engineer* and has been a contributor to both *W.W.* and *W.E.* for the past 30 years. He is the author of "Basic Mathematics for Radio Students" published from this office.

A. I. F. Simpson, appointed an M.B.E., has been engaged in the design of radio equipment in the Coventry group of the G.E.C. for the past 19 years. Since the war he has been leading teams on various government projects, including one on the remote control of aircraft. Towards the end of the war he led the engineering team working on airborne, multi-channel radio-telephone equipment.

Joshua Sieger, who has been in the United States since the end of 1946, has returned to this country and proposes to continue his consulting work in radio and electronics. From 1930 to 1939 he was with Scophony and during the major part of the war was principal technical officer at T.R.E. During his stay in America he has acted as consultant and directed the research and development of aeronautical radar equipment and television gear. He was a member of two of the planning committees of the National Television Systems Committee, which established principles for a compatible colour system. Mr. Sieger's address is "Montcalm," Cliff Drive, Canford Cliffs, Bournemouth, Hants.

Stanley Kelly, whose article on piezoelectric crystals is concluded in this issue, has resigned the post of chief engineer with Cosmocord, Ltd., and has been appointed technical director of Thames Industries, Ltd., 143, Cannon Street, London, E.C.4, manufacturers of chemical and scientific equipment.

A. W. Montgomery, O.B.E., B.Sc., M.I.E.E., joint general manager of Standard Telephones and Cables, has been elected a Fellow of the American Institute of Radio Engineers for his "leadership in radio and telecommunication research in England, and his services in the international liaison in these fields." During the war he was engaged on the development of this country's defence teleprinter network and communication equipment.

Fred R. Lesser, formerly overseas sales manager, Goodmans Industries, Ltd., is now operating on his own account as representative of manufacturers of radio and electronic equipment and components. His address is 66, Holland Park Avenue, London, W.11 (Tel.: Bayswater 6792).

IN BRIEF

Television Licences in the U.K. increased by 51,946 during April, bringing the total to 3,300,838. The number of broadcast receiving licences, including television and 229,542 for car radio sets, totalled 13,455,061.

Receiver Oscillator Radiation.—Reports continue to be received that oscillation radiation from television receivers is causing considerable trouble on some of the v.h.f. bands and it is a pity the Admiralty's lead in regard to naval receivers cannot be more widely applied. A rigid requirement is imposed in regard to oscillator radiation from both set and aerial, the specified level being less than 0.1 μV/m at one nautical mile. Incidentally, the Rees Mace naval set, CAT, described elsewhere in this issue, fully complies with this requirement.

Ships' Newspapers.—The jubilee of the first regular daily newspaper to be published in transatlantic liners was celebrated by *Ocean Times* on June 4th. It was first published on R.M.S. *Campania* in 1904 as the *Cunard Daily Bulletin*. News collated from many sources is sent from the London office of the publishers, Wireless Press, Ltd., via the Rugby radio station, and similar dispatches are sent from New York.

Television as an advertising medium, and the problems facing advertisers using the medium, are dealt with in a booklet, **"Advertising by Television,"** issued by TV Commercials, Ltd., of 35, Portland Place, London, W.1. The new company will provide advertisers with technical as well as programme services for television advertising. Among the directors is Richard Meyer, who was from 1930 to 1940 general manager of the International Broadcasting Company, organizers of commercial programmes from Radio Normandy and Radio Luxembourg.

French F.M.—The French broadcasting authority, Radiodiffusion et Télévision Françaises, is to introduce a v.h.f. service based on the Stockholm Plan, which provides for some 170 French stations in Band II. Regular transmissions have been radiated from the new Paris f.m. station since the end of March. The 5-kW transmitter, with an e.r.p. of 20 kW, radiates on 96.1 Mc/s.

A further step in the plan to improve the coverage of the **Home Service** was taken by the B.B.C. on May 30th when the permanent 2-kW transmitter at Barrow-in-Furness took over from the 0.5-kW temporary station set up some time ago. It radiates on the international common frequency of 1484 kc/s (202.2 metres).

Television Society.—At the annual general meeting of the Television Society on May 27th the following were elected to fill the vacancies on the council: C. H. Banthorpe (Derwent Radio); J. H. Etheridge (Cinema-Television); H. A. Fairhurst (Murphy Radio); and E. A. Wood (Radio Rentals).

Radio Industries Club membership stood at 841 at the end of March—an increase of 47 during the year. The new president is C. O. Stanley, managing director of Pye, Ltd., and this year's chairman is R. F. Payne-Gallwey.

Acknowledgement.—The photograph of the *Sir John Cass*—the training vessel of the Navigation Department of the Sir John Cass College—reproduced in our last issue should have been acknowledged to *Motor Boat and Yachting*.

Mobile Radio.—The Postmaster-General has set up a committee to "examine the practical problems which the Television Advisory Committee's first report [on television] raises in relation to the mobile radio services." The Mobile Radio Committee, as it is called, which is under the chairmanship of R. J. P. Harvey (G.P.O.), includes two representatives of the Post Office, Ministry of Transport and Mobile Radio Users' Association, and a representative of marine users. Capt. L. P. S. Orr, M.P., and J. R. Brinkley (Pye Telecommunications) are representing the M.R.U.A. One of the Post Office representatives is C. W. Sowton, who is secretary of the T.A.C. Technical Sub-Committee.

EDUCATION AND TRAINING

Transistor Course.—Dr. G. N. Patchett, head of the Department of Electrical Engineering of the Bradford Technical College, is giving a course of eight lectures on the principles and applications of transistors at the college in the autumn. The fee for the eight lectures, which will be given on Wednesday evenings from September 29th, is £1 10s. Students should have reached the standard of the H.N.C. in electrical engineering.

Radio Recruiting.—A brief outline of the opportunities open to those who enter the radio and electronics industry and of the qualifications needed is given in "Careers in Radio and Electronics," a 12-page booklet issued by the Radio Industry Council. It is for free circulation to schools and technical colleges, and is obtainable from the R.I.C., 59, Russell Square, London, W.C.1.

"Careers in Engineering," an 18-minute film made by the English Electric Company, portrays the training available to the three grades of apprentice—craft, student and graduate—through the English Electric group of companies, which includes Marconi's. The 16-mm sound film, which is available on loan to technical colleges, schools, etc., covers the various branches of engineering including telecommunications and electronics. Further details of the company's apprenticeship schemes are given in two booklets entitled "Earning While Learning" and "Opportunities for University Graduates."

Details of **Day and Evening Courses** in radio, television and electronics provided by the Department of Telecommunications Engineering of the Northern Polytechnic, London, N.7, are given in the 1954-55 prospectus, which is obtainable from the secretary.

INDUSTRIAL NEWS

Birmingham's new **Engineering Centre** at Stephenson Place, which was opened on June 17th, provides a permanent exhibition for the display of engineering equipment. Kelvin & Hughes (Industrial), Ltd., are showing an electronic controller for the regulation of temperature in furnaces, dye vats, heat exchangers, etc.

To facilitate rescue operations in the 111 collieries under the jurisdiction of the N.W. Division of the National Coal Board, the vehicles used by the mines rescue service have been fitted with **G.E.C.** v.h.f. radio-communication equipment. Fixed stations have been installed at Boothstown (the headquarters of the service), Burnley and Wrexham.

A chain of **Decca** stations has been erected in the Sahara Desert to assist in a survey of some hundreds of square miles for oil.

Marconi Organization.—G. R. Tyler has been appointed manager of the recently-formed Maritime Division of Marconi's W.T. Company. He is succeeded as manager of the company's Central Division by R. H. Deighton. Chief engineer of the new division is J. Watt, B.Sc. (Hons.), D.I.C. The company's Services Equipment Division will in future be known as the Radar Division, of which H. J. H. Wassell, O.B.E., B.Sc. (Hons.), has been appointed chief engineer.

Among the four cable ships for which **Mullard's Equipment Division** is supplying "Discovery" direction-finding equipment is the *Monarch*, being refitted by the Post

Office in readiness for the laying of the transatlantic telephone cable.

Minnesota Mining & Manufacturing Company, whose products include "Scotch Boy" sound-recording tape, have opened a sales office at 90, Mitchell Street, Glasgow, C.1 (Tel.: City 6704).

EXPORT NEWS

Colour c.r. tubes are to be manufactured in this country by a new company—**Sylvania-Thorn Colour Laboratories, Ltd.**—which has been formed jointly by Sylvania Electric Products, Inc., of New York, and Thorn Electrical Industries, Ltd., manufacturers of Ferguson receivers. Sylvania's patents and technical know-how will be available to the new company.

S.H.F. radio networks, intended for the two-way transmission of 525-line television, are being supplied by **Standard Telephones & Cables** to the Canadian Pacific and Canadian National Railways. Five unattended intermediate repeaters will link Montreal and Quebec, and three will link Toronto and London. On the latter chain two spurs will go to Kitchener and Hamilton. These radio links can provide up to seven radio channels in each direction, and each of these can be utilized for carrying a television channel or 600 telephone channels.

B.T-H. has received a third contract for mobile fire-control radar from the U.S. Army European Headquarters Command. This contract, valued at £2.02M, brings the total value of the three orders to nearly £5M. All the equipment is for N.A.T.O. countries.

Marconi-I.A.L. Contract.—By combining their manufacturing and planning resources, Marconi's W.T. Company and International Aeradio, Ltd., have jointly secured a contract from the Syrian Ministry of Defence for the planning and equipment of a complete radio communications network for the Syrian air force. The contract also includes v.h.f./d.f. stations and a training school.

Precision approach radar equipment, which provides an airfield ground controller with visual and three-dimensional information (distance, azimuth and elevation) relating to an approaching aircraft, is being installed by **Standard Telephones & Cables** at the Royal Canadian Navy's airfield at Dartmouth, Nova Scotia. Similar equipment is already in use at two Ministry of Supply airfields in the U.K., two air force stations in Holland and the international airport at Zurich.

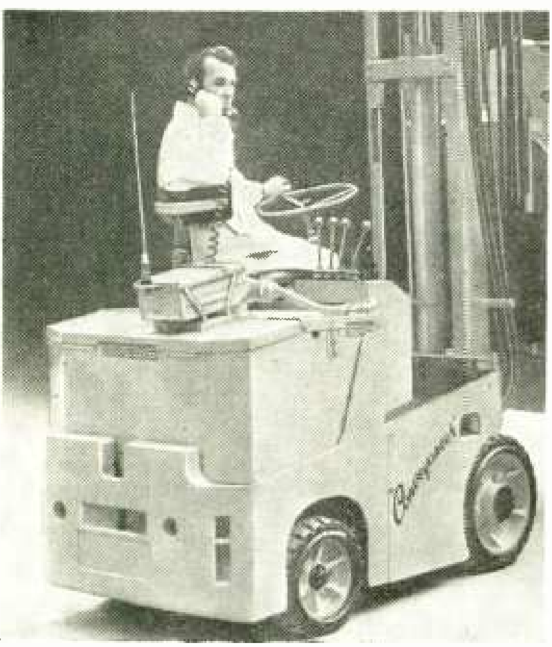
N. American Agency Enquiries.—Manufacturers of record changers not already represented in the United States are invited by the J. M. Zamoiski Company, 110, South Paca Street, Baltimore, Maryland, U.S.A., to send them particulars of their products. A.P.M., Ltd., of 15, Bacon Street, Moncton, New Brunswick, Canada, wish to undertake the distribution of British-made television aerial accessories, including masts. (B.o.T. references ESB/10817/54, ESB/10807/54).

Exporting Amateur Gear.—The Export Services Branch of the B.o.T. advise us that W. B. Dismukes, of 125, Velarde, Albuquerque, New Mexico, U.S.A., would like to receive catalogues and price lists of British amateur transmitting and receiving equipment with a view to acting as distributor in New Mexico. Further particulars are available from the Branch at Lacon House, Theobalds Road, London, W.C.1. (Ref. ESB/13794/54.)

British manufacturers of **Television Aerials,** covering the U.S. Channels 2-13 (54-216 Mc/s), and aerial accessories are invited by C. L. Curren of Atlantic Television Distributors, Ltd., 207, Charlotte Street, St. John, New Brunswick, Canada, to send him particulars of equipment by air mail.

Marconi's recently shipped to Brazil complete sound and vision equipment for a television station in Sao Paulo. The installation included four television camera channels, a vision mixer and associated equipment.

AIDS TO MECHANICAL HANDLING



Pye v.h.f. radio-telephone installed in a "Conveyancer" truck shown at the Mechanical Handling Exhibition.

CLOSED-CIRCUIT television has a sufficiently promising future in the industrial field to warrant the commercial introduction of suitable equipment. This, in the form shown by Pye at the recent Mechanical Handling Exhibition and Convention organized by *Mechanical Handling*, consists of two units. One is a camera unit embodying a miniature camera tube measuring 6 in × 1 in, operating on the photo-conductive as distinct from the photo-emissive principle; it is known as a Cathodeon Staticon.

Focusing of the image is achieved by moving the tube and its coil assembly to or from the three-lens turret by means of gearing operated by an external knob.

The camera is entirely self-contained and includes all the tube operating circuits, power supply, pulse generators for the 405-line or 525/625-line standards (there are two models) and a v.h.f. oscillator which can be modulated by the picture and pulse signals.

Either a video, or a modulated v.h.f., output can be taken from the camera, the former for displaying on the companion picture monitor and the latter for feeding into one or more normal television receivers as required. Video signals can be taken up to 1,000 ft and the r.f. signals very much further.

The picture monitor embodies a 14-in tube with light filter and is a precision instrument designed to give a very high-quality picture.

Several of the special types of truck designed for mechanical handling of materials and the finished product were shown this year fitted with Pye v.h.f. radio telephone equipment. The set used is in most cases the "Reporter" which operates on 6 or 12 volts, gives an output of 1 to 3 watts according to which part of the 60- to 185-Mc/s band it is operating in and employs amplitude modulation.

Developments in

Sound Reproduction

NEW PRODUCTS SHOWN AT RECENT EXHIBITIONS*

THOSE who are interested in audio matters and like to gain first-hand knowledge of new products by discussion with manufacturers have long been clamouring for a comprehensive Audio Fair in this country. Until this comes about, it is necessary for the enthusiast to attend at least three exhibitions, each with some restriction either of space or objective, to be sure of getting a reasonably broad view of what is new in sound reproduction.

Accordingly, in reporting these exhibitions we believe that a single review may be of more service than a series of restricted articles on the individual exhibitions, and we make no apology for laying the emphasis on the equipment rather than on the occasion on which it was shown.

Microphones.—A directional pressure-gradient moving coil microphone, Type DPA, has been developed by Reslosound. It is of all-metal construction and employs an aluminium-magnesium alloy diaphragm 0.0005in thick with a self-supporting coil working in a 0.02in air gap. Self-damped slit cavities provide the requisite phase differences between back and front of the diaphragm, and no absorbent material is used. A spring-loaded ball joint allows 22½ degrees of movement from the vertical.

In the ribbon (Type M8) and moving coil (Type M7) microphones recently introduced by Film Industries a semi-flexible metal tube gives instant adjustment to any required position without the necessity for clamped joints. The diameter of the ribbon microphone is only 1⅜in.

A new "pencil" microphone has been developed by Lustraphone. This is a miniature moving-coil type for speech and is carried on a flexible tube which can be fitted to a stand or desk mount It is designed for speech with a frequency response from 150 c/s to 10 kc/s ±4 db. The sensitivity referred to 1V/dyne/cm² is −86db. Another interesting Lustraphone product is a moving-coil microphone insert (Type C151/HMF) designed to replace the carbon microphone in standard telephone handsets for use in v.h.f. communications where reduction of background noise is important.

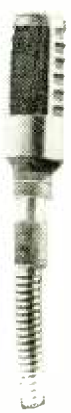
The inexpensive Mic 36 series of crystal microphones introduced by Cosmocord (Acos) are of attractive appearance and can be adapted for stand or desk mounting. They have an omni-directional response substantially flat from 30 to 7,000 c/s with a sensitivity of −55db referred to 1 volt/dyne/cm².

G.E.C. are now supplying an inexpensive counter-balanced boom for use with their ribbon microphone.

Pickups—A diamond stylus is standard in the latest moving-coil pickup developed by H. J. Leak. The response is claimed to be within ±1db from 40 to 20,000 cs. On long-playing records the high-frequency resonance is 21 kc/s ±2 kc/s and, on the shellac, above 27 kc/s. The low frequency resonance is 20 c/s ±5 c/s. Output is 11mV per cm/sec recorded r.m.s. velocity. Playing weights are 5-6 gm on 78 r.p.m. and 2-3 gm on long-playing records.

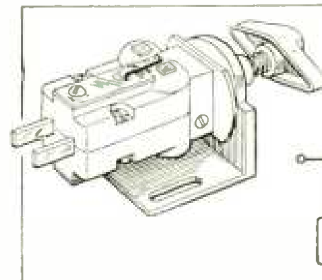
A new super-lightweight (Mark II) pickup by A. R. Sugden (Connoisseur) works on the moving-iron principle and employs a diamond stylus. The mass of the armature is only 5 milligrams and the top resonance on vinylite is in the region of 20-21 kc/s. The stylus tip is constrained longitudinally but sufficient vertical compliance is provided to overcome pinch effect, and to prevent damage if the head is accidentally dropped on the record.

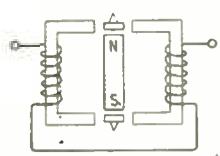
Goldring, who have for many years specialized in the design of electromagnetic pickups, have introduced a "variable reluctance" (moving iron) turnover head of small size in which exceptionally wide gaps reduce non-linearity distortion. The permanent



Above: Cosmocord (Acos) Mic 36 crystal microphone.

Left: Film Industries Type M8 ribbon microphone.



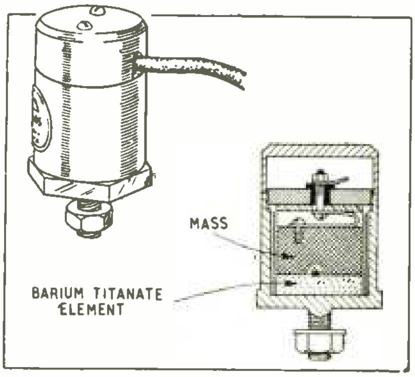


Goldring variable reluctance magnetic pickup.

* Radio and Electronic Component Manufacturers Federation, April 6th to 8th; Association of Public Address Engineers, April 28th and 29th; British Sound Recording Association, May 22nd and 23rd.

magnet is placed between the sockets of the cantilever styli which form part of the magnetic circuit. The coil arrangement cancels any hum picked up from uniform external fields.

The HGP39/1 heads now available for the GP20 Cosmocord (Acos) pickup are designed to track any accelerations which can be cut on commercial records



Acos accelerometer.

with a playing weight not exceeding 8 gm. The sensitivity of the Rochelle salt crystal element gives an output of the order of 1 volt on standard and 1/3 volt on microgroove records.

A piezoelectric pickup (GCE3) using ceramic (barium titanate) elements has been developed by Garrard and will be supplied if required for extreme tropical conditions. Acos also are actively interested in all applications of barium titanite materials and have produced a neat accelerometer unit, with this substance as the pressure element, for use in ballistics research and many other applications. It is capable of withstanding and recording accelerations up to at least 3,000 g.

Gramophone Turntables. — The latest Plessey record changer will play 10-in and 12-in records

Collaro Model 2010 transcription unit and pickup.

Garrard Model 301 transcription motor.

mixed, and has three turntable speeds. Attention has been given to reducing the time of changing, and since the unit is designed to take long-playing records, a lightweight pickup is fitted.

For the reproduction of high-quality long-playing records a turntable mechanism of more than average quality is a necessity, and to meet this demand Collaro have introduced the Model 2010 which has a heavy turntable and large main bearing. Two types are available, one with a pickup arm capable of accommodating records up to 16in diameter.

The Garrard Model 301 transcription turntable has been re-tooled and will be in quantity production soon. The main bearing is machined from cast phosphor bronze and is pressure grease lubricated. Spring mounting for all controls as well as for the induction motor itself has been adopted to ensure that vibration is not transmitted to the pickup. An interlock between the main switch and speed change control ensures that the intermediate friction drive wheel is not damaged by excessive slip. Another recent product of Garrard is the Type LRS2 large record spindle, designed for use on RC110 and RC11 record changers with 7-in, 45 r.p.m. records with 1½-in centre holes.

The Swiss-made Thorens three-speed motor (E53PA) is now available in this country through the Lowther Manufacturing Company.

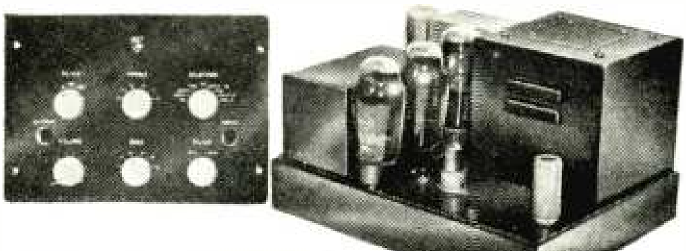
Amplifiers.—Many excellent new high-quality amplifiers have made their appearance, usually in conjunction with comprehensive tone-control units for the various recording characteristics used by record manufacturers.

In the Quad II amplifier made by the Acoustical Manufacturing Company, push-button selection of four main characteristics is provided, and other variants can be obtained by using permutations of two or more buttons. In addition, correct impedance matching for all types of pickup is obtained by changing plug-in units at the back of the unit. The system is flexible and will cope with future as well as existing developments.

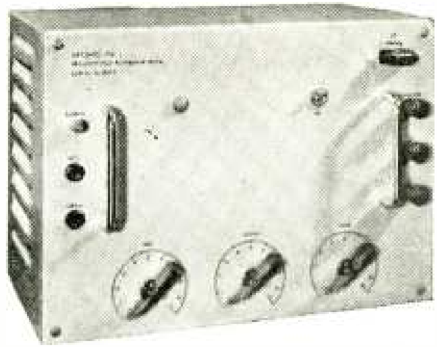
Provision is made in the control unit of the Leak TL/10 amplifier for connection to a tape recorder—either for recording or reproduction. This feature is in addition to the usual input connections for radio and records together with fixed compensating circuits for the principal disc recording characteristics and variable bass and treble controls.

Facilities for tape recording and playback are also included in the RD Senior amplifier and control unit. This amplifier, which is based on the Williamson circuit and uses a C-cored output transformer, is rated at 15 watts for 0.08 per cent distortion and 20 watts for 0.2 per cent. For 15 watts output the input required from a microphone is 3mV, from a gramophone pickup, 6 to 8mV, and from radio, 40mV. An attractive feature is the translucent illuminated control panel.

For public address work and for use in hospitals and schools, G.E.C. have developed an "industrial" radio receiver/amplifier with an output of 15 watts. Connections are provided for microphone or gramophone and separate tone controls are included. There is a tuning indicator and a built-in 3½in monitoring loudspeaker. Another new G.E.C. product is an inexpensive 8-10 watt amplifier capable of giving full output from a ribbon microphone and with a fader control for microphone and radio or gramophone inputs.

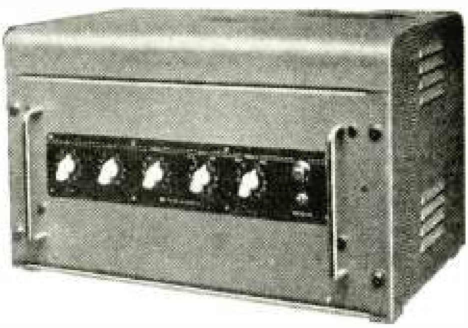


Rogers R.D. Senior amplifier and control unit.



N.S.R. 15-watt quality amplifier.

Quad II quality control unit.



Trix T635 amplifier for mains or battery.

Four KT66 valves in Class AB1 parallel push-pull give a rated output of 100 watts in the Grampian 531A combined amplifier and pre-amplifier. There are two 15Ω microphone inputs, one 0.25MΩ gramophone and one 0.22MΩ radio input. The Grampian Type MS12 portable a.c./d.c. amplifier is also new. It gives 12 watts for 2 per cent distortion and has inputs for a moving-coil microphone and a magnetic type pickup. The weight is 13lb.

N.S.R. Manufacturing, Ltd., have introduced a 15-watt quality amplifier which is based on many years' experience of p.a. installation work. Compactness and reliability have been given priority and the controls and inputs have been reduced to the minimum essentials.

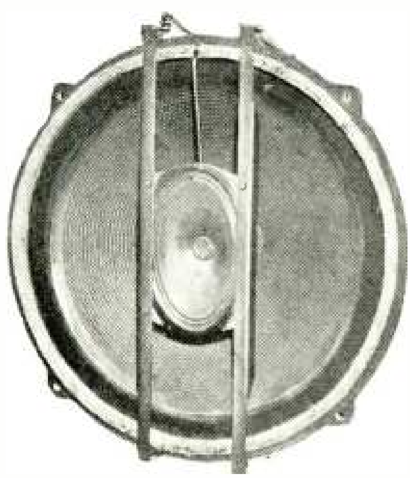
Neat workmanship and ready accessibility to components under the chassis are noteworthy features of the Trix T635 amplifier, which has been given a specification which meets the requirements of the majority of sound reinforcement systems. Normally it runs from a.c. mains and gives 30 watts output, but it can also be run from a 6-volt converter unit, when the power output available is 22 watts. The Trix T621 is a 25 (21) watt mains or battery operated amplifier with a somewhat simpler specification.

Loudspeakers.—Rather more activity than usual was evident among loudspeaker manufacturers represented at this year's exhibitions. Plessey have introduced a high-quality reproducer consisting of a 15in low-frequency unit combined with an elliptical h.f. unit mounted coaxially on a bridge across the main cone—with the major axis vertical to give wide-angle distribution of high frequencies in a horizontal plane. This particular speaker will be sold through Amplion (1932), Ltd.

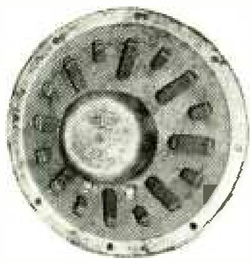
The cambric cone introduced by Whiteley Electrical Radio has proved so successful that it has been decided to fit it in their 10in and 12in concentric duplex speakers, as well as in many other units in the range. A new horn-loaded "tweeter" unit rated at 15 watts, is now available for use in conjunction with W.B., 12, 15 and 18in and similar moving-coil diaphragm types.

The Körting electrostatic tweeter (described in the March issue, p. 148) is now being supplied by C. T. Chapman (Reproducers). Also working on the electrostatic principle is the Type ES1 tweeter recently introduced by Grundig (Great Britain). It is designed for frequencies above 5,000 c/s, and for inputs up to 50V (a.c.) with a polarizing voltage of 250.

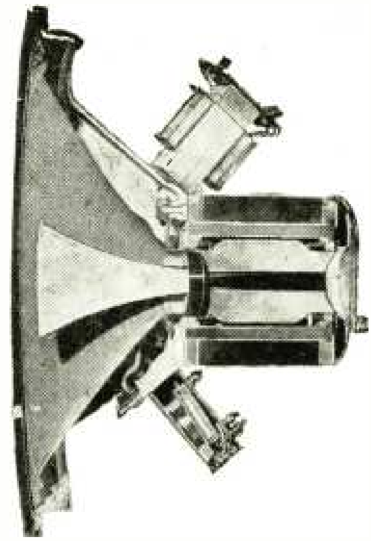
A horn-loaded twin-diaphragm moving coil unit



Plessey 15-in dual high-quality loudspeaker.



Rola-Celestion rear-protected car radio loudspeaker and (right) Grundig ES1 electrostatic loudspeaker.



Right: Sectional model of 12-in W.B. concentric duplex loudspeaker with cambric cone.

Elac 4in × 7in elliptical loudspeaker and (right) Wharfedale 12-in Type 12/CS/AL loudspeaker.

(PM3) with a 21-kilogauss flux density forms the basis of the latest Lowther corner reproducer (Type TP1). There is no electrical cross-over unit and a smooth transition between the loading of the horns at front and back of the diaphragm is effected acoustically by the design of the rear throat chamber. No bass resonance device is used.

Wharfedale, in addition to their three-speaker corner cabinet reproducer, were demonstrating a versatile single unit Type 12/CS/AL with a wide frequency range and good power-handling capacity. It is fitted with an aluminium voice coil and a cloth surround provides an effective termination for the edge of the diaphragm. The flux density of the magnet is 17 kilogauss.

A new high-quality loudspeaker, the "Victor," has been introduced by Pamphonic Reproducers. It combines a 15in unit with a 16-kilogauss magnet, operating in a vented chamber, with an elliptical high-frequency unit mounted to give wide-angle diffusion.

Many manufacturers are now producing small elliptical loudspeakers for television sets and car radios where space is restricted. Rola Celestion have a circular-diaphragm car-radio speaker with a protected back to minimize the possibility of accidental finger damage during installation or servicing. This combine was also showing an attractive range of shallow miniature moving-coil loudspeakers ranging from 2½ to 5in diameter. The 2½in unit has a depth of only 1¼in.

A new "pressure" driving unit (DC30, rated at 30 watts, has been developed by Truvox for use in conjunction with their exponential horns. Six units are combined in the LH100 projector loudspeaker which will handle 120 watts over a frequency of 125-7,000 c/s.

In addition to the omni-directional sound diffuser (DC/77) Goodmans Industries now make a smaller version (CD/66) with an overall diameter of 12 in and a 6in unit rated at 6 watts peak.

Richard Allan, hitherto known for their cabinet extension loudspeakers, have now entered the set manufacturers loudspeaker market with 5-in (6,000 line) and 10-in (8,000 and 10,000 line) dustproof and tropicalized units.

Tape Recorders.—In the Grundig TK9 recorder, which is smaller and lighter than the 700L "Reporter," separate fixed heads are used for top and bottom half-tracks. The tape drive is reversible, and, in conjunction with switching of the heads, enables both tracks to be fully recorded without changing over the spools. With 850-ft of tape the playing time at 3¾ in/sec is 90 minutes with one break. An automatic brake stops the tape at the end of each track.

The professional magnetic recording equipment made by Leevers-Rich, and used by many of the leading film companies, can be obtained for a.c. mains operation as well as for use with batteries, and the Model D will accommodate spools of the N.A.B. or European standard types up to 11½in in diameter. Detail improvements have been made in the amplifier layout, and the chassis can be hinged forward to give more ready access to the underside. There is a separate monitoring head, amplifier and loudspeaker, and in the Type A21B unit a built-in 1 kc/s oscillator and level meter are included for routine checking of optimum bias, amplifier gain and signal/noise ratio.

The tape mechanism used in M.S.S. recorders is now available separately as a unit (Model X). In addition to the normal functions of recording, replay, fast forward and fast rewind, the control knob has a fifth "cueing" position which simultaneously energizes the wind and re-wind motors to hold the tape at any predetermined place. M.S.S. are now producing their own tape and are paying special attention to the production of a highly finished working surface, for low background noise and reduced wear on the heads.

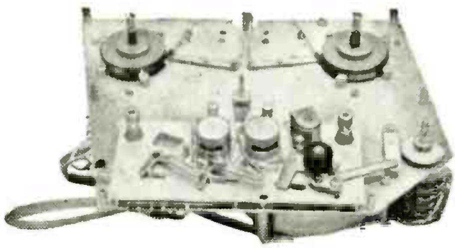
A new 7-in plastic tape spool for "Scotch Boy" tape has been introduced by Minnesota Mining and Manufacturing Co., with a 2¼-in hub for quicker re-winding and with improved tape anchorage slots.

The "gear lever"-controlled tape mechanism used in the Simon Model SP/1 portable recorder is now available as a separate unit. An interesting detail is the use of parallel-action push rods for actuating the tape pressure pads.

The design of the "Soundmirror" (Thermionic Products Model TP445), has been extensively revised and now includes twin tracks and alternative tape speeds of $3\frac{3}{4}$ and $7\frac{1}{2}$ in/sec. A separate mixer unit for two microphones, radio and crystal pickup is available. The new "Diplomat" office recording machine, like the earlier "Recordon" makes use of flexible magnetic coated discs. It is fitted with a built-in loudspeaker, but the microphone can also be used for low-level playback. Facilities are included for using the amplifier as part of an "intercom" system.

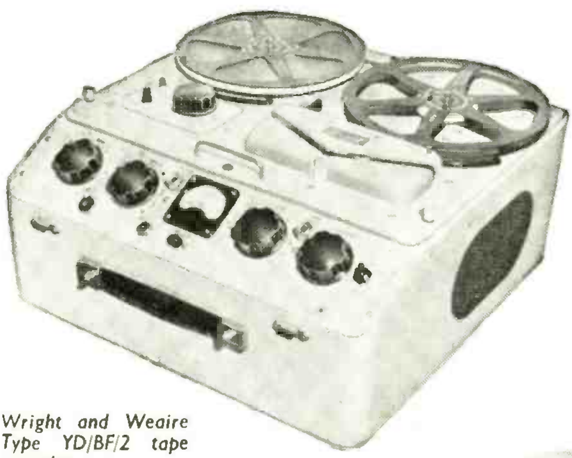
Wright and Weaire demonstrated the many forms in which their tape deck can be used for entertainment or research. A new version of the domestic model will be supplied with Noval valves and will be known as Model 2AN. The scientific and industrial Model YD has been completely redesigned in a more convenient and compact form and will be known as Model YD/BF/2.

Truvox gave a comprehensive display of the many portable recorders making use of their Mark III tape deck, and were also showing a neat "radio jack" incorporating a two-station tuner unit and germanium rectifier, which, under favourable conditions, enables broadcast programmes to be received by any audio amplifier fitted with a standard Post Office type input jack.

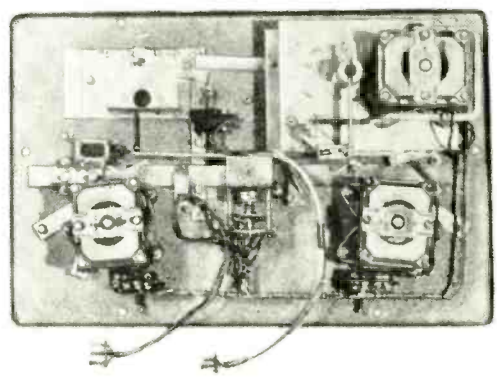


M.S.S. Model X tape mechanism.

Thermionic Products "Diplomat" office recorder.



Wright and Weaire Type YD/BF/2 tape recorder.



Underside of Simon tape recorder unit.

Leevers-Rich Model D professional magnetic recorder.

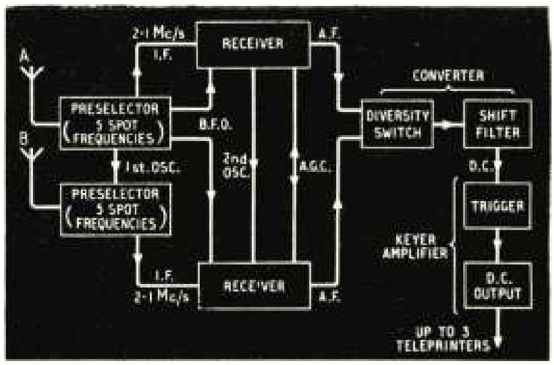
Truvox "radio jack" broadcast receiver.

Simplified Radio Teleprinter Terminal

A NEW frequency-shift, dual-diversity, receiving equipment (generally called a terminal) has been introduced by International Aeradio for operating teleprinters over radio-communication circuits where a certain amount of manual control is acceptable. It should fill the need for a relatively simple installation for receiving meterological radio reports, press radio broadcasts and for point-to-point radio traffic not wholly automatic in operation.

The normal Type "A" terminal can be operated by switch selection on any one of five pre-set crystal-controlled radio channels in the band 3 to 20 Mc/s. Based on the IAL/Plessey "Radprint" equipment, it consists of two double superheterodyne receivers working in diversity with the first, or pre-selector as it is called, giving an output on 2.1 Mc/s which is converted to 455 kc/s in the main receiver for amplification and demodulation.

The output from the two main receivers, which is in the form of an a.f. signal, is fed into an electronic diversity switch which selects the better of the two signals and completely rejects the weaker. The final amplifier gives an output sufficient to operate three teleprinters. A schematic drawing showing the arrangement of the main items of the equipment is reproduced here.



Schematic arrangement of the International Aeradio Type "A" dual-diversity teleprinter receiver.

A feature of the electronic switch is that the change-over from one receiver to the other is effected so quickly that the "mark" signal might be received on one and the "space" on the other without interruption or distortion of the printed message.

All the equipment is assembled in a modern 19-in rack-type cabinet standing 3 ft high and fitted with a hinged door at the front. The whole is fully tropicalized.

METAL FILM RESISTORS

OUR report of the R.E.C.M.F. Exhibition (May issue) may have given a somewhat misleading impression about metallic film resistors. A sharp distinction should have been drawn between the metallic oxide type, like those that were shown by the Ministry of Supply, and the true metallic film.

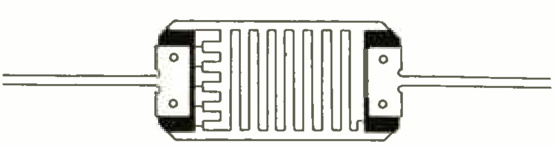
On the face of it, the metallic film offers many attractions, especially in the matter of stability and low noise. Resistors consisting of metallic films deposited on glass rods were in fact made commercially in the 1920s, but the technique then in use did not lend itself to the production of high ohmic values. A new method, described in British Patent No. 689,795, is used by Painton and Company in the manufacture, under the trade name of "Metlohm," of true metallic film resistors in values up to 400,000 ohms.

The manufacturing process consists, briefly, in coating a glass base with an extremely thin layer of a platinum-gold solution, firing to bond the metal firmly to the glass and burn away the unwanted ingredients in the solution, and then scribe the coated surface by a photo-etching process to produce a long, thin ribbon-like track.

The actual elements are cut from the parent sheet and for the ¼-watt range (MF104) measure 1 in × ½ in × $\frac{1}{16}$ in. A typical element, fitted with end-connecting wires, has the appearance shown in the drawing. For protection the resistors are given an overall coating of Silicone lacquer.

Resistance values range from 25 to 400,000 ohms with tolerances of 1% to 2% and a positive temperature coefficient of 0.025% to 0.027% per deg C. Over the normal audio range the noise level is said to be better than 0.05 μV per applied volt d.c. The shelf-life is good as after 12 months' storage the resistance change is less than 0.2%.

An ⅛-watt range (MF103) with resistance elements measuring ½ in × ¼ in × $\frac{1}{32}$ in only is in course of preparation.



A typical etched pattern used on the new metal film resistors made by Painton.

Public Address Quality

THE Association of Public Address Engineers held its fifth annual luncheon and exhibition in London recently, at which the principal speakers were A. E. Mason of the B.B.C., L. W. Murkham, the president, and A. E. Buchan, the immediate past president. Mr. Buchan paid tribute to the standards of quality established by the B.B.C. over the past 25 years, and drew attention to the increasing public appreciation of high quality of reproduction in sound reinforcing systems. In his opinion the time had come for the establishment of standards of quality among responsible p.a. engineers; those who ignored this trend would find themselves left by the wayside. Mr. Murkham entered a strong plea for more active participation by users of p.a. equipment in the work of the Association, which had so far fallen principally on the manufacturer and founder members.

The exhibition, which was well attended, showed the products of seventeen firms, and details of some of the items of interest are included in the report on another page of this issue. Demonstrations of equipment were a much-appreciated feature of the exhibition.

After the luncheon, the annual general meeting was held, at which J. F. Doust was elected president for the coming year.

EUROPEAN TELEVISION

Some of the Engineering Problems in International Exchanges

By J. TREEBY DICKINSON*

IT may be asked, what is the object of the present series of experimental television exchanges between eight countries organized by the European Broadcasting Union? First, to seek to determine, under reasonably representative operational conditions, the practical difficulties to be overcome, to establish a code of good engineering practice and to test draft specifications for the technical performances of the different kinds of links. It is also providing an opportunity for the concentrated training of operators and for enabling the officials responsible for programme production and presentation to obtain first-hand knowledge of the potentialities and limitations of the system.

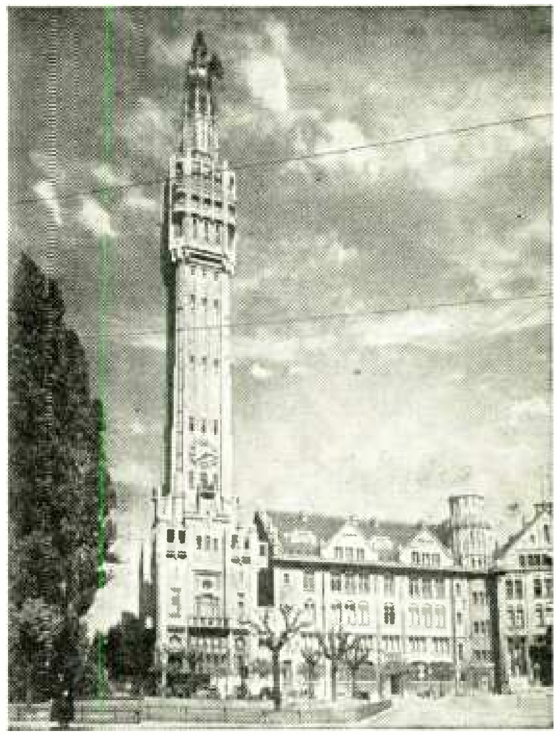
There are, in effect, three phases in the development of a European television network. The first, the linking of countries by temporary and often transportable radio links provided by the television authorities and set up for each individual operation; the second, when permanent interconnections between neighbouring countries are provided by the telecommunications administrations of the countries concerned; and the third, when each country has adequate facilities for the transit of exchange programmes over circuits quite separate from those provided for distributing its own domestic television programmes.

At present the establishment of a single vision channel across Western Europe involves the temporary installation of a very large quantity of equipment, often in locations which are difficult of access, and this material has in general to be temporarily released from its normal assignments.

The planning engineers would have preferred to carry out these tests *in camera*, but the very high costs involved and the necessity of diverting staff and equipment from normal programme operations virtually made it essential to broadcast the programmes relayed, and, in general, they are being transmitted by all the eight participating countries.

The operation is probably unique in the field of broadcasting for the amount of international collaboration which went into its organization. It has involved not only the television engineers and programme officials from the broadcasting organizations of the eight countries but also engineers of the national telecommunications administrations who were required to provide extremely elaborate telephone facilities for carrying the sound components of the programmes, for the normal engineering control and for programme and engineering co-ordination

* European Broadcasting Union.



The paraboloid for the normal link with Paris can be seen at the top of the tower of the Lille town hall, which also houses the international co-ordination centres. The tower also carries the paraboloids for the links with Cassel (for London) and Flobecq (for Brussels).

purposes. One technical principle adopted was that, where a radio-link crosses an international frontier, the whole link, including both the transmitter and the receiver, should be the responsibility of one of the countries. Either the transmitter or the receiver would accordingly have to be installed and, in many cases, manned in a foreign country.

There are, in effect, three television networks in Europe:—The B.B.C. network of nine stations, operating on 405 lines; the composite chain consisting of four 819-line stations in France, two 625-line stations in Holland and two in Belgium†; and the 625-line network comprising 16 transmitting stations in Germany, two in Switzerland, nine in Italy and one in Denmark.

The ultimate object is to have available technical facilities for relaying television programmes from any one of the countries to any other, but the object of the present series of exchanges is to determine the practicability of connecting up the existing national networks into a single entity, so that a television programme originating in any one of the countries could be radiated simultaneously in all the eight countries.

The problem in its simplest terms was to decide upon the most expedient means of interconnecting the countries and the most appropriate locations for

† The two Belgian stations use modified versions of the French 819-line system and of the so-called "European" 625-line system.

the equipment necessary for the conversion of the signals from one system to another. From the experience gained, it is hoped to prepare operating procedure and suitable performance specifications, applicable at any rate to the extremely heterogeneous circuits which will have to be used until permanent wide-band international interconnections are provided by the telephone administrations.

From the sketch map it will be seen that, in effect, England has to be connected to the Dutch-Belgian-French group and that group to the German network, which itself has to be connected in the north to Denmark and in the south to Switzerland and Italy. Moreover, each of these connections has to be two-way.

On the fifth floor of the campanile of the Town Hall at Lille, the Radiodiffusion-Télévision Française has temporarily converted its only large television studio in Lille into two International Co-ordination Centres, one for the programme and presentation aspects, the other for engineering matters. The Technical Co-ordination Centre is equipped with picture monitors for the three different standards, waveform monitors and the like, together with direct telephone circuits to the Technical Control Centres in each of the eight countries, with a direct teleprinter service for exchanging reports and other information.

As the equipment available was all extremely diverse in design and performance and as there was very little accumulated experience upon which to draw, it was necessary to prepare first of all a provisional performance specification for this operation. This would, it was hoped, be adequate to ensure the transmission of acceptable pictures, but would at the same time not be beyond the capabilities of the large number of different links in tandem. The main requirements decided upon (principally from B.B.C. recommendations) included:—

Video pass-band.—The upper frequency response should be such that the time of rise, measured at any point of handing over responsibility, for a square wavefront amplitude representing peak white, does not exceed 0.3 microseconds, counted from 10 per cent to 90 per cent of the final amplitude.

Random noise.—Should not exceed 50 per cent of the sync. pulse amplitude.

Hum.—Should not exceed 15 per cent of the sync. pulse amplitude.

Synchronization amplitude variation with picture content.—Variation should not exceed ± 10 per cent of synchronization amplitude, between white and black pictures.

Suppression periods.—The post-synchronization suppression period should be at least 5 microseconds. The tilt should not exceed ± 10 per cent synchronization amplitude.

Overshoot.—Should not exceed 20 per cent of synchronization amplitude.

Gradation.—Should be linear within 30 per cent, measured as the difference between the slope at any point on the reproduced saw-tooth signal, and the slope of the straight line joining its extremities.

Pattern interference.—Should not be worse than -40 db in the lower half of the video spectrum or -30 db in the upper half.

Picture black level.—There should be a difference of at least 5 per cent of the synchronization amplitude between the picture black level and the suppression level, to allow deformed sync. pulses to be removed completely without risk of mutilating the picture signals, where it is necessary to provide entirely new sync. pulses to render the signals suitable for onward transmission. To permit these parameters to be observed and measured with the minimum of difficulty, the following three standardized test signals were used (see diagram).

Test Signal A.—This is a flat-topped pulse of the full length of the line, repeating at line frequency. After remaining at full-white amplitude for a minute or two, it is slowly reduced to picture black-level, where it also remains a little while. It is used to show up any change of synchronization amplitude with varying picture content, and also to measure the overshoot noise and interference.

Test Signal B.—This consists of one or more narrow pulses of full-white amplitude. It is used to show up the time of rise, the overshoot and the difference between picture-black and suppression levels.

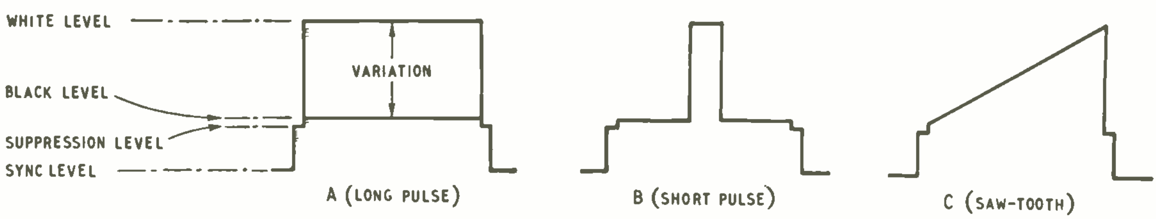
Test Signal C.—This is a saw-tooth of full-line length rising uniformly from picture black-level to full-white level and is used to indicate the linearity of gradation.

In addition to these signals, test patterns of various kinds incorporating gratings for assessing the transmitted definition are used, together, of course, with "live" camera shots and films.

The problems on the sound side are too various to be discussed here, especially as they are organizational and programme problems rather than engineering ones.

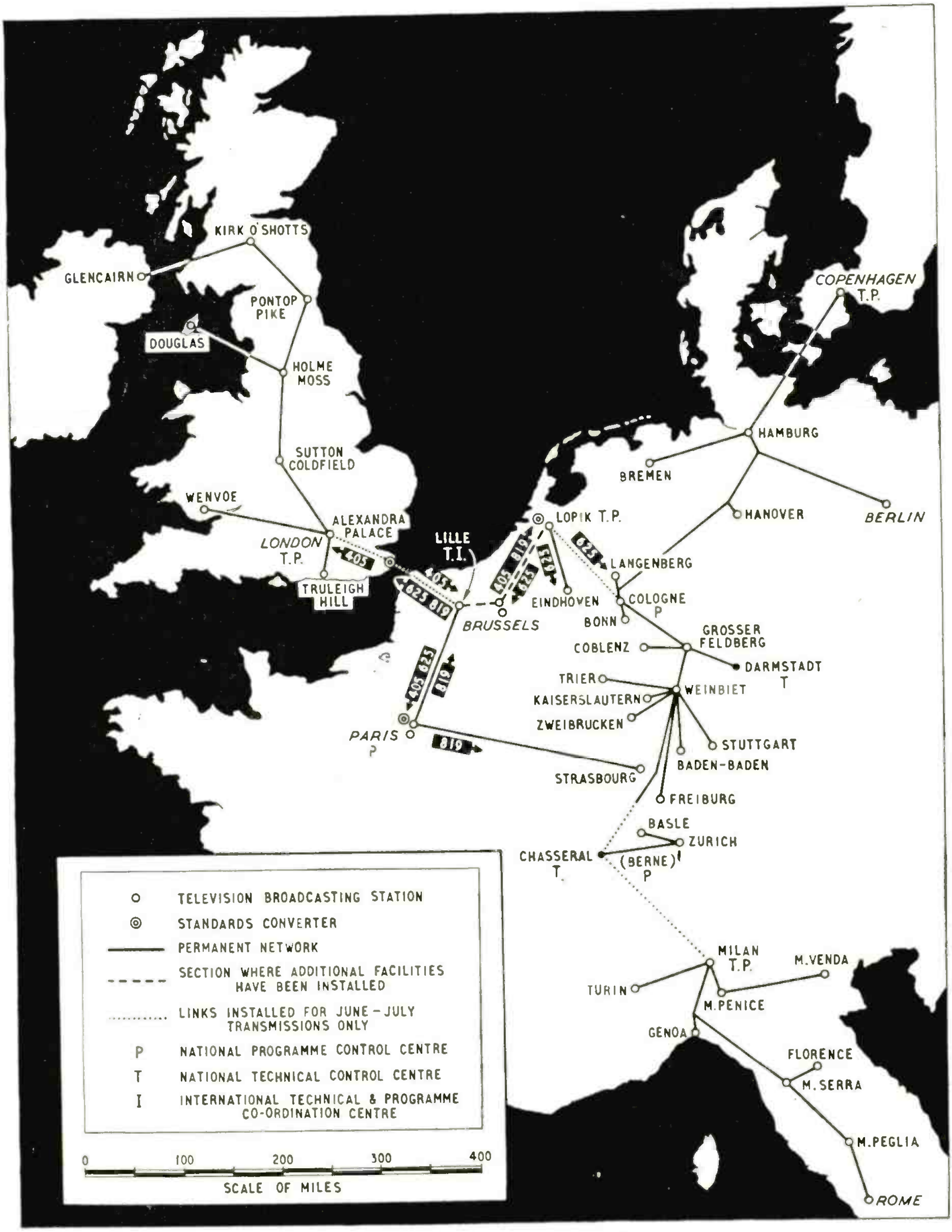
Few of the engineers were quite prepared for the very satisfactory pictures which were transmitted from Rome and Montreaux to all the other countries on 6th June, the day when the series of programmes opened, though there were temporary breakdowns. The last few minutes of the transmission from the Vatican were marred by picture jumping caused by surges on the supply mains at Milan, which was then experiencing a severe thunderstorm.

It is, at the time of writing, too early to make any prediction, but it seems justifiable to say that, apart



Standardized test signals used during the experiment. More than one short pulse (B) may occur during the line period.

from unreliability due to the absence of reserve equipment on the various links, the transmission problem appears soluble along the lines that we have adopted. The weak points are certainly the standards converters. The results that they are giving, however, justify the view that normal development will in due course enable results to be obtained of a quality acceptable to the great majority of viewers.



Television I.F. Inquiry

Aspects of Receiver Design in Various Countries

By G. H. RUSSELL, Assoc.Brit.I.R.E.

IN December, 1952, a questionnaire on television receiver problems was sent to manufacturers' organizations in a number of countries by the European Broadcasting Union's technical centre. Replies were received from Belgium, Denmark, France, Germany, Holland, Italy, Sweden, Switzerland, the United Kingdom and the United States of America at various dates during 1953 and 1954. These replies are given in a document recently published by the E.B.U.* This report deals mainly with intermediate frequency problems but also includes some interesting information on other aspects of receiver design in the various countries. The object of the questionnaire was to ascertain whether any measure of international agreement could be obtained on specific technical points, and on the basis of this inquiry the E.B.U. evidently intends to pursue this admirable objective.

On the subject of choosing intermediate frequencies, six major causes of interference were listed: second channel, i.f. breakthrough, oscillator second harmonic, i.f. harmonics, oscillator radiation from a nearby receiver, and harmonics of Band I transmitters appearing on Band III. Respondents were asked to say which of these they considered most important, and why. Each country was also required to give intermediate frequencies in general use and those that will be in general use in the near future, indication to be given in each case of whether the oscillator frequency is, or will be, above or below the signal frequency. The replies to these last questions are given in the table.

Local Conditions

The replies on the question of interference are, as one would expect, very much conditioned by local considerations. For example, whereas Belgium, Denmark, Germany, Holland and the U.S.A. consider second channel interference as the most important, Italy places it about third on the list, claiming that the disposition of her transmitters effects a considerable alleviation of this problem. On the other hand, Italy is very worried about the effects of the harmonics of the f.m. sound broadcasting stations. Another example of local thinking occurs over the question of i.f. breakthrough, considered to be the most important source of interference in Sweden and the U.K. but the least important in Holland. The reason for Sweden's fears is that public-services transmitters operate in the recommended i.f. bands. France is very pessimistic about the whole problem of interference, stating, quite correctly, that no i.f. will give complete immunity and that the solution lies in that elusive talisman, international agreement. No opinions are expressed on the relative importance of the six sources of interference listed. There is a private contribution to the document from Britain and in this the analysis of the problem and the conclusions reached are similar to those published in *Wireless World* recently.* One of the more surprising results obtained from an examination of the answers is that oscillator radiation is considered of so little importance. No one, except the U.K., places it higher than fourth in importance, the majority rating it as fifth or sixth.

Some information is given on oscillator radiation in America and this country. The limits proposed by R.E.T.M.A. (Radio, Electronic and Television Manufacturers' Association) in the U.S.A. are 50μV/metre at a distance of 30 metres from the receiver for Band I. The corresponding figure for Band III is 150μV/metre. Elsewhere in America, a figure of 15μV/metre has been proposed as both desirable and practicable. The B.R.E.M.A. limits are also quoted. To show how far the industry is from achieving these limits, results of measurements of receivers are given. Receivers measured in America at various periods in 1950, 1952 and 1953 gave between 63 and 762μV/metre at a distance of 30 metres from the receivers on Bands II and III. A British receiver is quoted as having given 890μV/metre at a distance of 10 metres from the receiver instead of the recommended 20μV/metre. The American manufacturers, having placed oscillator radiation as fourth in order of importance, evidently do not see eye to eye with the F.C.C., as that body considers the radiation problem so serious that they have threatened legislation if manufacturers do not conform to the recommended limits.

It is only to be expected that at u.h.f. all forms of interference are intensified owing to the difficulty of providing adequate pre-selection at these frequencies. Representative oscillator radiation figures lie between 512 and 2,840 μV/metre at a distance of 30 metres from the receiver at frequencies between 375 and 810 Mc/s. The difficulties at u.h.f. of providing adequate protection at the receiver against interference have been recognized in the U.S.A. and a solution has been adopted which provides protection by frequency allocation. It is based upon the standard i.f. (41.25 and 45.75 Mc/s sound and vision carriers respectively) and a standard channel separation of 6 Mc/s. This frequency allocation system operates as follows:

(a) Protection against oscillator radiation: transmitters 7 channels apart (42 Mc/s) must be separated by at least 60 miles.

(b) Protection against second channel interference

* Document Tech. 3062. "Enquête de l'U.E.R. sur le choix des fréquences intermédiaires dans les récepteurs de télévision (et questions connexes)." Not available to the general public.

* "Two-band Television Receivers," by G. H. Russell, April, 1954.

(sound and vision); transmitters 14 and 15 channels apart (84 and 90 Mc/s) must be separated by at least 60 and 75 miles respectively.

(c) Protection against i.f. beat interference: transmitters 8 channels apart (48 Mc/s) must be separated by at least 20 miles.

(d) Protection against intermodulation interference: transmitters 6 channels apart (36 Mc/s) must be separated by at least 20 miles.

I.F. beat interference refers to a situation where two signals beat together to produce an interfering signal whose frequency is equal, or close to, that of the intermediate frequency. For the parameters chosen this can occur with transmitters 7 or 8 channels apart. The former was covered in (a). Intermodulation interference occurs when two signals beat together to produce an interfering signal whose frequency is equal or close to that of the signal being received.

Systems in Use

It may not be generally realized that five television systems exist in western Europe to-day. First of all there is our own 405-line system. Next comes the C.C.I.R. system, used by all the countries of western Europe which have television except Belgium, France and ourselves. This operates with 625 lines, negative picture modulation, f.m. sound, 5.5-Mc/s spacing between sound and vision carriers and 7-Mc/s channel width. Then there is the French system, operating with 819 lines, positive modulation, a.m. sound, 11.15-Mc/s spacing between sound and vision carriers and 14-Mc/s channel width. Lastly comes Belgium with two systems: a French service which operates with 819 lines and a Flemish service with 625 lines, both with positive modulation, a.m. sound, 5.5-Mc/s spacing between sound and vision carriers and 7-Mc/s channel width. A further complication lies in the fact that in the French system the relative positions of the sound and vision carriers are inverted as compared with the C.C.I.R. and Belgian systems.

This poses some rather pretty problems in the frontier regions of Europe and particularly in Belgium where, depending upon the geographical location, it is possible to receive alternative programmes from France, Germany or Holland. A demand for multi-standard receivers evidently exists in all these countries, but not in those which are separated from countries using other systems by long distance or by mountainous terrain. The provision of a multi-standard receiver may testify to man's ingenuity, if not to his good sense, but the reader can judge for himself. Here are some of the replies, summarized, which were received in answer to the part of the

Table of intermediate frequencies in current use and those that it is expected will be in general use in the near future.

Country	Intermediate Frequencies In Current Use			Future Intermediate Frequencies		
	Vision i.f. (Mc/s)	Sound i.f. (Mc/s)	Position of Osc. relative to Signal Frequency	Vision i.f. (Mc/s)	Sound i.f. (Mc/s)	Position of Osc. relative to Signal Frequency
Belgium	41.75 25.5	36.25 20	Above and below	—	—	—
Denmark	Below 25 41.75 39.75	 36.25 34.25	 Above Above	39.75	34.25	Above
France	80 40 66 24	66 24 80 40	} Sound i.f. lower than vision i.f. } Sound i.f. higher than vision i.f.			
Germany	About 25	—	Above	38.9	33.4	Above
Holland	23.5	18	Above	38.9	33.4	Above
Italy	25.75 45.75	20.25 40.25	Above Above	45.75	40.25	Above
Sweden	23.5 39.5	18 34	Above Above	—	—	—
Switzerland	23.5 39.5	18 34	— —	39.5	34	—
United Kingdom	12—13 16 34	— — —	Below Above Above	—	—	—
U.S.A.	25.75—26.4 45.75	21.25—21.8 41.25	Above Above	45.75	41.25	Above

questionnaire concerned with receiver design and performance.

Belgium.—Nine-channel receivers are being manufactured capable of operating on four systems. A 12-position tuner is fitted but only nine positions are actually used. The tuner is provided with a fine tuning control. The wavechange switch automatically selects the system appropriate to the station being received; e.g., for German stations the receiver is automatically switched to negative picture modulation and f.m. sound. Only the line frequency is controlled independently. This must be so because Belgian transmitters are arranged to work with either line frequency in the event of relayed programmes. It is not clear how the differences in bandwidth requirements between the French systems and the rest are brought about, but it is mentioned that one Belgian manufacturer fits an extra switch which varies the i.f. pass band from 5.5 to 11.15 Mc/s. Sensitivity is 10-15 μV for Band I and 20-50 μV for Band III. Input impedance is 75Ω.

Denmark.—In practice, there are no receivers available capable of receiving all the C.C.I.R. channels, but 50 per cent of Danish receivers are fitted with a turret tuner in which it is a fairly simple operation to insert coils corresponding to any of the channels. The majority of the other receivers in use are of the single-channel variety with space provided for a similar tuner. The insertion of new coils into an existing turret costs two to five per cent the initial cost of the receiver, and the fitting of a tuning unit 10 to 20 per cent. In either case it is necessary to return the receiver to the dealer or the manufacturer for the work to be carried out. It appears that the majority of customers prefer the single-channel receiver once they know that they can have the tuner fitted if required. One "straight" receiver was being made in Denmark in 1952: all others are superheterodynes with r.f. stages. The sensitivity of the single-channel receiver is 200-300 μV and the multi-channel 30-75 μV. Most aerials are of the two-element variety with 70-Ω coaxial feeder.

France.—As at present only a one-programme television network is visualized for the whole of France, French manufacturers consider that the most useful receiver would be single-channel with easily interchangeable coil-deck. If the customer moves to an area which is served by a different transmitter from that to which the receiver is tuned, the coil-deck can be changed in his home at an estimated cost of five per cent of the original cost of the receiver. Although it is possible that at some time in the future a second programme may be available, the public do not appear to be unduly worried about the prospect. For the frontier regions it has been suggested that a receiver similar to the Belgian might be an answer, but the matter is still under consideration. In the meantime, a receiver has been built for the Strasbourg region (where it is possible to receive German programmes) which employs two separate i.f. amplifier chains; one using 37.6 and 26.45 Mc/s for vision and sound, the other with 28.5 and 23 Mc/s. The inversion of the vision and sound carriers is presumably carried out by placing the oscillator above or below the carrier frequency. One or two r.f. stages are employed and a fine tuning control is provided on all receivers. Proposed sensitivities are, for Band III, better than 500μV for "standard" receivers and better than 50μV for "fringe" receivers (75Ω input impedance). These figures are quoted for 10V peak-to-peak output at the tube when the signal is 30 per cent sine-wave modulated. Sensitivity requirements for Band I have yet to be determined.

Germany.—All receivers except one are multi-channel. All employ an r.f. stage and a fine tuning control. The majority are switch tuned. Some receivers are made for Band III only, but can be converted to Band I if returned to the factory. No provision is made for other systems of transmission, and it is not made clear whether a demand for such receivers exists. Average sensitivity for 30db signal-to-noise ratio is 200-500μV. Input impedance is 240Ω. The standard aerial is a half-wave folded dipole with reflector and director.

Holland.—Receivers actually on the market are of two types: a four-channel version for Band I only and a 10-channel version for Bands I and III. All have a tuned r.f. stage, and continuous tuning is provided in conjunction with a turret switch. Sensitivity figures are given for "regional" and "sensitive" models as follows: 500 μV on Band I and 650 μV on Band III for the first, and 50 μV on Band I and 100 μV on Band III for the second. It is proposed to improve the sensitivity of the "sensitive" receiver in the future to 15 μV for Band I and 25 μV for Band III.

Italy.—Receivers being made in Italy operate on five channels between 61 and 216 Mc/s. It is possible that when the final disposition of Italian transmitters is known, single-channel receivers will be made on a limited scale for certain areas. Most receivers are superheterodynes with r.f. stage, switch tuning and fine oscillator tuning control. Sensitivity figures are quoted for 20 db signal-to-noise ratio and 20V peak-to-peak at the tube as follows: 150-200 μV for Band I and 250-350 μV for Band III. Input impedance is 300Ω. Nearly all receivers use the intercarrier-sound system.

Sweden.—As the Swedish television service is still experimental practically no receivers of Swedish manufacture exist. Imported models have a 10-channel tuner. This is another country for which only one programme is visualized. Nevertheless, it is felt that many receivers will require at least two channels, as it may be possible in certain areas to receive foreign programmes; e.g., in the south from Denmark. To combat oscillator radiation an r.f. amplifier is considered necessary, even on a simple receiver. It is expected that the following will be the sensitivity requirements. Single-channel receivers: 200 μV for Band I and 500 μV for Band III. Tunable receivers: 30-60 μV for Band I and 50-100 μV for Band III. These figures are for 3V output at the tube when the signal is modulated 30 per cent. Owing to the existence of large numbers of blocks of flats in the towns communal aerials will be largely used. It is intended to provide high-power transmitters for densely populated areas to permit the use of indoor aerials. Communal aerials erected on adjacent high ground are recommended for remote villages.

Switzerland.—The Swiss television service was still in the experimental stage when the replies to the questionnaire were sent. These are, therefore, rather in the nature of recommendations than an expression of fact or opinion. It is expected that single and multi-channel receivers will be in equal demand. Recommended aerials are similar to those in use in Germany, except that 60Ω unbalanced feeder is given as an alternative to 240Ω balanced.

U.S.A.—All v.h.f. receivers have 12-channel tuners. Most employ switched channels as this is the method of tuning preferred by Americans. During the first six months of 1953, 15 per cent of all receivers manufactured had a u.h.f. band. By the end of the year this type of receiver had reached 40 per cent of total production. Two methods of u.h.f. operation are in use. One uses a tuner which converts directly to the receiver i.f.; the other has a converter which turns the receiver into a double superheterodyne, one of the v.h.f. channels being used as the first i.f. A large number of receivers are being used with separate tuners or converters which cost between $10 and $50. Two methods of u.h.f. tuning are in use. One employs a turret switch with a fixed number of positions; the other is a continuous tuning system. With the turret switch method, channels can be changed by changing the coils—an operation that can be carried out in the customer's home without the use of a soldering iron. As there are 70 u.h.f. channels, continuous tuning systems are favoured by the manufacturer, if not by the customer. R.F. amplifiers are always used at v.h.f. but rarely at u.h.f. Most receivers have a sensitivity of 70 μV; the u.h.f. figure is a little higher than this. At this level noise is perceptible, but the picture is considered acceptable. The majority of the receivers are used with indoor aerials or with single-element dipole aerials mounted on the roof or in the attic. In fringe areas folded dipole aerials with reflectors mounted at a height of 50-100ft are usual.

The French reply also contains some interesting information on the aerial situation in that country. Until September, 1953, landlords had the right to oppose the erection of aerials on their premises and evidently used it, for on that date an edict was published decreeing that television and radio are, like the telephone, public services. As such, the landlord cannot (under certain conditions that have yet to be determined) object to the installation of an outdoor aerial. Nevertheless, this evidently does not solve the problem, as the French nation, being both practical and artistic, dislikes outdoor aerials, partly because of their cost and partly because of æsthetic considerations. Technical problems still to be solved are those relating to multi-channel, multi-directional aerials and communal outdoor aerials, which raise judicial and administrative problems as well. Some communal aerials already exist in Paris, but it is felt that television development in France will depend to a great extent on the ability of receivers to operate satisfactorily with indoor aerials.

On the question of whether any provision is being made in receivers for the reception of colour television, all countries answered negatively except America and, surprisingly, Sweden. It appears that, as the start of a television service has been so long delayed in Sweden, it may well come about that monochrome and colour television will be introduced almost coincidentally. One of the modifications suggested is that the i.f. bandwidth be reduced by one megacycle to reduce the possibility of interference from the colour signal to monochrome receivers.

To the question of whether it would be possible to standardize the phase distortion in receivers so that a pre-correction could be made at the transmitter, answers ranged from a downright "no" from Belgium to an enthusiastic "yes" from Sweden. America considers it a possibility that such an arrangement might be introduced for colour television.

In the "conclusions" to the E.B.U. document, part of an editorial in *Télévision* by E. Aisberg is quoted: "A radio receiver can be used practically anywhere in the world. In revenge, a television receiver must be made, if not for each transmitter, at least for each country." When it is remembered that one more television system exists in eastern Europe, making a total of six for Europe alone, for the present, one can only add that television's revenge has been remarkably complete. The situation may yet be saved when Europe embarks upon Band IV and colour television, and we must surely all hope that the efforts of organizations such as the E.B.U. will be crowned with success when they attempt to obtain international agreement on these matters. Unfortunately, while all countries are in full support of international agreement, they are all very vague as to the method of attaining it. The situation is best summed up by Sweden's succinct observation that the possibility of such agreement "seems utopian."

In the meantime, perhaps the one redeeming feature of the present diversity of systems is that it possibly makes engineers' lives more interesting. In conclusion, one cannot help remarking that it is a great pity that the mainland of Europe did not adopt a certain well-tried system which uses 405 lines, positive modulation, a.m. sound, etc., etc. . . .

LETTERS TO THE EDITOR

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

Transistor Symbols

WITH regard to letters in your March and April issues by F. Oakes and Henry Morgan on symbols for transistors, I enclose a copy of a DRTE/EL Memorandum* on the subject.

There is a small group at the Electronics Laboratory of the Canadian Defence Research Telecommunications Establishment, under N. F. Moody, which has been working on transistors for some time. We have adopted this convention for our own publications, particularly because it contributes to our understanding of the operation of circuits.

You will note that our convention has been developed from the electrical function of transistors rather than their mechanical form. Mr. Morgan's symbols represent the mechanical form of a diffused junction, or alloy transistor, and would not suggest a grown junction or surface barrier.

Since the enclosed memo. was written I have seen several other conventions used. Some of these use features of ours, and the trend seems to be towards one like we suggest.

I feel that the convention suggested in the memo. is a logical beginning from which symbols for new semi-conductor devices can grow.

Ottawa, Canada. P. M. Thompson.

[* The following is an extract of the relevant part of the memorandum.—Ed.]

"*A Logical Convention Based on p-n Junctions.*

"It is well known that a junction rectifier or diode consists of a *p-n* junction, a junction transistor of two such junctions, and compound transistors of several. Also the impedance characteristics of the emitter of a junction transistor are those of a diode polarized in the forward direction, and the collector of a diode polarized in the reverse direction.

"There is an accepted symbol for a rectifier, as shown in Fig. 2 (a). It is suggested, therefore, that they should be drawn as combinations of these rectifiers. This leads to a convention for drawing transistors as shown in Fig. 2. The *p-n* junctions are shown as they are in the standard rectifier convention, and the emitters are shaded, or could be marked with a dot.

"A point transistor may be regarded functionally as a *p-n-p* transistor with $\alpha > 1$, and hence the base current flowing the opposite direction. It can also be considered as consisting of two point diodes.

"Diodes or rectifiers are commonly drawn either as shown in Fig. 2 (a) or in Fig. 3 (a). It is suggested that Fig. 2 (a) should represent a junction diode, while the

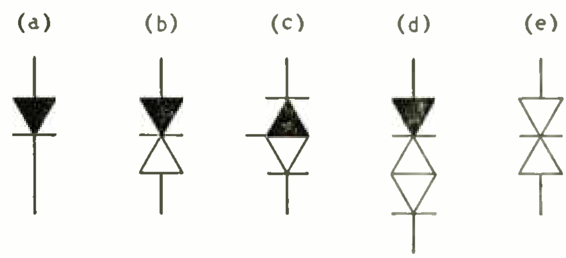


Fig. 2. A convention for junction transistors. (a) rectifier, (b) p-n-p transistor, (c) n-p-n transistor, (d) p-n-p-n compound transistor, (e) p-n-p symmetrical transistor.

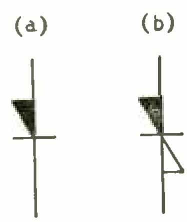


Fig. 3. A convention for point transistors. (a) rectifier. (b) transistor.

use of Fig. 3 (a) should be confined to point diodes. The above convention for junction transistors can be modified for point transistors as shown in Fig. 3."

British Colour Television

I THINK all engineers will agree that the Americans have earned the admiration of the technical world for the vast effort which has been put into their colour TV. And the result of all this effort has meant that a colour TV system has been evolved which can only be rivalled in complexity by those mysterious units installed in every automatic telephone exchange. In spite of this complexity, however, man's ingenuity has been stretched to a remarkable degree, and the system is capable of transmitting a colour picture from A to B. That is, of course, if one has unlimited financial resources and one or two skilled engineers are supplied with each receiver.

At some time in the future we must make a decision in this country as to the exact colour TV system which we shall inflict on our children and grandchildren. Without a doubt, once the receivers are sold we cannot change the system. It must therefore be a good system. With no colour service in operation the way must surely be obvious. The engineering profession and the various technical committees must not be subject to pressure from anywhere during these early colour TV decisions. They must not be panicked into thinking that any colour picture is better than none.

Here is a chance that will not occur again. The scanning standards must be reviewed. The u.h.f. bands must be considered. Due consideration must be given to the wonderful work done by the N.T.S.C., but this must not be allowed to affect our own approach to the problem. To make the system compatible may tie a weight round the necks of every receiver designer for the next century—so is it worth it?

The N.T.S.C. system has several disadvantages, all of which have been fairly stated in the published information. The one major handicap to my mind is that "it doesn't seem the way to do it." (I would hasten to add that I have no other workable solution!) In the past all major technical achievements have been finalized in a workable form in much the same way as had been predicted as a "dream solution" prior to the final realization. Dare we also anticipate the way to do colour TV? With one pick-up tube and the c.r.t. of the future that changes its colour according to a potential applied to an electrode (see "The Chromoscope." *Proceedings of the National Electronics Conference*, 1947, p. 549).

The engineer who works all day at his bench and who specializes in one branch or another may tend to lose sight of the larger goal which must be sought. Colour TV is desirable because at present there is something missing. That in itself is a challenge. That something may or may not be worth while, and indeed the colour picture will *not* be worth while if the resulting receiver is not a practical proposition. After all, surely that is what we must keep in mind. Whether we like it or not the real reason why anybody buys a TV set is to have a box in the corner that gives pleasure and entertainment to those who watch the screen.

Television, we are always being told, is a family affair. There is little doubt that all colour TV designers should remember this. Receivers at £250 to £300 will not sell—not even in America.

Carshalton, Surrey. CHARLES A. MARSHALL.

COMMERCIAL LITERATURE

Five-core Solder giving quick release of flux; brief technical details in the 2nd edition of "Modern Solders," an illustrated booklet from Multicore Solders, Hemel Hempstead, Herts.

H.T. Transformers; a leaflet giving specifications with the unusual feature of listing d.c. output voltage with current and the d.c. regulation for a given transformer, valve and capacitor combination. From Radford Electronics, 149 Newfoundland Road, Bristol 2.

Record Storage Cabinets in polished walnut, with top large enough to take a receiver or record player. Leaflet from Whiteley Electrical Radio Co., Victoria Street, Mansfield, Notts.

Miniature Soldering Iron for 2.5-6 V supply a.c. or d.c. With 4-V transformer (also available) the heating time is 6 seconds. Leaflet from Arthur Gray, Ltd., 150-152 Charing Cross Road, London, W.C.2.

Marine Broadcast Receiver (Cameo Senior, model RM215); a 5-valve superhet covering long, medium, trawler and short wavebands. Specification and descriptive leaflet from Rees Mace Marine, 11 Hinde Street, Manchester Square, London, W.1.

Vacuum Pumps (oil and mercury diffusion types), silicone pump fluids, leak detectors, ionization gauges and other vacuum equipment described in illustrated technical leaflets from W. Edwards & Co., Manor Royal, Crawley, Sussex.

Superhet Chassis with gramophone connection, bass and treble controls and push-pull output giving 8 watts. Specification on a leaflet from Tape Recorders (Electronics), 3 Fitzroy Street, London, W.1.

Automatic Mains Voltage Regulator, using motor-driven variable auto-transformer, with stabilization of within ±1% for input variation range of 50 V. Max. load current 22 amps. Illustrated leaflet from Airmec, High Wycombe, Bucks.

Digital Computor of plug-in unit construction with 550 valves, punched-tape input and typewriter output. The digit rate is 333,000 per second and the power consumption 6 kVA. Specification and brief description from Elliott Brothers (London), Century Works, London, S.E.13.

Anti-vibration Mounts for airborne equipment, with air damping and non-linear springs giving substantially constant natural frequency (8 c/s) with varying loads. Catalogues from Cementation (Muffelite), 39 Victoria Street, London, S.W.1.

Power Rheostats, toroidal wound, in five sizes from 25 to 150 watts and interchangeable with certain American types. Illustrated brochure of technical data from the British Electric Resistance Co., Queensway, Enfield, Middlesex.

Marine Radar Operation; a brochure on the Marconi "Radiolocator IV" giving a pictorial explanation of the controls to avoid frequent reference to the detailed instruction manual. From Marconi Marine, Marconi House, Chelmsford, Essex, price 4s.

Government Surplus Equipment; a new illustrated catalogue from A. T. Sallis, 93 North Road, Brighton, Sussex, price (including postage) 1s inland, or 2s 6d overseas by air mail.

Crystal Set, using germanium diode, mounted on standard two-pole telephone jack and intended to be plugged into any amplifier with a high-impedance microphone input. Selection of two preset-tuned m.w. stations by toggle switch. Leaflet from Truvox, 15 Lyon Road, Harrow, Middlesex.

Vector Diagrams Again

"CATHODE RAY" Advocates a Less Confusing System

SOME while ago an Australian reader sought an explanation of the phase shift between primary and secondary in r.f. transformers, which, he said, seemed to be taken for granted in the books. It is quite an important point, especially in connection with f.m. receivers. And it could hardly be answered properly without vector diagrams. The question was: What kind of vector diagrams? A few years earlier I had tried to show that vector diagrams as commonly seen are unsatisfactory, and explained a modified type of diagram that had just been described in *Electrical Review* by M. G. Scroggie. But if now I adopted this type without warning it would probably find everyone in the state of having forgotten all about it, if indeed they had ever heard of it. On the other hand, could I go back to the bad old style?

While I was pondering this dilemma, more and better information on the revised diagram appeared in *Electrical Review**. One distinct improvement was a new current notation to balance the already familiar subscript notation for voltages. Seeing that my previous exposition of vector diagrams had been unlucky in attracting the activities of an exceptional number of hostile gremlins, this seems to be the time for a review. The transformer question can then come in nicely as an example.

* 1st, 15th and 22nd January, 1954.

The purpose of vector diagrams, of course, is to show the relative magnitudes and phases of alternating quantities, such as voltages and currents. One method of doing this is what might be called the oscillographic or waveform diagram, such as Fig. 1. Even with only two quantities, as here, it is quite troublesome to draw clearly, and with eight or nine is just a mess. Most of the effort goes in depicting the waveform, and instead of making the relative magnitudes and phases clearer it obscures them. To compare magnitudes one has to visualize dimensional lines joining the peaks of the waves with the base line, at right-angles, as in Fig. 2. The relative phase is judged by comparing the distance between the V_{max} and I_{max} lines with one whole cycle—the distance between two successive V_{max} lines.

But when, as fortunately is so often the case, all the waveforms are the same—sinusoidal—there is no need to waste time drawing them; only the peak dimensional lines need be shown. That being so, they can be rearranged to show phases more clearly, the standard method being to set them at different angles, as in Fig. 3, a whole cycle being represented by a complete turn of 360°. This scheme has the advantage,

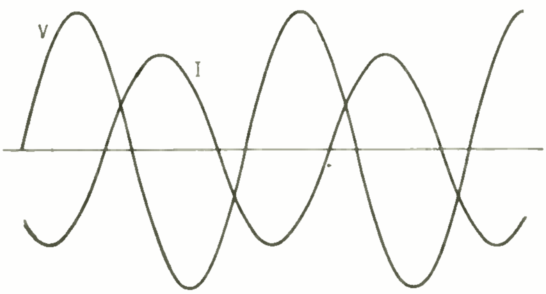


Fig. 1. Waveform presentation of alternating quantities.

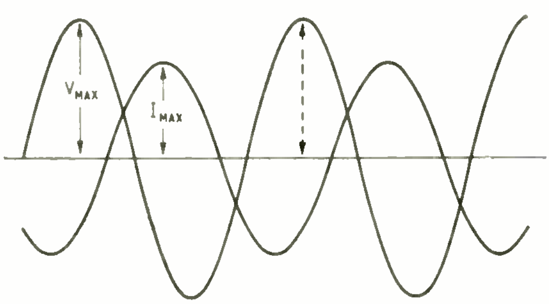
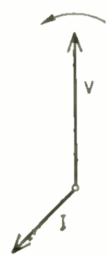


Fig. 2. In the Fig. 1 type of diagram, relative magnitudes are compared by noting the dimensions marked—the peak values—and phase by the distance between (in this example) I_{max} and V_{max}, compared with one whole cycle.

Right: Fig. 3. When the waveforms are all the same and known, it is a waste of time drawing them, and all one needs are the peak dimension lines, which can be arranged to show phase much more clearly as angle. (Quarter of a cycle is much more easily recognized as a right angle than as quarter of the distance along a line.)



too, that as the whole diagram is supposed to be rotating anti-clockwise at one rev. per cycle the instantaneous values of all the quantities shown are represented continuously by the vertical heights of the points of the vectors above the centre of rotation. When a point is below the centre, its height is of course negative. Thus in Fig. 3 V is at its positive maximum, and the instantaneous value of I (if it is, as it looks, 135° ahead of V) is $-I_{max}/\sqrt{2}$. Still another—and very considerable—advantage of the vector form of diagram is the ease of adding and subtracting magnitudes in different phase.

Circuit and Vector Relationship

A vector diagram by itself is not much good, however; one would not know what the "V," "I," etc., stood for. They are voltages and currents in a circuit, so one should have a circuit diagram on which these things are marked. Now, this is where the trouble begins. The diagrams of even the most reputable and eminent authorities often fail to provide an unmistakably clear tie-up between circuit diagram and vector diagram. The first book I looked at, written by the Principal of a technical college, was wholly devoted to electrical vector diagrams. As it was about 20 years old, however, I next looked up one of the most recent works by a progressive Professor of Electrical Engineering. Both these books agreed in marking voltages between points in circuits by two-way arrows as in Fig. 4(a). (The reference letters to mark the points are my own.) This scheme does at least show the points between which the voltages exist, and it does suggest that the voltage is alternating. But that is the utmost that can be said in its favour. Suppose the corresponding parts of the vector diagram were as in Fig. 4(b). This tells us that V_2 is exactly opposite in phase to V_1. But when we try to apply this information to the circuit diagram we find two possible and exactly opposite interpretations. It is like the man who, when asked if Oxford or Cambridge would win the boat race, replied " Yes! " When point *b* is maximum positive with respect to *a*, we can be sure that either *c* or *d* is maximum negative with respect to the other. It looks as if we shall have to toss for it, and have a fifty-fifty chance of being right. To so-called sportsmen that may be magnificent but it is not electrical engineering. The learned authors might perhaps reply that if we were to study the rest of the circuit and apply fundamental principles we ought to be able to work out the correct answer. But surely, gentlemen, that is not good enough! These diagrams are intended to save our brains, not to give them needless mysteries to solve!

Oddly enough, both these eminent authors marked *currents* in the circuit by one-way arrows, so their two-way voltage arrows are not even a consistent policy. Manchester has a reputation for ideas, and turning there I found an instructional publication for teachers of electrical engineering, in which both currents and voltages are marked with one-way arrows. These do not quite so clearly indicate exactly the points between which voltages are reckoned, and might be rather confusing in circuits where d.c. also existed. If we were really critical we might also think it a little queer to mark alternating quantities as if they went in one direction only. But these are perhaps carping criticisms, and we ought to be thankful to find that there are authorities who advocate a system that does not leave one guessing. If Fig. 5 was their version of Fig. 4(a), then Fig. 4(b) would unmistakably mean that when *b* was maximum positive to *a*, *c* would be maximum negative to *d*, and so on around the cycle.

Other authorities, though strangely few in this country, label the points of the circuit with letters, as I have done. Then instead of having to use an arbitrary number to distinguish one V from another, the natural and obvious thing is to use letters—V_{ab}, V_{cd}, etc.—which not only distinguish the voltages but also show definitely the points between which they exist and the relative directions in which they act. So this system combines the best features of the other two, and adds some that they lack. Using it, there is no need to mark the circuit diagram with any voltage labels or arrows; only to letter the points concerned. The vector diagram Fig. 6 provides the information of Figs. 4(b) and 5 combined. Obviously V_{dc} is the same thing as $-V_{cd}$, so the same information would be given by a diagram consisting of two vectors, V_{ab} and V_{cd} pointing in the *same* direction.

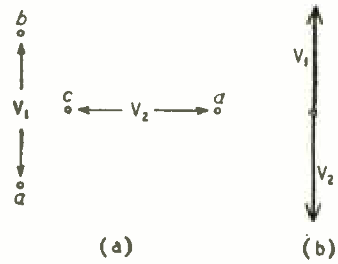


Fig. 4. (a) is a common method of marking voltages between two circuit points, in relation to a vector diagram (b), but it is ambiguous.

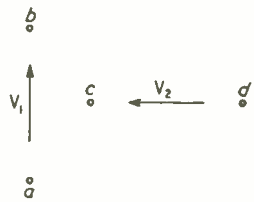


Fig. 5. This alternative to Fig. 4(a) removes the ambiguity, but suggests that the voltages are unidirectional, and is quite unnecessary.

Fig. 6. This alternative to Fig. 4(b) identifies the voltages on the circuit diagram unambiguously without any arrows at all.

Notice particularly that all this works quite smoothly without our having to decide whether positive V_{ab} means *a* more positive than *b* or *b* more positive than *a*. If the meaning is reversed, it is reversed for all the voltages in the diagram, and with a.c. that is all right. For if you and I were to give opposite meanings to V_{ab}, and you were right during all the positive half-cycles, I would be right during all the negative half-cycles, so we would be quits! But this is because so far we have only considered voltages. In any real problems we have to consider currents too, and then it becomes necessary to know which convention has been adopted about the order in which the letters come in naming the voltages.

Indicating Currents

Although this may seem quite a small point, it is vitally important and there will be endless misunderstanding if we don't get it clear now. Fig. 7 shows perhaps the simplest possible circuit—a source of e.m.f. driving current through resistance. Although it may be crazy (see " Alice in Solidconductorland," March issue, p. 152) it is nevertheless a universal custom to consider electrons as negative. The positive direction of current flow is therefore the direction of positive ion flow (if any) and opposite to the direction of electron flow. So we may say that current flows from the carbon electrode of a battery (which is conventionally called positive and marked red or " + ") through the external circuit to the zinc electrode. This is shown by the arrow's head in Fig. 7. In this diagram, therefore, *b* is positive with respect to *a*. We have the choice of calling the positive voltage in this circuit V_{ba} or V_{ab}. If we called it V_{ba}, then this would mean $V_b - V_a$, or the voltage of the first-mentioned point with respect to that of the second. This is the " voltage-fall " convention, because whether one goes from *b* to *a* through the battery or through the resistance (or through the surrounding space, for that matter) the potential is falling. If on the other hand we adopted the voltage-rise convention we would call the positive voltage V_{ab}, still meaning $V_b - V_a$, or the voltage change in the direction $a \rightarrow b$. (It is the principle of the thing that counts of course; if the top terminal had been labelled a the positive voltage according to the potential-rise convention would have been V_{ba}.)

So long as we make our choice clear at the start and stick to it, there is no excuse for misunderstanding. The majority of those who use a double-subscript-letter notation at all seem to favour the voltage-fall convention. So I only recommend the other because I am convinced that it is considerably better. Why is it? Look again at Fig. 7. The thing that is driving the current clockwise round this circuit is the e.m.f. of the battery. It seems reasonable to say that the direction of e.m.f. in a source is the direction in which the e.m.f. tends to drive current. In Fig. 7 the battery tends to drive positive current (and is succeeding in doing so) through itself from a to b, so I like to think that V_{ab} here is positive, not negative. Whatever we think, however, has to be in harmony with the principle that *the current flowing through a pure resistance is* (to use the a.c. term) *in phase with the applied e.m.f.* In Fig. 7 the current is flowing through the resistance from b to a and the applied e.m.f. (according to the voltage-rise convention) is V_{ab}. This is probably why so many people prefer the opposite convention. It admittedly comes easier to say " Oh yes; current from b to a, applied e.m.f. must be V_{ba}." But it is very much a matter of viewpoint. The source of the e.m.f. may be in quite another part of the circuit; there may be several sources, in fact. With the voltage-rise convention there is no need to worry about that; the whole of the rest of the circuit connected to the resistance being considered is in effect the source of the e.m.f. driving current through that resistance, and is acting through itself from a to b. If when considering a resistance one prefers to consider the voltage as acting through the resistance, then one's thinking can still be in harmony with the voltage-rise convention by regarding the resistance as a source of back voltage, V_{ab}, *opposite* to the direction of current; just as a box pushed across the floor is a source of pressure against the hand pushing it. Not everyone may take to this idea, but it is difficult to deny that inductance and capacitance in a circuit are sources of e.m.f. opposing the applied e.m.f.

If most people do prefer to think of the direction in which an e.m.f. acts as being the direction through the external circuit rather than through the source of the e.m.f., and there were no more to it, I would readily give in for the sake of uniformity. But there *is* more to it.

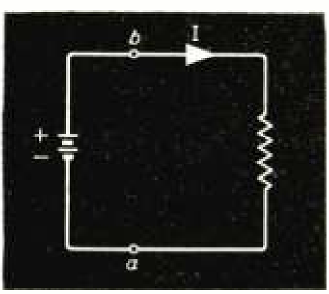
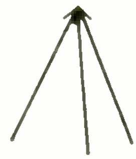


Fig. 7. Very simple circuit as a basis for discussion of circuit conventions.

Fig. 8. Provided that the circuit conventions are known, this is the simplest and clearest type of vector for the voltage between two units.

Fig. 9. The absence of arrow heads in the Fig. 8 type of vector obviates this kind of thing.



In Fig. 6 we have a vector V_{ab}. The same vector would represent V_{ba} if the label were changed and the arrow-head transferred to the other end. But electrical vectors invariably represent alternating quantities, which are constantly reversing, so it seems silly to pick on one of the two alternate directions rather than the other. It is altogether more logical to abolish both the label " V_{ab} " and the arrow-head, and simply to mark the ends of the vector line as in Fig. 8 to correspond with the points in the circuit. We British are supposed not to be logical, so that particular argument may not carry much weight; but as a practical race we ought to appreciate two things. One is that in a complicated diagram it is difficult to write in all the voltages so that no mistake can be made about which vectors they all belong to. The other is that when two or more arrow-headed lines meet, as in Fig. 9, it makes a mess. And if in order to avoid this the heads are put elsewhere on the lines there is risk of a confusion that I will mention a little later.

Seeing at a Glance

Fig. 8, then, is a neater (and more logical) job; but by far its most important advantage is still to come. It is, in fact, perhaps the outstanding advantage of the recommended type of vector diagrams. By marking all the voltage vectors in this way, we can see at a glance the instantaneous potential of every point in the circuit relative to every other point. Turning the diagram round clockwise, we can see how all these relative potentials vary as the cycle proceeds. With ordinary vector diagrams, this information has to be deduced laboriously, and unless one is exceptionally clever there are plenty of chances of going wrong. It is like the difference between seeing a working model and reading a specification of it—all the information may be in the specification, but it is difficult to visualize.

Before we go on to realize this by constructing a real vector diagram, we must just see how the idea of showing the vectors as in Fig. 8 affects our attitude to the potential-rise *versus* potential-fall question. One thing everybody will agree about is that in vector diagrams " up " means positive and " down " is negative. The natural meaning of the vector ab as shown in Fig. 8 is that point b in the circuit is maximum positive with respect to a. It is unthinkable that it should represent b as being negative to a. Now, we have already seen that this kind of vector is really two in one, for it is both upward and downward. If you wanted to refer to it in its upward sense, what would you call it ? Surely ab! Again, it is unthinkable that ab in Fig. 8 could mean the downward sense. And a third unthinkable thing is that the vector ab should represent the voltage V_{ba}. Unless therefore our brains are topsy-turvy, we are bound to take ab in Fig. 8 to represent V_{ab} at its maximum positive value, b being positive with respect to a.

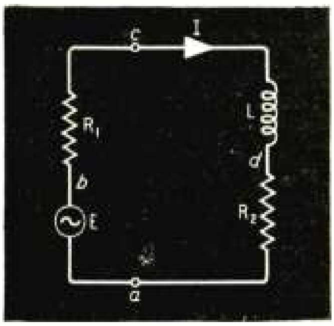


Fig. 10. Simple a.c. circuit as an example for comparing different types of voltage vector diagram.

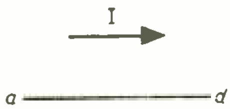


Fig. 11. First stages of a general vector diagram for Fig. 10.

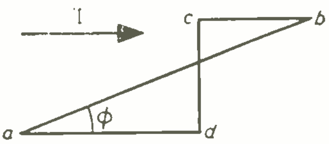


Fig. 12. A complete general vector diagram for Fig. 10.

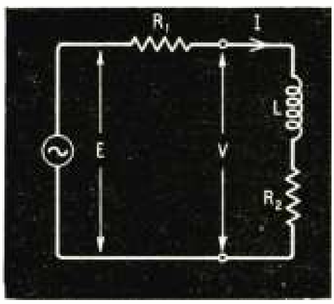


Fig. 13. How Fig. 10 would be drawn by some teachers.

In other words, we are bound to adopt the potential-rise convention. There is no way out that I can see!

Well, you may say, that is all very convincing and Q.E.D., but this new-fangled so-called vector is like the grand old Duke of York—neither up nor down; or, what is just as bad, both at once. If we had a pointing arrow we would know where we were! The answer is that only this two-way kind of vector suitably represents the undeniable fact that if *b* is positive with respect to *a*, *a* must at the same time be negative with respect to *b*. All the usual arrow-headed vectors, on the contrary, prejudice the case by picking out one of these two inseparable conditions. Not that this is necessarily wrong. There is often a good reason for picking one out rather than the other. If we were told that *a* in the circuit was earthed, then its potential would be fixed all the time at zero and it would be the potential of *b* that alternated. The natural way to represent this is to make *a* in the vector diagram the fixed point around which the whole diagram revolves. The usual method of showing this is to mark it with a dot or a small o. If you think this is not clear enough, then by all means mark the other end with an arrow-head. My point is this: until we *know* that *a* is earthed, and not *b*, or some other point altogether, it is not really right to assume that it is, by making all the vectors radiate from one particular point. And what about points *c* and *d*, when *a* is earthed? Since neither of these has any claim to priority, to mark the vector representing the voltage between them with an arrow at either one end or the other is arbitrary and meaningless, and may even be confusing. Everything in the perfect diagram has a logical meaning. The arrow-less vector, with the conventions I have just outlined, is so far as I know the only form that

(a) achieves a perfect tie-up between circuit and vector diagrams.

(b) is completely general, not assuming anything before it is known, and

(c) has one particular right form to represent a a given situation, and not a lot of confusing alternatives.

The best way of demonstrating these claims is to show some examples. We really ought to agree on a method of current notation first, but if we stopped to do that now we would come to the end of this month's allowance without a single real vector diagram, and that would be stretching patience too far. So just for now let us take an example with only a single current, shown in the usual way as in Fig. 7.

Fig. 10 is the circuit diagram. It represents a source of e.m.f. E with resistance R_1, feeding a load comprising inductance L and resistance R_2. In accordance with the recommended system the junctions have been lettered. Let us make sure that we have ready for use the basic phase relationships of a.c. circuits, for it is with these that vector diagrams are constructed:

(1) Current through resistance is in phase with applied e.m.f.

(2) Current through inductance lags applied e.m.f. by a quarter of a cycle (90°).

(3) Current through capacitance leads applied e.m.f. by 90°.

And remember that with the potential-rise convention the direction of the applied e.m.f. is regarded as the same as the direction of current *through the source of the e.m.f.*

The first thing to do when starting a vector diagram is to decide on a reference vector—i.e., one to which everything else can be related. In a simple series circuit like this, the current makes a good reference, because it is common to all parts of the circuit. The reference vector can be laid down in any direction we please, but it is usual to draw it at "3 o'clock," as in Fig. 11, that being the conventional zero of angular measure. If we had to construct the diagram to scale, in order to find, say, the actual magnitude and phase of current, given E, R_1, R_2 and L, then the I vector would usually be made unit length, representing 1 amp, and the diagram would in due course tell us the e.m.f. required for that current. Then it would be simple proportion: if that number of volts caused 1 amp, how many would E volts cause? Just now, however, let us draw an ordinary "qualitative" diagram, not bothering about particular numerical values.

At the moment we have no idea how the e.m.f. (V_{ab}) should be drawn, so we go on to something we do know, V_{ad}. That is the e.m.f. the rest of the circuit is applying to R_2 to make I flow through it from *d* to *a*. So we draw vector *ad* in the same direction as I (Fig. 11 again). Next comes V_{dc}, which is the e.m.f. applied to L, and must be 90° ahead of I if I is to be 90° behind it. So we draw *dc* accordingly, as in Fig. 12. Then *cb* in the same direction as *ad*.

Now a and b are located, so the relative direction (phase) and magnitude of the e.m.f. is revealed. Since ad is in the same direction as I, the angle marked ϕ is the angle the current in this circuit lags behind the e.m.f. If R_1 is the generator resistance, then the terminal voltage is V_{ac}, and Fig. 12 shows us that the current lags this more than it does the e.m.f. The point b is really fictitious, in the sense that it does not exist in the circuit represented by Fig. 10, for the e.m.f. is mixed up with R_1. But supposing now that R_1 did have a separate existence, Fig. 12 shows us without any effort the magnitude and phase of the voltage between b and d, in either direction.

Notice, too, the complete information about relative potentials. We see that at the chosen instant, when I is just passing through zero, b has recently started to be positive with respect to a. Point d is maximum negative to c, and so on. If you are not a novice, all this may be obvious without any vector diagram at all, or with only the usual sort. But that is because we have taken a very simple example; in problems that are worth making a vector diagram for in earnest it is very often far from obvious what all the relative potentials are. Note that Fig. 12 not only shows the potentials between any of the points marked, but likewise points unmarked; for example, one third of the way down R_2 from d. And it gives an instant answer to questions such as this: When the e.m.f. is at its positive peak, what is the potential of c relative to a? All one need do is turn Fig. 12 until b is vertically above a, and then note the vertical distance of c above a. The phase angle is also clearly shown.

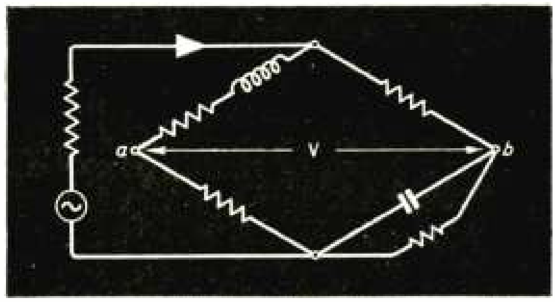


Fig. 15. Example of a circuit in which the ambiguity of the two-way arrow shows up.

Now let us end this month's instalment by comparing the usual kinds of vector diagram for Fig. 10 with Fig. 12. I am conscientiously going to follow the methods of eminent teachers. Their version of Fig. 10 would probably be something like Fig. 13. When it came to the vector diagram, however, there might well be considerable diversity. Fig. 14 (a) is a likely starter. It was commenced by drawing the I vector as before. The voltage drop in R_1 is of course R_1I, and is in phase with I. Invariably it would be drawn coinciding with the I vector. So would R_2I. This is where the confusion begins. Some authorities make every vector sprout from one point, while others sometimes put them head to tail. Unless one happens to know the idiosyncrasies of the particular author of the diagram, there is a possibility of misunderstanding when, as here, there are several vectors in the same line. For your information, I and R_1I here start from the same point, but R_2I begins where R_1I leaves off. Where R_2I leaves off, the voltage across L, which is $j\omega LI$, begins (the j merely being an instruction to turn it 90° clockwise). The line marked E clearly represents the voltage across all of them—the e.m.f. And the line V, being across the two load components, represents the terminal voltage V.

By now there is a nice mess of arrow-heads at the junction of the E and V vectors. If, to avoid this, the arrow-heads are drawn some way down the vectors, they might (in a less simple diagram) mislead one to suppose that they indicated part-way vectors like R_1I. It is, of course, standard practice to mix the current and voltage sectors up together, and often flux

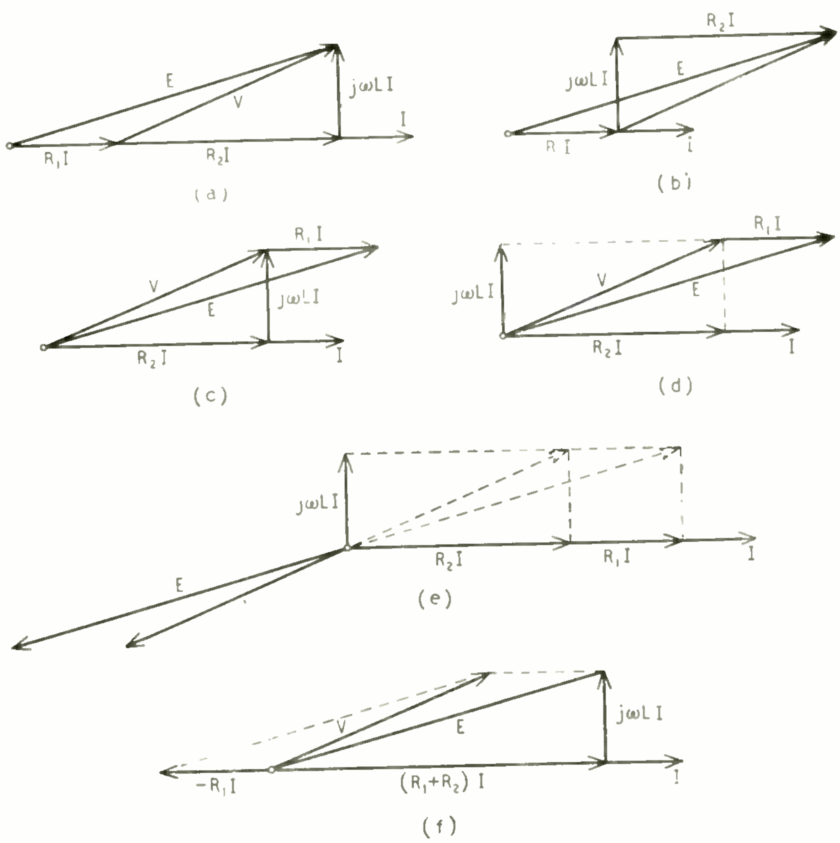


Fig. 14. Some of the many ways in which the vector diagram for Fig. 10 might be drawn, according to commonly taught methods.

vectors too. Some authorities use different types of arrow-heads to distinguish them, but not my learned mentors.

Altogether, then, one has to study this kind of diagram pretty closely to sort it out, even though this is such a simple example as to be almost trivial. And as for the information it supplies, one cannot even be certain, by looking at the vector diagram alone, which terminal is positive when the current is flowing as shown. In such a simple example it is easy enough to find out by looking at the circuit diagram, but if the circuit had been Fig. 15 would either the circuit diagram or a vector diagram drawn by the Fig. 14 method, or both combined, give a quick answer to the question: which is more positive, *a* or *b*? With the Fig. 12 type of diagram, all one has to do is to put the diagram so that the current vector is pointing upwards and then see which of the two points in question is higher than the other. It is surely a bad policy to use a system which, while it may not let one down on many occasions, is liable to do so on others, seeing that there is an alternative system that is reliable every time.

Look again at Fig. 14(a) and use it to find the answers to the questions we solved so easily with Fig. 12, and then ask yourself why people use the Fig. 14(a) type, and whether you are going to continue to use it in preference to Fig. 12. And remember that the more complicated the problem the greater the contrast between the two types. I would not say that the Fig. 12 type is the easier to construct at first, if you have been used to the other, but even at first it reveals its information more quickly and clearly and unmistakably. Of course there is no reason why $j\omega LI$ should not be written alongside the vector *dc* to save one having to look at the circuit diagram; and the same for any other notes that may be convenient.

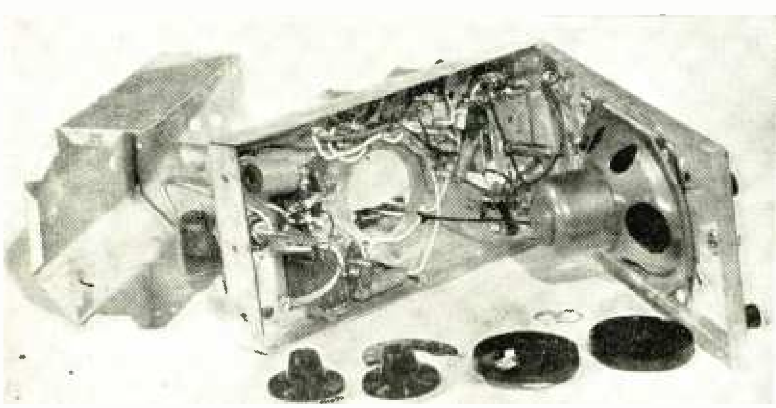
Lastly, there was the point about Fig. 12 being the one and only correct diagram for the given circuit and component values. That, I think, is important, because it must be very confusing for students to see a number of quite different-looking vector diagrams for identically the same circuit. Of course the current vector in Fig. 12 could be put elsewhere, so long as it was parallel to *cb*; and the diagram as a whole can be looked at from any angle. But it seems strong evidence of soundness in principle that no alternative shape can be arrived at, using the rules correctly. Contrast this with ordinary vector diagrams. Fig. 14(a) is a typical result, but we would have had an equal chance of full marks if we had drawn it in the other ways shown in Fig. 14. We might have taken the impedances in strict clockwise rotation, as at (b). Or we might have gone anti-clockwise, as at (c). Or we might have made R_2I and $j\omega LI$ sprout from the common centre and "completed the parallelogram" to find the resultant load, as at (d). Or we might have put the arrow-head at the other end of the vector R_1I, to show that V, the terminal voltage, is the resultant of E and R_1I, as not shown separately. Or, following another school of thought, we could have drawn the V and E vectors in the opposite direction, to show they opposed the impedances, as at (e). Or we might have shown the same thing rather differently, as at (f). And there are many other possible combinations; all correct according to the textbooks. In place of this multifarious confusion, would it not be better to adopt the simple and informative Fig. 12, where any variation or modification signifies some real change in the circuit; not merely a different person happening to be drawing the diagram?

Seeing, then, that what is called the general type of vector diagram has so many and manifest advantages over other kinds, why is it not in common use? It may be that although I have been deriving great benefit for years from my own use of it there is some fatal flaw that I have been too blind to see. In which case you would be doing a great kindness by pointing it out to me. It may be that too few people have seen it for too short a time. If you do *not* see any fatal flaw and can *not* deny the advantages, you would be doing a kindness by pointing them out to others. It may be that people who use or teach vector diagrams are too firmly entrenched in their habits and can't be bothered to change them. But of course that wouldn't mean you!

NOVEL CAR RADIO RECEIVER

THE illustration shows the special radio receiver designed by Pye and now being installed in every "Metropolitan" motor car made by the Austin Company for the Nash Corporation of America.

An unorthodox form of construction is employed, for, as can be seen, the loudspeaker is mounted on a hinged cover enclosing the underside of the receiver chassis with the magnet protruding through the receiver section. This cover actually forms the front of the set, the spindles of the controls, one of which is dual concentric, being located on each side of the elliptical loudspeaker. The concentric pair actuate the combined volume/on-off and tone controls, while the single spindle is for tuning. This form of construction undoubtedly simplifies servicing and it is said that the set can be installed in a matter of minutes only. Some of its features have not so far been seen in car radio receivers produced for the home market.

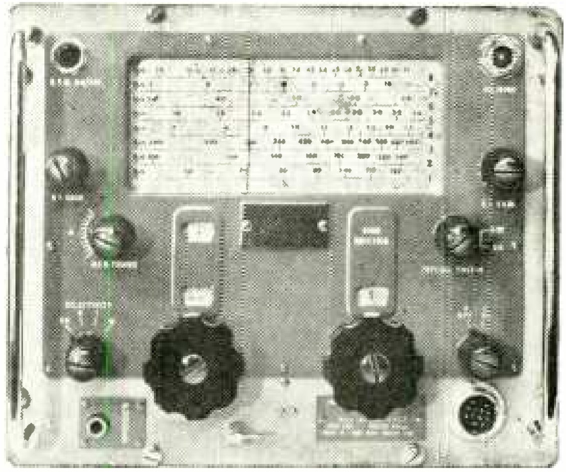


Accessibility of all components is the special feature of the new Pye receiver installed in the Nash "Metropolitan" motor car.

Wide-Band Communication Receiver

DESIGNED TO ADMIRALTY SPECIFICATION FOR USE IN NAVAL VESSELS

Coverage: 60 kc/s to 31 Mc/s



THE set to be described was designed to conform to a fairly rigid Admiralty specification for use in ships of the Royal Navy. Approval has been given also for it to be fitted in ships of the N.A.T.O. navies. Although primarily a naval receiver it is not restricted to use in ships and either the same model, or one closely resembling it, will be available for general use before long.

As at present produced, frequency coverage is continuous from 60 kc/s to 31 Mc/s, this band being covered in eight switched ranges; the actual extent of each is outlined in the wavelength table reproduced here.

In this table, mention is made of the use of either one or of two intermediate frequencies for the various ranges and this is brought about by the fact that whilst the receiver is basically a double superheterodyne, on certain ranges the first, or high i.f., is inconvenient to use or else it clashes with the signal. To overcome this trouble the expedient is adopted of switching from double to single superheterodyne as the need arises. These changes are effected by the waveband switch and all circuits are automatically aligned for whichever mode of operation is employed.

WAVELENGTH TABLE

Range	Coverage	I.F.(s)
1	60–125 kc/s	460 kc/s
2	100–260 kc/s	
3	260–660 kc/s	1.4 Mc/s and 460 kc/s
4	0.66–1.5 Mc/s	460 kc/s
5	1.5–3.4 Mc/s	
6	3.4–7 Mc/s	1.4 Mc/s and 460 kc/s
7	7–15 Mc/s	
8	15–31 Mc/s	

I.F. SELECTIVITY TABLE

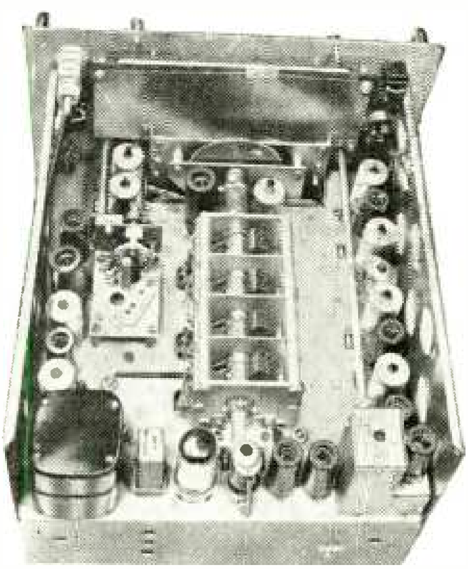
(as single superhet)

Response db	Wide	Interme-diate	Narrow	Very Narrow
−6	6.5 kc/s	4.6 kc/s	1 kc/s	700 c/s
−20	10 kc/s	7.5 kc/s	3 kc/s	1.1 kc/s
−60	20 kc/s	15.5 kc/s	10 kc/s	4.5 kc/s

The double superheterodyne principle offers certain advantages on all but the longest wavelengths, but especially so on those below 100 metres (3 Mc/s). The wider separation between the signal and the first mixer oscillator frequencies assists circuit alignment by minimizing "pulling" and, perhaps most important of all, it gives greater freedom from second-channel interference. As the table shows, the two i.f.s used in this set are 1.4 Mc/s and 460 kc/s respectively.

As the single r.f. stage might not offer a good enough barrier to break-through of signals on the intermediate frequencies, two wavetraps are provided, one in the aerial circuit, tuned to 460 kc/s; the other in the intervalve coupling of the r.f. stage tuned to 1.4 Mc/s. They are brought in as required by the waveband switch.

The bandwidth of the i.f. amplifier can be adjusted over quite a wide range, but in four steps, not continuously. These steps are marked on the switch as "wide," "intermediate," "narrow" and "very narrow," their respective bandwidths depend on the



Chassis of the Rees Mace communications receiver, model CAT.

points on the response curve between which they are measured and these are given in the selectivity table. For the "wide" bandwidth, additional inductive coupling is switched in between the primary and secondary windings of the 460-kc/s i.f. transformers; when switched out it gives "intermediate"; interposing a double quartz crystal filter between valves V_5 and V_6 gives "narrow"; tapping the filter across part of the V_5-V_6 i.f. transformer secondary provides "very narrow." Incidentally, tapping down V_6 on the secondary of the preceding i.f. transformer obtains in all positions of the selectivity switch except the "narrow."

There are 12 valves in the receiver and the valve function table gives, in condensed form, the type of valve in each stage and its function on the various tuning ranges. Some of the valves perform more than one function at different times. The only comment required is perhaps on the use of the triode of V_2 as a crystal-controlled oscillator. It is not normally used, but when it is it replaces the tunable oscillator V_3 in the first frequency-changer circuit.

The noise limiting function performed by V_8 is for suppression of impulse noise. It is a series-parallel type in which one diode opens the a.f. signal path while the other short-circuits it. There is a threshold control to adjust the point at which suppression starts.

As a safeguard for the receiver when it is used in proximity to a transmitter, there is included a muting relay which can be operated by a subsidiary contact on the morse sending key. This applies a positive voltage to the cathodes of valves V_1, V_2, V_4 and V_5, thus effectively de-sensitizing the set.

So far as the a.f. stages are concerned it need only be said that negative feedback is applied from the anode of the output valve to the penultimate a.f. amplifier; and the output transformer provides two outputs, one at 500 ohms giving 2 W and the other at 100 ohms giving 60 mW.

The receiver, which is described as the Model CAT, is supplied by Rees Mace Marine, Oulton Works, Lowestoft, Suffolk.

VALVE FUNCTION TABLE

Position	Type	Circuit Functions: Ranges 1, 2, 4, 5	Circuit Functions: Ranges 3, 6, 7, 8
V_1	6BA6	R.F. Amplifier	R.F. Amplifier
V_2	ECH81	Heptode: 1st mixer to 460 kc/s circuit Triode: Crystal circuit oscillator Range 5 only	1st mixer to 1.4 Mc/s Crystal circuit oscillator Ranges 6, 7 and 8 only
V_3	6C4	1st Oscillator: signal + 460 kc/s	1st Oscillator: signal + 1.4 Mc/s
V_4	ECH81	Heptode: I.F. amplifier Triode: not used	2nd Mixer to 460 kc/s 2nd Oscillator at 1.86 Mc/s
V_5	EF92	I.F. Amplifier at 460 kc/s	
V_6	EF92	I.F. Amplifier at 460 kc/s	
V_7	EB91	Signal detector and A.G.C. rectifier	
V_8	EB91	Noise limiter	
V_9	EF92	A.F. Amplifier	
V_{10}	6CH6	Output tetrode	
V_{11}	QS150/45	Voltage stabilizer	
V_{12}	EF92	Beat frequency oscillator	

NEWS FROM THE CLUBS

Birkenhead.—Wirral Amateur Radio Society continues to meet on the first and third Wednesdays of each month at 7.30 at the Y.M.C.A., Whetstone Lane, Birkenhead. Sec.: C. Wattleworth, 17, Iris Avenue, Claughton, Birkenhead.

Liverpool.—The Liverpool & District Amateur Radio Club (previously known as the Liverpool & District Short Wave Club) meets on Tuesdays at 8.0 in St. Barnabas Hall, Penny Lane, Liverpool, 15. The club transmitter, G3AHD, can be heard most Tuesday evenings on 160 metres. Reports on the transmissions would be welcomed. Sec.: A. D. H. Looney, 81, Alstonfield Road, Knotty Ash, Liverpool, 14.

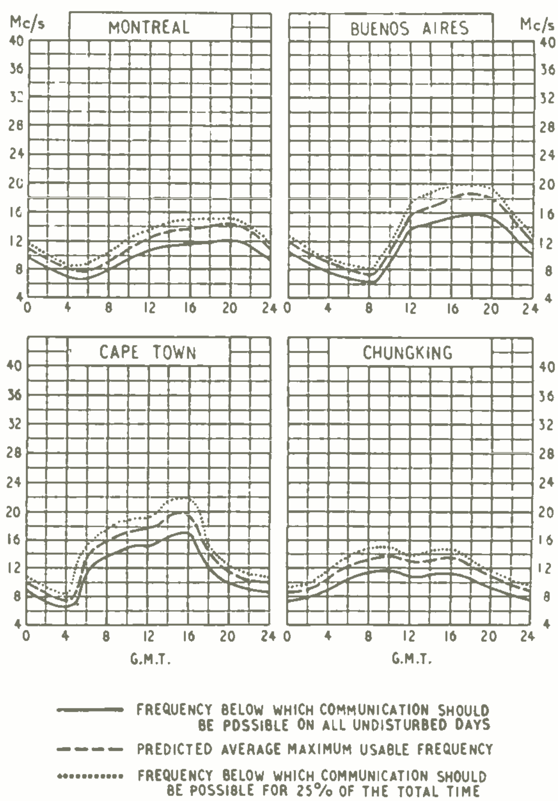
QRP.—The number of clubs which have become affiliated to the QRP Society is such that the society is planning inter-club QRP tests. It is also arranging its own exhibition for October. Sec.: J. Whitehead, 92, Rydens Avenue, Walton-on-Thames, Surrey.

Short-wave Conditions

Predictions for July

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 July.

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



Negative Resistance

Two Kinds — and How to Use Them

By THOMAS RODDAM

THE idea of resistance is the starting point for most of our circuit theory: the idea of negative quantities is the starting point for an engineer's study of banking practice. If I had a copy of *Pickwick Papers* handy I would make a quick reference to Mr. Potts' assistant the Chinese metaphysician; but there, I have completely forgotten, though you no doubt know what I mean. Anyway, given the idea of resistance, and the idea of negative quantities, there is no difficulty at all in envisaging a negative resistance. So I used to think, until I started to construct a device called a negative impedance converter. My problems were recalled by "Cathode Ray" in the April issue of *Wireless World*, who wrote in a footnote (p. 195): "If you are sceptical about the sign of a parallel combination of positive and negative resistances being the same as that of the *smaller* of the two, try using the formula $\frac{R_1 R_2}{R_1 + R_2}$ to find the resistance when R_1 is, say, -15 kΩ and R_2 is $+20$ kΩ. (The answer should be -60 kΩ.)"

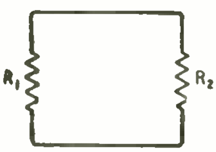


Fig. 1. Two resistances, in series or in parallel?

Now, I do not come from Missouri, but you will have to show me, and in order to convince myself that "Cathode Ray" was right I drew Fig. 1. Two resistances in parallel, R_1 and R_2, and the result, as "Cathode Ray" says, is $R_1R_2/(R_1 + R_2)$, which, if $R_1 = -15$ kΩ and $R_2 = +20$kΩ, is just -60 kΩ. But are there two resistances in parallel, or are they in series? If they are in series, the total resistance of the loop is $(R_1 + R_2)$, or $+5$ kΩ. In one view we have the makings of instability, and in the other we have a perfectly stable system. Of course, if we make $R_1 = -20$ kΩ and $R_2 = +15$ kΩ, the round-the-loop resistance is -5 kΩ, and the parallel combination is $+60$ kΩ, so that the loop is the unstable view and the parallel arrangement the stable one.

It might be suggested that somehow this is just a bit of algebraic fiddling of no practical importance, intended merely to blind you with science and give me something to write about. In fact, the distinction is one of great practical value which must be understood if any use is to be made of negative resistance circuits. In the simplest possible problem, when we wish to make a negative resistance oscillator, we must decide whether to replace R_1 by a parallel LC circuit, as in the dynatron oscillator, or by a series LC circuit, as in some of the transistor oscillators.

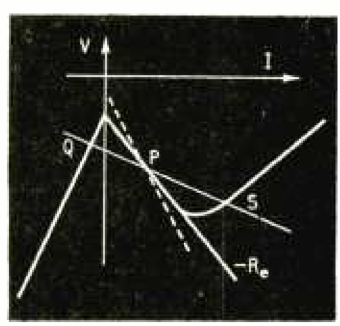
There are two quite independent approaches to this question of the two kinds of negative resistance, because it turns out that there are, in fact, two different sorts of negative resistance. Both these approaches depend on the fact that a practical negative resistance is only negative over a limited range of working conditions and, as we shall see, there is no obvious connecting link between the two approaches.

First of all we may follow "Cathode Ray" and plot a graph showing the relation between the voltage and current. We shall be working with the incremental resistance, the value of dV/dI, and since this is most conveniently thought of as the slope of the graph we shall take the current axis as the horizontal axis and the voltage axis as the vertical one. This is not the way we plot valve characteristics, but it is the standard method for negative resistance studies, and we shall see in a moment why we must keep to this standard.

Fig. 2 is a typical negative resistance characteristic, which is easily produced with a point transistor. It is a plot of the emitter voltage-current characteristics in a circuit with a fairly large base resistance, and for reasons which are obvious it is called an N-type characteristic. In the neighbourhood of the point P the resistance is negative, and has some value $-R_e$. Across the curve, I have drawn a load line QPS intersecting the curve at three points, of which P is unstable and Q and S are both stable. This load line corresponds to some resistance R_L, which is less than R_e. The other load line, dotted in through P, corresponds to a resistance $R'_L > R_e$, and there is only one intersection, at P, which must therefore be stable. Two special cases of these load lines are important. The one through P parallel to the I-axis, the short-circuit case, has three intersections, so that $-R_e$ is short-circuit unstable: the one through P parallel to the V-axis has only one intersection and thus $-R_e$ is open-circuit stable.

Now let us look at the base characteristic of a point transistor, shown in Fig. 3. Again we have a negative resistance region round P, and a load line QPS intersecting the curve at three points. This characteristic is that of an S-type negative resistance. You will see from the two figures why we must use the standard arrangement of axes if we want to have standard terminology. Q and S are stable intersections, while P is unstable, but this time the load resistance $R_L > R_b$.

Fig. 2. One type of negative resistance characteristic, showing stable and unstable load lines through P.



The dotted load line, for $R'_L < R_b$, has only a single stable intersection, at P. Quite clearly the S-type characteristic is short-circuit stable and open-circuit unstable.

It is, I think, fairly obvious that to produce an oscillator using an N-type negative resistance we should use a controlling circuit which drops to a low resistance at the frequency we want, while to produce an oscillator using an S-type characteristic we must use a controlling circuit which rises to a high resistance at the wanted frequency. In practice we use a series LC circuit for the N-type, and a parallel LC circuit for the S-type.

How do these two kinds of negative resistance come into existence? We know that in all the circuit forms —we do not want to talk about gas-discharge tubes— there is some positive feedback somewhere in the circuit. Let us assume that we have arranged matters so that we can control this feedback, and settle down to plot the voltage-current characteristics with different amounts, starting with no feedback at all. Our first graphs will be straight lines, corresponding to some value of positive resistance. As we turn up the feedback, we find a kink developing: in the region of this kink the resistance may be either greater or less than the initial value: with more feedback still, the curve actually bends back, as you can see from Fig. 4. The S-type characteristic in Fig. 4(a) is obtained from a circuit giving an increase in resistance for small positive feedback, so that the negative resistance has been reached through infinity. The N-type characteristics in Fig. 4(b) is obtained from a circuit giving a decrease of resistance for small positive feedback, so that the negative resistance is reached through zero. Those curves can easily be plotted on an oscilloscope, and the changing shape watched as the feedback is varied. To do this, though, you must drive the single-valued co-ordinate with a " stiff " source, which means that to plot Fig. 4(a) we apply a sweep voltage and pick off the current produced, while to plot Fig. 4(b) we apply a sweep current and pick off the voltage. If you sweep the emitter voltage in Fig. 2 the current will simply cut the corners and will never show you the negative resistance region at all.

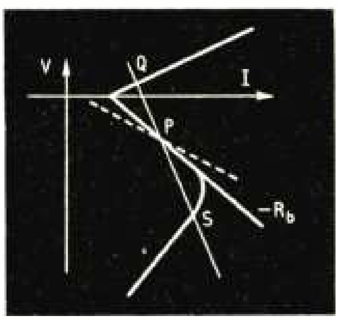
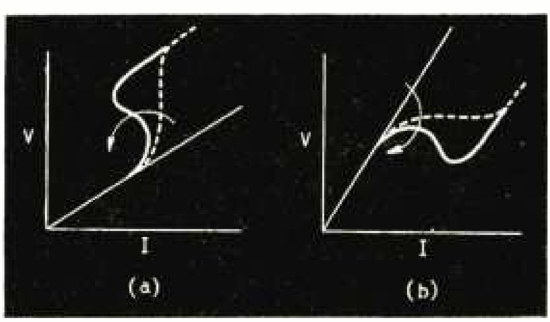


Fig. 3. The other type of negative resistance characteristic.

Fig. 4. A negative resistance can be developed by bending the V-I curve up through $R = \infty$ (a), or by bending it down through $R = 0$ (b).



This division of negative resistances into two kinds is enough to tell us how to use them, but it leaves one point completely unsettled. Suppose that we have a circuit known to be a negative resistance and that we plot a small section of the characteristics and apply a load line. All the information is given in Fig. 5: is this arrangement stable or unstable? How can the circuit know, if it is brought to the point P, whether this is an unstable condition or not? This problem seems to have been left without discussion for quite a long time. The idea that there are two types of negative resistance, the N-type and the S-type, was introduced by Crisson, who called them the series and shunt types, because this analysis was concerned with the use of negative resistance for telephone repeaters. In this application it is essential to know what happens when the repeater is not being used, which normally means that the line in which it is connected is open-circuited: a series type is perfectly safe in this condition, but a shunt type will oscillate and may disturb other equipment.

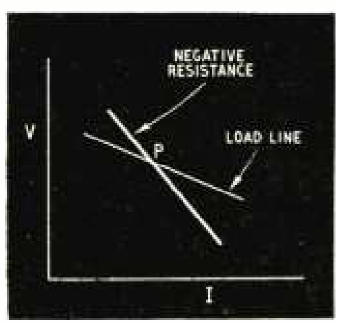
Resistance + . . .?

The approach to negative resistance which tells us why one kind is short-circuit stable and the other short-circuit unstable depends on a hard physical fact: there is no such thing as a pure resistance. Any practical negative resistance must have some capacitance and will probably have some inductance associated with it. A theoretically pure negative resistance, of its very nature, cannot lead to instability, for reasons which are beyond our scope here, but which are discussed in a paper[1] referred to at the end of this article. The stability of a negative resistance circuit is therefore determined by the actual impedance over the whole frequency range, from $-\infty$ to $+\infty$.

We can determine this impedance quite easily by using the circuit shown in Fig. 6. The variable resistance and capacitance (or inductance) elements are adjusted until the voltmeter shows a balance, when the total impedance $(R + j\omega L) - Z$, for the LR case, is zero. Obviously then $Z = R + j\omega L = R + jX$.

For each frequency we plot a point on the R, X

Below: Fig. 5. If this is all the information available, is the system stable or unstable?



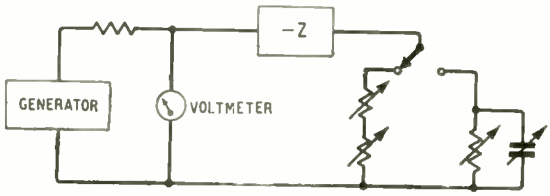


Fig. 6. Test circuit for measuring negative impedance.

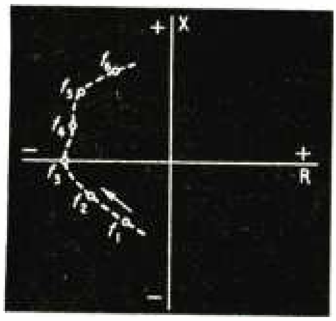


Fig. 7. The locus of the complex impedance $R + jX$ as the frequency is increased from f_1 to f_6. This particular example shows a negative resistance.

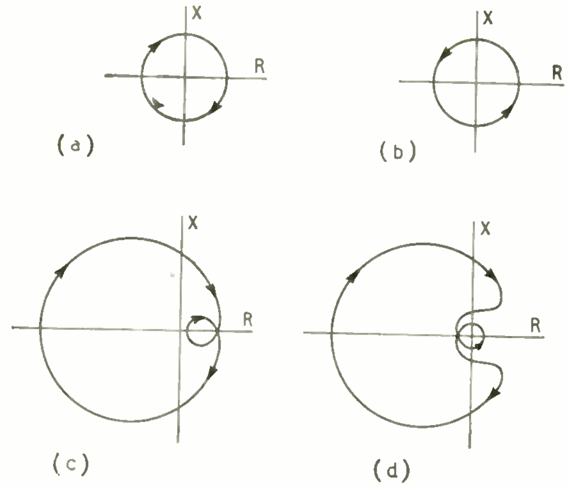


Fig. 8. Typical plots of R and X for, (a) and (c), series type and, (b) and (d) shunt type negative impedances.

graph shown in Fig. 7, and join the points to give a curve. When we do this we find that the graphs look something like the lower ones of Fig. 8, in which the arrow shows the direction of increasing frequency. Over on the left the two graphs are very similar, so that at some frequency both correspond to, say, —1,000 ohms, non-reactive. In order to appreciate the difference between these two curves, let us look at Fig. 8(a) and (b). We can consider these curves as the boundaries, the cages, separating two regions of the plane RX. One of these regions is *inside*, the other *outside*, and we must use a consistent rule for deciding which is which. The rule is that the Right Bank is *inside*, left and right being distinguished by looking in the direction of increasing frequency. The origin is inside in Fig. 8(a), but in 8(b) the origin is outside the boundary. The origin, of course, corresponds to a short circuit, and as it can be shown that points inside the boundary are unstable loads for a negative impedance, Fig. 8(a) corresponds to a short-circuit unstable system, while Fig. 8(b) is unstable with high impedances connected to it. The loops of Figs. 8(c) and 8(d) are not quite so obvious. The easiest way to check inside and outside here is to see how the pattern changes if it is treated as a piece of string, marked with directional arrows, and with a stick at the origin to prevent any crossing of the origin. In Fig. 8(c) the little loop on the right can easily be collapsed to a knot, so the origin is inside, as it is in Fig. 8(a). In Fig. 8(d) the small loop round the origin must be enlarged until the big kidney-shaped loop on the left collapses to a knot; Fig. 8(d) is like 8(c), with the origin outside.

These diagrams, as you will have guessed, are related to the Nyquist diagrams used in feedback amplifier theory. There is, indeed, another way of treating feedback amplifiers, by breaking the feedback path and measuring the impedance at the break, which leads to exactly these curves. If you get a curve like Fig. 8(a) or 8(c) when the feedback path is closed, the amplifier will be unstable. What we are doing in this analysis is finding the frequencies at which oscillation can take place, if it can: the noise in the circuit will build up at those frequencies to allow the system to trigger over to the point Q or S in the earlier diagrams.

The reader may be tempted to think that this idea of negative resistance is all very academic. Useful for oscillators, perhaps, but of no other application is the view which most of us used to take. In recent years, however, a new idea has grown up and is likely to be of great importance. It begins, for our purposes, with a method of designing negative resistance circuits of very reliable characteristics. The dynatron circuit suffers from the disadvantage that it is really a " trick circuit " depending on valve characteristics which are not strictly controlled. It works well so long as you are prepared to adjust it carefully, but it cannot be designed, built and left alone. There is, however, a very interesting circuit based on the grounded-grid amplifier which will provide negative impedances that are almost independent of the valve characteristics. In an article on the grounded-grid amplifier (May issue, p. 214) I showed that the input and output impedances of a grounded-grid amplifier with feedback from anode to grid are:

$$\text{input impedance} = \frac{\rho}{1+\mu} + \frac{1+\mu k}{1+\mu} R_2$$

$$\text{output impedance} = \frac{(1+\mu) R_1 + \rho}{1+\mu k}$$

Let us now take $k = -1$. Then

$$R_{in} = \frac{\rho}{1+\mu} - \frac{\mu - 1}{\mu + 1} R_2$$

$$R_{out} = -\frac{\mu+1}{\mu-1} R_1 + \frac{\rho}{\mu - 1}$$

If we neglect the term $\rho/(\mu + 1)$, which will be about 200 ohms, positive, we have

$$R_{in} = -\frac{\mu - 1}{\mu + 1} R_2$$

$$R_{out} = -\frac{\mu + 1}{\mu - 1} R_1$$

Since μ will be about 50 for a 12AT7, the term $(\mu - 1)/(\mu + 1)$ is very close to unity, and both R_{in} and R_{out} are approximately equal to the negative of the im-

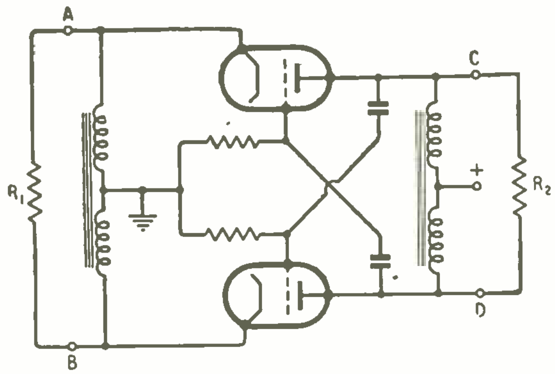


Fig. 9. Basic circuit of negative impedance converter. Across AB the impedance is of series type, and is about $-R_2$: across CD the impedance is of shunt type, and is about $-R_1$.

pedance at the other side of the valve. As you can see, if μ drops from 50 to 40, the coefficient $(\mu - 1)(\mu + 1)$ changes only from 0.961 to 0.95.

The actual circuit used to produce this high-stability negative impedance (it is called, for obvious reasons, a negative impedance converter) is shown in Fig. 9. As you can see, it is a push-pull grounded-grid amplifier, with feedback to each grid directly from the opposite anode. The direct coupling makes $|k| = 1$, and the cross connection gives the minus sign. We can remove R_1 and see $-R_2$ across terminals C and D. In practice it is just slightly more complicated, because to make the circuit work well we will try to keep R_2 in the region of 10-30 kΩ, the sort of value which suits the valve, and if we want a low negative impedance at AB we must use an input transformer.

An interesting feature of this circuit is that it gives us a chance to work with either series or shunt types of reactive impedance. At AB the impedance is of the series type, while at CD it is of the shunt type. This result was implicit in the discussion of the way the impedances varied with k in the previous article. An amplifier of this kind, called an E1 repeater[2], is being used in America in telephone circuits: the line is broken and connected through AB. The negative impedance acts as an amplifier in both directions, quite impartially. A corresponding circuit using transistors has been described by Linvill[3], who has gone on to show[4] how a device of this kind can be used together with RC circuits to produce some quite impressive filters. One of these basic circuits, with the response obtained, is shown in Fig. 10.

I do not propose to discuss these negative resistance circuits in any more detail here, because they are both complicated and rather specialized. They are examples of the trend of modern circuit design towards a form in which the valve is so controlled in the circuit that changes in its characteristics do not affect the operation of the system. The basic theory of negative resistance, too, shows an increasing concentration on the full story of a situation. Whether you look at the V-I characteristic, or at the impedance presented at the terminals, you must investigate conditions quite a long way from the actual working region. You must, indeed, search for

"... The five unmistakable marks
By which you may know, wheresoever you go
The warranted genuine Snarks."

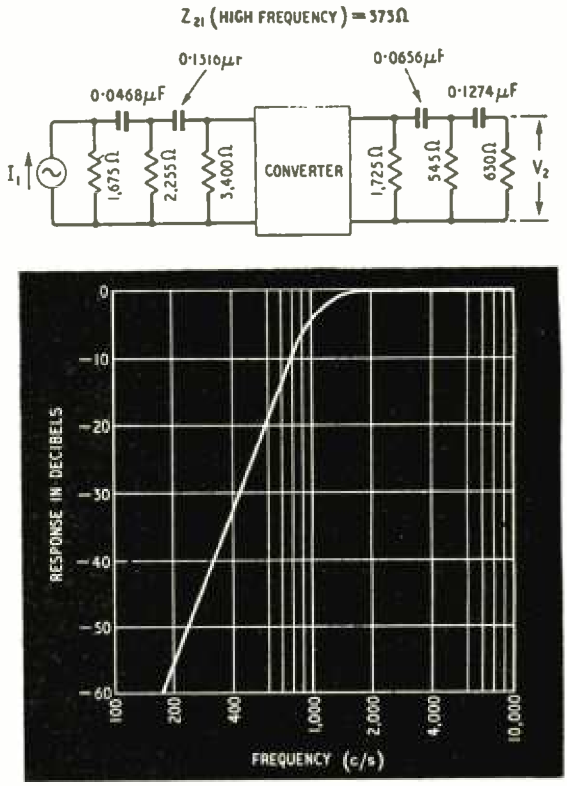


Fig. 10. High pass filter using transistor negative impedance converter.

And then, having made your negative resistance, and decided how you are to use it,

"I feel it my duty to say,
Some are Boojums . . ."

References

1 "Some Fundamental Properties of Transmission Circuits," by F. B. Llewellyn, *Proc. I.R.E.*, Vol. 40, p. 271, March, 1952.

2 "Theory of the Negative Impedance Converter," by J. L. Merrill, Jr., *B.S.T.J.* Vol. 30, p. 88, Jan, 1951.

3 "Transistor Negative Impedance Converters" by J. G. Linvill, *Proc. I.R.E.*, Vol. 41, p. 275, June, 1953.

4 "RC Active Filters" by J. G. Linvill, *Proc. I.R.E.*, Vol. 42, p. 555, March, 1954.

"The Oscilloscope at Work"

ALTHOUGH the cathode-ray oscilloscope has become an everyday tool in radio, not everybody realizes its full potentialities. A new *Wireless World* book "The Oscilloscope at Work" by A. Haas and R. W. Hallows, M.A. (Cantab), M.I.E.E., is therefore likely to open a good many people's eyes to just what can be done with this versatile instrument. After a description of the c.r.o. itself the book starts with a general chapter on the investigation of electrical properties such as voltages, frequencies and phase relationships, also including such topics as Lissajous figures, circular time bases and hysteresis—loop traces. The remaining chapters deal with the use of the c.r.o. on amplifiers, oscillators, rectifiers and detectors, modulators, phase-shifting circuits and finally television receivers. Oscilloscope operating troubles are also discussed as are various refinements and accessories to the instrument.

The book is liberally illustrated with 217 oscillograms and 102 diagrams. It is available from booksellers at 15s or direct from our Publishers at 15s 6d by post.

The Diode Rectifier in Valve Voltmeters

(Concluded from p. 286 of the previous issue)

Limitations of Use Imposed by Specified Maximum Error

By M. G. SCROGGIE, B.Sc., M.I.E.E.

THE mathematical derivations of the results now to be given will be omitted; they have been submitted for publication in *Wireless Engineer*. The basis of the calculations is the fact that under steady a.c. conditions the charge taken in by a capacitor during each whole cycle must be equal to the discharge. In circuits (a) and (b) of Fig. 2 the capacitor C is charged during the period when the diode conducts (which with our assumed diode is when the anode is more positive than the cathode). The resistance is then only the generator resistance R_s (including the forward resistance of the diode), and the charging voltage is the instantaneous voltage of E, minus the voltage to which C is charged. To exclude the complication of a simultaneous error due to C not being large enough in relation to the frequency, and also to make the calculations much easier, C is assumed to be so large that the cyclical variations of voltage across it are negligible. Circuits (c) and (d) are at best complicated enough, for in addition to C_1 being charged by E there are some periods when it is being charged by C_2. In circuit (a) C is discharging through R all the time. In (b) it is discharging through R and the source impedance (R_s) in series when the diode is non-conducting. In (c) and (d) the equating of charge to discharge must be done for both C_1 and C_2.

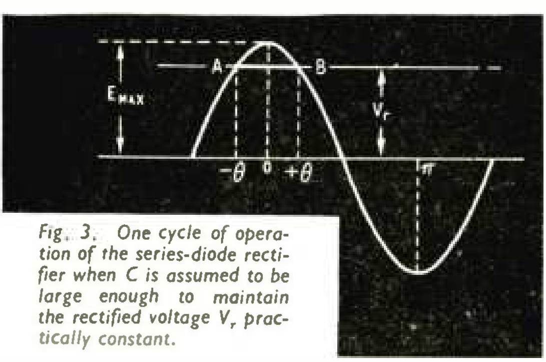


Fig. 3. One cycle of operation of the series-diode rectifier when C is assumed to be large enough to maintain the rectified voltage V_r practically constant.

Fig. 3 illustrates the comparatively simple operation of circuit (a). V_r being the practically constant voltage to which C is charged, it is only exceeded by the input voltage near the positive peak, from A to B. This is the period during which the diode conducts. It is best referred to in terms of angle; if the positive peak is taken as the starting point, the conducting period lasts from $-\theta$ to $+\theta$. This is the charging period for a whole cycle; for half a cycle (0 to π) it is 0 to θ. These angles are all reckoned in radians (π radians = 180 degrees). This angle of conduction, θ, is in every case the king pin of the whole calculation. Given θ, the corresponding value of R_s/R can be calculated; in the series circuit it is $(\tan\theta - \theta)/\pi$. And from Fig. 3 it is obvious that $V_r = E_{max}\cos\theta$. The graph of V_r/E_{max} against R_s/R was plotted by calculating each of them for a number of assumed values of θ.

In the shunt circuit V_r is not a constant voltage; it is the average value of V_{ad} (Fig. 4), which is a sine wave, $R/(R + R_s)$ times the amplitude of that generated by E, and with the positive peak clipped short and pushed down to zero level. Seeing that in this and other ways the shunt circuit differs markedly from the series circuit, it is rather surprising that R_s/R and V_r/E_{max} in terms of θ turn out to be the same. Fig. 5, which except for changed symbols and experimental plots is a repetition of Fig. 6 in the March 1952 article, therefore serves for both circuits. Incidentally, with the diodes connected as in Fig. 2 the polarity of V_r in the shunt circuits is opposite to that in the series circuit. The values of R_s used for plotting were the values actually inserted during the experimental readings, augmented by 450 Ω, — the estimated average forward

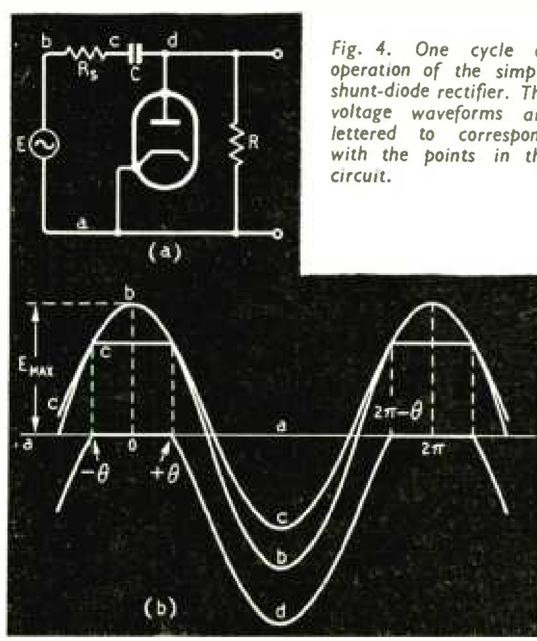


Fig. 4. One cycle of operation of the simple shunt-diode rectifier. The voltage waveforms are lettered to correspond with the points in the circuit.

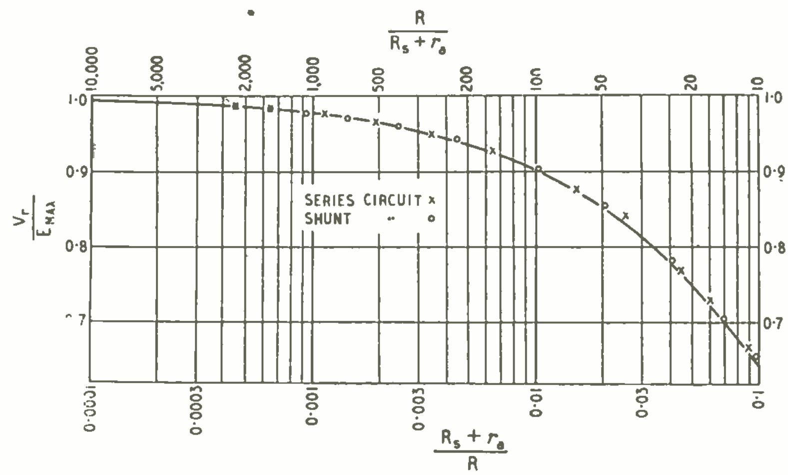


Fig. 5. (Left) Graph showing the efficiency of rectification V_r/E_{max} as a function of series resistance in the series-diode rectifier. It also applies exactly to the shunt-diode circuit if either R_s or r_a is zero, and nearly exactly for any values of R_s and r_a within the limits of the curve shown. The points relate to experimental readings with the shunt and series circuits.

resistance r_a of the diode used (EA50) plus the initial resistance of the 50 c/s source. R was 1MΩ and C, 1μF. The theoretically calculated curve is well supported by the experimental readings.

As already mentioned, however, this graph does not show the 99 per cent region clearly, and Fig. 6 is an enlargement of this part, plotted as percentage error. Because the values of $(R_s + r_a)/R$ are so small, a reciprocal scale of $R/(R_s + r_a)$ has been added as an alternative. This shows how many times bigger R must be than R_s if the error due to R_s is to be as shown by the curve. The value of θ for 1 per cent error ($V_r/E_{max} = \cos\theta = 0.99$), is 8.1 deg., so the total conduction angle is 16.2 deg. out of the whole 360-deg. cycle. R has to be over 3,000 times $R_s + r_a$, and the peak current taken from the source (at 0 deg.) is 30 times the average current in the load resistance R. Under these conditions, θ in radians is so nearly equal to tan θ that four-figure tables are barely enough for calculating $(R_s + r_a)/R$, and at 2 deg. it is necessary to use seven-figure tables.

If, in order to minimize the effect of R_s, R is made very large, there is likely to be trouble with grid current in the following amplifier[3]; even 10MΩ calls for some care in that respect. And the value of R_s+r_a for 1 per cent drop is even then only 3,100Ω, which certainly gives no justification for regarding the instrument as an infinite-resistance voltmeter! At 0.5 per cent, R_s+r_a is only 1,000Ω. But the greater the drop allowed, the less sensitive the instrument is to R_s. If r_a were 1,000Ω, it would cause an initial drop of 0.5 per cent; but the next 0.5 per cent drop the resistance would have to be 2,100Ω greater. The point is that the first 0.5 per cent would be allowed for in the calibration. Following this idea, we find from Fig. 5 that to reduce V_r/E_{max} to $1/\sqrt{2}$, so that with a sinusoidal input V_r would be equal to E_{rms}, (R_s+r_a) R is 0.068, so with R = 10MΩ and R_s=0, r_a would have to be 0.68MΩ; and to reduce V_r by 1 per cent from this level would necessitate an R_s of 31kΩ, so this dodge gives very nearly a ten-fold improvement. Carried to this length, however, it could not be expected to be satisfactory at radio frequencies, owing to stray capacitance shunting the comparatively large series resistance needed to augment r_a. Another objection is that whereas with low

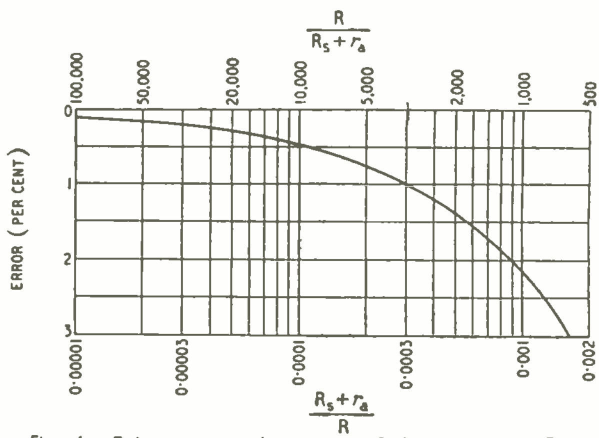


Fig. 6. Enlargement and extension of the top part of Fig. 5 to show small errors more clearly.

series resistance the diode voltmeter does read very nearly the peak voltage regardless of waveform, with large added resistance the waveform relationship is not at all clear. Nevertheless, for measuring sinusoidal low-frequency voltages in high-impedance circuits it is worth considering. Another advantage is that it greatly improves the linearity of the diode. As a compromise, for general purposes, enough resistance could be incorporated to cause a drop of a few per cent, to be absorbed in the calibration; even such a small resistance would materially reduce the sensitiveness to source resistance.

Diode Resistance

In all this we have been tacitly assuming that diode forward resistance (r_a) and source resistance (R_s) are indistinguishable in their effects. In Fig. 2(a) this is obviously true, but not necessarily in (b). Fig. 7 shows the diode resistance (with or without added series resistance) separately. The diode, while it is conducting, does not now completely short out R, as was assumed in the calculation for Fig. 2(b), and the total resistance is R_s in series with r_a and R in parallel. In spite of this, V_r still turns out to be E_{max} cos θ, but $(\tan\theta - \theta)/\pi$ is no longer $(R_s+r_a)/R$ but $\frac{R_s+r'_a}{R-r'_a}$, where r'_a is the resistance of r_a and R

[3] "Valve Voltmeter without Calibration Drift." *Wireless World*, Jan. 1952, p. 14.

in parallel. If $R_s = 0$, this comes to r_a/R, so R_s and r_a are interchangeable. The only difference is when both are present at once; and even in the worst case (when they are equal) the inaccuracy in using Fig. 5 with its $(R_s+r_a)/R$ instead of $(R_s+r'_a)/(R-r_a')$ is hardly perceptible, right down to V_r/E_{max} = about 0.7.

We now come to the filtered shunt circuits, Fig. 2(c) and (d). It would be pleasant if from the values of R_1 and R_2 an equivalent could be found to R in the unfiltered circuits, so that the same V_r/E_{max} curve could be used; but this does not seem to be possible. However, if V_r/E_{max} is plotted against $(R_s+r_a)/R_1$ in Fig. 2(c) and $(R_s+r_a)/(R_1+R_2)$ in (d), not only are these two curves identical for any given value of R_1/R_2, but for reasonable values of R_1/R_2 the curve begins by following the one in Fig. 5 so closely as to be hardly distinguishable from it, and only deviates seriously below it when the R_s error is more than about 10 per cent. Where with the unfiltered circuits V_r/E_{max} is 0.7, with filtered circuits in which $R_1/R_2 = 1.85$ (for example) it is 0.64. This curve also is confirmed by experiment.

The outstanding and convenient fact is that for *all* the circuits considered Fig. 6 is either correct or near enough, if for Fig. 2(c) and (d) R is replaced by R_1 and R_1+R_2 respectively and R_1 is not large compared with R_2.

The procedure for calculating the error in measuring the voltage across a *resonant* circuit when r_a is not negligible, or there is other resistance (R_s) in series, or both, is first to reckon the drop of voltage across the resonant circuit due to the R_i of the rectifier connected to it, and then, regarding this reduced value as E, to find the additional R_s+r_a error as has been shown.

Filter Capacitor

The remaining question concerns the value of C (or C_1 and C_2). It is sometimes supposed, or at least implied, that the principle at work is the same as in the ordinary valve coupling, Fig. 8. Here, to pass 99 per cent of the applied voltage to the valve, fCR must be 1.12; so at 50 c/s CR must be 0.0224 megohm-microfarads. But in the diode rectifier this mode of calculation does not apply, even if R_i (or any other value of resistance) is substituted for R. The relationship is much more subtle. For one thing, it is bound up with what we have just been studying—R_s.

The calculation of fCR error, even for the simple series-diode circuit and after making various simplifying assumptions, is more difficult.† On the assumption that $R_s = 0$, Bell's method leads to the simplified result:

$$\frac{V_r}{E_{max}} \simeq \frac{1+\cos\alpha}{2}$$

where α is the conduction angle, given by

$$\exp.\left(\frac{\alpha/2\pi - 1}{fCR}\right) = \cos\alpha$$

Fig. 9 is a graph of this, in the form of percentage error against fCR. Owing to the simplifying assumptions, and the fact that series resistance never is entirely absent, it is not safe to regard this graph as giving more than a rough idea. It can, however, continue to give a rough idea even when R_s is not zero, for, as Bell has pointed out, R_s has little effect on the combined R_s and fCR error until the R_s-alone error curve overtakes the fCR error curve. In other words, one can adapt a R_s curve such as Fig. 5 to a finite value of C by plotting at its left-hand margin the level found from Fig. 9, and continuing this level as a horizontal line until it merges into the downward sweep of the original curve.

This result was obtained by Bell for the series-diode circuit only. The experience we have already obtained might lead us to expect that it would not be drastically different for the simple shunt circuit. And experiment confirms this, the readings with the shunt circuit being indistinguishable from those with the series circuit. Fig. 10 shows the infinite-fCR curve of Fig. 5 with the addition of measured plots for a number of finite values of fCR. They were actually read in the simple shunt circuit, but can be taken as applying to the series circuit. It is interesting to note that $fCR = 1$, which in Fig. 8 causes a loss of just over 1 per cent, in rectifier circuits causes a loss of 30 per cent.

How about the effect of the filters on fCR error? There is, of course, the complication of the filter capacitor C_2. As it happens, its value has much less effect than that of C_1 on the efficiency of rectification; so long as fC_2R_2 is not less than about 2 it is practically the same as infinity. We have already seen that the addition of either type of filter to the simple shunt circuit causes the R_s error to increase somewhat, the increase being greater the greater the value of R_1/R_2,

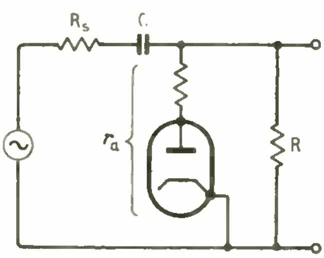
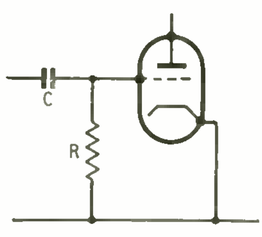


Fig. 7. When the diode forward resistance r_a is greatly augmented by series resistance, its effect is not precisely the same as that of the same amount of resistance added to R_s.



Left: Fig. 8. The voltage loss caused by C in this type of circuit is far less than that in a diode circuit with equal CR.

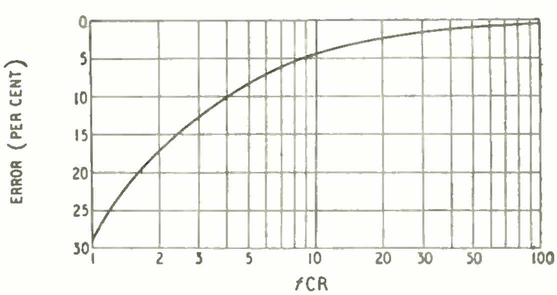


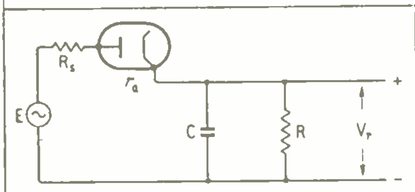
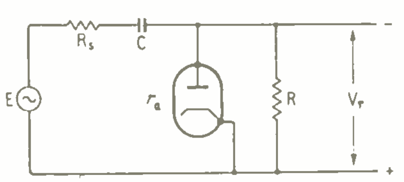
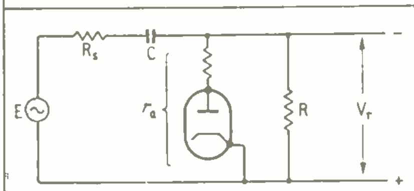
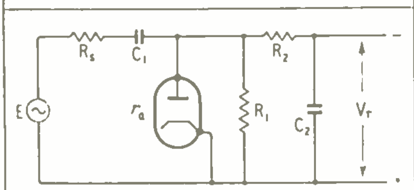
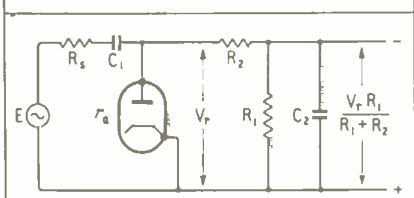
Fig. 9. Approximate low-frequency error curve calculated by Bell's method for series-diode circuit on the assumption that $R_s + r_a$ is negligible.

† See reference (2) (D. A. Bell) and also J. Marique, *Wireless Engineer*, Jan. 1935 pp. 17–22.

and that for practical values of R_1/R_2 the increase is negligible if the original R_s error is only a few per cent. The same can be said of the effect of the filter on errors caused by fC_1R_1 being too small. Actually, other things being equal, the increase of error is greater with fC_1R_1 error than with R_s error, but it is still negligible with small errors, unless R_1 R_2 is exceptionally large.

Fig. 10 shows that, just as a little initial r_a drop has the advantage of reducing errors due to R_s, so does a fCR error. But whereas the r_a drop can be absorbed into the calibration, the fCR drop depends on frequency, so ought to be avoided at all working frequencies. However, as Fig. 10 again shows, the r_a drop is not only beneficial in reducing liability to R_s error, but also reduces fCR error, or (to put it another way) enables a smaller value of C to be used than would otherwise be necessary. The point of this is that even r.f. valve voltmeters usually have to be calibrated at 50 c/s, and for a.f. purposes it may be desirable to go down to 20 c/s without serious error. If the initial resistance drop is made negligible by using a low-resistance diode and no other internal series resistance, the minimum value of CR (time constant) needed to restrict the fCR error at 50 c/s

TABULATED SUMMARY OF FORMULAE

CIRCUIT	$\frac{V_r}{E_{MAX}}$	$\frac{\tan\theta-\theta}{\pi}$	WHEN $\frac{V_r}{E_{MAX}} = 0.99$	R_i (APPROX)
	$\cos\theta$	$\frac{R_s+r_a}{R}$	$\frac{R_s+r_a}{R} = 0.00031$	$\frac{R}{2}$
	$\cos\theta$	* $\frac{R_s+r_a}{R}$	* $\frac{R_s+r_a}{R} = 0.00031$	$\frac{R}{3}$
	$\cos\theta$	$\frac{R_s+r'_a}{R-r'_a}$ WHERE $r'_a = \frac{R\,r_a}{R+r_a}$	* $\frac{R_s+r_a}{R} = 0.00031$	
	$\cos\theta\left(1-\frac{R_1}{R_2}\cdot\frac{\tan\theta-\theta}{\pi}\right)$ $= \cos\theta\left(\frac{R_2}{R_2+R_s+r_a}\right)$	$\frac{R_s+r_a}{R_1+(R_s+r_a)R_1/R_2}$ $\left[\frac{R_s+r_a}{R_1} = \frac{1}{\frac{\pi}{\tan\theta-\theta}-\frac{R_1}{R_2}}\right]$	* $\frac{R_s+r_a}{R_1} = 0.00031$ IF $\frac{R_1}{R_2}$ NOT LARGE	$\frac{R_1R_2}{R_1+3R_2}$
	$\cos\theta\left(1-\frac{R_1}{R_2}\cdot\frac{\tan\theta-\theta}{\pi}\right)$ $= \cos\theta\left(\frac{R_1+R_2}{R_1+R_2+(R_s+r_a)R_1/R_2}\right)$	$\frac{R_s+r_a}{R_1+R_2+(R_s+r_a)R_1/R_2}$ $\left[\frac{R_s+r_a}{R_1+R_2} = \frac{1}{\frac{\pi}{\tan\theta-\theta}-\frac{R_1}{R_2}}\right]$	* $\frac{R_s+r_a}{R_1+R_2} = 0.00031$ IF $\frac{R_1}{R_2}$ NOT LARGE	$\frac{(R_1+R_2)R_2}{R_1+3R_2}$

* *Indicates an approximation with negligible error.*

It is assumed that fCR, fC_1R_1 and fC_2R_2 are large enough to keep voltage across C, C_1 and C_2 constant (formulae given are practically correct if fCR and fC_1R_1 are over 100 and fC_2R_2 over 2). V_r is the mean rectified voltage. θ is half the angle of diode conduction, in radians. The values given for R_i are those to which R_i tends as V_r/E_{max} tends to 1. In the second circuit the diode resistance r_a is assumed to be much less (not more than a few per cent) of R, but the third case covers augmented values. Plotting $\cos\theta$ against $(\tan\theta - \theta)/\pi$ gives a graph of V_r/E_{max} in terms of R_s, etc., as in Figs. 5 and 6.

to 1 per cent and at 20 c/s to 2 per cent is about 1 (e.g. R = 10MΩ and C = 0.1μF) and that is so large as to make the response of the instrument to changes of voltage rather sluggish. Also the capacitor is inclined to be rather bulkier than one cares for use at high r.f. One solution for a general-purpose diode voltmeter is to use a small C in a probe head for r.f. and to augment it by a large C when measuring at low frequencies. But for a purely a.f. instrument the sluggish action can be avoided by augmenting the resistance of the diode. As Fig. 10 shows, if r_a/R at R_s = 0 is made 0.03, the *f*CR error is less even when *f*CR is as low as 5 than it is with *f*CR = 50 when r_a is small.

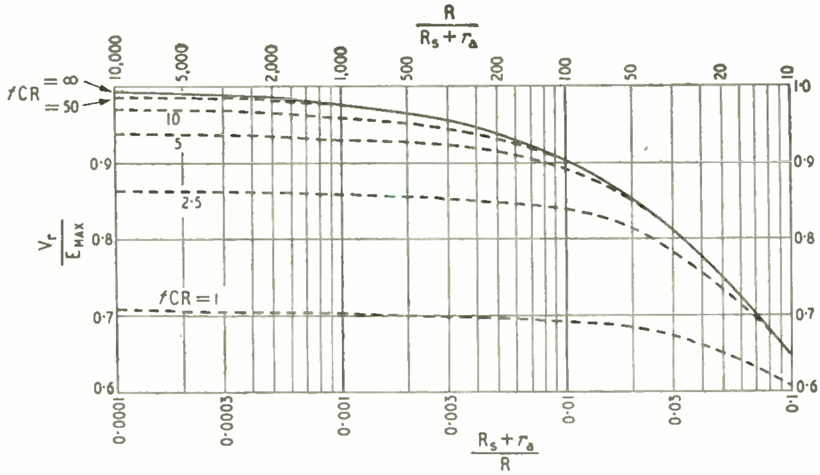


Fig. 10. The dotted curves are measured characteristics of a shunt-diode circuit, but may be taken as applying also to the series circuit. The full-line curve is the theoretical characteristic as in Fig. 5.

Summing up, one can hardly avoid the conclusion that for measurements at a.f. only, in circuits that may have high impedance, one would be well advised to consider the type in which a stabilized pre-amplifier is used, not only to extend the linear ranges to low voltages, but also to reduce error from source impedance. If, for simplicity, the unamplified diode is used, its performance can be improved by incorporating series resistance. At r.f. this is undesirable, but as high-impedance r.f. circuits to be measured will in the majority of cases be resonant, there is less need for it.

Long-distance V.H.F. Reception

A PHENOMENON which is associated with electrical discharges in the lower atmosphere has been recently encountered in the long-distance reception of v.h.f. signals, and is described by G. A. Isted in the current issue of *The Marconi Review*.

During some experiments which involved the automatic recording, in great detail, of the Kirk o' Shotts (53.25 Mc/s) and Wenvoe (63.25 Mc/s) sound channels at Great Baddow, Essex, it was observed that the signals often arrived in a succession of impulsive bursts, having a duration between 0.1 sec and 1.0 sec, and varying in amplitude between 5 and at least 20 db above the very weak background signal. The distances involved are 330 miles to Kirk o' Shotts and 180 miles to Wenvoe. It was found that the signal bursts often took the form of trains, consisting of bursts equally spaced in time, and that, apart from single bursts, there were many such trains consisting of from two bursts up to six or seven in number. The burst activity on the Wenvoe signals was much less than on those from Kirk o' Shotts, but at times there was strong evidence that a certain arrangement of signal bursts from Kirk o' Shotts occurred on the Wenvoe signals at a slightly different time.

By arranging one receiving channel to record the Kirk o' Shotts signal (and also the radio energy from a lightning flash) and another to record the lightning energy only (by detuning it from the Kirk o' Shotts frequency), a simultaneous recording system was set up which permitted identification of the signal bursts and lightning flashes. It was found that the trains of signal bursts were very often associated with a lightning flash, the bursts sometimes preceding, sometimes occurring simultaneously with, and sometimes following the lightning flash.

By the use of a "static receiver" connected to a recorder, the electrostatic clicks which it received, and which indicate rapid changes of an electric field in the atmosphere not necessarily due to lightning flashes, were also found to be closely associated with the trains of signal bursts.

Vertical incidence inospheric recordings of pulse-signals on 10.6 Mc/s were then examined, and these showed the presence of sporadic scatter points of high ionization density at heights corresponding roughly to that of the E layer, and having durations and time spacings similar to those of the signal bursts. These ionospheric echoes also often occurred in trains and it was found that they were often associated with lightning flashes.

It was concluded that the v.h.f. signal bursts (such signals would not normally be reflected from the ionosphere) were due to reflection from these short-lived localized patches of high ionization in the E layer. They are attributed to recurrent electrical discharges from clouds in the lower atmosphere, these discharges not necessarily amounting to lightning.

After an examination of the relevant meteorological information a theory is put forward to account for this. It is suggested that certain types of cloud in the lower atmosphere become charged until, the charge reaching a critical striking potential (dependent upon the electrical characteristics of the air above the cloud), it discharges in the form of a current flowing upwards to the E layer; and then, recharging, reaches the critical striking potential at regular time intervals. (The relaxation time connected with charging and discharging clouds would seem to be in close correspondence with that for triple and quadruple trains of bursts, which has an average value of 4.0 sec.) The energy flowing from the clouds to the E layer causes the short-lived patches of high ionization, which, in turn, give rise to the signal bursts. The energy is then conducted along the E layer to fine weather regions, where it leaks by conduction through the air to the earth. (Lightning flashes between cloud and earth complete the circuit.) It is also suggested that more continuous ionization in the E layer (apart from that due to solar radiation) may be set up in this way, and that it may account in part for the Sporadic E phenomenon.

Whether or not these theories are proved to be correct, the experimental evidence is extremely interesting, and the author is to be congratulated upon the very lucid and painstaking way in which he has presented it. A lot of work must have gone into this project, as a result of which our knowledge of radio propagation and related phenomena cannot fail to be enhanced. T. W. B.

SOUNDS—PAST AND PRESENT

AS a prelude to the British Sound Recording Association's annual convention and exhibition, held recently at the Waldorf Hotel, London, W.C.2, Brian George, of the central programme department of the B.B.C., gave a talk on "Voices and Sounds from History," illustrated by examples from the B.B.C.'s record archives. These included the voices of Alfred Lord Tennyson and Gladstone—transcribed from phonograph cylinders, the "home recording" of that day—and Mr. George spoke of the difficulties of authenticating early records of celebrities in view of the many examples of amateur mimicry which still survive and are discovered from time to time. Not all the records are of the great; the B.B.C. archives contain specimens of contemporary wit and dialect, from people in all walks of life. Much effort is being expended to trace among the older generations the rich dialects that are in some danger of losing their edge as the result of the tendency towards standardization in the accents of B.B.C. announcers.

Guests at the annual dinner included Sir Noel Ashbridge and Harold Bishop.

After two years' service H. Davies is retiring as president and will be succeeded by Norman Leevers.

Both Saturday and Sunday attendances at the exhibition were high, and on both days visitors were able to hear demonstrations of high-quality commercial reproducers.

This year's competition for amateur constructors showed a wide range of interests and no falling off in enthusiasm. The President's Trophy and the *Wireless World* prize were won by G. M. Simpson for his cathode-ray oscilloscope, designed for work on wide-frequency-range sound recording and reproduction. Made from surplus parts and incorporating a 2¾in VCR139A tube, this instrument was notable for the very high standard of workmanship and finish. The Committee prize went to A. G. Tucker for an experimenter's console giving quick access to the undersides of the various chassis for modifications, while presenting a permanently neat appearance when closed. Principal sections included a three-speed record turntable, a tape deck, a radio feeder unit and a control panel.

Notes on the commercial exhibits are included in the review of audio developments elsewhere in this issue.

SMALL-CRAFT RADIO INSTALLATION

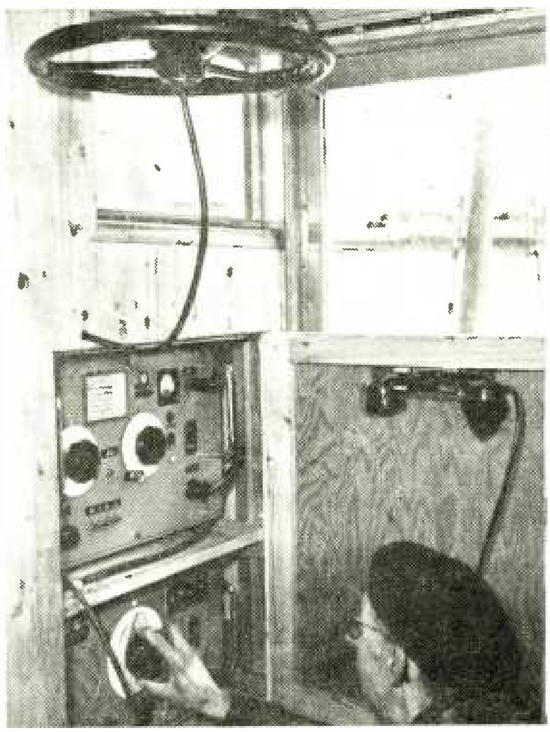
A RADIO installation intended for the smaller and "middle-water" type of fishing craft and providing for reception over the ranges 45 to 131 kc/s and 375 kc/s to 3.4 Mc/s; radio telephone transmission on any of six crystal-controlled spot frequencies in the band 1.6 to 2.85 Mc/s and direction-finding facilities has been introduced by the Marconi International Marine Communication Company, Chelmsford, Essex.

Controls are reduced to a minimum while retaining full flexibility to meet widely different conditions of operation and all are fitted with knobs that can be handled while wearing gloves.

The aerial is a single loop in a rotating frame controlled by a large handwheel from below and it is intended to be mounted above a wheelhouse or chart-room housing the radio equipment.

The receiver, known as the "Renown," and the transmitter ("Guillemot") are approximately the same size and can be mounted very conveniently one above the other in a recess as shown in the illustration. "Seapilot" is the direction-finding equipment.

The equipment is designed for operation from 24-volt batteries.



Renown-Guillemot-Seapilot radio-telephone and direction-finding equipment introduced by Marconi Marine.

Piezoelectric Crystals

Survey of Physical Properties and Their Practical Exploitation

(*Concluded from page 280 of the previous issue*)

By S. KELLY*

THE analogue of the crystal transducer is shown in Fig. 9, in which C_e is the electrical capacitance, C_m is the effective compliance, M is the effective mass and 1:N is the "transformer" converting electrical to mechanical energy and vice versa. The capacity presented to the electrical terminals, the compliance C_m, and M, will all be a function of the mounting of the crystal, together with any mechanical appendages such as stylus, reed, etc. The "mechanical" terminals are open-circuited when the crystal is clamped (zero velocity) and short-circuited when completely free: under working conditions some form of complex impedance will normally be connected to them. In these analogues the following relations hold:—

Electrical	*Mechanical*
E.m.f.	Force
Current	Velocity
Inductance	Mass
Capacitance	Compliance

Although crystals are anisotropic, when one is investigating a particular cut it is admissible to treat the crystal constants as isotropic using the values obtained experimentally for that particular cut.

In the elementary theory of elasticity the three elastic constants of an isotropic solid are Young's modulus Y, the rigidity or shear modulus n, and the bulk modulus or volume elasticity E. Any one of the three can be expressed in terms of the other two by the relations given below, which also involves Poisson's ratio σ:

$$Y = 2n(1 - \sigma) \quad \text{(1a)}$$

$$n = \frac{Y}{2(1 + \sigma)} \quad \text{(1b)}$$

$$E = \frac{Y}{3(1 + 2\sigma)} \quad \text{(1c)}$$

$$\sigma = \frac{Y - 2n}{2n} \quad \text{(1d)}$$

These various factors all enter into the mechanical design equations of the working transducer, and to obtain some insight into their application we shall consider one or two hypothetical examples.

The maximum displacement of a gramophone record groove is of the order of 0.01 cm. Assume for the sake of argument a crystal expander plate of 1 cm × 0.5 cm × 0.07 cm, which is a normal size for crystals used in pickups, the Young's modulus being 2×10^{11}. The crystal (Fig. 10) is firmly fixed at one end and is driven by the stylus at the other. At low frequencies where compliance is dominant the minimum playing weight necessary to keep the stylus in the groove when driven in compression and tension, (1) in Fig. 10, would be:—

$$W = \frac{D}{981.C_m} \quad \text{(2)}$$

where W = playing weight, D = displacement of stylus in cm, C_m = compliance in cm/dyne.

The compliance of the crystal as an expander is:—

$$C_m = \frac{l}{Y.w.t} \quad \text{(3)}$$

where Y = Young's modulus, l = length in cm, t = thickness in cm, w = width in cm.

From (2) and (3):—

$$W = \frac{D.Y.w.t}{981.l}$$

$$= \frac{10^{-2} \times 2 \times 10^{11} \times 0.5 \times 0.07}{981 \times 1}$$

$$= 7.14 \times 10^4 \text{ gm (71.4 kilograms).}$$

This value is somewhat high even for pre-war crystal

*Cosmocord Ltd

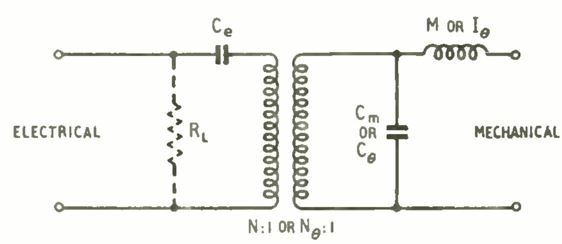


Fig. 9. Analogue of electro-mechanical relations in a crystal transducer.

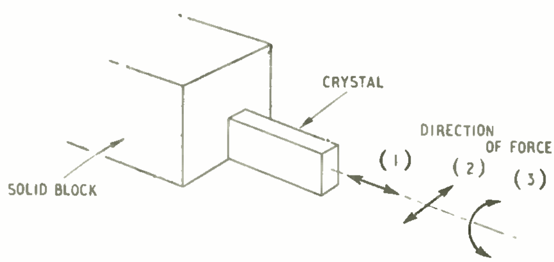


Fig. 10. Elementary crystal transducer illustrating the modes of applying stress open to the pickup designer: (1) compression, (2) cantilever, (3) torsion.

pickups! Let us therefore use the crystal as a cantilever, Fig. 10 (2), in which the direction of vibration will be at right-angles to the case cited above.

The compliance C_m of the crystal as a cantilever is:—

$$C_m = \frac{4l^3}{Y.w.t^3} \quad \ldots \quad (5)$$

$$\text{and } W = \frac{D.Y.w.t^3}{4l^3.981} \quad \ldots \quad (6)$$

$$= \frac{10^{-2} \times 2 \times 10^{11} \times 0.5 \times 0.343 \times 10^{-3}}{4 \times 1 \times 981}$$

$$= 82.5 \text{ gm.}$$

This value is still much too high for modern pickups, but is within striking distance of the optimum and represents about the average for pre-war pickups. The third alternative is to use the crystal in torsion (Fig. 10 (C)), by supporting the front end in a bearing and using a stylus, say, 1 cm long.

$$C_\theta = \frac{3l}{n.w.t^3\left(1 - 0.63\frac{t}{w}\right)} \quad \ldots \quad (7)$$

where n is the modulus of rigidity and is obtained from equation (1b).

The assumption of a Poisson's ratio of 0.1 results in a rigidity modulus of 9.1×10^{10}, and

$$W = \frac{D.n.w.t^3\left(1 - 0.63\frac{t}{w}\right)}{3l.981} \quad \ldots \quad (8)$$

$$= \frac{10^{-2} \times 9.1 \times 10^{10} \times 0.343 \times 10^{-3} \times (0.91)}{3 \times 1 \times 981}$$

$$= 48 \text{ gm.}$$

This is somewhat better and in actual practice the extra compliance required for a practical pickup would be obtained by using an elastic type of material for a support (such as rubber or p.v.c.) together with a cantilever stylus. At the high-frequency end of the band, mass impedance rather than compliance is the controlling factor and this is where the torsional crystal scores with the materially reduced effective mass and increased voltage force sensitivity.

The effective mass of a cantilever is:—

$$\frac{l.w.t.\rho}{3} \quad \ldots \quad (9)$$

where ρ = density.

The moment of inertia of the same plate in torsion is:—

$$I_\theta = \frac{\rho.l.w^3.t}{36}\left(1 + \frac{t^2}{w^2}\right) \quad \ldots \quad (10)$$

If a stylus of 1 cm length is used the effective mass at the stylus tip will be the numerical value given by equation (10) in grams. Assuming $\rho = 2$, and using the same sizes as before for the cantilever:—

$$M_e = \frac{1 \times 0.5 \times 0.07}{36} = 0.0233 \text{ gm}$$

$$= 23.3 \text{ milligrams}$$

where M_e = effective mass referred to the stylus point,

and for the torsional unit:—

$$M_e = \frac{2 \times 1 \times 0.125 \times 0.07 \times (1.02)}{36}$$

$$= 0.000495 \text{ gm} = 0.495 \text{ milligram.}$$

In other words, a greatly reduced effective mass compared to the cantilever crystal.

Practical crystals of the cantilever or torsional type consist of two correctly oriented plates cemented together with electrodes, connecting leads, and some form of protective coating, and are usually named "bimorphs." These units then behave as a homogeneous whole and the foregoing philosophy can be successfully applied.

It is now standard practice to specify crystal constants in M.K.S. units, and these can easily be converted to c.g.s. units if one remembers that the M.K.S. unit of force is the newton and is equal to 10^5 dynes; the accompanying table gives multiplying factors for both systems. Because most engineers still use the foot rule (and the majority of machine tools in this country are calibrated in inches) the physical dimensions of the crystals listed in Table 2 are given in inches and the other parameters are in the standard electrical nomenclature.

Table 2 shows the various constants of the equivalent circuit shown in Fig. 9. It should be noted that the torsional coupling coefficient is given in volts/newton.metre or volts/dyne.cm. The torsional compliance is given in radians/newton.metre or radians/dyne.cm. The effective moment of inertia is given in kgm.m^2 or gm.cm.^{2}.

Practical crystal stoday are usually between 0.5in and 1in long, 0.25in to 0.375in wide and 0.015in to 0.06in thick. In the case of barium titanate the length varies between 0.5in and 1in, width 0.06in to 0.1in and the thickness is usually 0.03in. Because of the low transducer ratio (N) and very high dielectric constant of barium titanate, the two elements are usually connected in series, giving twice the output voltage for a quarter of the parallel capacity. In the case of Rochelle salt units, where the reverse conditions hold, the parallel connections are used. The nominal value of capacity is usually set at a minimum 1,000 pF. In each case the compliance of the crystal is of the order of 10 times lower than that required for present-day pickups. The additional compliance is obtained by supporting the crystal on resilient rubber pads or using some other form of compliant coupling.

The resonant frequency of the system can be obtained from:—

$$f_r = \frac{1}{2\pi\sqrt{M.C_m}}$$

where M is the effective mass, or the moment of inertia, and C_m is the effective compliance.

From the values given in Table 2, it will be seen that the resonant frequency for bimorphs of identical size will be lower for cantilever units than for torsional units and the effective transducer ratio is also lower. It is important to use either M.K.S. or c.g.s. units throughout otherwise the resonant frequency of a pickup may appear to be in the megacycle band! If we compare a Rochelle salt bimorph of 0.5in × 0.25in × 0.03in a torsional and a bender unit, together with a barium titanate bimorph 0.7in × 0.1in × 0.03in (these are the normal sizes commercially available today) the following results are obtained:—

Rochelle salt

(Torsional parallel)	C	$= 1.25 \times 10^{-9}$ farad
	N_θ	$= 2.93 \times 10^4$ volt/newton.metre
	C_θ	= 1.3 radians/newton.metre
	I_θ	$= 1.64 \times 10^{-10}$ kgm.metre
	f_r	= 11,000 c/s.

Rochelle salt
(Cantilever parallel) $C = 1.25 \times 10^{-9}$ farad
$N = 2.0 \times 10^{2}$ volt/newton
$C_m = 1.3 \times 10^{-4}$ metre/newton
$M = 25 \times 10^{-6}$ kgm
$f_r = 2{,}800$ c/s.

Ceramic
(Cantilever series) $C = 7.6 \times 10^{-10}$ farad
$N = 63$ volt/newton
$C_m = 2 \times 10^{-4}$ metre/newton
$M = 52.5 \times 10^{-6}$ kgm
$f_r = 1{,}550$ c/s.

To bring these values down to the familiar c.g.s. units and assuming a stylus length of 1 cm for the torsional unit (a normal practical value), we get the following:—

	C ($\mu\mu$F)	N (mV/dyne)	C_m (cm/dyne) $\times 10^{-6}$	M (mgm)	f_r (kc/s)
Rochelle salt (Parallel torsional)	1250	2.93	0.13	1.64	11.0
Rochelle salt (Parallel cantilever)	1250	2.0	0.13	25.0	2.8
Barium titanate (Cantilever)	760	0.63	0.20	52.5	1.55

It will be seen that a torsional unit of the same size and material gives a superior performance for both the voltage sensitivity and resonant frequency, and that the sensitivity of the ceramic element is considerably lower than either of the two Rochelle salt units. The sensitivity of the titanate can be improved by decreasing the thickness, width, or increasing the length; the thickness of 0.03in is the present commercial minimum, this value being dictated by fragility in handling, warping during firing, etc. Increasing the length will decrease the resonant frequency and decreasing the width will reduce the capacity (but will not affect the resonant frequency) although the compliance will be inversely proportional to it. The same remarks in general apply to Rochelle salt, except that the minimum commercial thickness is 0.015in and the minimum width is about 0.2in, but in view of the higher coupling coefficient more liberties may be taken with the Rochelle salt than with the titanate.

Conclusions.—Of the three possible sources of transducer material at present available, A.D.P. can be counted out for most pickup applications by virtue of the extremely low dielectric constant, although it is used to some extent for microphones. Rochelle

TABLE 2.
(Dimensions of crystals in inches)

	C_e Parallel	C_e Series	Twister "Bimorph" — Linear Three-Corner: N Parallel	N Series	C_m	M	Torsional: N_θ Parallel	N_θ Series	C_θ	I_θ
M.K.S. Multiply figures by	Farads 10^{-12}	Farads 10^{-12}	1	1	10^{-9}	kgm 10^{-3}	10^{2}	10^{2}	10^{-6}	10^{-7}
c.g.s. Multiply figures by	$\mu\mu$F 1	$\mu\mu$F 1	10^{-5}	10^{-6}	10^{-12}	gm 1	10^{-5}	10^{-5}	10^{-13}	1
Rochelle salt (30°C)	$300 \frac{lw}{t}$	$75 \frac{lw}{t}$	$\frac{5.65}{t}$	$\frac{11.3}{t}$	$11.3 \frac{lw}{t^3}$	$4.28 lwt$	$\frac{2.2}{wt}$	$\frac{4.4}{wt}$	$17.5 \frac{l}{wt^3}$	$6.98 lw^3t$
A.D.P.	$12.9 \frac{lw}{t}$	$3.23 \frac{lw}{t}$	$\frac{9.9}{t}$	$\frac{19.7}{t}$	$17.5 \frac{lw}{t^3}$	$3.74 lwt$	$\frac{3.9}{wt}$	$\frac{7.8}{wt}$	$27.1 \frac{l}{wt^3}$	$6.05 lw^3t$

	C_e Parallel	C_e Series	Bender "Bimorph" — Cantilever: N Parallel	N Series	C_m	M	Centre Drive: N Parallel	N Series	C_m	M
M.K.S. Multiply figures by	Farads 10^{-12}	Farads 10^{-12}	1	1	10^{-9}	kgm 10^{-3}	1	1	10^{-9}	kgm 10^{-3}
c.g.s. Multiply figures by	$\mu\mu$F 1	$\mu\mu$F 1	10^{-5}	10^{-5}	10^{-12}	gm 1	10^{-5}	10^{-6}	10^{-12}	gm 1
Rochelle salt (30°C)	$300 \frac{lw}{t}$	$75 \frac{lw}{t}$	$2.9 \frac{l}{wt}$	$5.8 \frac{l}{wt}$	$7.04 \frac{l^3}{wt^3}$	$6.68 lwt$	$0.73 \frac{l}{wt}$	$1.45 \frac{l}{wt}$	$0.44 \frac{l^3}{wt^3}$	$13.35 lwt$
A.D.P.	$12.9 \frac{lw}{t}$	$3.23 \frac{lw}{t}$	$6.0 \frac{l}{wt}$	$12.0 \frac{l}{wt}$	$7.84 \frac{l^3}{wt}$	$7.15 lwt$	$1.5 \frac{l}{wt}$	$3.0 \frac{l}{wt}$	$0.49 \frac{l^3}{wt^3}$	$14.3 lwt$
Ceramic	$1300 \frac{lw}{t}$	$325 \frac{lw}{t}$	$0.135 \frac{l}{wt}$	$0.27 \frac{l}{wt}$	$1.6 \frac{l^3}{wt^3}$	$25 lwt$	$0.034 \frac{l}{wt}$	$0.068 \frac{l}{wt}$	$0.1 \frac{l^3}{wt^3}$	$50 lwt$

salt, when correctly used, can result in highly efficient, consistent and cheap mass-produced gramophone pickups. It should not be used at temperatures above 45°C and it must not be subjected to temperatures in excess of 55°C. In general, it is wise not to use Rochelle salt units within ± 20 degrees of latitude of the equator.

Barium titanate units have the advantage over Rochelle salt that they can be made completely tropical proof, although due allowance must be made for possible variation in sensitivity with temperature on zirconium-loaded elements. The capacity is virtually independent of temperature, but the voltage sensitivity is about − 20 db compared with Rochelle salt for the same needle-tip compliance. Because of the cantilever construction, the effective mass is considerably greater than that of a torsional unit, and if the needle tip impedance is to be kept within reasonable values at high frequencies some form of mechanical decoupling must be introduced between the stylus and the crystal element, and considerable high-frequency attenuation must be expected in the pickup.

From the foregoing it will be appreciated that the final solution of a particular pickup design problem is governed by many factors, and at present there is no one ideal solution for a crystal cartridge with a wide frequency range, of high compliance, which is completely tropical proof and has a high sensitivity; although each new development and improvement in technique brings the goal appreciably nearer.

Acknowledgment is made to Mr. A. C. Dobelli, of the Brush Crystal Co. Ltd., for information on fundamental crystal parameters.

Congress on Sound Recording—Paris 1954

Some Points from the Discussions and Items of Interest in the Exhibition

By H. J. HOULGATE, A.M.I.E.E.

FROM April 5th to 10th, 1954, an International Congress on Sound Recording was held in Paris. It was organized by the Société des Radioélectriciens, under the direction of G. Rabuteau, the President of the Society.

During the week of the Congress some 64 papers were read, and six visits to technical or industrial organizations were arranged.

An exhibition of everything appertaining to recording was open for the whole week, including Sunday, April 11th. In addition to this very full programme, evening engagements included a symphony concert, and a demonstration of synthetic music (including "Musique Concrete") arranged by Radiodiffusion-Télévision Française (R.T.F.).

The Congress was opened at a ceremony at which speeches were made by the President and by the distinguished physicist Louis de Broglie.

Technical Papers

The papers covered the whole field of the art and science of recording and were divided into five sections. Section 1 covered the history of recording, common problems, and measurements. Section 2 dealt entirely with magnetic recording and reproduction, including its future application in the television field. Recording for the cinema in all its aspects was dealt with in Section 3, whilst Section 4 was devoted to disc recording including the special problems of microgroove and factory production of gramophone records. Section 5 included papers on many applications of recording in industry and science, covering the recording and storage of pulses, cathode-ray memory systems, long-duration data recording, and the generation of synthetic music.

An account of the measurement of "wow" and "flutter" and its subjective effect, by M. Caciotti, of the Italian Broadcasting Organization, was read by his colleague Signorina Bordone. For testing magnetic recorders having had very little speed fluctuation, the following method was suggested. A continuous loop of tape, lasting some seconds, is used, and the output of the machine is connected to its input after the loop has been recorded with tone. Each "pass" of the loop through the machine then reproduces and re-records the tone, a process which results in an increase in the "wow" content of the recording. It was shown that if the "wow" and "flutter" are of a random nature, as is often the case in first-class machines, then the final speed fluctuation is equal to $h\sqrt{n}$, where h is the original fluctuation and n is the number of dubbings. Such a method is also applicable to measurements on disc recorders. Subjective tests led to the statement that speed fluctuations at the rate of 15 per second were the most objectionable to the ear. Reference was also made to the fact that the frictional forces on the tape can result in longitudinal vibrations, which in their turn give rise to frequency modulation of the recorded signal. This effect produces high-frequency flutter, which although at much too high a rate to be noticed as a variation in pitch, results in the generation of objectionable sidebands.

F. Gallet, an engineer on the staff of R.T.F., discussed in detail the causes of noise in magnetic recording systems. He gave the signal/noise ratio for a typical machine as 50 db when measured by a "flat" voltmeter, and 65 db if an aural simulation network were used. It was pointed out that, although these figures were acceptable for a recording system, an amplifier to be used in a broadcasting chain would have a much better signal/noise ratio, and that every effort should be made to improve the performance of magnetic recorders in this respect. Some considerable attention was given to modulation noise, which was shown to be due to two distinct causes. The variations in the magnetic properties of the tape and the imperfect contact it made with the head resulted in amplitude modulation of the programme by signals of a random nature, whilst longitudinal vibration of the tape gave rise to frequency modulation of the programme, the modulation being in general random, but being "coloured" by the natural longitudinal resonance of the tape in the region of the heads. Such a frequency modulation causes the noise spectrum accompanying a tone to include sidebands. It is, of course, desirable to give a measure in terms of signal/noise ratio to the modulation noise. This is not easy to do since the noise is always accompanied by the signal, which is of much higher amplitude, and must be removed, together with its harmonics, by very sharp filters. It was shown, however, that the spectrum produced by amplitude modulation of the signal was independent of the signal frequency, and so could be measured using a signal of zero frequency, i.e., d.c. Such a measurement is not all that could be desired, but it is of use in assessing the properties of the tape, since the components which are ignored by this method are those due to frequency modulation and these are as much a function of the recorder as of the tape itself.

Testing Magnetic Tape

A second paper by F. Gallet was devoted to the problems involved in testing tape received from the manufacturers. He described a machine for testing nine tapes at once, which was on show in the exhibition. It consisted of nine channels of recording and reproducing heads together with feed and take-up spools, and a common capstan shaft, driven by motors on the bedplate of the machine. Each of the nine tapes was tested for sensitivity at 800 c/s throughout its length under standardized conditions. The output from each tape was recorded by a recording voltmeter on a strip of paper about 10in long. In addition to the sensitivity tests, two of the tapes on the machine were given a modulation noise test and the resulting noise output was recorded on further charts.

It is well known that in the manufacture of recording tape the support material is coated with the oxide in fairly large widths, and each batch is subsequently slit into the ¼in tape used on the machines. The lecturer stated that it was desirable that more stringent tests be performed on at least one tape from each batch. Special equipment is therefore used to plot graphs of frequency response, output *v.* bias, distortion *v.* output, and, after a 24-hour delay, to record the "print" level. All these tests are recorded on one strip of paper, which, in common with the sheet recording sensitivity, carries a code number identifying the tape completely, both as to batch, and the position the particular tape occupied in the original wide sheet. This equipment is of particular interest, since a controlling amplifier connected between the output of the system and the input to the recorder is used to keep the output of the system constant. The actual output from the reproducing amplifier is then determined by a variable attenuator connected between its output and the control point. Thus the signal applied to the harmonic analyser can be taken from the constant level control point and the recording meter has only to measure the harmonic output, and not, as would be more difficult, the harmonic to total signal ratio.

Maurice Soubrier had been concerned with the problem of correcting a recording, such as that on a magnetic dictating machine, either by the deletion of undesired matter or by the addition of new material. He described a method of doing this without cutting the tape, or re-dictating the matter coming after the additions. He proposed using two or more coupled recorders capable of recording or reproducing in either direction of travel of the tape, and so arranged that subject matter could be transferred from one tape to another at will. To save time the re-recording could be carried out whilst the machine was running backwards. An apparatus could certainly be made to do this, but the present writer fears that it would be rather complicated for office use, but might have applications in broadcasting when much editing is necessary.

Dr. Schiesser, of Rundfunk-Technisches Institute G.m.b.H., discussed the magnetic recorders and ancillary equipment which have been developed for use in the German Federal Broadcasting System. Of special interest was the small portable recorder, Type R85, which records at 7½in per sec. using 1,200ft spools. The motor system is fed by batteries. A separate reproducing head and amplifier are fitted for monitoring and subsequent reproduction, and the overall response was stated to be flat to 10 kc/s. The recorder measures approximately 10in × 15in × 5in and weighs 22lb. Dr. Schiesser referred amongst other things to the work done by N.W.D.R. on artificial reverberation, and mentioned work of a similar nature which had already been carried out by Dr. Axon at the B.B.C. Research Department.

Recording Television Signals

One afternoon was devoted to the application of the magnetic system to television recording. J. T. Mullin, of Bing Crosby Enterprises, described the multi-track system developed by his company, and Commander C. G. Mayer gave an account of the system developed by R.C.A. This latter system uses ½in-wide tape to record both sound and colour television signals and is capable of recording black and white television and sound on normal ¼in-wide tape. The tape speed is about 30ft per sec and special measures are taken to maintain the tape tension constant at all times. Commander Mayer pointed out that the speed constancy requirements were extremely stringent for this work and stated that constancy in excess of 1 part in 10^6 was needed. The recording and reproducing heads present unusual problems, since the recorded wavelength at 4 Mc/s is only about 2½ microns. A further trouble occurs in the sound channel and indeed at the l.f. end of the video channel, because the tape speed is so high that the wavelength becomes large compared with the head dimensions and results in a low-frequency loss in addition to that normally encountered in the magnetic system.

J. Borne, of the Laboratories d'Electronique de Physique Appliquée, discussed the influence of the physical and magnetic characteristic of the recording head upon the response at high frequencies, whilst his colleague, J. Perilhou, discussed, in addition, some of the mechanical problems involved. He endorsed the statement already made by others, that separating a reproducing head from the tape by one wavelength results in 55 db loss of output.

The last item on the afternoon's agenda was a demonstration by Prof. Boutry, from the Conservatoire National des Arts et Métiers, of television recording on a magnetically coated drum. The programme radiated by R.T.F. was recorded, immediately reproduced, and shown on a projection receiver screen. The bandwidth in use was only about one megacycle, so the results were not perfect, but for most people present it was the first time they had seen such a demonstration. It was stated that the clearance between the heads and the drum, necessary to eliminate wear, was about 0.00004in. Such a fine clearance necessitated great precision in the drum bearings.

Several papers were devoted to the use of magnetic recording as a memory for calculating machines. One interesting application was that of recording teleprinter signals. It was stated that one character could be recorded, on a multi-track system, in 0.0005in length of tape. Thus much more information could be stored in a given space with the magnetic system than was possible on the normal perforated paper tape. In fact a foot or two of tape could contain the equivalent of many pages of typescript.

In the section on disc recording an interesting paper was read by P. Meunier, of R.T.F. He and his colleagues have been concerned at the difficulty of cutting microgrooves on lacquer recording blanks. He has noted that the degree of flatness required for this purpose is very high, and showed that a re-design of the usual cutter head mounting is of considerable help. Briefly he established that the head must be pivoted so as to possess minimum inertia and minimum friction. The head, with a minimum of added mass, is mounted on a pivoted arm with no counterbalance. A second arm, separately pivoted, projects beyond the pivots and carries a counterbalance weight. It is coupled to the head by a spring and dashpot system. In the published paper* the simplified equivalent electrical circuits of the mechanical system are analysed. Considerable improvement was claimed, not only in the reduction of effects due to lack of disc flatness, but also in those caused by motor vibrations.

Exhibition

As might be expected, a large proportion of the forty-nine exhibitors were showing magnetic recorders of one type or another. Studio machines were represented by E.M.I. of England, Tolana and Bordereau of France, A.E.G. and Vollmer of Germany, and Ampex of U.S.A. Some of these machines were provided with push-button operated shears to cut the tape adjacent to the reproducing head when editing.

On the N.W.D.R. stand an interesting midget tape recorder made by Maihak was shown. It operated at 7½in per sec and would record for 7½ mins on one winding of its spring motor. The recording or reproducing amplifier was battery operated. The complete instrument was about 9½in × 12½in × 4½in in size, and weighed 16lb. It was stated that a second head could be fitted to record timing signals from a film camera so that the tape could subsequently be synchronized with the film. In another version of this recorder the spring motor gave a constant-speed drive for 12 minutes.

A somewhat larger and heavier battery and spring-operated recorder was shown by Acémaphone.

Another spring-driven recorder was shown by Rocke International on behalf of the Amplifier Corporation of America. Called the "Magnemite," it was available with tape speeds ranging from 11/16in per sec to 15in per sec. The slow-speed machine was stated to record from 200 to 2,500 c/s and to run for 30 minutes on one winding. An unusual feature of some of these models was an external flywheel mounted on top of the capstan. The smallest and lightest of the range, operating at 1⅞in per sec, was 11in × 8in × 5in in size and weighed 10lb. A portable battery-driven recorder intended for professional use and of similar dimensions and weight to the above instruments is available from E.M.I.

Domestic tape recorders were on many stands, but only two will be referred to. The A.E.G. model KL25 operates at 3¾in per sec and has a counter operated by one spool to facilitate "place finding." A response to 10 kc/s was claimed and a separate reproducing head and amplifier is included.

Radio Star were showing a very small domestic recorder, including amplifier and oscillator, which could be stood complete on any turntable or clockwork gramophone to provide the tape drive. The amplifier would function on a.c. or d.c. mains.

A device of great interest to film enthusiasts was a stabilized, film-pulled, magnetic sound attachment which could be mounted between the arm carrying the feed spool and the body of almost any projector. The unit, which is reminiscent of some of the units fitted to professional projectors for stereophonic sound in cinemas, is marketed by Fred. Jeannot.

One of those things which had to be produced sooner or later was a simple but satisfactory clip for holding the free end of a reel of tape firmly to one cheek of the spool. It is made by H. Gravillon, Paris.

A machine for making welded joints in p.v.c. tape was being demonstrated by Sonocolor. A joint could be made in about 10 seconds, including trimming the ends of the tape and loading and unloading the machine.

Two gramophone turntable units are worthy of mention. Thorens of Switzerland were showing a three-speed motor, governor controlled, which used a gear change to go from 78 to 33⅓ r.p.m. 45 r.p.m. was obtained by using the governor. Thus all three speeds were adjustable. The pickup fitted to the model on show was an American G.E. variable reluctance unit, which could be lowered by push-button at any of the three usual record diameters.

A high-grade, three-speed, 17in diameter turntable was being exhibited and demonstrated by E.M.T. of Germany. This incorporated many refinements, including an optical device for locating the pickup on the disc and a remotely controlled rapidly starting turntable.

A most unusual-looking loudspeaker was exhibited by Elipson and was used in the demonstrations of "Musique Concrete." The unit is conventional, but the enclosure appears to be cast in plaster and is ported in the normal way. Over the cone, which faces upwards, is a large, shell-like elliptical reflector, also of plaster, which gives the unit its name—"La Conque." The reflector is so placed that the loudspeaker unit is at one focus of the ellipse, and hence an image source appears at the second focus. The result is claimed to be a uniform sound distribution over a fairly wide angle down to 800 c/s, but outside this angle the sound is attenuated and hence undesirable building echoes are not excited.

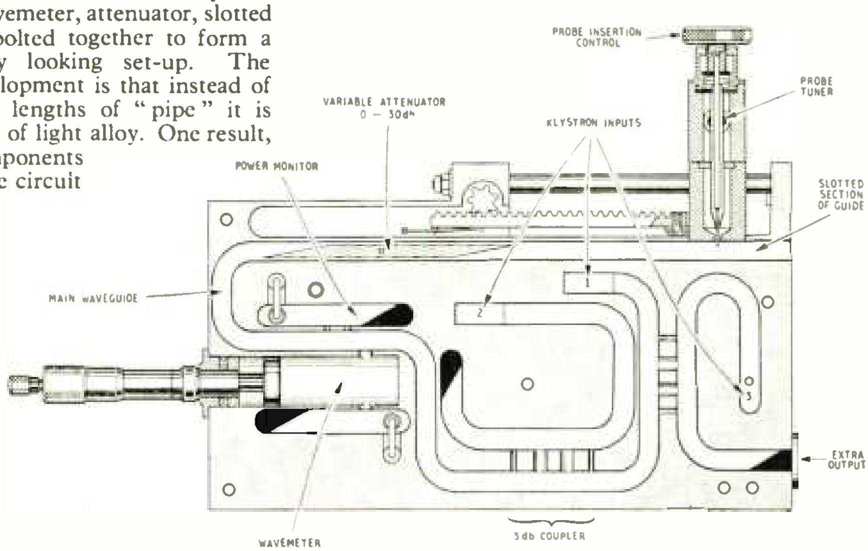
* The original text (in French) of some of the papers read at the Congress, and a summary of others, can be consulted in the March 1954 issue of *L'Onde Electrique* (Vol. 34, No. 324).

Integrated Microwave Test Bench

Losses and Reflections Due to Imperfect Assembly Avoided

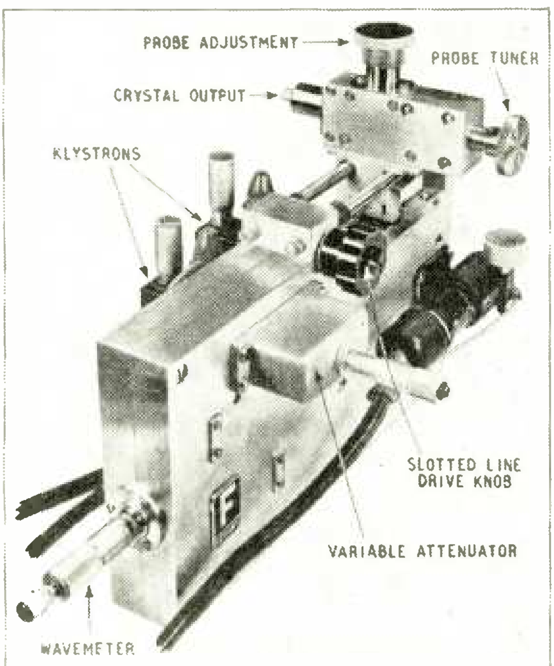
AN interesting and original exhibit at the recent R.E.C.M.F. show was the Ferranti X-Band Test Bench, referred to briefly in last month's report. It appears to be a distinct step forward in microwave technique.

Ordinarily, the outfit needed for microwave tests and measurements comprises a number of separate waveguide instruments—wavemeter, attenuator, slotted line, matched loads, etc.—bolted together to form a rather lengthy and untidy looking set-up. The essence of the Ferranti development is that instead of being built up of separate lengths of "pipe" it is milled out of one solid block of light alloy. One result, at least as regards the components thus "integrated," is that the circuit is fixed. This may be a disadvantage for general experimental purposes requiring flexibility of apparatus. But for carrying out standard tests it is an immense advantage to have equipment that can be relied upon to be always the same; that is to say, with no alterations or borrowing of essential parts by



Right: Section through the Ferranti X-Band Test Bench showing positions of the items mentioned in the text.

Below: The block of the unit provides a convenient mount for additional items of test equipment.



some other worker since one last used it. As there are no joints between sections of guide, there is no chance of variable losses and reflections due to imperfect assembly. The only joint is the one between the two halves of the block, and because this comes half-way along the major dimension of the rectangular guide section, it impedes no current.

Manufacturing Advantages

The method of manufacture greatly reduces costs (it is said to take one-third of the time required to produce a conventional test bench); it makes possible a more consistent product; it facilitates internal inspection and accessibility; and because there is no question of the guide being deformed by its being taken around sharp bends the whole apparatus is very compact, as well as being cleaner in appearance, stronger, and more rigid. The block forms an adequate mount for additional components that may be required; amplifiers can be plugged directly into the waveguide, thereby avoiding the use of flexible leads.

Provision is made for any number up to three klystron oscillators; this is convenient for covering a wide frequency band or for testing at several spot frequencies without having to make readjustments.

The black areas in the drawing indicate matched terminations. From the klystrons the main waveguide leads in turn to:—

(a) a micrometer-controlled wavemeter, operating in the H_{112} mode,

(b) a crystal detector for monitoring the output power,

(c) a micrometer-controlled nichrome-film glass-vane attenuator with a range of 0-30 db, accurate to ±0.1 db, and

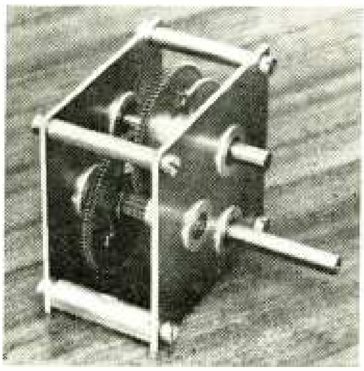
(d) the slotted line, with probe insertion controllable up to 2 mm, and longitudinal position variable over 90 mm to an accuracy of 0.02 mm, providing voltage standing-wave ratio discrimination down to 1.01. The frequency range of the whole unit is 9-10 kMc/s (3.00-3.33 cm wavelength).

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

High-Ratio Tuning Drive

A GEARED drive with a reduction ratio of 56.25 to 1 intended primarily for bandspread or precision tuning over shortwave bands in a receiver has been introduced by Jackson Bros., Kingsway, Waddon, Surrey.



Jackson high-ratio geared drive Type G1.

It is fitted with spring-loaded gears and self-aligning ball bearings to ensure a smooth action free of backlash at all shaft loads up to 24 oz/in. Stops are included to prevent overdriving at the limits of rotation as a safeguard against damage to the gears.

High- and low-speed shafts (driving and driven respectively) project back and front of the casing, thus permitting the addition of a driving motor if required and providing facilities for a pointer or scale on the front extension of the capacitor shaft.

At present the drive is available to equipment makers only and without dial, knob or other accessories.

Industrial P.A. Amplifiers

POWER outputs up to 2.4 kW for large factories, railway stations and wire relay systems are provided by parallel connection of unit 100-watt amplifiers recently introduced by the General Electric Company, Magnet House, Kingsway, London, W.C.2. Two DA100 valves in push-pull may be operated to give 100 W with 3 per cent distortion under Class A conditions, or 175 W under Class AB2 with 6 per cent total harmonic. The output transformers have divided secondaries with impedances suitable for series or parallel connected loads, and the l.t. and h.t. supplies are derived from separate transformers to simplify stand-by running of heaters. Four bridge-connected directly heated vacuum rectifier valves are used for h.t. supply with a choke input smoothing system employing paper dielectric condensers.

The panels, which are 15¾in high, fit racks of the standard 19in width.

F. M. Feeder Unit

DESIGNED specifically for the B.B.C. experimental transmissions from Wrotham, this unit covers 87.5 to 100 Mc/s and comprises an r.f. stage, self-oscillating triode frequency changer, two i.f. amplifiers with a.v.c. to prevent overloading and to minimize aircraft flutter, and a ratio-type discriminator. A cathode-ray tuning indicator occupies the centre of the horizontal tuning dial.

The unit has been designed to have good frequency stability after the initial warming up period, and with a field strength of 3 mV/m gives an average of 40 mV audio output into 100 kΩ.

When required for use in conjunction with existing high-quality amplifiers, such as the Leak TL/10 or Quad I or II, appropriate power supply and output plugs can be supplied and suitable h.t. dropper resistors included in the set.

Chapman FM81 feeder unit.

The price is £18 10s, and a half-wave dipole aerial with window sill fitting can be supplied for £1 18s 6d. If necessary a horizontal H aerial with 5ft chimney mast and fittings costs £4 15s 6d.

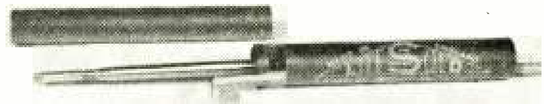
The makers are C. T. Chapman (Reproducers), Ltd., Riley Street, London, S.W.10.

Miniature Soldering Iron

AN overall length of only 6in and a weight of only ½ oz are features of a new miniature soldering iron which can be supplied with bits ranging in diameter from ⅛in to ⅜in. The loading of the smallest size (⅛-in bit) is 12 watts, while that of the largest is 40 watts. Working voltages range from 6 to 250 V, a.c. or d.c.

Despite their small size it is claimed that the mains element irons can be left switched on while not in actual use for very long periods without coming to harm.

The "Litesold," as the iron is known, is made by Light Soldering Developments, Ltd., 106, George Street, Croydon, Surrey, and the

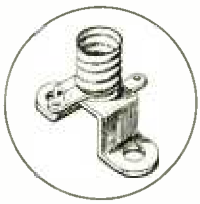


"Litesold" miniature soldering iron with replaceable bit and cover.

price is 19s 6d with a fixed ⅛-in diameter bit and 21s 6d with a replaceable bit. A protecting cap for the bit and element is included.

Lilliput Lampholders

A RANGE of sub-miniature lampholders described as the Type LES (lilliput Edison screw) conforming to Section E of BS98 as regards lampholder dimensions, has been introduced by A. F. Bulgin and Company. They are available with fixing brackets of five different shapes; one is the baseboard model shown here in its actual size, while the others are shaped for securing to various types of scale and other devices for which illumination is required. Other types of bracket can be supplied by special arrangement.



Bulgin lilliput lampholder Type LES4 shown actual size.

The list price of each of the five normal types is 9d. The maker's address is Bye Pass Road, Barking, Essex.

Precision Potentiometer

WIRE-WOUND precision potentiometers with linear or graded windings, accurate to one part in 10^4 of a given law, are now obtainable from Salford Electrical Instruments. These find applications in radio compasses, altimeters, prediction and computor equipments as well as in many types of industrial electronic apparatus.

They are made with either toroidal or card windings of from 300 to 50,000 ohms resistance and with a normal rotation of 340 deg, but a full 360-deg movement can be supplied for special purposes.

In the toroidal types the windings range from 1 to 3½in in diameter and while these generally follow a linear law, slight deviations from the linear can be embodied in the winding if necessary.

The strip type, on the other hand, can be supplied with linear or non-linear windings and made to incorporate functions such as sine-cosine relationships, these being achieved by suitably shaping the winding card and fitting special wiper contacts.

Machines have been developed which will cut several cards at a time to an accuracy of $\frac{1}{1000}$ in of a

Special sine-cosine potentiometer made by Salford Electrical Instruments.

calculated shape, while other machines wind wire as fine as 0.0006in in the case of toroids and 0.0008in for strips.

Tappings are fitted wherever required by a brazing process specially developed to permit attachment of wires to within 0.5 deg of a calculated position.

The maker's address is Peel Works, Silk Street, Salford 3, Lancs.

High-quality Amplifier

THE Type PF91 amplifier and remote control unit recently introduced by Pye, Cambridge, is designed for high-quality reproduction from gramophone records and radio. It incorporates four alternative equalizer circuits, to compensate for most recording and pickup characteristics in addition to continuously variable bass and treble tone controls and a steep-cut filter for 4, 7 and 12 kc/s.

The power output for less than 0.1 per cent distortion at 1 kc/s is stated to be 12 watts and hum and noise level −90 db relative to 15 watts.

An interesting feature of the design is the provision of adjustable positive feedback (in addition to the main negative feedback) in order that the effective output impedance may be reduced to zero to improve loudspeaker damping.

The price of the main amplifier (PF91) will be £29 8s and of the pre-amplifier (PF91A) £12 12s.

Pye Type FF91 amplifier and PF91A pre-amplifier and control unit.

RANDOM RADIATIONS

By "DIALLIST"

Peace, Perfect Peace

WHAT a joy it is to have two simultaneous f.m. transmissions from Wrotham on most days of the week. The programmes *certainly* come in free from interference of any kind. That, I'm afraid, is a lot more than can be said for the same programmes as transmitted on the medium or the long waves. With 90-Mc/s f.m., fading, sideband splash, heterodynes, atmospherics and re-radiated interference just don't happen. "Sporadic E" may, I suppose, have dire effects; but I've never experienced them. For some reason that I can't make out I've never yet been able to pick up any of the Continental f.m. broadcasts, though a good many other people have reported them. I should be pretty well placed too. My f.m. dipole is 550 feet above sea-level and it "points" almost straight at Paris. I've tried the 96-Mc/s neighbourhood time and again during the station's advertised working periods; but not a sniff of a signal can I get.

A Wonderful Chance

IT is reported that receivers for the frequency-modulated transmissions on Band II are to be a feature of this year's National Radio Show. I trust that they will include high-grade models, able to do full justice to the quality of these signals with their wide range of modulation frequencies. With a really good receiver, the quality of both speech and music is something of a revelation. To begin with, you have an absolutely silent background, which means that low sound levels in the transmission can be allowed to be really low. In fact, the volume contrasts when an orchestra is playing can be given their full value, with no need for "compression." And the designers of a.f. circuits and of loudspeakers can let themselves go, knowing that they are dealing with signals worthy of their best. For the first time since broadcasting began, genuine high-fidelity radio has become possible. Let's hope the manufacturers will rise to the occasion by producing receivers of the luxury class which are real musical instruments. Recalling, though, what the urge for "cheapness first" has done to the sound accompanying television in so many table model sets, one isn't too optimistic.

Simple—But it Works

IN the ordinary way I'm not fond of indoor TV aerials; they're too prone to pick up any interference that's going. Still, they come in handy at times. You may, for example, want for one reason or another to use the receiver in a room in which there is no connection to the outdoor aerial. Well, provided that you've an adequate signal, here's a cheap and simple way of rigging up an indoor dipole that will do the trick. The ingredients needed are a length of single flex, p.v.c. covered for choice; an old 4-pin valveholder; a suitable length of the right feeder for the set, with connector; and a pair of battery wander plugs. Cut two lengths of flex, using the formula $L = 231/f$ (Mc/s), where L is the length of each piece. Bare one end of each piece, fixing one to the grid terminal and the other to a filament terminal of the valveholder. Connect one wander plug to the inner, and the other to the outer, of the feeder, which we'll suppose to be co-axial cable. And that is practically that. To "erect" the aerial, drive a small nail into the picture rail and fasten the end of the flex connected to the filament terminal of the valveholder to it with a piece of string. Fix the valveholder to the wall so that this bit of flex is vertical. Run the other piece of flex along the wall at right-angles to the first and anchor to a nail as before. Stick the wander plug connected to the inner into the socket in the valveholder corresponding to the vertical leg of the dipole and t'other into that corresponding to the horizontal. I trust you'll find, as I do, that you get remarkably good results from this simple arrangement.

Proof by Nine

MY very best thanks to the army of readers in this country, on the Continent, in the U.S.A. and elsewhere who have sent (and are still sending) me proofs of the Proof by Nine. It appears that my vague recollection of "casting out the nines" rang the bell. There are many ways of proving the Proof by Nine algebraically: some readers did it in one page; some needed from two to ten pages before they could write Q.E.D. Various proofs appear in a number of published works on arithmetic, or on mathematical curiosities. The basic fact is that if you take any complete number of units, tens, hundreds, thousands . . . the initial digit gives the remainder when that number is divided by nine. Thus: $5 \div 9$, $R=5$; $10 \div 9$, R = 1; 200 ÷ 9, R = 2; 6,000 ÷ 9, R = 6. Now 6,215 = 6,000 + 200 + 10 + 5; and the remainder when it is divided by 9 must be 6 + 2 + 1 + 5 = 14. But 14 divided by 9 gives the remainder 1 + 4 = 5. Hence the continuous addition. We could also work: 6 + 2 + 1 = 9; cast out the nine; R = 5.

Multiplication

This first step shows that the continuous addition of the digits of any number gives the remainder R when it is divided by 9. Now take two numbers *a* and *b* and suppose that R_a is *x* and R_b is *y*. Then it isn't difficult to prove algebraically that for the product *ab*, $R_{ab} = xy$. The Proof by Nine, then, amounts to this:

Unless the continuous addition of the product of multiplying *a* by *b* is equal to *xy*, the answer is wrong; if the two are equal, the answer is right—provided, as I mentioned originally, several "bloomers" are not involved. The Proof by Nine, then, is a quick and sound method of checking multiplications. Even more can be done by casting out the elevens (not the elevenses!) and I leave it to readers to chew that one over for themselves.

Television in Colour

FROM friends in the U.S.A. I gather that colour television is far from going with the expected bang. There are regular transmissions and receivers are on sale; but buyers are proving coy and their sales resistance high. I'm not surprised at that myself, for the present price of a colour receiver is three to four times that of a monochrome set. The B.B.C. is, I am sure, taking the right line by deciding not to launch colour TV in this country until it is completely satisfied that reliable systems of transmission and reception have been evolved. Nor, I imagine, would the radio industry be greatly interested in the manufacture of domestic receivers unless they could be turned out at not more than double the price of similar black-and-white models. A problem that will take a bit of solving when the time comes is that of servicing the colour sets. There are far too few first-rate servicemen as it is; and jobs such as alignment and fault finding in colour receivers are likely to call for considerably more knowledge and skill than is needed for dealing with the monochrome sets of to-day.

UNBIASED

By FREE GRID

Somnidicta

IT HAS BEEN said that a specialist is one who knows more and more about less and less. This appears to apply with peculiar force to the "big shots" of the medical profession, some of whom seem quite ignorant of the ways in which other branches of science could help them. A leading psychiatrist, who has just published a weighty volume on his own particular subject, does not seem to have heard even of the existence of such very ordinary things as microphones and tape recorders, the use of which would solve at least one difficulty for which he sees no immediate solution.

It appears from his book that a lot could be learned of the causes of a patient's nervous or mental troubles if a careful record could be kept over a long period of the remarks he makes when he talks in his sleep, especially after he has been given a drug to loosen his tongue when in the arms of Morpheus. But it would be very wrong for a wife, for instance, to take a note of the morphic mutterings of her husband and attempt to base a home-made diagnosis upon them, for such "somnidicta" are symbolic rather than factual.

Thus if a man raves in his sleep of the charms of winsome Winnie or gladsome Gladys he is not talking about a contemporary blonde but of something quite different and it takes a specially trained medico to interpret his cryptic utterances. Strangely enough, I can personally confirm this, as a friend of Mrs. Free Grid once confided to her that she was much worried by her sleeping husband's references to Maggie, whom she gathered from his "somnidicta" was very reliable and amenable if you kept her well oiled.

I was fortunately able to save this marriage from disaster by pointing out that a "well-oiled Maggie" referred to the Marconi magnetic detector of which her husband would have had considerable experience as he was an ex-wireless operator of pre-1920 vintage. The excessive humidity of the tropics was apt to cause the clockwork spring of this famous old detector to rust and break unless a drop or two of the correct grade of oil was applied in due season.

In his book the good doctor bewails the fact that it is obviously impossible for him or any other expert to sit by the patient's bedside night after night to listen to his "symbolic ramblings." Has this scion of a famous medical school never heard of a tape recorder and the "Vogad" principle (used on the transatlantic telephone) whereby the patient's voice could close the switch of the recorder motor and hold it closed so long as he was speaking? Perhaps some manufacturer will market a specially designed somnigraph or somnidictaphone for the use of the medical profession.

Symbolic Somnidicta

Blind Broadcasting

MANY PEOPLE are of the opinion that ordinary sightless broadcasting will one day disappear and television will reign supreme. I don't agree with this, although I do think that eventually most of us will have TV sets, using the sound channel part of them to listen to those items which do not need a visual accompaniment. All this business of separate wavelengths for "sound-only" sets will eventually die out.

Evidently, however, the Government does not agree with me in this and is of the opinion that "sound-only" broadcasting is doomed to early extinction. If this were not so I think that the powers-that-be would have made up their minds to break the B.B.C. monopoly of sound broadcasting as well as to remove its stranglehold on TV. The fact that the panjandrums of Parliament are leaving the B.B.C. in undisputed possession of "sound-only" can only mean that they think that the days of this form of broadcasting are numbered and, therefore, it is not worth bothering about.

Such is my opinion, and if I am wrong I think that the Government ought to dispel my illusion, if illusion it be. I do know that many people share my opinion and when commercial TV gets going I do not think it will take the new Authority long to disparage the B.B.C.'s efforts by taking advantage of its initials to dub it the *Blind* Broadcasting Corporation. The younger generation will soon cotton on to this idea and will become firmly convinced that this is indeed what the initials B.B.C. really stand for.

Wireless for the Deaf

THOSE who have the misfortune to be blind are always sure of receiving the maximum of sympathy and practical help from all classes of the community, but those who are hard-of-hearing are in a far less fortunate position.

It has been my experience that this lack of sympathy with—or at any rate indifference to—the plight of the partially deaf is very real. I little thought, however, that I should read a newspaper report, as I did recently, that a responsible person like a County Court judge had said that the deaf should not be allowed to have a wireless set. His Honour was dealing with a case in which possession of some rooms was sought because the tenants, being deaf, operated their set so loudly as to cause disturbance to others in the house.

The fact that deaf people are apt to cause annoyance to others by using their sets at full blast is the fault of all of us who are radio listeners, because we do not help them with their broadcast listening as we do blind people. There are specially designed sets for the blind and an appeal is made every year on Christmas day for money to supply these sets to those who need them. Yet, so far as I am aware, there is no similar fund for supplying special sets for the deaf or to enable them to have their existing sets specially adapted.

It is not sufficient to tell deaf people to connect up a pair of headphones in place of the loudspeaker or to sit with their hearing aid near the loudspeaker. Several manufacturers do market special devices, complete with refinements like a.v.c., for installing in any sound or television set, but such things cannot be cheap while the demand for them remains so limited.

I do wonder, therefore, whether something cannot be done to help deaf listeners in the same way as the blind are assisted. There may be organizations which *are* doing something,* but they do not seem to get much publicity as is obvious from the fact that so many deaf people seem to know of no way to listen to broadcast programmes but the one which called forth the judge's irresponsible remark.

*The National Institute for the Deaf issues a leaflet giving instructions for fitting headphones to television and sound receivers.—ED.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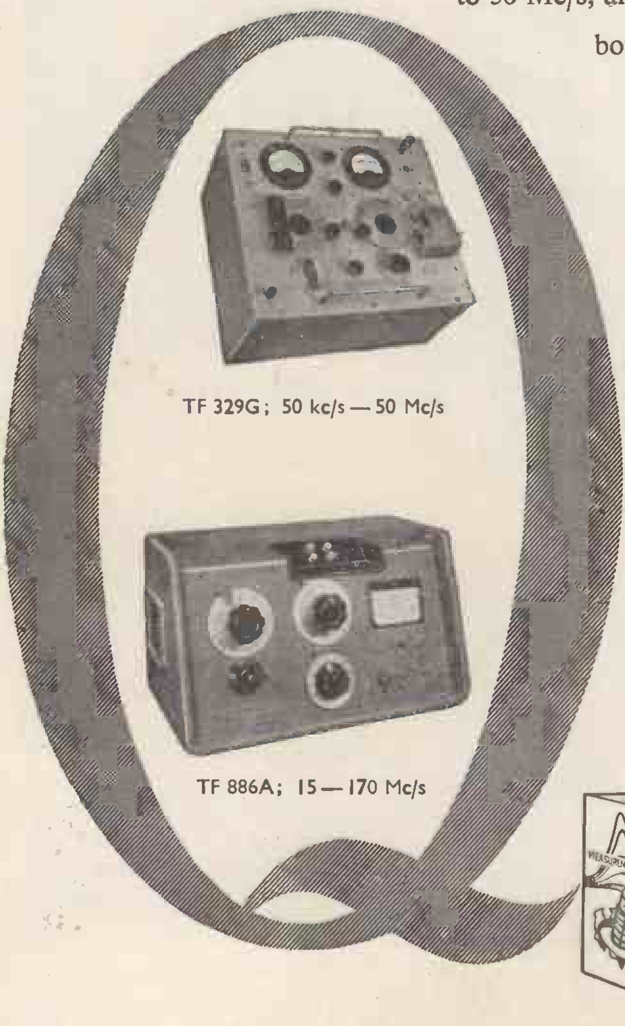

TF 329G; 50 kc/s — 50 Mc/s

TF 886A; 15 — 170 Mc/s

TF 329G; 50 kc/s—50 Mc/s; 10—500 Q; 40—450 μμF.
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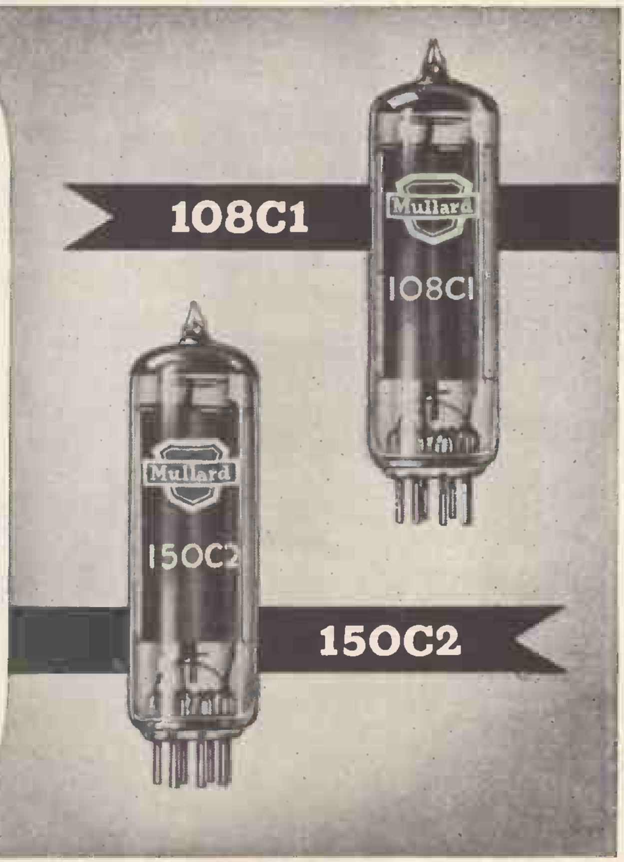
TC 8

2 NEW VOLTAGE STABILISER TUBES

with low regulation voltages



In order to meet the requirements of designers for stabilisers with very low regulation voltages, Mullard have added to their range two new tubes, the 108C1 and 150C2. They are particularly suitable for simple stabiliser circuits in which a constant output voltage is required over wide variations in input voltage and load current.

The burning voltages of these new stabilisers are 108V and 150V as indicated by their respective type numbers, while the current range is 5 to 30mA in both cases. As shown in the table they are directly interchangeable with American stabilisers 0B2 and 0A2.

For applications in which long term stability of burning voltage is paramount, designers are, of course, recommended to continue using the well-known stabilisers 90C1 and 150B2.

Brief technical details of preferred Mullard voltage stabilisers are shown on this page. Particulars of voltage reference tubes and more comprehensive information on the full range of voltage stabilisers will be gladly supplied on request.

Mullard Type No.	American Type No.	British Services Type No.	Burning Voltage (V)	Burning Current Range (mA)	Max. Ignition Voltage (V)	Maximum Regulation Voltage (V)	Max. Variation of burning voltage during 1,000 hours
90C1	—	—	90	1 to 40	125	14	1%
108C1	0B2	CV1833	108	5 to 30	130	3·5	2%
150B2	—	CV2225	150	5 to 15	180	5·0	1%
150C2	0A2	CV1832	150	5 to 30	180	6·0	2%

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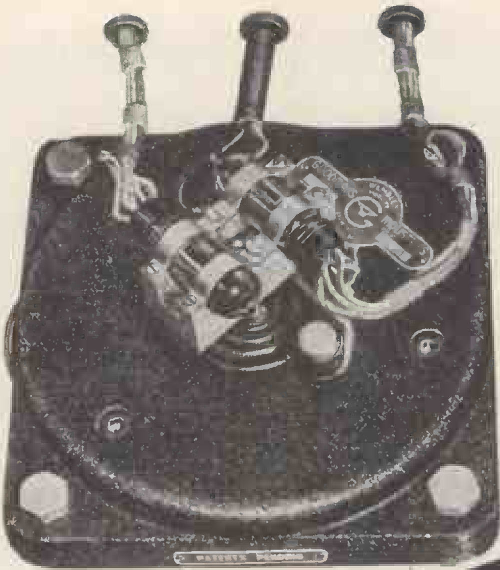
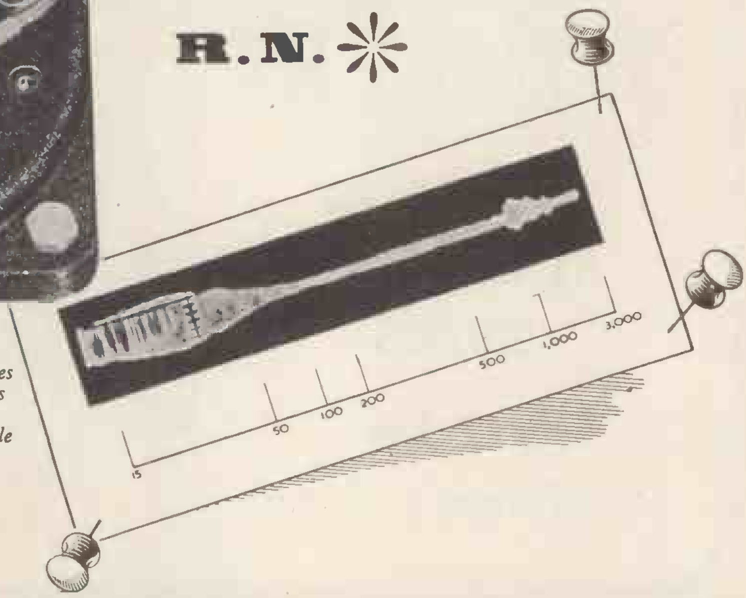
MVT 158



BRIMAR

Pin down

R.N. ✳



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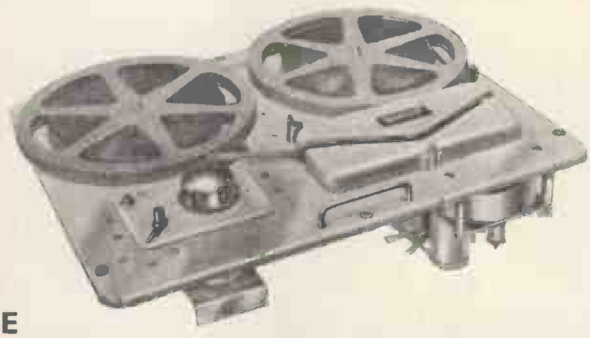

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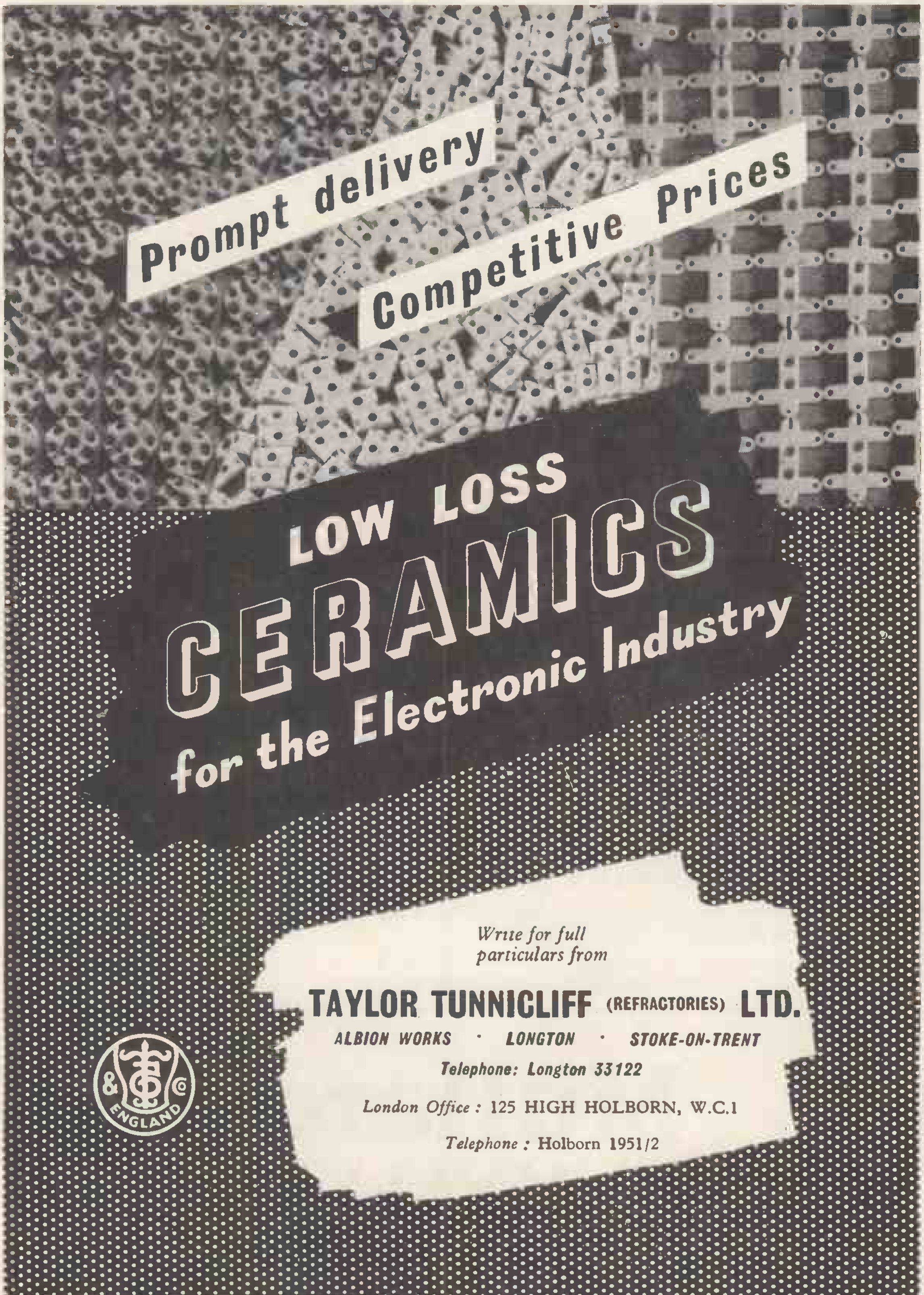
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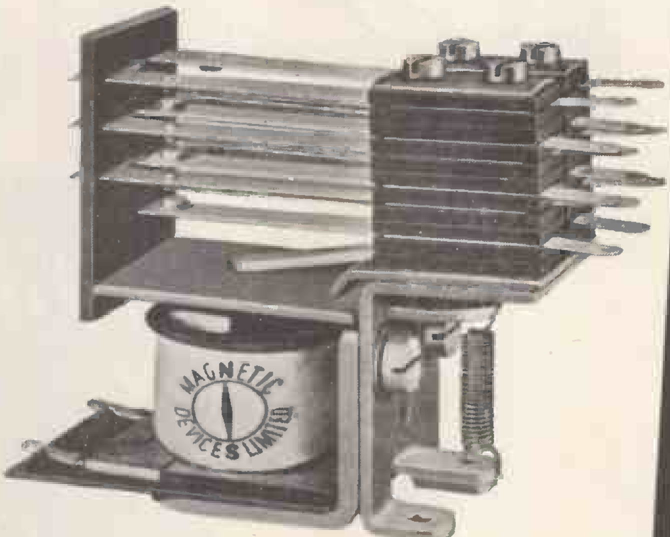

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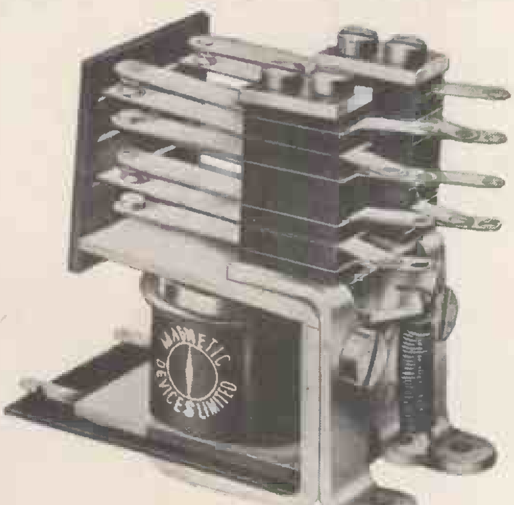

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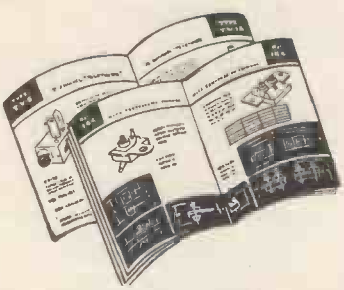

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Letter from AMERICA

From . . . C.H.S.,
Palo Alto,
California,
U.S.A.

April 1, 1954

Dear Mr. Briggs,

I do not often feel impelled by the purchase of a new product to write its manufacturer soon thereafter, offering an opinion. But after enjoying my new Super 12/CS/AL for a few weeks only, I cannot repress the thanks I have many times felt for the superb quality designed and built into your product.

I listened, in fact, to virtually every 12 and 15 inch speaker made over here; though, since A-B test facilities are very limited out this way, had to make most of my comparisons, between concerts, with what I could recall of "live" symphony performances, and their instruments. For less than double a Super-12's cost, I could find no one whose accuracy of reproduction, and freedom from distortion, appeared fairly comparable with the Wharfedale.

Because I am interested in reasons behind such performance, your little book, and articles in "High Fidelity," were of considerably more help than contributions from any other source.

I have learned that your production, from choice, is somewhat more limited. Which explains, in great part, why it took me over eight months of searching, through the Los Angeles and San Francisco areas, and by mail, to find a Super-12. I am very glad that I waited.

The only possible criticism that I could offer—tempered by realisation that there are other markets than America—stems from the English standard for bolt-hole locations. I was unprepared for this, had to re-model my enclosure to get the speaker in. But again, it was well worth it.

My thanks and warm congratulations to you, Sir, and your associates, for taking time to do a job so well.

Sincerely yours,
C.H.S.

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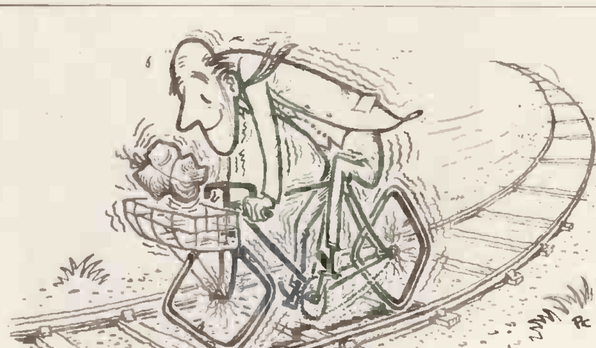
VIBRATION TESTING ?



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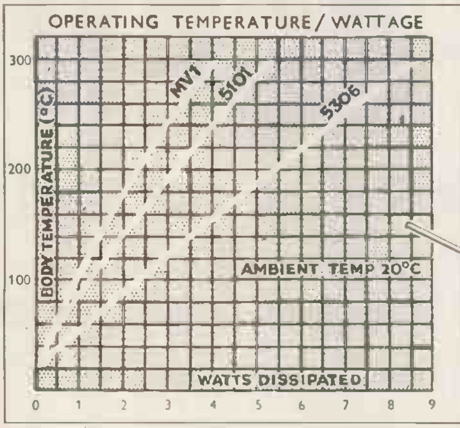

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(a) the use of a sintered alumina ceramic former, with thermal conductivity approximating steel (Patent 626128), in conjunction with a Painton glaze developed to match the thermal and mechanical properties of sintered alumina,
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Range	Type	Resistance Range Ohms		Tol.	Rating Watts		Max. Working Temp.	Temperature Coefficient	DIMENSIONS			
									Length	Diam.	Lead	
		Min.	Max.		Normal 20 °C.	Tropical 70 °C.					Length	Material
Standard	MVI	1 10	9.99 4,700	10% 5%	4	3	300 °C.	BELOW 100°— NEGLIGIBLE ABOVE 100°— 0.01% /°C.	15/32"	13/64"	1 1/4"	20 S.W.G. Silver Clad Copper Wire
Heavy Duty	5101	1 10	9.99 4,700	10% 5%	5.5	4	350 °C.	BELOW 100°— NEGLIGIBLE ABOVE 100°— 0.01% /°C.	15/32"	13/64"	1 1/4"	
Heavy Duty	5306	10	15,000	5%	8.5	7	350 °C.	BELOW 200°— NEGLIGIBLE ABOVE 200°— 0.01% /°C.	13/16"	9/32"	1 1/2"	

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Northampton England

ATTENUATORS AND FADERS • STUD SWITCHES • FIXED AND ADJUSTABLE WIREWOUND RESISTORS
WIREWOUND POTENTIOMETERS • MIDGET R.F. CHOKES • HIGH STABILITY CARBON RESISTORS • TERMINALS
PLUGS AND SOCKETS • KNOBS, DIALS AND POINTERS • TOGGLE SWITCHES • PUSH BUTTON SWITCHES

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GENERAL REMOTE CONTROL USES

OPERATING from an accessible point, switches, valves and other electrical and mechanical devices located in remote or inaccessible places. Flexible shafts are readily adapted for either manual or automotive operation of controls.

OPERATING any element requiring rotation or push-pull movement or both, with the controlled element close to or at a distance from the control point. Where an element requires both push-pull and rotation, both actions can be accomplished with a single shaft.

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The S. S. White Company manufactures standard shafts and is prepared to develop special shafts providing sensitive control over long and short distances.

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pre-set potentiometers

- **wire-wound linear, type 126**
- **carbon linear, type 127**

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These Egen potentiometers are based on long experience of the needs of television and electronic equipment manufacturers.

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MAXI-Q F.M. COMPONENTS

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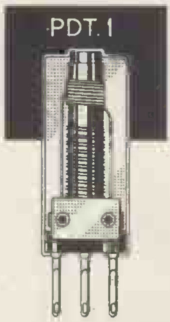
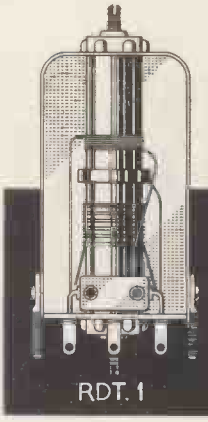


RATIO DISCRIMINATOR TRANSFORMER 10.7 Mc/s. Ref. RDT. I

A 10.7 Mc/s. transformer for use in ratio discriminator type circuits. Can size 1⅜in. square x 2½in. high. Secondary winding of bifilar construction. Iron dust core tuning, polystyrene former and silver mica condensers. Price 12/6 each.

PHASE DISCRIMINATOR TRANSFORMER 10.7 Mc/s. Ref. PDT. I

A miniature 10.7 Mc/s. transformer for use in frequency modulation detector circuits where the limiter/Foster-Seeley type of circuit is employed. Designed for carrier deviation of +75 kc/s. Qk.—1.5. Wound on black bakelite former, complete with iron dust slugs and two 6 B.A. threaded fixing holes on .532in. centres. Screening can: 1⅞in. x 13/16in. square. Price 9/- each.



I.F. TRANSFORMER IFT.11/10.7

A miniature I.F. Transformer of nominal frequency 10.7 Mc/s. The transformer is primarily intended for the I.F. stages of frequency modulation receivers and convertors. The Q of each winding is 90 and the coupling critical. Construction and dimensions as PDT.1. Price 6/- each.

I.F. TRANSFORMER IFT.11/10.7/L

As IFT.11/10.7 but with secondary tap for limiter input circuits. Price 6/- each.

Full constructional details for building an F.M. Feeder unit are given in our TECHNICAL BULLETIN (DTB.8). Price 1/6 each.

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DENCO (CLACTON) LTD. 357/9 Old Road, Clacton-on-Sea, Essex

LONGEST SCALE—SMALLEST SPACE

This compact, robust D.C. Milliammeter is flush mounting and is ideal for use in restricted space.

SCALE LENGTH : 9″

RANGE FROM 0-500 μA

The meter with the dead beat movement

The meter measures only 5″ across and the depth behind the panel is only 2″ yet it retains a scale length of 9″. It is available with spade or knife-edge pointer and special scales can be supplied to customers' specification if required. Send for prices and full details.

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Have your cake-and eat it!

Take your annual holidays —

Reading through this Magazine you will find a variety of equipment that you would like to possess immediately, apart from the items we list in our own advertisements. Our PERSONAL CREDIT PLAN will allow you to do this. We are now introducing a further facility to assist our customers, this being the reduction of the initial deposit to only 20/– with eight further monthly payments. We are extending hire purchase facilities also to 18 months if so desired. A selection of equipments is tabulated below, but space prevents us from listing the vast range we have available. Whatever you want, send us your enquiry (S.A.E.), and if it is available we will supply it. All prices are ex warehouse. Please add to your deposit sufficient to cover carriage and packing.

and buy your Electronic Equipment at the same time for only £1 deposit

SEND ONLY £1 TO SECURE ANY EQUIPMENT

ITEM	CASH PRICE	CREDIT SALE £1 dep. 8 inst.	HIRE PURCHASE Deposit	12 inst.	18 inst.
			(Instalments are monthly)		
AMPLIFIERS AND TUNERS	£ s. d.	s. d.	£ s. d.	s. d.	s. d.
Goodsell					
GW18 Williamson	£33 5 0	90/-	£11 1 8	42/5	28/6
GW12 Williamson	£27 10 0	74/-	£9 3 4	35/-	24/-
MA5	£13 10 0	36/-	£4 10 0	18/4	12/6
F/TC Tone Control	£10 10 0	28/6	£3 10 0	15/-	10/4
F/U/TC Tone Control	£14 14 0	38/6	£4 18 0	20/-	13/8
PFA Tone Control	£18 18 0	50/-	£6 6 0	24/6	16/8
Lowther AM/FM Tuner	£22 0 0	58/6	£7 6 8	28/-	18/11
Leak					
TL10 Amp. & Pre-amp.	£28 7 0	76/-	£9 9 0	36/2	24/6
Tuner Unit	£35 0 0	94/-	£11 13 4	46/6	31/6
Quad Mk. II Amplifier	£42 0 0	114/-	£14 0 0	53/4	36/-
Rogers					
Senior Main Amplifier	£28 0 0	75/-	£9 6 8	35/-	23/7
Senior Control Unit	£15 0 0	39/6	£5 0 0	20/-	13/6
Mark II Baby de Luxe Amp.	£14 0 0	37/6	£4 13 4	19/-	12/10
Mark II Junior Pre-Amp.	£9 0 0	25/-	£3 0 0	13/4	9/-
Mark II Minor Amplifier	£12 17 6	34/6	£4 5 10	17/7	12/-
RD Minor Baffle	£8 15 0	24/6	£3 18 4	13/-	8/9
RD Junior Corner Horn	£18 17 6	50/-	£6 6 0	24/6	16/8
Junior Tuner Unit	£25 6 1	66/6	£3 9 0	31/6	21/6
Burgoyne					
RG1 8-valve Superhet	£23 2 0	63/9	£7 14 0	29/-	19/6
RF1 TRF Tuner	£3 12 6	11/3	£1 4 2	6/4	4/6
A8 Amplifier	£3 19 6	12/6	£1 6 6	7/6	5/6
Chapman					
AM/FM Tuner	£15 0 0	39/6	£5 0 0	20/-	13/6
84 Tuner	£16 0 0	42/-	£5 6 8	21/2	14/4
85/85E Tuner	£21 6 8	58/-	£7 2 3	27/-	18/11
EMG Steep Cutting Filter	£4 10 0	12/6	£1 10 0	8/3	6/-
LOUDSPEAKERS					
Goodmans					
Axiom 150	£10 5 6	28/3	£3 8 6	14/9	10/-
Axiom 102	£9 18 2	27/-	£3 6 0	14/4	9/9
Axiom 101	£6 12 1	18/9	£2 4 0	10/7	7/6
Axiom 22	£14 14 0	38/6	£4 18 0	20/-	13/8
Tannoy					
15in. Dual Concentric	£33 10 0	90/-	£11 3 4	42/5	28/6
12in. Dual Concentric	£27 10 0	73/6	£9 3 4	36/-	25/-
Wharfedale					
W12CS	£9 15 0	26/9	£3 5 0	14/2	9/8
W10CSB	£12 6 6	33/6	£4 2 6	16/11	12/-
Super 8 CSAL	£6 13 3	18/9	£2 4 5	10/9	7/9
Golden 10	£7 13 3	21/6	£2 11 1	11/10	8/3
Bronze 10	£4 12 8	14/-	£1 10 11	8/2	5/9
W.B.					
HF 610	£2 10 6	8/6	16 10	6/-	4/2
HF 810	£3 0 6	9/8	£1 0 2	6/6	4/6
HF 912	£3 7 0	10/8	£1 2 4	6/11	4/10
HF 1012	£3 13 6	11/6	£1 4 6	7/3	5/2
Lowther PM2	£35 0 0	94/-	£11 13 4	46/6	31/6
GRAMOPHONE UNITS					
Collaro Transcription	£13 9 6	36/3	£4 10 0	18/-	12/6
Connoisseur 3-speed	£23 8 11	64/-	£7 16 4	30/-	21/-
Collaro AC3/534	£10 6 1	27/6	£3 8 9	14/9	10/3
B.S.R. Monarch, complete	£16 10 0	43/9	£5 10 0	21/8	15/-
B.S.R. Regent, complete	£9 4 11	25/6	£3 1 4	13/3	9/2
B.S.R. GU4, with 2 XMS heads	£12 18 0	34/8	£4 6 0	17/8	12/4
Garrard T, less head	£7 11 1	21/-	£2 10 4	11/8	8/1
Plessey Auto Changer, complete	£9 9 6	26/2	£3 3 2	14/-	9/6
Thorens Variable Speed Motor	£32 0 0	85/6	£10 13 4	42/-	29/-

ITEM	CASH PRICE	CREDIT SALE £1 dep. 8 inst.	HIRE PURCHASE Deposit	12 inst.	18 inst.
			(Instalments are monthly)		
PICK-UPS	£ s. d.	s. d.	£ s. d.	s. d.	s. d.
Connoisseur, with 2 Heads	£9 5 6	25/6	£3 1 10	13/4	9/3
Decca XMS, with 2 Heads	£6 9 3	18/-	£2 3 1	10/-	7/-
Cosmocord HGP39/GP20 Arm	£3 8 4	—	£1 2 9	7/-	4/11
Leak Ruby 78 r.p.m. or LP	£11 11 0	31/-	£3 17 0	15/10	11/-
Ronette Miniweight, with 2 Heads	£3 9 6	—	£1 3 2	7/-	4/11
Ronette Superweight, with 2 Heads	£3 16 3	—	£1 5 5	7/4	5/3
PLAYERS					
Regentone RP2 3-speed	£9 19 6	27/-	£3 6 6	14/6	10/-
Regentone HG2 3-speed Amplifier	£15 15 0	41/6	£5 5 0	20/10	14/3
Regentone AHG2 3-speed Auto Amp.	£21 0 0	55/-	£7 0 0	26/8	18/2
Plus-A-Gram Junior	£9 9 0	26/-	£3 3 0	14/-	9/6
Trixette A.375 3-speed Auto Amp.	£37 16 0	101/-	£12 12 0	48/4	32/8
E.A.R. Auto 3-speed Amplifier	£24 17 6	66/-	£8 5 10	31/6	21/6
E.A.R. Non-Auto 3-speed Amp.	£19 15 0	52/-	£6 11 8	25/4	17/4
Volmar L425 3-speed Auto Amp.	£24 13 6	65/6	£8 4 6	31/6	21/5
TEST EQUIPMENT					
Advance					
P1 Generator	£19 19 0	52/6	£6 13 0	25/6	17/9
J1 Generator	£35 12 0	95/-	£11 17 4	45/6	31/6
E2 Generator	£28 0 0	75/3	£9 6 8	36/6	24/3
H1 Generator	£25 0 0	66/3	£8 6 8	32/-	23/-
Avo					
Model 8 Meter	£23 10 0	64/9	£7 16 8	30/4	21/3
Model 7 Meter	£19 10 0	51/6	£6 10 0	26/-	18/4
Universal Avominor	£10 10 0	29/-	£3 10 0	14/6	10/6
Electronic Test Meter	£40 0 0	107/6	£13 6 8	51/-	35/-
Signal Generator	£30 0 0	80/6	£10 0 0	39/-	27/-
D.C. Avominor	£5 5 0	15/-	£1 15 0	9/2	6/6
Universal Bridge	£34 0 0	91/-	£11 6 8	43/-	29/6
Amplion Test Meter	£5 19 6	17/-	£2 0 0	9/3	6/8
Cossor					
Oscilloscope 1039	£29 10 0	79/6	£9 16 8	37/3	25/9
Oscilloscope 1052	£104 0 0	283/-	£34 13 4	132/10	90/-
Voltage Calibrator 1433	£18 5 0	49/-	£6 1 8	24/-	16/4
Denco Modulated Test Oscillator	£3 15 0	—	£1 5 0	7/6	5/3
Pullin Series 100 Test Meter	£11 11 0	31/-	£2 0 0	19/6	13/6
Taylor					
44A Meter	£2 10 0	—	16 8	5/-	3/9
77A Universal Meter	£15 0 0	39/6	£5 0 0	20/-	13/9
88A Universal Meter	£22 0 0	57/9	£7 6 8	28/-	19/3
110C Bridge	£14 10 0	38/-	£4 16 8	19/5	13/4
150A Output Meter	£33 10 0	90/-	£11 3 4	42/4	29/-
TAPE RECORDERS, DECKS AND ACCESSORIES					
"EDITOR" Recorder	£47 5 0	132/6	£15 15 0	60/-	42/-
GRUNDIG TK9 Recorder	£68 5 0	189/-	£22 15 0	86/6	59/-
700L Recorder	£84 0 0	230/-	£28 0 0	106/9	72/6
BAIRD Soundmaster Recorder	£68 5 0	189/-	£22 15 0	86/6	59/-
MSS Recorder	£99 15 0	273/-	£33 5 0	126/3	86/-
VORTEXION 2A Recorder	£84 0 0	230/-	£28 0 0	106/9	72/6
FERROGRAPH 2A Recorder	£79 16 0	220/-	£26 6 8	101/7	69/3
TRUVOX Tape Deck	£23 2 0	63/6	£7 14 0	29/-	19/6
WEARITE 2A Tape Deck	£35 0 0	94/-	£11 13 4	46/6	31/6
2B Tape Deck	£40 0 0	107/6	£13 6 8	51/-	35/-
LANE Tape Deck	£17 10 0	46/-	£5 16 8	22/-	15/3
BURGOYNE Oscillator Unit	£2 2 0	—	14 0	4/-	3/-
GRUNDIG Moving Coil Microphone for TK9	£6 6 0	18/-	£2 2 0	10/-	7/-
TRUVOX Radio Jack	£3 19 11	—	£1 6 8	7/-	4/11
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25th ANNIVERSARY ISSUE

BRITISH PLASTICS

July 1954

FROM YOUR NEWSAGENT OR DIRECT FROM DORSET HOUSE. STAMFORD ST. LONDON S.E.1

Modesty forbids...

...that we reproduce all the letters of appreciation we receive. But when one like this turns up what can we do?

261 Heather Road,
Small Heath,
Birmingham.

Dear Sir,
I do a great deal of record reproducing as a pastime I have already made a corner cabinet for the Audiom 60 and the sound production is simply marvellous, and in my honest opinion I think it is superb.
I have had all different types but never have I found anything to equal the Audiom type of reproducer.

What other loudspeaker could bring forth greater genuine praise?—except, perhaps, another Goodmans' High Quality reproducer. What immense versatility this high-powered, single cone AUDIOM 60 has! The secret?—fine sensitivity plus robust construction. The AUDIOM 60 will work as well from a domestic radio receiver as it does in an Electronic organ. For radio and record reproduction of varied input, it will reduce background noise encountered in the playing of vintage recordings—and more—because of its low harmonic and intermodulation distortion the AUDIOM 60 is extensively used as a bass unit in cross over networks, whilst its success as a P.A. unit is widely acclaimed.

AUDIOM 60

BRIEF SPECIFICATION

*Fundamental Resonance	75 c/s
Voice Coil Impedance	15 ohms
Power handling capacity	15 watts peak A.C.
Flux density	14,000 gauss
Net weight	12 lb 3 oz.
Price	**£8 12 6**

(Free of Purchase Tax)

**The AUDIOM 60 is available with 35 and 55 c.p.s. Bass Resonances. These two units are particularly suited for High Fidelity cross over systems. A suitable treble unit for the AUDIOM 60 is the AXIOM 101.*
Drawings of Bass Reflex Chambers are available on demand for all units.

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These holders have special resilient mountings which absorb unpleasant shocks and knocks. The B9A and B7G holders are both screened and unscreened while B8A is unscreened. All are available in P.V.C. or Silicone rubber mountings. Use P.V.C. when operation temperature does not exceed 50° C and Silicone rubber up to 120° C. For full details write for information to-day.

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Victoria Works, Ashtead, Surrey
Telephone: ASHSTEAD 3401

It's a DELIBERATE MISTAKE if you don't make sure of NATURAL REPRODUCTION

With a BAKERS Permanent Magnet LOUD SPEAKER

12in. 15 WATT 'DE LUXE'
Frequency Range 18 to 17,000 c.p.s. Fundamental Resonance (approx.) 35 c.p.s. Peak A.C. Input (open baffle) 15 watts.

12in. 20 WATT SINGLE CONE
Frequency Range 25 to 16,000 c.p.s. Fundamental Resonance (approx.) 45 c.p.s. Peak A.C. Input (open baffle) 20 watts.

15in. 30 WATT 'AUDITORIUM'
Frequency Range 20 to 14,000 c.p.s. Fundamental Resonance (approx.) 40 c.p.s. Peak A.C. Input (open baffle) 30 watts.

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BAKERS 'Selhurst' RADIO

Please write for full details to .
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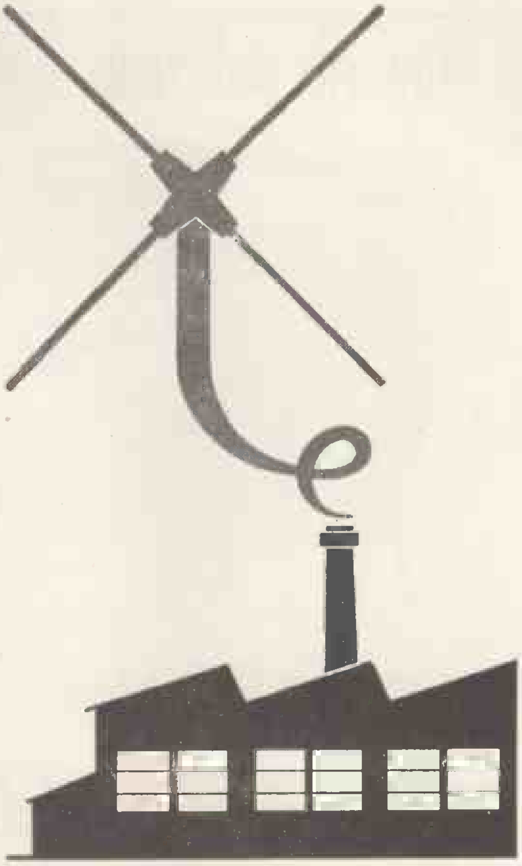
Your Aerial Installation starts in our factory...



" Antiference " stands for more than just fine TV aerials . . . it stands for full and careful attention to the dealer's needs.

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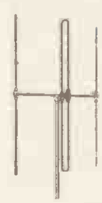
Remember too that Antiference Aerials are corrosion-proof. The capacitor couplings guarantee life-long electrical efficiency and eliminate servicing worries.



FD 73 PRICE 210/-

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HELPING THE DEALER

Antiference policy is two-fold. First, by constant research and high engineering skill, to produce the finest possible aerials. (Remember how Antiference pioneered the Antex Aerial.)
Secondly, by careful design, to save the dealer all possible time on his erection service. We're pledged to help the dealer to the full.

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7·5 to 250 Mc/s

ON FUNDAMENTALS
IN FIVE RANG
SINE A
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1 μV to 100 m

a new SIGNAL GENERATOR for BAND 3 SERVICING

Advance

Again Advance lead the way—this time with a V.H.F. Signal Generator covering 7·5 to 250 Mc/s, a range that embraces Bands 1 and 2 *and also the impending Very High Frequency Television Transmissions on Band* 3. Moreover, this instrument is available at a price well within the reach of every service man. In the traditional Advance manner, this instrument is designed for simple operation and with a versatility that not only fulfils present needs, but anticipates the even more exacting requirements to deal with the television test problems of tomorrow.

Below are some outstanding features:-

- WIDE RANGE—7·5 to 250 Mc/s
- SINE AND SQUARE WAVE MODULATION (*internal and external*)
- RELIABLE ATTENUATION
- LOW LEAKAGE—*less than 3 microvolts*
- TRULY PORTABLE—*weighs only 17lbs.*
- COMPETITIVE PRICE

MODEL Q1

£45
(List price in U.K.)

Full technical details available in Folder W23 on request.

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

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They say we make a perfect pair...

..with excellent connections

To be exact, this is the 12 pin version of the Multi-Way Plug and Socket range, which covers 4, 8, 12, 20 and 28 ways. The range features unusually low insertion pressures, and embodies considerable experience in meeting humid conditions. Designed to overcome as far as possible the difficulties encountered when using this type of connector in rack mounting applications, they have greater latitude in matching up than any comparable product, and are in use throughout the world in Radio, Television and Telecommunications equipment by such renowned firms as:— Messrs. Marconi's Wireless Telegraph Co. Ltd., The English Electric Co. Ltd. and Messrs. Standard Telephones & Cables Ltd.

A.I.D & A.R.B — APPROVED

POWER CONTROLS

LIMITED

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PHONE: NEW 3181/2/3

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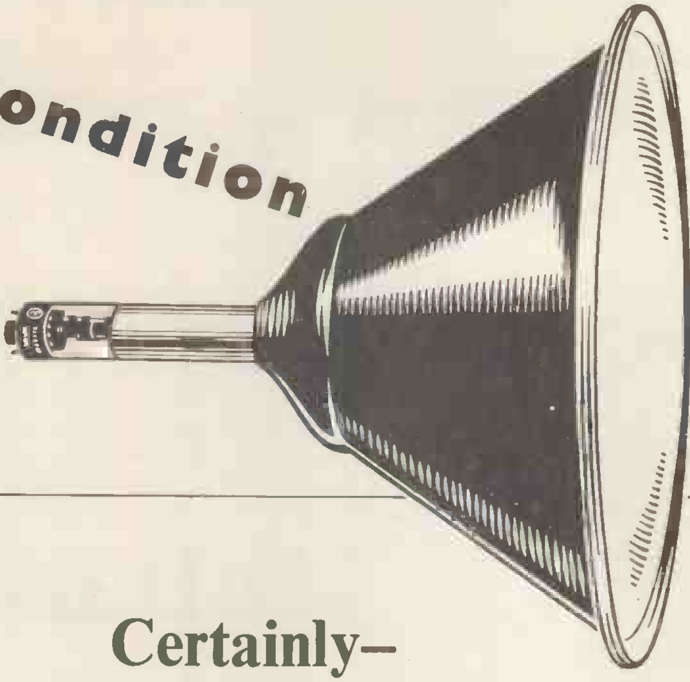

a C.R.T.?

Certainly–

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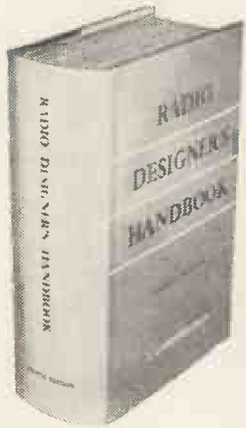

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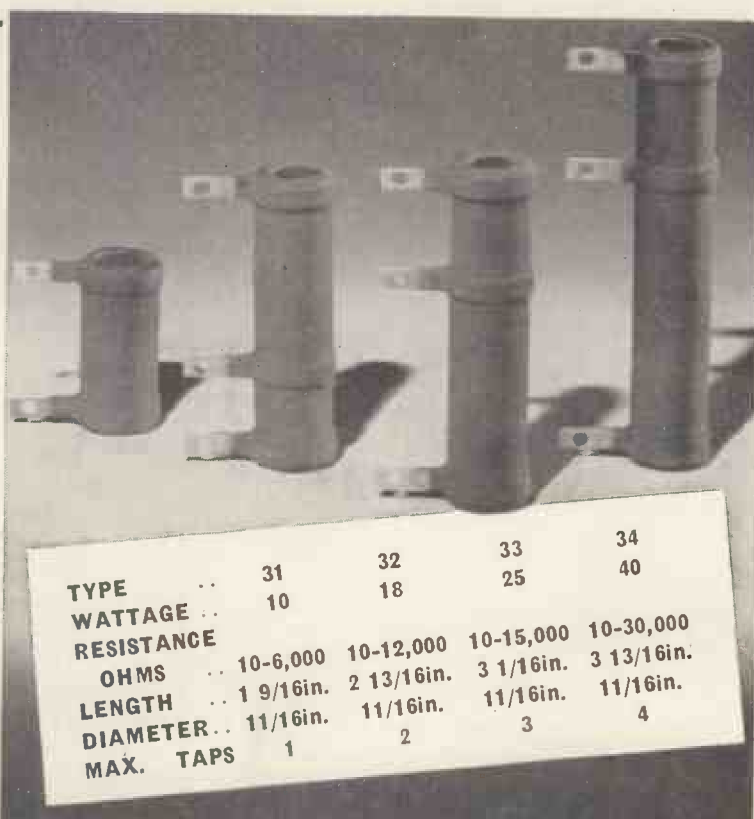

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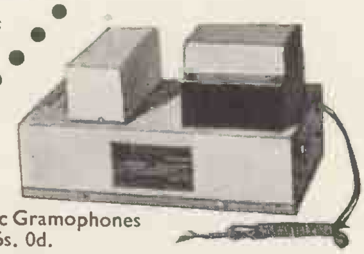

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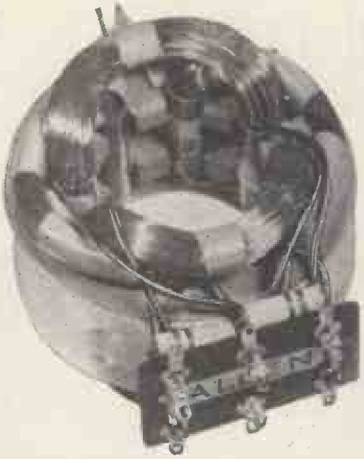

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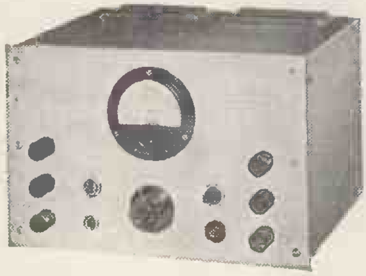

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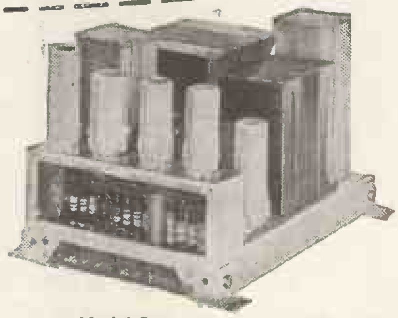

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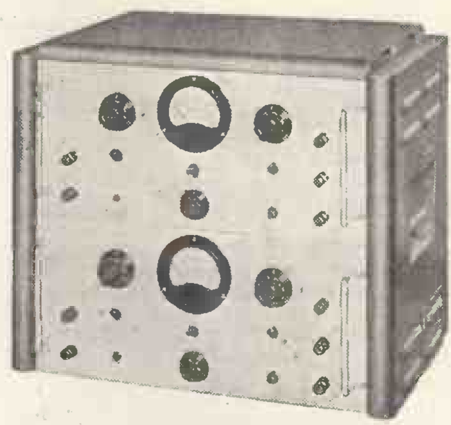

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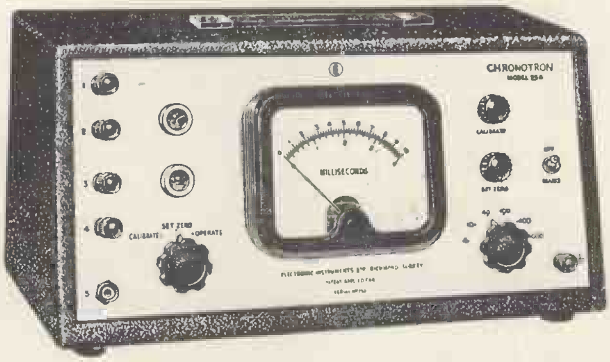

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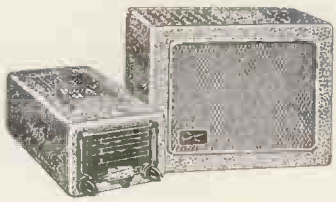

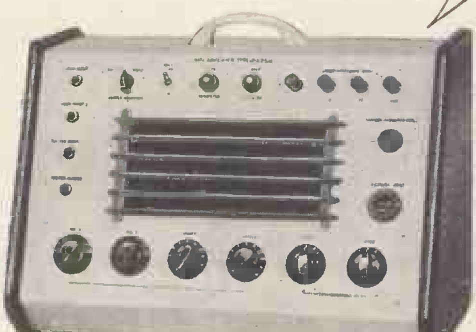

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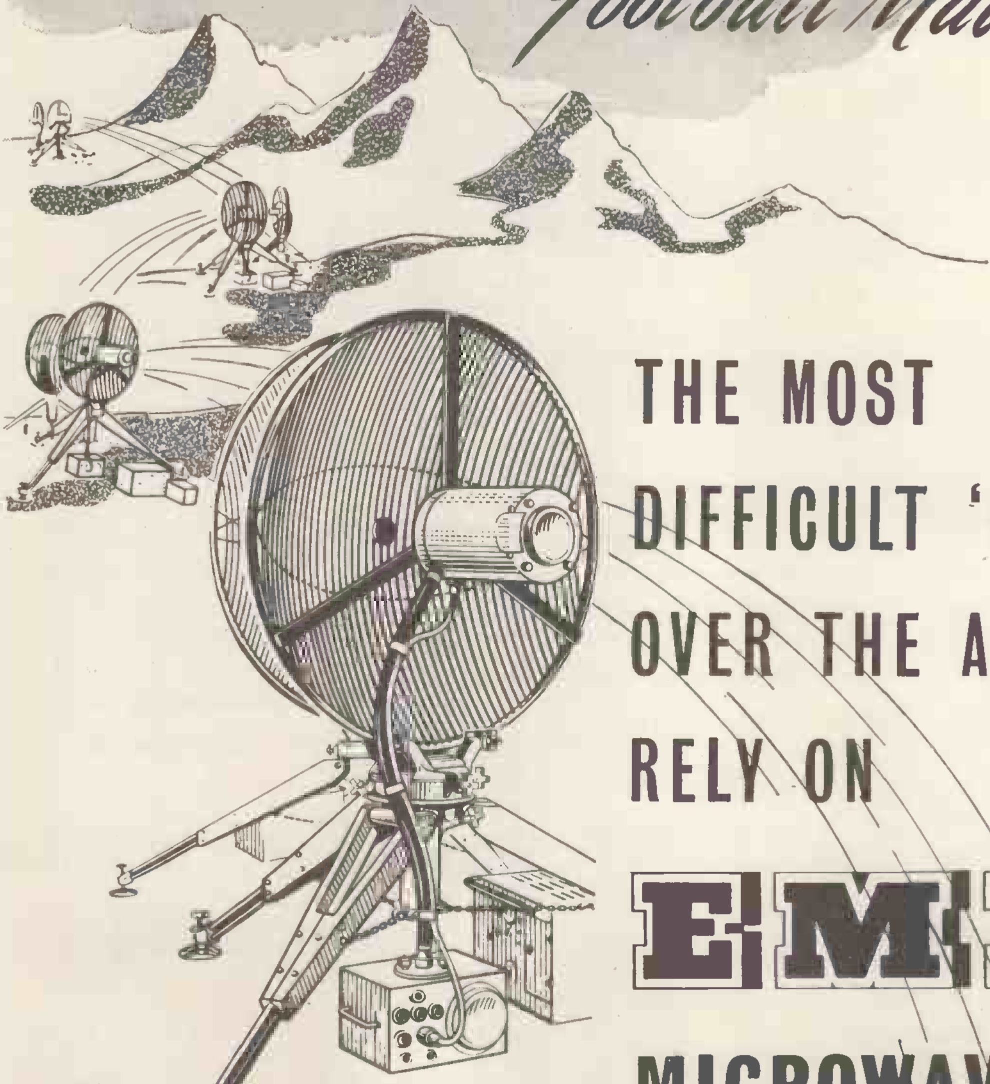

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3B24	6AT6	6L7	7E6	14S7	72	801A	3951	CL33	DH81	EL22	L77
3B26	6AU6	6L7G	7E7	15D2	73	803	4003A	CMG8	DH101	EL32	L610
3B/151A	6AV6	6N7	7F7	15E	75	805	4019A	CMG22	DH107	EL33	LD210
3BP1	6B4G	6N7G	7G7	15R	76	807	4019B	CMG25	DK91	EL41	LD410

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SEE PAGE 131 FOR OUR RADIO AND T.V. MODELS.
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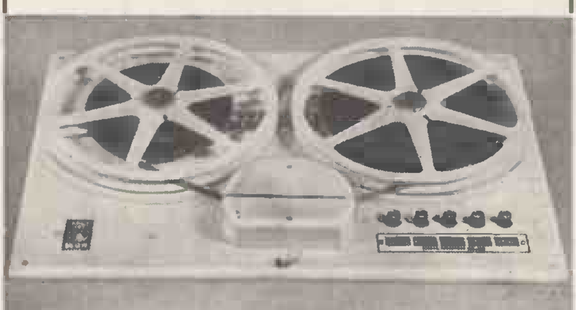

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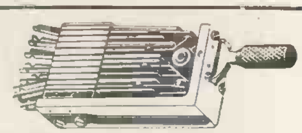

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Introduced at the BIF Olympia

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Model PLF2 — DC, sensibly flat from zero to 250 cycles, but — 3DB at 250 cycles. Automatic setting of the DC level. Balanced DC coupled input preamplifier. Input sensitivity 10 mV, 100 mV and 1 volt.

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MAY BE BUILT FOR

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including all valves.
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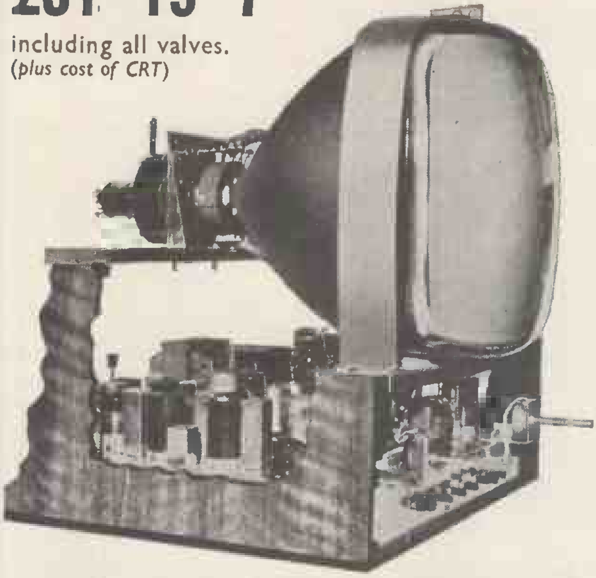

The NEW

PREMIER TELEVISOR

Brief Technical Details are as follows:
20 valves (plus tube) Superhet Receiver, tunable from 40-68 Mc/s without coil or core changing. Wide Angle scanning Flyback EHT giving 14 kV, Duomag Focaliser, permanent magnet focussing with simple picture centring adjustments, suitable for any 17in. or 14in. wide angle Tube, may also be used with a 12in. Tube with very minor modifications.

VISION CIRCUIT Common RF Amplifier single valve frequency changer, two IF stages, Video Detector and Noise Limiter followed by special type of Video Output Valve. ALL COILS PRE-TUNED ASSURING ACCURATE ALIGNMENT AND EXCELLENT BAND-WIDTH.

SOUND CIRCUIT Coupling from anode of frequency changer, two IF stages, Double Diode Triode detector and first LF Amplifier, Diode Noise Limiter and Beam type Output Valve, feeding a 10in. Speaker. ALL COILS PRE-TUNED

TIME BASES 2 valve sync. Separator, giving very firm lock and excellent interlace.

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Instruction book 3/6 Post Free.

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Including ALL parts, Valves, Portable Cabinet, 8in. Loudspeaker, Tape-Table, Reel of 'Scotch Boy' Tape and Rewind Spool, and Microphone. **PRICE £37.4.0** *(Plus 15/- Pkg. Carr. & Ins.)*

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PORTABLE CABINET (rexine covered)	£4 19 6	plus 5/- pkg./carr.
MICROPHONE	£2 19 6	plus 1/- pkg./carr.
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Supplied completely assembled 39 GNS.
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Automatically handling 10 Records 7″, 10″ and 12″, with 3 seconds changeover, providing uninterrupted armchair entertainment for up to 5 hours—that's the Monarch 'Magidisk' performance! Tested and proved reliable by radiogram manufacturers, applauded by gramophone experts, this unique feature is only one of the many attributes for enthusiasts in the Monarch Record Changer. It is the leading automatic electrical high fidelity record reproducer which is giving pleasure to millions all over the world.

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- ★Simple unit control 'ON', 'OFF', 'REJECT' and speed switch.
- ★Fitted anti-acoustic feed back suspension springs.
- ★Compact overall dimensions ideal for radiogram, T.V. console and portable player.
- ★Turntable rim driven by vibration damped induction motor eliminating rumble and 'wow'.
- ★10″ diameter heavy steel recessed turntable with rubber mat.
- ★Beautifully styled smooth, modern lines: faultless finish.

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RADIO, TELEVISION AND ELECTRONICS

44th YEAR OF PUBLICATION

Managing Editor : HUGH S. POCOCK, M.I.E.E.
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JULY 1954

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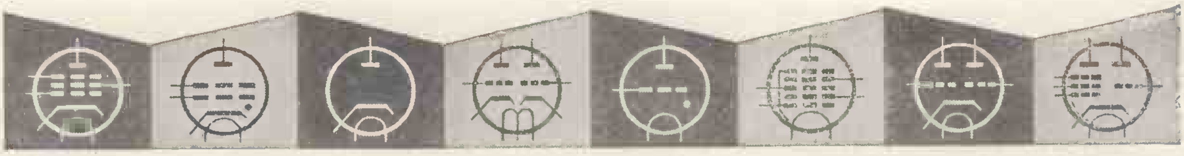


VALVES, TUBES & CIRCUITS

19. ECC85: COMBINED R.F. AMPLIFIER AND MIXER FOR BAND II F.M. RECEPTION

Preliminary Valve Data

HEATER

V_h	6.3	V
I_h	0.435	A

CAPACITANCES

$^*c_{a-g}$	1.5	pF
$^*c_{g-(k+h+s)}$	3.0	pF
$^*c_{a-k}$	0.17	pF
$^*c_{a-(k+h+s)}$	1.2	pF
$^{**}c_{a'-(k'+h+s)}$	1.9	pF
$^{**}c_{a''-(k''+h+s)}$	1.8	pF
$c_{a'-a''}$	<0.04	pF
$^{**}c_{a'-a''}$	<0.008	pF
$c_{a'-k''}$	<0.008	pF
$c_{g'-g''}$	<0.003	pF
$c_{a'-g''}$	<0.008	pF
$c_{a''-g'}$	<0.008	pF
$c_{a''-k'}$	<0.008	pF
$c_{g'-k''}$	<0.003	pF
$c_{g''-k'}$	<0.003	pF

*Each section
**Measured with an external shield

CHARACTERISTICS

V_a	250	V
I_a	10	mA
V_g	−2.3	V
gm	6.0	mA/V
μ	57	

OPERATING CONDITIONS

R.F. Amplifier

V_b	250	V
V_a	230	V
I_a	10	mA
V_g	−2.0	V
gm	6.0	mA/V
r_a	9.0	kΩ

Self-Oscillating Mixer

V_b	250	V
R_a	12	kΩ
R_{g-k}	1.0	MΩ
I_a	5.2	mA
$V_{osc(r.m.s.)}$	3.0	V
gc	2.3	mA/V
r_a	20	kΩ

LIMITING VALUES (each section)

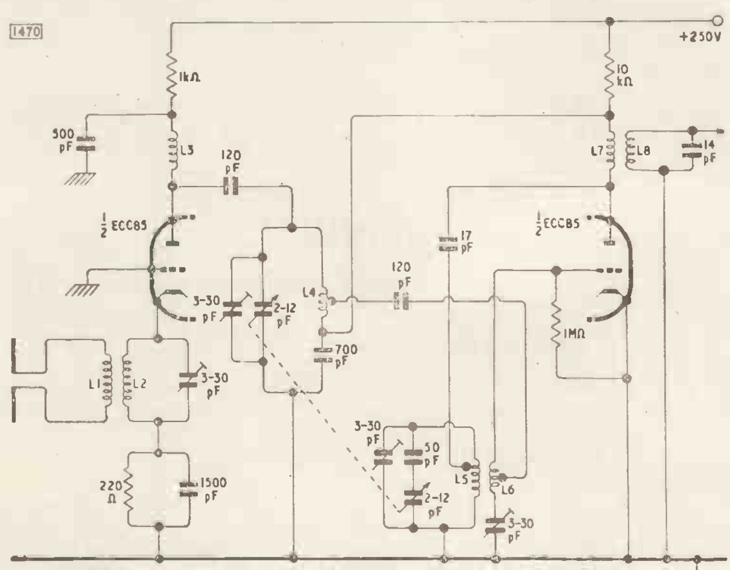
$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.5	W
$p_{a'}+p_{a''}$ max.	4.5	W
I_k max.	15	mA
$-V_g$ max.	100	V
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	90	V
R_{h-k} max.	20	kΩ

BASE B9A

It is essential when designing F.M. receivers for operation at V.H.F. to reduce noise in the input stages and radiation from the local oscillator by including an R.F. amplifier before the frequency changer. A triode is preferred for the R.F. stage because it has better noise properties than a pentode. The Mullard double triode type ECC85 has been specially designed for the 'front-end' stages in F.M. reception. One triode section is used as the low-noise amplifier and the other triode section follows it as a self-oscillating additive mixer. With this arrangement both oscillator radiation and noise are reduced by feeding the signal from the R.F. stage to a null point on the oscillator coil.

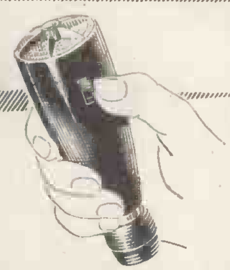
The outstanding feature of the ECC85 is that extensive internal screening has been provided to reduce the capacitance between the anodes to less than 0.04 pF, so that in a suitable circuit the oscillator radiation can be made lower than with any double triode previously available. This capacitance can be reduced to less than 0.008 pF by surrounding the valve with a screening can 22.5 mm in diameter. The front-end stages are thus separated effectively without the cost of using two separate triodes. These measures are completely satisfactory in reducing oscillator radiation to an acceptable value, since only a relatively low oscillator voltage is required to drive the mixer. In addition to having high slope and input resistance, the ECC85 has an amplification factor of 57.

A typical circuit for the ECC85 is given below in which the R.F. section is operated with a grounded grid and the mixer with a grounded cathode. A grounded-grid circuit has the advantage of being more easily adjusted than one which requires special measures to neutralise the anode-to-grid capacitance. Any additional gain which might be obtained from more complex circuits is not necessary, and in fact the input coils L1, L2 can be matched for minimum noise rather than maximum power. The frequency changer input is taken from a tap on the R.F. coil, L4, in order to increase the R.F. gain and also to ensure that the required frequency range is covered by the 2-12 pF tuning capacitor. The oscillator circuit is anode-tuned and is coupled to the anode by a 17 pF capacitor which because it presents a low impedance to an intermediate frequency of, say, 10.7 Mc/s also tunes the I.F. transformer. Internal anode-to-grid capacitance in the mixer triode, which might reduce the amplification, is neutralised by applying an I.F. feedback voltage to the grid.



Another Fine ACOS

CRYSTAL MICROPHONE...



Desk Stand or Hand

MIC 36 SERIES

MODEL Nos.

Microphone without switch and with table stand - **MIC 36-3**
Microphone with switch and table stand - - - **MIC 36-4**
Microphone without switch and with floor stand adaptor **MIC 36-5**
Microphone with switch and floor stand adaptor - - **MIC 36-6**

All models are suitable for hand use.

This new ACOS microphone has all the signs of being a "winner". It is a very handsome instrument—and its performance matches its looks. The die-cast microphone insert has a high sensitivity with a pick-up field that may be considered as omni-directional. Alternative models, with or without switch are available with suitable adaptors for floor or table stands.

SPECIFICATION

Output level: — 55 db. ref. 1 volt/dyne/cm^2.
Nominal capacity: ·002mfd.
Omni-directional frequency response: Substantially flat from 30–7,000 c/s.
Recommended load resistance: Not less than 1 megohm dependent on the low frequency response required.

always well ahead

Retail Price in Gt. Britain	
Models without switch - -	**£3 - 3**
Models with switch - -	**£3 - 8**

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

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"BELLING-LEE" NOTES

Band III Television Aerials

There is no problem in producing Band III aerials as such. With our associates overseas we have in fact made comparable aerials in considerable numbers. We were the first to show a production model at the Radio Show two years ago, incidentally the first Band III aerial to be shown at any British Radio Exhibition.

Before we feel that we can offer Band III aerials for sale, we must have certain confirmed details of the transmitters (1) siting (2) polarisation (3) power and (4) mast height.

Our development policy is quite clear: we have in fact made every type of aerial that will be required, but it would be wrong of us to guess what type of aerial to sell for use in any particular locality.

As the acknowledged leaders in technical development, our services are more and more called upon by the highest possible authorities in the country. We can assure everyone that we will make Band III aerials available in sufficient quantities and in plenty of time to meet requirements.

It would be very easy to sell Band III aerials for use in say, London, Birmingham and Manchester but we would be unable to give any assurance that we were selling the correct type.

COAXIAL OUTLET SOCKETS
for TV installations

L 735 OUTLET SOCKET BOX A new, improved single outlet box in an attractive bronze finish for neat termination at the skirting board. Accommodates $\frac{5}{16}$ in. dia. feeder. Designed for use with the range of plugs L734/P, L781, etc., and also the "Belling-Lee" line attenuator.

L 763 DOUBLE OUTLET SOCKET BOX Has two standard outlet sockets and a "star" matching network which provides the coupling. When two receivers are connected, the input to each is 6 dB down on the input to box. For demonstration rooms, workshops and laboratories, etc., or where neighbours wish to share an aerial installation.

L 742 6-WAY DISTRIBUTION SOCKET BOX For use in demonstration rooms, workshops, etc., where up to six television receivers are required to operate at the same time without interaction. As the insertion loss at each outlet is considerable (25 dB), it should only be used where a high signal level is available.

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

Designed for a purpose

In the March issue of the "Wireless World," we told readers of the varying results that were obtainable from aerials fairly close to each other. We showed how it was that a lower gain aerial could provide better results than a more sensitive aerial, due to standing waves. The result of these effects sometimes gave users the impression that there were better aerials than those manufactured by "Belling-Lee," but on investigation, almost invariably the alleged improvement was due, either to the faulty erection or to the bad siting of our product. Quite recently a most interesting case of this type came to our notice. We heard of a 3-element array with a folded dipole giving better results than a "Belling-Lee" "Junior Multirod." Now we knew this could not be, so we set out to investigate the matter. The situation was a bad one, on the wrong side of a hill and the results were very poor. The first thing we looked at was the connection to the matching transformer. The entire transformer had been removed and nobody would accept the responsibility for the missing part. When a transformer was connected as laid down in the instructions, up came the signal, very much better both on sound and vision than the other array. Admittedly the picture had a lot of grain, as the situation was a very bad one and the available signal was weak, but no better signal could be found with any other aerial.

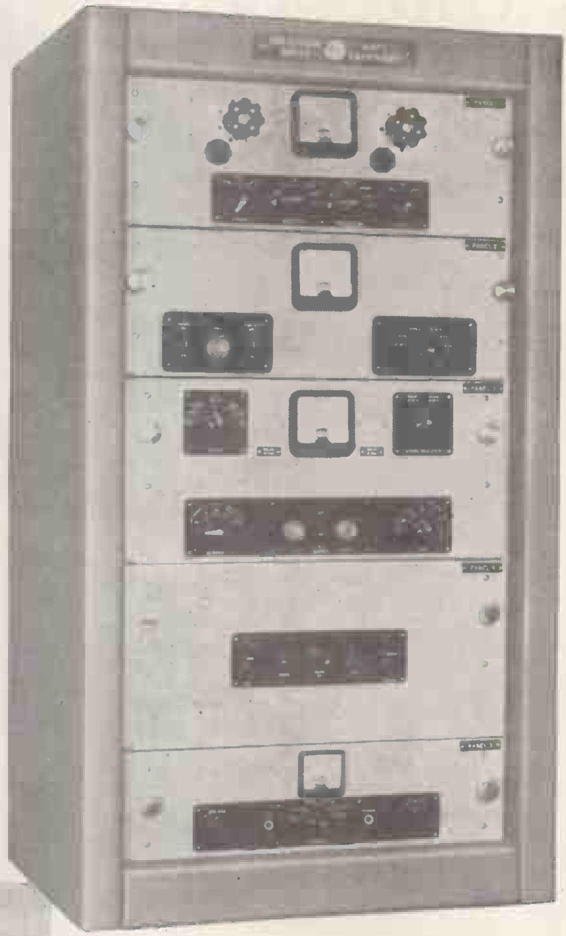
We have mentioned the question of the matching unit before. If only people would read instructions; we can just see a not very technical rigger looking at a stub transformer, wondering what it is, and removing it. The only time you remove the built-in matching stub is when the aerial is being used with a mast head pre-amplifier. But we repeat, do read the instructions, if only to make sure that there has not been some modification since the last one you saw or used.

Advertisement of
BELLING & LEE LTD.
Great Cambridge Rd., Enfield, Middx.
Written 24th May, 1954.

Frequency-Shift Diplex Drive and Keying Equipment

TYPE HD 61

Diplex or twin-channel Frequency-Shift Keying is a development of the single-channel FSK system which has proved its advantages in recent years. Diplex FSK enables two simultaneous frequency-shift telegraph channels to be operated on a single CW transmission. The Type HD 61 equipment illustrated is designed for keying most class C transmitters, including the Marconi S.W.B. series, by the diplex frequency-shift system. It also provides single-channel FSK for telegraphy and on-off keying of CW. Any one of six pre-set crystal controlled frequencies may be instantaneously selected.



The equipment comprises five units (mixer, crystal, keyer, power supply and monitor). Units may be readily removed for replacement or servicing.

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MODERN TELEVISION TECHNIQUE

FRINGE AREA RECEPTION

Before setting out to design a receiver for Fringe Areas, a number of tests were made to determine the requirements. The first showed that increased gain, whilst essential, was not in itself enough and that a reduction in the bandwidth was detrimental.

Under these severe conditions the noise grain produced by a high gain wide band vision receiver consists of a very fine dot structure which disappears when viewed at the correct distance, i.e. when the lines are not noticeable. The narrow band receiver on the other hand produces a much coarser grain, and this is far more visible and objectionable.

The limit of gain is set at some point where the amplified signal is considerably less than the aggregate of noise due to cosmic radiation, man-made static and receiver noise. A picture under these conditions has but two tones, grey, and noise modulated by whiter than grey signals. Its entertainment value over long periods may be doubtful, but it is still possible to derive information from it and many viewers in remote areas are prepared to accept pictures of this standard pending increased coverage by the B.B.C. The experiments showed that careful attention to the aerial, feeders, input valve and mixer circuits enable signals as low as two or three micro-volts on Band 1 to be considered in this category and displayed in a worthwhile form.

Also present with noise of low amplitude is a snowstorm of man-made and natural static impulses, capable of overloading the cathode ray tube. It is, therefore, essential not only to limit these impulses but to reduce their intensity so that they merge with the grey tone. The "His Master's Voice" impulse inverter circuit behaves admirably under these conditions discriminating easily between the low amplitude wanted signals and the high amplitude noise.

Experiments conducted by "His Master's Voice" have shown that the entertainment value from a noisy signal is greatly enhanced when viewed on a receiver controlled by clean synchronizing pulses, and that by averaging the synch. information over a period of at least ten frames, ragging or wobble of the picture is eliminated.

To obtain full value from a noisy signal entails the use of synchronizing circuits fundamentally improved in design over conventional ones. Such a circuit requires to be of extremely high stability yet sensitive to control so that, providing an occasional burst of synchronizing information is received within the ten frame period, an unbroken picture is maintained.

A schematic diagram showing a flywheel scanning arrangement which meets this requirement is shown in figure 1. Circuits, which do not employ highly stable oscillators, and hence which have to average the synch. information over a much shorter period give markedly inferior performance and were therefore discarded by "His Master's Voice" engineers, when designing Model 1828.

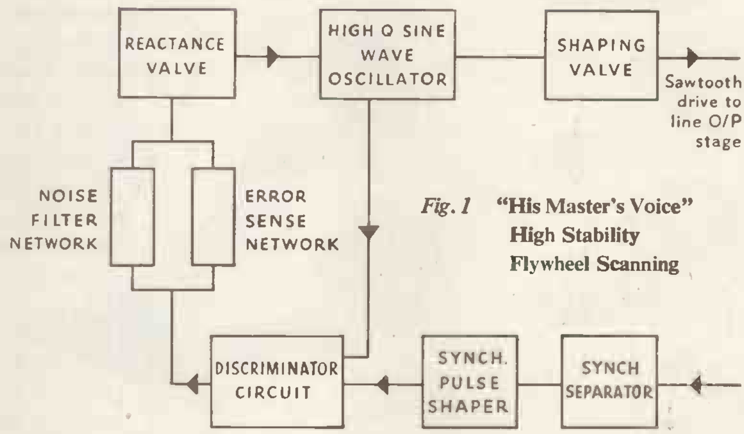


Fig. 1 **"His Master's Voice" High Stability Flywheel Scanning**

Experience in the field has shown that in areas where the mean signal level is less than 25 micro-volts the slow fades that occur, say, between daylight and darkness, can vary the signal down to below 5 micro-volts and above 50.

In addition, certain weather conditions, and cloud reflections produce signal cancellation and signal addition resulting in variations from one to a hundred micro-volts. Furthermore, the sound and vision signals do not vary in sympathy. It is, therefore, essential that a fringe model should be equipped with two highly efficient AGC systems operating independently on sound and vision, capable of maintaining the output appreciably constant with variations of input ranging from five micro-volts to at least 200. AGC systems which are designed ostensibly to deal with aircraft flutter and which begin to operate only at twenty-five to fifty micro-volts are obviously useless for fringe area reception. Furthermore, the AGC circuit must not be dependent on the line output circuit, since transmission phase shifts and variable delays produce objectionable gain fluctuation.

The specification of the "His Master's Voice" Fringe Area Model 1828 (given in brief below) incorporates all the essential and desirable fringe features outlined above.

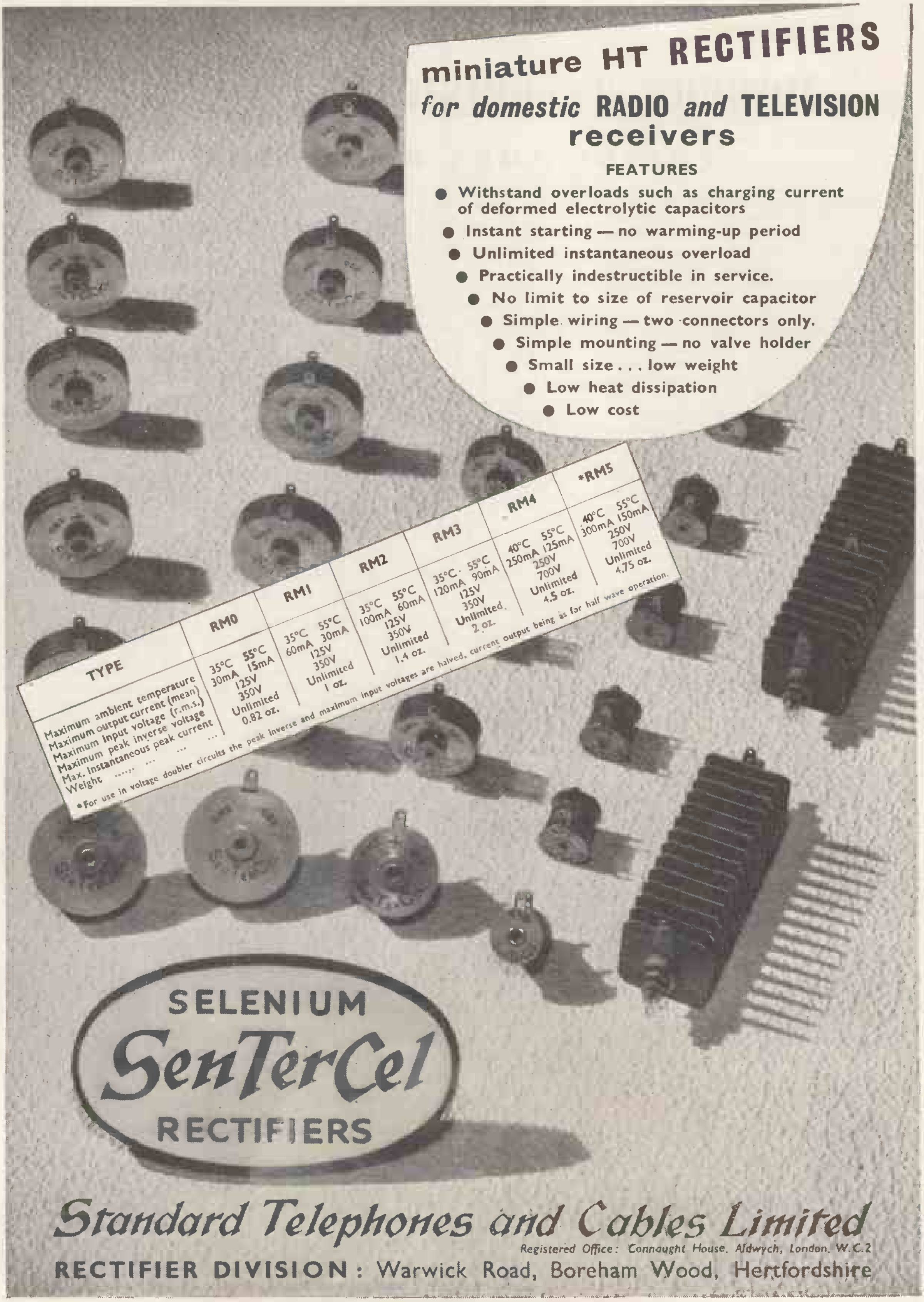
SPECIFICATION

Vision Sensitivity for full modulation 5 micro-volts
Sound Sensitivity 1 micro-volt.
I.F. Bandwidth 3 Mc/s.
Impulsive Interference Inverter.
Long Time constant flywheel scanning.
AGC on sound.
AGC on vision.

"HIS MASTER'S VOICE"

"HIS MASTER'S VOICE"

THE GRAMOPHONE COMPANY LIMITED · HAYES · MIDDLESEX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for domestic RADIO and TELEVISION receivers
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● Practically indestructible in service.
● No limit to size of reservoir capacitor
● Simple wiring — two connectors only.
● Simple mounting — no valve holder
● Small size . . . low weight
● Low heat dissipation
● Low cost

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

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

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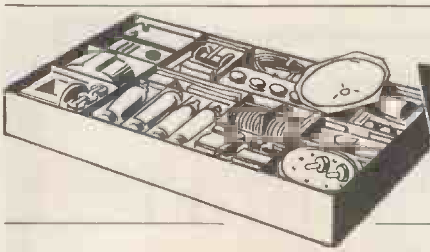
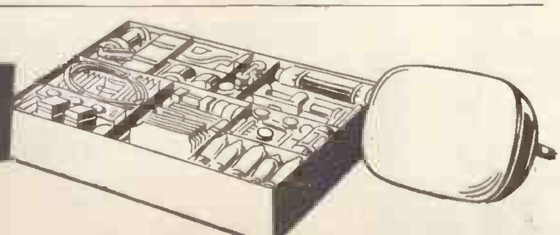


2

RADIO Outfit No. 2.—With this equipment, you are instructed in the design construction, testing and servicing of a complete modern Superhet Radio Receiver.

TELEVISION Outfit No. 3.—With this equipment you are instructed in the design, construction, servicing and testing of a modern high-quality Television Receiver.

3



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TL/10 AMPLIFIER & "POINT ONE" PRE-AMPLIFIER

27 GNS COMPLETE

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TL/10 POWER AMPLIFIER

This 10 watt amplifier maintains, in every respect, the world-renowned Leak reputation for precision engineering, fine appearance and fastidious wiring.

SPECIFICATION

Circuitry
A triple loop feedback circuit based on the famous TL/12. The output transformer is the same size as in the TL/12.

Maximum power output: 10 watts.

Frequency Response: ± 1 db 20 c/s to 20,000 c/s.

Harmonic Distortion: 0.1%, 1,000 c/s, 7.5 watts output.

Feedback Magnitude: 26 db, main loop.

Damping Factor: 25.

Hum: —80 db referred to 10 watts.

Loudspeaker Impedances: 16 ohms, 8 ohms, and 4 ohms.

"POINT ONE" PRE-AMPLIFIER

The handsome gold escutcheon plate contributes to the elegant appearance, and blends with all woods.

★ **Pickup**
The pre-amplifier will operate from any pickup generally available in the world. A continuously variable input attenuator at the rear of the pre-amplifier permits the instantaneous use of crystal, moving-iron and moving-coil pickups.

★ **Radio**
The radio input sockets at the rear permit the connection of the LEAK V.S. tuner unit. An input attenuator is fitted. H.T. and filament supplies are available from the pre-amplifier.

★ **Distortion**
Of the order of 0.1%

★ **Hum**
Negligible, due to the use of recently developed valves and special techniques.

★ **Input selector**
Radio, tape, records; any and all records can be accurately equalised.

★ **Treble**
Continuously variable, + 9 db to − 15 db at 10,000 c/s.

★ **Bass**
Continuously variable, + 12 db to − 13 db at 40 c/s.

★ **Volume Control and switch**
The switch controls the power supply to the TL/10 power amplifier

★ **Tape Recording Jacks**
An exclusive feature. Readily accessible jacks are provided on the front panel for instantaneous use with Tape Recorders which have built-in (low level) amplifiers.

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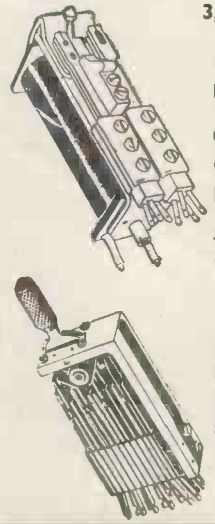

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Designed originally for use in Hearing Aids, Amplivox miniature e.m. microphones are now doing a full size job in industry and commerce. Possessing a frequency characteristic virtually level from 0.4 to above 4.5 Kc/s, speech quality is excellent. These robust and inexpensive microphone inserts have found wide acceptance for speech recording, mobile VHF, and aircraft communication systems.

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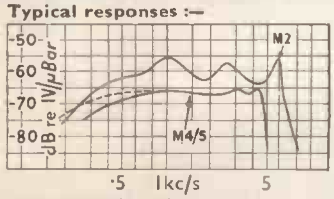

SPECIFICATIONS

MODEL M.2: 0.4 to 6.5 Kc/s: dia. 0.84" × 0.520" deep. Weight ¼-oz. Sensitivity -55 dB re: 1V dyne/cm². (Std. Z = 5,000 ohms)

MODEL M.4/5: Illustrated: 0.4 to 5 Kc/s: weight ⅜-oz. M5 similar to M4 with polythene membrane for close-speaking applications. (Std. Z = 600 ohms)

Enquiries invited. *Prices on application*

AMPLIVOX LTD.

2, Bentinck Street,
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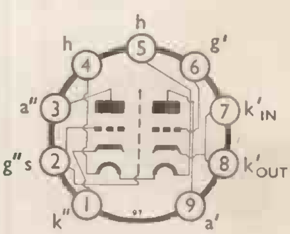
B319 **Cascode R.F. amplifier**

LZ319 **Triode pentode frequency changer**

Introduced to meet the special 'front end' requirements of V.H.F. television receivers, these new OSRAM valves enable a high performance to be obtained at these frequencies with simple and inexpensive circuitry.



B319 Double triode designed for use as a series cascode R.F. amplifier with the accompanying advantages of high gain and good signal to noise ratio. The high slope at low anode voltage ensures efficient operation at H.T. supplies of 180V. The maximum heater-cathode has been increased to 250V to meet the special requirements of this application.

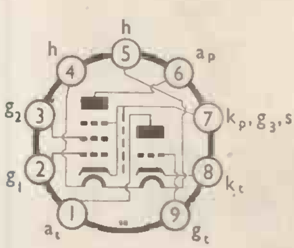
Heater

I_h	0.3A
V_h	7.0V

Characteristics (per system)

V_a	90V
V_g	—1.5V
I_a	12 mA
μ	24
r_a	4 kΩ
g_m	6 mA/V

Base B9A



LZ319 Triode pentode designed for use as a frequency changer following the B319 cascode amplifier. The LZ319 operates efficiently at H.T. voltage of 170-180, and gives a high conversion gain with standard circuitry.

Heater

I_h	0.3A
V_h	9.0V

Characteristics

	pentode system	triode system	
V_a	170	100	V
V_{g2}	170		V
V_{g1}	—2	—2	V
I_a	10	14	mA
μ_{g1-g2}	50		
μ		20	
r_a	400	4	kΩ
g_m	6	5	mA/V

Base B9A

Write to the Osram Valve & Electronics Dept. for further information

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Here are some typical "standard" full-wave types

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Output 12/15 Volts D.C. 1 Ampere.	List Price	9/-
Output 12/15 Volts D.C. 2.5 Ampere.	,,	13/6
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- **Heavy duty rectifiers with say 230/250 volts A.C. input and 220 volts D.C. output a speciality.**
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This 10-watt amplifier maintains, in every respect, the world-renowned LEAK reputation for precision engineering, fine appearance, and fastidious wiring. The Pre-amplifier will operate from any well known pick-up, whether crystal, moving iron or moving coil. Provision is made for Tape Recorder and Playback and as an exclusive feature, readily accessible jacks are provided on the front panel for instantaneous use.
See *maker's advertisement—Page 87 for full technical specification.*

The total Cash Price for these Two Units is £28.7.0 and our EASY TERMS are £3 Deposit with order and 8 monthly instalments of 70/- carriage paid (crate returnable).

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BALCOMBE Telephone: Balcombe 254 **SUSSEX**

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Model P44
Lightweight 12″ Loudspeaker

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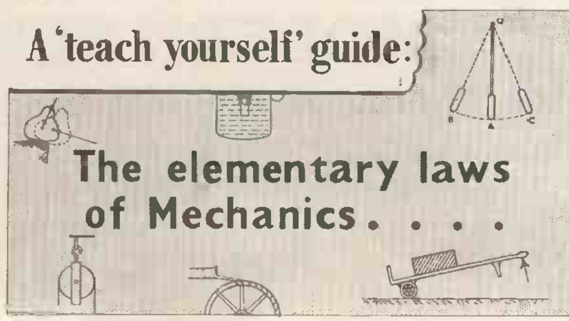

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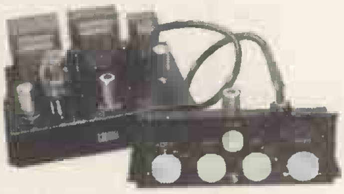

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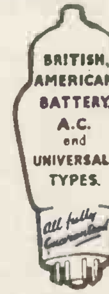

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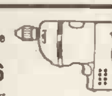

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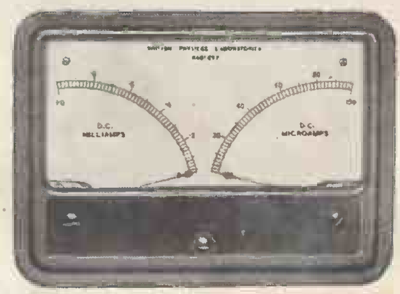

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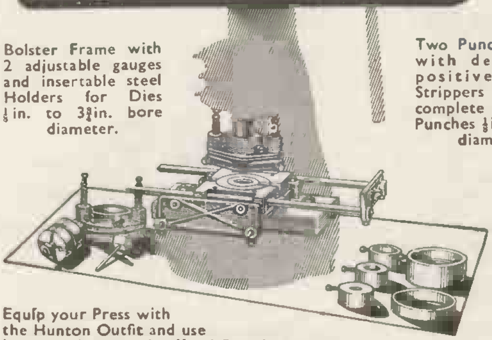

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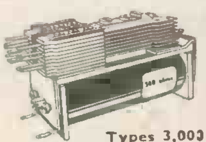

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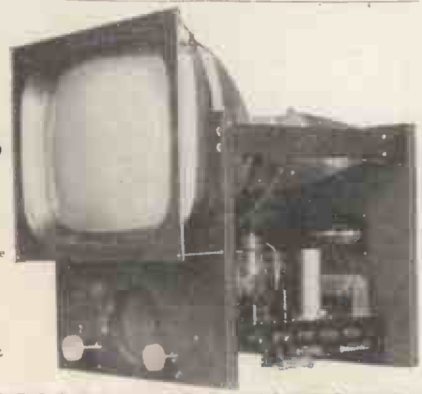

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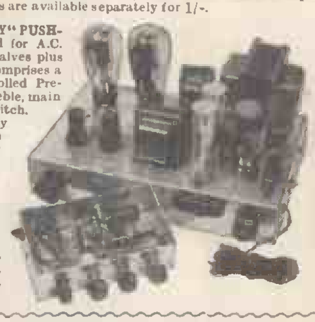
A 4-VALVE QUALITY "PUSH-PULL" 6-8 watt AMPLIFIER for A.C. mains. Incorporating Negative Feedback. Filter Input Circuit and employing 6V6s in Push-Pull. A simple arrangement is provided to enable either a magnetic, crystal or lightweight pick-up to be used, and is suitable for use with Standard or long-playing records. A tone control is incorporated, and the 10-watt output transformer is designed to match 2 to 15 ohm speakers. The overall size of the assembled chassis is 10in. × 8in. × 7¼in. high, and full practical diagrams are supplied. Price, including drilled chassis and valves, of complete kit, **£6/17/6**. Price of assembled chassis, supplied ready for use, **£8/12/6**. Plus 5/- Carr. & Ins. Full descriptive leaflets are available separately for 1/-.



A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts employs 6 valves plus rectifier with negative feedback, and comprises a main amplifier chassis and a remote controlled Pre-amplifier and Tone Control Unit, incorporating four controls—bass, treble, main volume or mixing control, and a radio, gram, microphone, selector switch. This control unit measures only 7 × 4 × 2in. The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV. 6.3 volts at 2 amps and 30 mA. H.T. is provided for tuning unit, etc. Price of complete kit, including drilled chassis and valves, **£14**. Complete specification and layout, **2/-**. We can also supply completely assembled and ready for use at **£17**. H.P. Terms (Assembled Chassis Only). **£5/13/3** Deposit and 12 months of **£1/1/4**. Plus 7/6 Carr. and Ins. **THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THEIR COST.**

VARLEY HEATER TRANSFORMER
Input 200-250 volts Output 4 volts (tapped at 2 volts) 5 amps. **14/9** (1/- post.)

FILAMENT TRANSFORMER
6.3 v. 1½ a. 5/9
4 v. 1½ a. 5/9

SPECIAL OFFER
NEW C.R.T.s.
Unused 12in. C.R.T.s by one of the leading manufacturers. 6.3 volt heater, 7-9 kV. standard size. Supplied in maker's sealed cartons. (Plus 15/- Carr. & Ins.) **£12/19/6**

BRAND NEW C.R.T. MASKS
Latest aspect ratio for 12in. "Round" tubes, finished Ivory. (Plus 1/- postage.) **12/6**

HALF WAVE MAINS TRANSFORMERS
Primary 200/220, 220/240 volts
Secondary 250 volts 50 mA.
6.3 volts 1½ amps.
(Plus 1/- postage.) **16/9**

SPEAKER BARGAINS

	£	s.	d.
PLESSEY, 10in. 3 ohm V/coil	£1	5	0
TRUVOX, 12in. 3 ohm V/coil	£2	9	6
ROLA, 12in. 3 ohm V/coil	£3	19	6
BAKERS, 12in. 15 ohm V/coil	£4	15	6
GOODMANS, 12in. 15 ohm V/coil	£5	5	0

(Carriage & Ins. 1/6 extra.)

THE NEW W. B. "STENTORIAN" HI FI SPEAKERS ARE IN STOCK

	£	s.	d.
Model H.F. 6-inch	£2	10	6
Model H.F. 9-inch	£3	7	0
Model H.F. 8-inch	£3	0	6
Model H.F. 10-inch	£3	13	6

These speakers are of the very latest design and provide quality reproduction for the lower-price range. 3 or 15 ohm models are available.

RECEIVER CHASSIS

Modernise your old Radiogram

RECORD PLAYERS

COMPLETE RADIOGRAM EQUIPMENT—QUALITY AT LOW COST

THREE COMPLETELY ASSEMBLED ALL-WAVE SUPERHET CHASSIS

- Model B.3 A 5-valve 3-waveband Receiver.
- Model B.3.P.P. A 6-valve 3-waveband Receiver with PUSH-PULL OUTPUT.
- Model B.3.P.P./R.F. A 7-valve 3-waveband Receiver incorporating an R.F. stage with PUSH-PULL OUTPUT.

The three Receivers are for operation on A.C. mains 100/110 volts and 200/250 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent clarity of speech and music on both gram. and radio, making them the ideal replacement chassis for that "old Radiogram," etc.

Brief specifications: Model B.3.—Valve line-up, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage short 16-50, medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel type); (3) wavechange and gram.; (4) tone (3-position switch operative on gram. and radio). Negative feedback is employed over the entire audio stages. Chassis size: 11 × 7¾ × 8½in. high. Dial size 8¾ × 4½in. Price complete and READY FOR USE, excluding speaker, £12/12/- (carr. and ins. 7/6 extra).

H.P. Terms: £4/4/- deposit. 12 months at 15/9.

Model B.3.P.P. This model is the B.3 Receiver but incorporates two 6BW6 VALVES in PUSH-PULL, resulting in really excellent quality reproduction up to approximately 6 watts. Price £15/15/- (plus 7/6 carr. and ins.) or £5/5/- deposit, 12 months at 19/8.

Model B.3. P.P./R.F. This model is similar in appearance and has same waveband coverage as the Model B.3, but in addition it incorporates an R.F. STAGE together with PUSH-PULL OUTPUT, employing a total of 7 valves with two type 6BW6 in Push-Pull. This makes for a really sensitive receiver with genuine quality reproduction. Price £18/18/- (plus 7/6 carr. and ins.) or £6/6/- deposit, 12 months at 23/7.

A NEW DESIGN FOR HOME CONSTRUCTORS

The STERNS "SUPER SIX"

A compact and highly efficient Superhet Radio-Radiogram Chassis of outstanding quality, far above any other design yet offered to the HOME CONSTRUCTOR. YOU can build it for

£10/7/6 It is designed to the very latest specification, great attention having been paid to the quality of reproduction which gives excellent clarity of speech and music on both radio reception and record playing. A few brief details:—

- Covers 3 Wavebands 18-50 metres, 190-550, 800-2,000 metres.
- Employs 6 Valves having PUSH-PULL for 5-6 watts OUTPUT.
- DELAYED A.V.C. on all WAVEBANDS.
- PRE-SELECTIVE FEEDBACK.
- 4 POSITION TONE CONTROL.
- REAL QUALITY ON BOTH RADIO AND GRAM.
- PROVIDES INDEPENDENT MAINS SUPPLY FOR RECORD PLAYER (if required).
- FOR A.C. MAINS SUPPLY 200-250 Volts, 50 Cycles.
- Size of assembled CHASSIS 12in. long × 8in. × 8in. Dial Aperture 8½in. × 4½in.

THE ASSEMBLY MANUAL IS AVAILABLE FOR 2/-. This gives very detailed practical drawings and layouts and includes a component price list.

THE COMPLETE RECEIVER CAN BE BUILT FOR £10/7/6 with the OCTAL VALVE LINE UP or for £12/7/6 with Miniature Valves.

A Replacement RADIO-RADIOGRAM CHASSIS

- MODEL AW3-5. A 5-Valve Superhet Receiver covering the standard 3 wavebands. 16-50. 190-550. 900-2,000 metres.

PRICE COMPLETELY ASSEMBLED AND READY FOR USE (plus 7/6 carr. and ins.). **£10'10'-**

H.P. Terms £3/10/- Deposit and 10 Months at 15/9.

This receiver is for operation on A.C. Mains 200-250 volts. It contains the latest MULLARD VALVE LINE UP, being ECH42 (Freq. Ch.), EF41 (I.F.), EBC41 (Det. 1st Audio), EL41 (Output) and EZ41 (Rect.). It incorporates Negative Feedback and delayed A.V.C., the four controls being (1) Tuning, (2) Wavechange and Gram. Switch, (3) TONE, (4) VOLUME-OFF. It provides really good reproduction on both Gram. and Radio and gives an exceptionally good range of station selection. Overall size 13½in. × 7in. high × 6in. deep. Dial aperture 10in. × 4½in.

This AUTOCHANGE UNIT by a famous Manufacturer is offered for £10'10'0 (Plus 7/6 Carr. and Ins.)

Hire Purchase Terms £3/10/0 Dep. and 10 Months at 15/9.

(Normal price is £16/10/-.)

- These units will autochange on all three speeds, 7in., 10in. and 12in.
- They play MIXED 7in., 10in. and 12in. records.
- They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- Minimum baseboard size required 14in. × 12½in., with height above 5½in. and height below baseboard 2½in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

The COLLARO 3RC/521 3-SPEED AUTO CHANGE UNIT

£9'19'6 (Plus 7/6 Carr. and Ins.) H.P. Terms £3/6/0 Deposit and 10 months at 15/-.

Normal price £18/10/-.

- Complete with High Fidelity Crystal "Turnover" Head which incorporates separate stylus for L.P. and 78 r.p.m. Records.
- Will autochange on 7in., 10in. and 12in. records not intermixed.
- Minimum Base plate size 15in. × 12½in., with height above 4¾in. and below baseplate 3in.
- Brand new in Maker's Cartons, complete with Mounting Instructions.

SPECIAL REDUCTIONS FOR COMPLETE EQUIPMENT

SUMMARY

Select a RECORD PLAYER and CHASSIS, and we will supply it TOGETHER WITH AN 8inch or 10inch P.M. SPEAKER as follows:

THE £10/10/- AUTOCHANGER WITH A SPEAKER AND :—	CASH PRICE	DEPOSIT	MONTHLY
(a) With Model B.3 Chassis	£23/15/-	£7/18/4	12 of £1/9/8
(b) ,, ,, B3PP ,,	£27	£9	12 of £1/13/9
(c) ,, ,, B3PP/RF ,,	£30/2/-	£10/2/-	12 of £1/17/6
(d) ,, ,, Super Six ,, (Assembled chassis only)	£27	£9	12 of £1/13/9
(e) ,, ,, AW3-5 ,,	£21/15/-	£7/5/-	12 of £1/7/2
THE COLLARO AUTOCHANGER MODEL 3RC/521 WITH A SPEAKER AND :—			
(a) with Model B3 chassis	£23/6/-	£7/15/6	12 of £1/9/2
(b) ,, ,, B3PP ,,	£26/9/-	£8/16/6	12 of £1/13/1
(c) ,, ,, B3PP/RF ,,	£29/12/-	£9/17/-	12 of £1/17/0
(d) ,, ,, Super Six ,, (Assembled chassis only.)	£26/9/-	£8/16/6	12 of £1/13/1
(e) ,, ,, AW3-5 ,,	£21/4/-	£7/1/4	12 of £1/6/6
THE COLLARO 3-SPEED UNIT MODEL 3/514 WITH A SPEAKER AND :—			
(a) With Model B3 chassis	£21/6/-	£7/3/4	12 of £1/6/6
(b) ,, ,, B3PP ,,	£24/9/-	£8/3/6	12 of £1/10/1
(c) ,, ,, B3PP/RF ,,	£27/12/-	£9/4/-	12 of £1/14/6
(d) ,, ,, Super Six ,, (Assembled chassis only.)	£24/9/-	£8/3/6	12 of £1/10/1
(e) ,, ,, AW3-5 ,,	£19/4/-	£6/8/-	12 of £1/4/0

An Additional Charge of 10/- is made in each case to cover Carriage and Insurance.

The COLLARO MODEL 3/514 3-Speed Non-Auto Change Unit

£7'19'6 (Plus 6/- Carr. and Insur.) Normal Price £12/17/6

- Complete with High Fidelity Crystal "TURNOVER" Head which incorporates a separate stylus for L.P. and Standard Records.
- Will play 7 inch, 10 inch and 12 inch Records.
- Brand New and Complete with mounting instructions.

When submitting orders please include post and packing

STERN RADIO Ltd.

109 & 115, FLEET STREET, E.C.4

Tel.: CENTRAL 5812-3-4

ALPHA CATALOGUE

Send 6d. in stamps for our NEW CATALOGUE Hot from the Press with Hundreds of Bargains for you

Special Purpose VALVES

CV509 ..	7/6	VU111....	3/6
VR54	2/6	9001......	6/3
7Q7	8/6	VU39	8/6
VS68	4/-	VR65A ..	3/6
6G6G	6/6	956	3/6
9004	6/3	9003......	6/9
VR136 ..	7/-	2X2	5/6
VR66	3/9	VR65	3/9
VU120A..	3/6	6SS7	8/-
9002	6/3	1A5GT ..	7/6
VR53	7/6	220VSG ..	6/9
VR91	6/-	931A	6/9
807	8/-	2A7	6/-
5Z3	8/6	6A3	6/9
955	4/-	7475......	4/9
TT11	6/6	19..........	6/-
VR116 ..	4/-	26..........	6/-
VR56	7/-	27..........	6/-
954	2/-	30..........	6/-
CV71	1/-	36..........	6/-
VR137 ..	5/-	84..........	6/-
VR55	7/3	6L5	6/-
6SA7	9/-	2A5	6/-
ATP4	6/9	CV287 ..	6/-

HEADPHONES
Type CLR Low resistance 120Ω, **7/6** pair.
Type CHR High resistance 4,000Ω, **11/-** pair.
Type DHR, a super job, **13/9** pair.
Headbands, wide type, **1/9** ea.
Headphones, by Trimm Radio Mfg. Co., Chicago, U.S.A., 1,200Ω each earpiece light headband complete with lead and Igranic jack plug, **13/6** pair.

MAINS TRANSFORMERS
3-way Mounting Type.
MT1. Primary 0-210-230-250 v. Secondary, 250-0-250 v. 80 mA. 6.3 v. 4 amps., 5 v. 2 amps., with taps at 4 v. on filament windings. Price **17/6** each.
MT2. Primary 0-210-230-250 v. Secondary 350-0-350 v. 80 mA., 6.3 v. 4 amps., 5 v. 2 amps. Both filament windings tapped 4 v. Price **17/6** each.
MT3. 30 volt 2 amp. tappings at follows: 3, 4, 5, 6, 8, 9, 10, 12, 15, 18 20, 24 v. **17/6** each.

LOUDSPEAKER UNITS
3in. Plessey Round type for portables, **12/9** each.
Elac, 3½in. Square type speaker, 2 to 3Ω, **13/6** ea.
Plessey 5in. unit, **13/6** ea.
Elac 4in. unit with 5in. fitting, **13/6** ea.
Elac 6½in. unit, **14/6** ea.
Lectrona and R. & A., 8in. units, **16/6** ea.
10in. Plessey lightweight, **19/6** ea.
10in. Elac, **22/6**.
10in. Goodmans, **29/6**.
8in. Lectrona, with output transformer, **20/-**.
Truvox BX11, 12in. unit, **49/6**.
Truvox wafer speaker, 6½in., **20/-**.
Plessey 8in. mains energised, 1,500Ω field, **21/-**.
6½in. unit with 1,500Ω field, **17/6**.
5in. Goodmans PM unit, **14/9**.

PORTABLE RECORDING OR PROJECTOR CASES.
Rexine covered. (Ready for carrying 15in. × 9½in. × 13in.). Internal dimensions, 14in. long, 11½in. deep, 5½in. front height, 8½in. rear height. Weight 8½lb. Price **13/6** each. Postage and Packing 2/-.

SPECIAL OFFER
CO-AXIAL CABLE
Best quality grade "A" cable solid 1/022 70 ohms, **7½d.** yd.
Best quality Grade "A" cable stranded 7/0076, **8½d.** yd.
Best quality Grade "A" cable air spaced 1/036, **1/-** yd.

SOLDERING IRONS
Solon type 964, fitted Oval Bit .... **19/11** ea.
Solon type 968, fitted Pencil Bit............ **19/11** ea.
Both types are complete with approx. 6ft. of Henley 3-core cable and are suitable for 230/250 v.

HAND MICROPHONE by "REGENT," complete with screened lead and plug—Crystal insert, nickel chrome plated head, listed at 2 gns. Our price, **21/-** each.

TYPE 6 INDICATOR UNITS
These units recommended as a basis for the Simplex TV receiver are brand new and contain the VCR97 tube. EF50, EB34, Valves, Volume Controls, resistors, condensers, suitable tag panels, etc., etc. Cut your construction costs at this special price, **69/6** plus 5/6 carriage.

ENGRAVED KNOBS.
Control Knobs clearly engraved in gold.
Size "A" diameter 1¼in.; Size "B" diameter 1½in. Both in two colours, Walnut or Cream. Inscriptions available:
RADIO: "Volume," "Vol./On/Off," "Wavechange," "On/Off," "Tuning," "SML Gram," "Radiogram," "Tone."
TELEVISION: "Contrast," "Brilliance," "Brilliance On/Off," "Focus," "Brightness."
AMPLIFIER: "Treble," "Bass" (Plus any above).
TAPE RECORDER: Record/Play.
Prices: Size "A," **1/6**; "B," **1/2**. Plain knobs can be supplied in either size, **1/-** each and **8d.** each respectively.

SOLDERING PASTE
Large tin soldering paste by Tyne Chemical Co. Approx. 1 lb., **1/0** per tin.

CONDENSERS
The following is a selection from our stocks of manufacturers' surplus condensers, all by well-known makers.
Aluminium Can types, Clip fixing

8×8 mfd. 450 v.	4/-
8×16 mfd. 450 v.	4/-
8×24 mfd. 350 v.	3/-
8×32 mfd. 475 v.	3/9
12×4 mfd. 450 v.	2/-
16 mfd. 450 v.	3/-
16×8 mfd. 350 v.	4/-
16×16 mfd. 350 v.	3/3
20×20 mfd. 500 v.	4/9
24 mfd. 450 v.	2/9
25×16 mfd. 350 v.	3/6
32×8 mfd. 250 v.	3/6
32×16 mfd. 350 v.	4/6
32×32 mfd. 450 v.	6/11
32×32×8 mA. 350 v.	5/6
32×32 mfd. 350 v. 25 mA. 25 v.	5/9
64 mfd. 350 v.	2/-

YAXLEY SWITCHES

1 bank switching 2 p. 2 w. and 2 p. 1 w. and a Mains On/Off Switch	1/6 ea.
2 bank 4 pole 3 way	1/6 ea.
2 bank switching 3 p. 2 w. and 1 p. 3 w.	1/6 ea.
1 bank 2 pole 5 way	1/6 ea.
1 bank 4 pole 1 way	1/6 ea.
1 bank 3 pole 4 way	1/6 ea.
2 bank 2 pole 7 way	1/6 ea.
1 pole Changeover	1/- ea.
2 pole Changeover	1/3 ea.
1 pole 4 way	1/6 ea.
1 pole 7 way	1/6 ea.
1 pole 8 way	1/9 ea.
3 pole 3 bank 3 way	1/6 ea.
4 pole 3 way (long spindle new type)	2/6 ea.
4 pole 2 way	1/9 ea.

"RECTAFORMA" BATTERY CHARGER
Size 10in. × 5in. × 7in., in grey crackle case with a switch for switching to either 6 v. or 12 v. at half or full charge. Two fuses are also incorporated, a 1 amp. fuse for mains and a 5-amp. fuse for L.T. and are accessible from outside, a mounted ammeter is also affixed, to show rate of charge. Price **£4/4/-**.

"CLEM" TRAVELLING IRON WITH ASBESTOS STAND
Size 4in. × 2in. × 2½in. including handle, complete with lead and switch to enable it to be used on any voltage between 110 and 250 v. A.B.C. adaptor is fitted to the lead (Colour as available, Blue, Green, etc.) Price **£1/1/-**.

PORTABLE RADIO ATTACHE CASE

available in the following colours:

- LIZARD GREY
- MAROON
- BLUE
- BROWN

complete with facia board and removable insert in lid for frame aerial.

PRICE **36/6** ONLY

We can supply components for making a 4-valve Superhet to fit the above case and a circuit diagram and full instructions available at 2/- each. Details of a few of the items required are as follows:—

Chassis, 3/- each.
Midget IF Transformers, 8/6 a pair.
Dial, 1/3 each.
.0005 Midget 2 gang Condenser, 11/-.

★★★★★★★★★★

"COLLARO" AC37 GRAMOPHONE MOTOR

Governor controlled to run at 78 r.p.m., suitable 100/125 v. and 200/250 v. Complete with 10in. turntable. Price 46/-. Post and Packing 2/6.

★★★★★★★★★★

THE ALPHA AMPLIFIER

3 valves (6B8G, 6V6GT, 6X5GT) A.C. mains fully isolated neg. feed back (voltage and current), controlled volume and tone, dual input network, for modern crystal or Hi-Fi mega. Less than 1 per cent. total 2nd and 3rd harmonic distortion at 3 watts output from 1,000 C.P.S. Complete ready for use. 79/6 post extra.

METAL RECTIFIERS, ETC.

12 volt ½ amp.	1/6 ea.
2 volt 1 amp.	3/- ea.
250 volt 45 mA.	6/9 ea.
250 volt 75 mA.	7/6 ea.
300 volt 60 mA.	7/6 ea.
Full Wave 12 volt 1 amp.	4/9 ea.
12 volt 2 amp.	8/6 ea.
12 volt 3 amp.	13/6 ea.

SEN-TER-CEL SELENIUM RECTIFIERS

Type RM1 125 v. 60 mA.	4/3 ea.
,, RM2 125 v. 100 mA.	4/9 ea.
,, RM3 125 v. 120 mA.	5/3 ea.
,, RM4 250 v. 250 mA.	16/- ea.

PENCIL RECTIFIERS

Type	Maximum Transient Inverse Peak Voltage	Peak Pulse Input Voltage	Half-Wave	Doubler	Tripler	Price
K3/25	2,125	2,000	1,950	3,700	5,050	5/8
K3/40	3,400	3,200	3,000	5,700	7,800	7/6
K3/45	3,825	3,600	3,300	6,250	8,600	8/2
K3/50	4,250	4,000	3,550	6,750	9,250	8/8
K3/60	[illegible]					9/8
K3/100	7,6[illegible]	7,200	6,500	13,700	18,700	14/8

MULTICORE SOLDER
Contains 3 cores of extra active non-corrosive Ersin Flux. Size 1. **5/-** per carton.
Carton colour red and black, Alloy 60/40 SWG18.
Carton colour green and black, Alloy 40/60 SWG16.
Size **2/6** per Carton
Containing 18 SWG 40/60 Alloy Ersin Multicore. Solder sufficient for 200 average joints.

(B.R. Range)

BR.850 8 mfd. 500 v. .. ea.	2/9
BR.1650 16 mfd. ...... ea.	3/3
BR.2050 20 mfd. 500 v... ea.	3/6
8×8 mfd. 500 v. ...... ea.	4/-
BR.501 50 mfd. 12 v. .. ea.	1/9

Midget Metal Types

2 mfd. 350 v.	1/9
8 mfd. 350 v.	1/1
8×8 mfd. 350 v.	3/-
8×8 mfd. 450 v.	4/-
16 mfd. 350 v.	2/9
16×8 mfd. 450 v.	4/-
16×16 mfd. 450 v.	4/6
16×24 mfd. 350 v.	4/9
24 mfd. 350 v.	2/9
32 mfd. 350 v.	1/9
32×32 mfd. 350 v.	4/9
250 mfd. 12 v.	1/9

Wire ended Types

8 mfd. 450 v. Cardboard covered	1/11
30 mfd. 450 v.	3/9

Bias Condensers
Tag ended metal types

12 mfd. 50 v.	1/-
25 mfd. 25 v.	1/3
50 mfd. 12 v.	1/-
50 mfd. 50 v.	2/6
100 mfd. 12 v.	1/9
100 mfd. 25 v.	1/9

Wire ended Types. Cardboard covered

25 mfd. 25 v.	1/9
50 mfd. 12 v.	1/9
50 mfd. 50 v.	2/3

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 9d.; 20/- add 1/-; 40/- add 1/6; £5 add 2/- unless otherwise stated. Minimum C.O.D. fee and postage 2/6.

MAIL ORDER ONLY

ALPHA RADIO SUPPLY CO.
5/6 VINCES CHAMBERS, VICTORIA SQUARE, LEEDS 1.

WHEN ORDERING PLEASE QUOTE "DEPT. W.W."

RADIO TRADERS LTD.

23 WARDOUR ST., LONDON, W.1. (Coventry Street end)

Phone No. GERrard 3977/8 *Grams: "Radiotrade"*

PAXOLIN SHEET

18in. x 4½in. x 1/16in. ...... 1/- each 10in. x 10in. x 1/16in. ...... 1/6 each
20in. x 10in. x 1/32in. ...... 1/6 „ 20in. x 10in. x 1/16in. ...... 3/- „

CONDENSERS Per doz.

2 Mfd. 150 v. Tubular Paper (aluminium tubes), 1/6 each 15/-
8 Mfd. 450 v. Electrolytic, 1/9 each 18/-
16 Mfd., 350 v., Electrolytic, 2/- each 21/-
24 Mfd., 350 v., Electrolytic, 2/- each 21/-
32 Mfd. 450 v. Electrolytic, 2/6 each 27/-
8 x 16 Mfd., 350 v., 1/6 each 15/-
20 x 20 Mfd., 275 v., Electrolytic, 2/9 each 30/-
16 x 16 Mfd., 350 v., Electrolytic, 2/6 each 27/-
16 x 24 Mfd., 350 v., Electrolytic, 2/6 each 27/-
16 x 8 Mfd. Metal Cans Electrolytic, 350 v., 1/6 each 15/-
32 Mfd. Metal Cans Electrolytic, 350 v., 1/6 each 15/-
32 x 8 Mfd. Metal Cans Electrolytic, 275 v., 1/9 each 18/-
64 Mfd. Metal Cans Electrolytic, 350 v., 2/6 each 24/-
Condenser clips for above 3/-
100 Mfd. 50 v. Metal Cans, 1/- each. 25 Mfd. 50 v. Tubular Cardboard 10/6
50 Mfd. 12 v., 1/- each 10/6
12 Mfd. 50 v. Tubular Paper (aluminium tubes), 1/- each 10/6
100 Mfd. 6 v. Tubular Paper (aluminium tubes), 1/- each 10/6
.00005 Tubular Miniature, 4/- per doz. .02, 500 v., 4/- per doz., .001, 350 v. 4/- per doz. .05, 350 v., 4/- per doz. .005, 200 v., 4/- per doz.

MIDGET MICA CONDENSERS: .0001, .0002, .0003, .0004, .0005 4/-
200 Assorted Moulded Micas. Popular Values £2 10 0
200 Assorted Silver Micas. Popular Values £2 10 0
200 Assorted Carbon Resistors: ¼, ½ and 1 watt. Good selection £1 10 0

CARBON RESISTORS: ¼ watt 2/6; ½ watt 3/-; 1 watt 4/-; 2 watt 6/-; 5 watt 9/- per doz.

HIGH STABILITY RESISTORS:

Tolerance:	1%	2%	5%
¼ watt	1/-	9d.	6d. each
½ watt	1/3	1/-	9d. each
1 watt	1/9	1/3	1/- each

8-40 MEG 2 watt .... 2/6 each

ALL CINCH COMPONENTS IN STOCK

PYE PLUGS AND SOCKETS .... 1/6 pair

W/W AND VITREOUS RESISTORS. 5 watt, 1/6; 10 watt, 2/6; 15 watt, 3/-; 20/30 watt, 3/6 each.

W/W V/CONTROLS. COLVERN and B-NSF. 5K PRESET and other values, 2-3 watt, 2/- each. 10K Isolated Spindle ...... 2/- „
500 ohms, 1K, 20K, 25K, 50K, with spindle .... 3/- „
V/CONTROLS WITH SWITCH: most values, B-NSF .... 2/6 „
V/CONTROLS: Less Switch, Preset and Spindle. MOST VALUES .... 1/9 „
TWIN MIDGET GANGS, .0005, with trimmers, PERSPEX COVER .... 5/6 „
4-WAY PUSH BUTTON UNITS, 1/6 each .... 15/- doz.
PUSH BUTTON KNOBS .... 3/- „
TAG STRIPS: 3-way, 2/- doz.; 4-way 2/6 doz.; 5-way, 3/- doz.; 7-way 4/- doz.; 28-way 10/- doz.
ASSORTED PILOT LAMP HOLDERS .... 4/- „
FUSES 1¼in. Most values from 750 mA. to 10 amp. .... 2/- „
POINTER KNOBS. Small black, with line, ¼in. hole ...... 7/6 „
STANDARD ROUND KNOBS: Small, ¼in. hole, 6/-; Large, ¼in. hole, 7/6; with spring clip, ¼in. hole .... 4/6 „
CLIX WANDER PLUGS, Type MP2. Red, black, blue .... 2/- „
PHILIPS TRIMMER TOOLS .... 1/- each
BELLING & LEE. P/M FUSE HOLDERS, Type L356 .... 2/6 „
WEARITE COILS: Types PA4, PO4, PA5, PO5, 1/3 each .... 12/- doz.
VALVE HOLDERS: Moulded. **B9A**, 7/6; **B7G**, 6/-; **EF50**, 6/-; **ENGLISH OCTAL**, 3/- per doz. **SCREEN CANS** for B9A, B7G, 6/- doz.; **PAXOLIN**—B7G, MAZDA 4-pin UX 3/- „
BELLING & LEE. PLUGS AND SOCKETS. Ex-Govt. BRAND NEW 5-pin, Chassis and Cable, 7-pin .... 1/6 pair
BULGIN. P73, Plug and Socket, 2/9 each; P74, Plug and Socket, 2/6; P200, Plug and Socket, 2/-; Rotary Switches, S.255, 2/-; Dolly Switches, S.267, 2/-; Dolly Switches, S.259, 1/6; Standard Switches, Ex-Govt., On-off .... 1/6 each
POST OFFICE LAMP JACKS, No. 10, 1/- each .... 9/- doz.
Lamp Covers for same .... 3/- „
L.F. CHOKES, 300 w., 60 mA. CH5 .... 4/6 each
OUTPUT TRANSFORMERS. Multi Ratio, 5/-; Pentode or Power .... 4/- „
VALVE SCREEN CANS for Standard Valves, 1/- each............ 10/6 doz.
DRUM DRIVES, 4½in. .... 1/- each
WESTECTORS. WX6, WX12, W1, W12, W4, 1/- each...... 9/- doz.
ARCOLECTRIC (Whitney Lamp), Red, green, clear, 1/6 each 15/- „
SIGNAL LAMP HOLDERS P/M, complete with adjusting lamp holders, 1/9 each .... 18/- „
AIR SPACE TRIMMERS. Preset and spindle types, 5PL, 10PF, 15PF, 20PF, 25PF, 50PF, 75PF, 15/-; 100PF Preset, 1/6 each 15/- „
JONES PLUG AND SOCKETS. 4-pin, 2/6; 6-pin, 3/-; 8-pin, 3/6; 10-pin, 4/-; 12-pin .... 6/- pair
NUTS. 8BA, 3/-; 6BA, 2/6; 4BA, 3/-; 2BA 4/-gross
SOLDER TAGS, 1/6 gross. **SHAKEPROOF WASHERS** ... 2/- „
WASHERS, 2, 4 and 6BA .... 1/- „
SHAKEPROOF SOLDER TAGS, 4BA and 6BA, 2/-; 2BA...... 2/3 „

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ALL ORDERS FOR LESS THAN £2 ADD POSTAGE

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G.E.C. DIODE VOLTMETER. Consists of a 3½in. 0-100 Micro-amp meter mounted in a neat black crackle instrument case size 7¾in. x 4in. x 3in. deep. The meter is calibrated 0-100 and 0-30 volts and a range switch is incorporated, as well as mains on/off switch, panel indicator light and filament transformer. The instrument was intended for use with an external probe (which is not available). Circuit of the instrument and probe supplied. BRAND NEW AND BOXED AND A BARGAIN AT ONLY **79/6.**

INDICATOR UNIT TYPE 182A. Contains 3-EF50, 1-5U4G, 4-SP61, and 6½in. C.R.T. type VCR 517. This tube will replace the VCR 97 without any alteration, is completely free from cut-off and has a more pleasant tube colour. Contains in addition a very large assortment of pots., resistors, condensers, etc. Tubes demonstrated. Supplied Brand New (less relay) for only **67/6**, plus 7/6 carr. In original transit case. Original circuit supplied free with each order, or 1/6 separately. Conversion of this unit to an oscilloscope is being described in the "Radio Constructor."

TYPE 12 TRANSMITTER. Mains operated transmitter covering 1.2 to 17.5 Mc/s in four bands crystal or V.F.O. Size 24in. x 12½in. x 17½in. weight 134 lbs. Complete with all valves, ready for operation. In first class condition and tested before despatch, with circuit and instructions ONLY **£16/16/-** plus 14/- carr. We have a few other types of transmitters at bargain prices for callers only.

UNIVERSAL AVO METERS, MODEL 40. Once more we are able to offer a further supply of these—very little used, thoroughly checked and tested. First class multi-range test meter for ONLY **£9/19/6.**

METER BARGAINS (all brand new and boxed).

15 volt (50 cycle) Moving Iron, 2½in. flush pnl. mtg., **10/-.**
20 Volt Moving Coil, 2in. sq. panl. mtg., **7/6.**
3,500 Volts Moving Coil, 3½in. projection, **15/-.**
150 Milli-Amp. 2in. sq. panel mtg., **7/6.**
5 Milli-Amp. Moving Coil 2in. sq. pnl. mgt., **7/6.**
200 Milli-Amp. Moving Coil 2½in. dia. flush pnl. mtg., **10/6.**
20 Amp. Moving Coil 2¼in. dia., **7/6.**
1 Milli-Amp. 2½in. barrel, flush pnl. mtg., **22/6.**
1 Milli-Amp. 2½in. barrel, desk type in sloping front case, **25/-.**
100 Micro-Amps. 2½in. barrel, flush panel mtg. Scaled 0-1,500 in 15 clear divisions. **ONLY 42/6.**
500 Milli-Amp. Thermo-couple 2in. square panel mtg., **5/-.**

METER RECTIFIERS Salford Instrument, full wave bridge type. Brand new 1 mA. at **11/6**, and 5 mA. at **8/6.**

BLOCK CONDENSERS. These are Nitrogol type with ceramic insulating terminals.

8 mF. 2,000 volt working size 5in. x 3¾in. x 4½in. high at **12/6** each.
4 mF. 2,000 volt working size 3¼in. x 2½in. x 4½in. high at **7/6** each.
4 mF. 1,250 volt working size 3¼in. x 2½in. x 4½in. high at **5/6** each.

TRANSFORMER BARGAINS. Brand new transformers, ex-manufacturer's surplus, drop through. Primary 200/250 volt, 50 cps.. Secondary 310-0-310 v. 70 mA., 6.3. 3 amps 4 v. 2 amps—can be used with 4 volt or 6.3 volt rectifier. Only **9/6** plus 1/6 post. A similar type transformer 325-0-325 100 mA. 6.3 4 amps, etc. can be supplied to callers only at **14/6.** Filament transformer. Standard tapped primary 12 volts 1½ amps., 4 volts 1½ amps. Only **7/6** each.

E.M.I. OUTPUT METER

Just arrived this month a very useful output meter. The instrument itself has a basic movement of 1 mA and incorporates a full-wave instrument rectifier. There are two ranges 0-500 milliwatts and 0-5 watts and also a decibel scale. The input impedance is 5,000 ohms. These are all BRAND NEW AND UNUSED in sealed individual Manufacturers cartons, complete with instructions and are offered at about a third of list price. Only **35/-** each plus 1/6 post.

E.M.I. OUTPUT METER

METER RECTIFIER. Full wave bridge 2 mA. by S.T.C. as used in the above instrument. Brand new Only **5/6** each..

GRAYSHAW RESISTANCE CAPACITY BRIDGES. We are London Stockists for these fine instruments which represent excellent value at **£6/19/6.** We can thoroughly recommend these as being superlative value comparing well with far more expensive equipment.

H.R.O. 6-VOLT VIBRATOR PACK. Gives 150 volts 80 mA. smoothed D.C. Uses Mallory vibrator, 6X5, heavy duty smoothing chokes, etc. In black crackle cabinet size 7in. x 7in. x 6in. Brand new, only **29/6.**

U.S.A. DYNOMOTOR. 12 volts D.C. input, 250 volts 60 mA. output. Weight 2¾ lb. Size 4½in. x 3in. dia. Ideal for car radio, mobile amplifiers. small transmitters, etc. All tested prior despatch. ONLY **22/6,** post paid.

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MAINS TRANSFORMERS

Primary, 200-250 v. P. & P. 2/-.

300-0-300 100 mA., 6 v. 3 amp., 5 v. 2 amp., **22/6**.

Drop thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., **14/6**.

Drop thro' 250-0-250 v. 80 mA., 6 v. 3 amp., 5 v. 2 amp., **14/6**.

280-0-280, drop through, 80 mA., 6 v. 3 amp., 5 v. 2 amp., **14/6**.

250-0-250 80 mA., 6 v. 4 amp., **14/-**.

Drop thro' 280-0-280, 200 mA., 6 v. 5 amp., 5 v. 3 amp., **27/6**.

Drop thro' 270-0-270 80 mA., 6 v. 3 amp., 4 v. 1.5 amp., **13/6**.

Drop thro' 270-0-270 60 mA., 6 v. 3 amp., **11/6**.

Auto Trans. Input 200/250. H.T. 350 v. 350 mA. Separate L.T. 6.3 v. 7 a., 6.3 v. 1½ amp., 5 v. 3 amp., **25/-**. P. & P. 3/-.

Heater Transformer. Pri. 230/250 v., 6 v. 1½ amp., **6/-**; 2 v. 2½ amp., **5/-**.

Mains Transformer, fully impregnated, input 210, 220, 230 and 240. Sec. 600-0-600, 275 mA., and 200 v. at 30 mA., complete with separate heater transformer. Input 210, 220, 220, 240. Sec. 6.3 v. 2 amp. three times, 0, 4, 6.3 v. at 3 amp. and 5 v. 3 amp., **45/-**. P. & P. 5/-.

Mains Transformer, fully impregnated, input 210, 220, 230, 240. Sec. 350-0-350, 100 mA. with separate heater transformer. Pri. 210, 220, 230, 240. Sec. 6.3 v. 2 amp., 6.3 v. 3 amp., 4 v. 6 amp. and 5 v. 2 amp., **30/-**. P. & P. 5/-.

MAINS TRANSFORMERS, chassis mounting, feet and voltage panel Primaries 200/250:

350-0-350 75 mA. 6.3 v. 3 a. tap 4 v. 6.3 v. 1 a., **13/6**.

350-0-350 70 mA. 4 v. 5 a., 4 v. 2.5 a. C.T., **18/6**.

500-0-500 125 mA. 4 v. C.T. 4 a., 4 v. C.T. 4 a., 4 v. C.T. 2.5 a., **27/6**.

500-0-500 250 mA. 4 v. C.T. 5 a. 4 v. C.T. 5 a., 4 v. C.T. 4 a., **39/6**.

9in. T.V. Cabinet, front in contrasting walnut veneers, size 16½in. long, 11¾in. high, by 12½in. wide. Complete with two pieces expanded aluminium in gold, 12×9in. and 5in. speaker baffle, **15/-**, post paid.

P.M. SPEAKERS (closed field):

	with trans.	less trans.
2½in.	—	**15/6**
3½in.	—	**13/6**
5in.	**16/6**	**12/6**
6½in.	**16/6**	**12/6**
8in.	**18/6**	**15/-**
10in.	—	**19/6**

6½in. M.E. Speaker. 1,000 ohm field, **15/-**.

R. & A. T.V. Energised 6½in. Speaker, field coil 175 ohms. Requires a minimum 150 mA. to energise, maximum current 250 mA., **9/6**. P. & P. 2/6.

Extension Speaker Cabinet, in contrasting walnut veneer, size 15×10½in. Will take 6½ or 8in. speaker, **17/6**.

Completely built All-dry Mains Unit by famous manufacturer, 200/250 v. Metal case size 8×5×3in., incorporating Westinghouse metal rectifiers, 3 500 mfd., 16×24 mfd., mains trans., 3 smoothing chokes, output 90 v. 10 mA., 1.4 v., 0.25 amp., **39/6**. P. & P. 2/6.

Volume Controls. Long spindle less switch. 50K, 500K, 1 meg., **2/6** each. P. & P. 3d. each.

Volume Controls. Long spindle and switch, ¼, ½, 1 and 2 meg., **4/-** each; 10K and 50K, **3/6** each. ½ and 1 meg., long spindle double pole switch, miniature, **5/-**. P. & P. 3d. each.

Trimmers, 5-40 pf., **5d.**; 10-110, 10-250, 10-450 pf., **10d**.

Twin-gang .0005 Tuning Condenser, **5/-**. With trimmers, **7/6**.

Line Cord, 2-way 0.3 amp., 60 ohms per foot, **1/3** per yard.

Twin-Gang .0005 with feet, size 3¼×3×1¾in., **6/6**.

3-gang .0005, with feet, size 4¼×3×1¾in., **7/6**.

T.V. Coils, moulded former, iron-cored, wound for re-winding purposes only. All-can 1½×1¾in., **1/-** each, 2 iron-cores all-can 2¼×¾in., **1/6** each.

Used Metal Rectifier. 250 v., 150 mA., **6/6**.

Metal Rectifier. 250 v., 250 mA., **12/6**.
Metal Rectifier. 230 v., 45 mA., **6/-**.

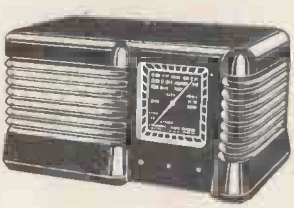
PERSONAL SHOPPERS ONLY. 9in. Enlarger, **17/6**; 12in., **27/6**.

Germanium Crystal Diode, 1/6, post paid.

Television Masks. White Rubber, 9in. with glass, **7/6**. Cream Rubber, 12in., with armour-plate glass, **15/-**.

Used 12in. C.R. Tube, aluminised, E.H.T. maximum 10 Kv., heaters 2-volt, with heater cathode short, guaranteed for 3 months. Complete with rubber mask, Elac P.M. focus unit, scan coils, low line, low frame and frame o.p. trans. £5/10/-, P. & P. 7/6.

HIGH-IMPEDANCE PLASTIC RECORDING TAPE, by famous manufacturer. 600ft. on aluminium spool, **8/-**. 1,200ft. on aluminium spool, **17/6**, post paid.



CABINET, as illustrated, 11½×6¾×5¼in., in walnut or cream, complete with TRF chassis, 2 waveband scale, station names, new waveband, backplate, drum pointer, spring, drive spindle, 3 knobs and back, **22/6**. P. & P. 3/6.
AS ABOVE, with superhet chassis, **23/6**. P. & P. 3/6.
AS ABOVE, complete with new 5in. speaker to fit, and O.P. trans., **35/-**. P. & P. 3/6, with superhet chassis, **36/-**. P. & P. 3/6.
Used metal rectifier, 230 v. 50 mA., **4/6**; gang with trimmers, **6/6**; M. & L. TRF coils, **5/-**; 3 obsolete ex-Govt. valves, 3 v/h and circuit, **6/6**; heater trans., **6/-**; volume control with switch, **3/6**; wave-change switch, **2/-**; 32×32 mfd., **4/-**; bias condenser, **1/-**; resistor kit, **2/-**; condenser kit, **4/-**.
M. & L. Superhet Coils with circuit, **6/6**: iron-cored 465 I.F.s **7/6**; min. gang, **5/6**; volume control with switch, **4/-**; wave-change switch, **2/6**; heater trans., **7/6**; 4 v/h, **1/6**; 4 obsolete ex-Govt. valves, metal rectifier and Xtal diode with circuit, **14/6**; 25×25 mfd., **1/-**; 16×16 mfd., **3/3**; condenser kit (17), **7/6**; resistor kit (14), **3/6**.

Clydon 5 channel T.V. Tuner, uses EF80 and 12AT7, less valves, **12/6**, post paid.

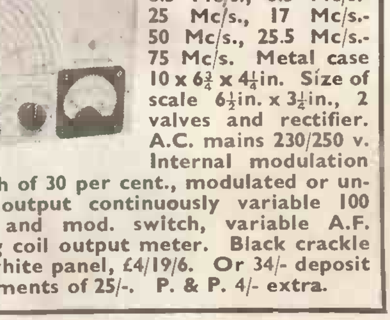
Radio-gram Chassis, 5 valve A.C./D.C. 3 wave-band superhet 195-255 v., 19-49, 200-550 and 1,000-2,000 metres, I.F. 470 Kc., size of chassis 13×6½×2½in., size of scale 7¼×3½in., valve line-up 10C1, 10F9, 10LD11, U404, and 10P14. Twin mains filter input, 2 dial lights and 8in. P.M. **£8/17/6**. P. & P. 5/-.

COMPLETELY BUILT SIGNAL GENERATOR

Coverage; 120 Kc/s.-320 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8.5 Mc/s.-25 Mc/s., 17 Mc/s.-50 Mc/s., 25.5 Mc/s.-75 Mc/s. Metal case 10 x 6¾ x 4¼in. Size of scale 6½in. x 3¼in., 2 valves and rectifier. A.C. mains 230/250 v. Internal modulation 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated. R.F. output continuously variable 100 millivolts. C.W. and mod. switch, variable A.F. output and moving coil output meter. Black crackle finished case and white panel, £4/19/6. Or 34/- deposit and 3 monthly payments of 25/-. P. & P. 4/- extra.

CONSTRUCTOR'S PARCEL No. 1 comprising chassis 12½×8×2in., cad. plated 18 gauge, v/h., I.F. and trans., cut-outs, backplate, 2 supporting brackets, 3 waveband scales, new wavelength station names. Size of scale 11½×4¾in., drive spindle drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin international octal valve holders, 4 knobs and pair of 465 I.F.s, **16/6**.

AS ABOVE, but complete with 16+16 mfd. 350 wkg. and semi-shrouded drop thro' 250-0-250 60 mA., 6 v. 3 amp. Pri. 200-250, and twin-gang, **31/6**. P. & P. 3/-.



CONSTRUCTOR'S PARCEL. As No. 1 plus 16×16 mfd. 350 wkg., semi-shrouded drop-thro' 250-0-250 60 mA., 6.3 v. 3 a., 5 v. 2 a., twin gang, and 6 L.M.S. superhet coils complete with trimmers and tracking condensers with circuit. **£2/5/-**. P. & P. 3/6.

Line and E.H.T. Transformer, 14 Kv., using ferrocart core, complete with line and width control, and corona shields, U37 rectifier winding, **35/-**.

Line and E.H.T. Transformer, 9 Kv., using ferrocart core complete with built-in line and width control. Mounted on small all-chassis. Overall size 4¾×1¾in., EY51 rec. winding, **27/6**.

Scan Coils, low line, low impedance frame, complete with frame transformer, to match above, **27/6**. P. & P. 2/-.

Valve Holders, moulded octal Mazda and loctal, **7d.** each. Paxolin, octal Mazda and loctal, **4d.** each. Moulded B7G, B8A and B9A, **7d.** each. B7G moulded with screening can, **1/6** each.

32 mfd., 350 wkg.	2/-
16×24, 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
40 mfd., 450 wkg.	3/6
16×8 mfd., 500 wkg.	4/6
16×16 mfd., 500 wkg.	5/9
16×16 mfd., 450 wkg.	3/9
32×32 mfd., 350 wkg.	4/-
32×32 mfd., 350 wkg., and 25 mfd., 25 wkg.	6/6
25 mfd., 25 wkg.	11d.
250 mfd., 12 v. wkg.	1/-
16 mfd., 500 wkg., wire ends	3/3
8 mfd., 500 v. wkg., wire ends	2/6
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
100 mfd., 350 wkg.	4/-
100+200 mfd., 350 wkg.	9/6
16+16 mfd., 350 wkg.	3/3
50 mfd., 180 wkg.	1/9
65 mfd., 220 wkg.	1/6
8 mfd., 150 wkg.	1/6
60+100 mfd., 280 wkg.	7/6
50 mfd., 12 wkg.	11d.
32+32 mfd., min., 275 wkg.	4/-
50 mfd., 50 wkg.	1/9
Miniature wire ends moulded, 100 pf., 500 pf., and .001 .. ea.	7d.

Combined 12in. mask and escutcheon in lightly tinted Perspex. New aspect, edged in brown. Fits on front of cabinet, **17/6**.

Frame Oscillator Blocking Trans., 4/6
Tube Mounting Bracket, size 9½×4¾in. 12in. tube clamps, **2/-**.

CHOKES:
2-20 Hen., 150 mA., **15/-**. P. & P. 3/-.
6 Hen., 275 mA., **15/-**. P. & P. 3/-.
100 Hen., 40 mA., **15/-**. P. & P. 3/-.
Smoothing Choke, 2 henry 150 mA. **3/6**; 250 mA., 10 henry, **10/6**; 5 henry 250 mA., 60 ohms, **8/6**.

P.M. Focus Unit for any 9 or 12in. tube except Mazda 12in., with Vernier adjustment, **15/-**.

P.M. Focus Unit for Mazda, 12in., with vernier adjustment, **17/6**.

Wide Angle P.M. Focus Units, Vernier adj., state tube, **25/-**.

Energised Focus Coil, low resistance mounting bracket, **17/6**.

Ion Traps for Mullard or English Electric tubes, 5/-, post paid.

465 Kc. I.F.s, size 2½×1½in. Q.110 removed from American equipment, **5/-** per pair. Standard 465 Kc. iron-cored I.F.s, 4×1½×1¾in., per pr. **7/6**. Wearite standard iron-cored 465 Kc. I.F.s, 3½×1½×1¾in., per pr. **9/6**.

Iron-cored 465 Kc. Whistle Filter, 2/6.

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., **4/9**; 42-1 with extra feed-back windings, **4/3**. Miniature 42-1, **3/3**. Multi-ratio 3,500, 7,000 and 14,000, **5/6**. 10-watt push-pull, 6V6 matching, **7/-**. 90-1 3 ohm speech coil, **6/6**.

PUSH-BACK CONNECTING WIRE. Doz. yds., **1/6**, post paid.

STANDARD WAVE-CHANGE SWITCHES, 4-pole 3-way, **1/9**; 5-pole 3-way, **1/9**; 3-pole 3-way, **1/9**; 9-pole 3-way, **3/6**; Miniature type, long spindle 5-pole 4-way, 4-pole 3-way and 4-pole 2-way, **2/6** each. P. & P. 3d.

465 KC. MIDGET I.F.s. Q.120 size 1½in. long, 1in. wide, ¾in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, **12/6**.

Mains Droppers. 0.3 amp., 460 ohms, tapped 280 and 410, **1/6**; 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous **1/6**; 0.3 amps., 950 ohms, tapped 700 and 825, **2/6**; 0.2 amp., 1,000 ohms, vitreous, tapped, **2/6**; Vitreous, 0.3 amp. 700, tapped 680, 640, 600, **3/6**. P. & P. on each 3d.

T.V. Width Controls, 3/6.

T.V. Sub Assembly, all-chassis, 12in.×3½in., with frame osc., line osc., 12 mfd. 275 wkg., Metroall, 8 condensers, 4 resistors and tag panel, **15/-**.

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All goods specially selected for quality and value. Prompt service—Money-back guarantee—It will pay you to visit our new rebuilt shop premises. Situated 50 yds. only from Tottenham Court Road Tube! (Genuine.)

TELESCOPIC AERIAL MAST. Ex-R.A.F. dinghy transmitter mast. Total length when extended, 17ft. Collapses into two sections each approx. 24in. Complete with dies and lashings, lightweight duralumin construction, diameter at thickest point, 1¼in. approx. tapering to ⅜in. New condition, 32/6, plus 2/- post and packing.

METER SPECIAL! We have a limited quantity of aircraft electrical thermometers, Brand new, by Weston. 2in. moving coil meter, flush square fitting. These meters have a luminous scale graduated 40-140 degrees centigrade, but the full scale deflection is approximately 150 microamps! Price 12/6 each only, plus 1/- P. & P.

VALVES. We have a very comprehensive stock of special surplus valves at competitive prices. A stamp will bring Valve Price List.

THE R.C. RAMBLER ALL-DRY PORTABLE KIT

Full assembly details with practical and theoretical diagrams can be supplied at 1/6, post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, adds to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attache-case type cabinet, measuring only 9in. × 7in. × 5½in. Weight (less batteries) 4¾ lb. with batteries 6½ lb. This set really has everything! Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up: 3V4, 1R5, 1S5, 1T4. All the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of £7/7/-, plus 2/6 P. & P. (less batteries). Uses Ever-Ready 90v. H.T. type B126 at 9/3. Also L.T. 1.5 v. AD.35 at 1/4. N.B. When batteries are removed there is adequate space for mains unit which will shortly be made available.

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 2in.	M.C.	R.P.	50/-
250 microamp	D.C. 2½in.	M.C.	F.R.	40/-
500 microamp	D.C. 2in.	M.C.	R.P.	13/6
500 microamp	D.C. 2in.	M.C.	F.R.	18/6
500 microamp	D.C. 2½in.	M.C.	F.R.	35/-
1 mA.	D.C. 2in.	M.C.	F. Sq.	17/6
1 mA.	D.C. 2in.	M.C.	F. Sq. (scale calib. 1.5 kV.)	15/-
1 mA.	D.C. 2½in.	M.C.	F.R.	22/6
1 mA.	D.C. 2½in.	M.C.	Desk Type	27/6
5 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
10 mA.	D.C. 2½in.	M.C.	R.P.	8/-
10 mA.	D.C. 2½in.	M.C.	F.R.	10/-
15 mA.	D.C. 2in.	M.C.	F.R.	7/6
20 mA.	D.C. 2in.	M.C.	F.R.	7/6
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
200 mA.	D.C. 2½in.	M.C.	R.P.	10/-
500 mA.	D.C. 2in.	M.C.	R.P.	6/6
500 mA.	D.C. 2½in.	M.C.	F.R.	8/6
0.5 amp.	R.F. 2in.	Thermo	F. Sq.	4/6
1 amp.	R.F. 2½in.	Thermo	R.P.	10/-
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
6 amp.	R.F. 2½in.	Thermo	F.R.	7/6
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
50-0-50 amp.	D.C. 2in.	M.C.	F. Sq.	7/6
15 volt	A.C. 2½in.	M.C.	F.R.	10/-
20 volt	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
150 volt	D.C. 2in.	M.C.	F.R.	15/-
300 volt	D.C. 2in.	M.C.	F. Sq.	8/6

R.P. = Round projection.
F. Sq. = Flush Square.
F.R. = Flush Round.
Thermo = Thermo-couple.
M.C. = Moving Coil.

ALL-PURPOSE TEST METERS. We also offer very limited supply of Ex-Naval All-purpose test meters by Everett, Edgecumbe. These instruments are not brand new, but all have been serviced and guaranteed 100 per cent. condition. Complete in strong wooden case. Size 9in. × 6in. × 5½in. Leather carrying handle. 3½in. Scale—1,000 ohms per volt—Measures 0-1,000 volts AC/DC—Capacity .02 mfd.-16 mfd.—Resistance to 10 megs.—While stocks last—Price £7/19/6 only! Plus 2/6 packing and carriage.

HIRE PURCHASE
We are pleased to announce advantageous hire purchase facilities on any single item over £10. Your specific enquiries will receive our very prompt attention.

COIL PACKS. MANUFACTURER'S SURPLUS. Few only, iron-covered, 7 waveband (2 medium, 5 short waves), comprising 14 coils, trimmers, wave-change switch, etc., etc., complete with copy of manufacturer's original circuit. 50/- only, tax paid. Completely assembled.

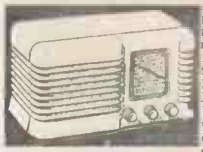
SINGLE PLAYING UNIT, by very famous manufacturer, cream, 3-speed, complete with Decca X.M.S. plug-in C. and D. heads for L.P. and Standard. £9/9/6 only!

INTRODUCING L.T. RECTIFIERS TYPE R.K. A newly manufactured range, fully guaranteed for 12 months.

6 or 12 v. 1 a. F.W. bridge type	7/6
6 or 12 v. 1.5 a. F.W. bridge type ..	9/-
6 or 12 v. 2 a. F.W. bridge type	11/3
6 or 12 v. 4 a. F.W. bridge type	15/-
6 or 12 v. 6 a. F.W. bridge type	23/6
6 or 12 v. 10 a. F.W. bridge type	37/6

CHARGER TRANSFORMERS. High grade wax dipped, 220/240 v. input, 6/12 v. 2 a., at 11/9 only. Also 6/12 v. 4 a., at 17/6; 6/12 v. 6 a., at 25/-.

THE "ECONOMY FOUR" T.R.F. KIT.



A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up: 6K7, 6J7 and 6V6. Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown Bakelite, or wooden, walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/6 post free—this is allowed if kit is purchased later — Please, add 2/6 packing and carriage for complete kit.

D.C. TESTMETER, EX-AIR-MINISTRY TYPE E, BY AVO. Instrument size 4¾in. × 3¾in. × 1¾in. Black Bakelite case. Meter scalelength 3in. D.C. volts., 2 v., 4 v., 20 v., 40 v., 200 v., 400 v., 1,000 v., 2,000 v. D.C. current, 20 mA., 100 mA., 200 mA., 2 amp., 20 amp. Resistance scale, 0-10,000 ohms. These meters have all been reconditioned, and are guaranteed perfect. Supplied complete in leather carrying case at £3/19/6, plus 2/- P. & P. Limited quantity.

HEATER TRANSFORMERS. Special Manufacturers' surplus. Brand new, tropicalised by Woden. Primary 0/110 v., 220/240 v., 280/440 v. Secondary 0/6.3 v./11 v. at 3 A. (very conservatively rated), 7/6 ea. only. Also, for instrument work: Primary 0/110 v., 220/240 v., 380/440 v. Secondaries 0/10 v./20 v./30 v./60 v./240 v. at 30 mA., 6.3 v. .45 A., 6.3 v. [illegible] A. Also 7/6 ea. only. Both plus 1/6 P. & P. Limited quantities!

T/V PRE-AMPLIFIER, London frequency, manufacturer's surplus. Brand new on chassis size 4¾in. × 2¼in. × 1½in., incorporating valve EF42, 22/6 each. (1/6 P. & P.).

R.F. UNITS. All new condition and complete. Case size 9½in. × 7½in. × 5in.
Type 24. 20-30 Mc/s., 15/-. Switched Tuning. Type 25—40-50 Mc/s., 19/6. Switched Tuning. RF26 at 45/-. We also have some RF26, not new, but in perfect condition, at 35/-. Type 27—64-85 Mc/s., 45/-. Variable Tuning.
We have a limited supply of RF27 new condition and complete, but tuning dial damaged. Price 30/- each only. ALL these units Post Free!!

LATEST PLESSEY 3-SPEED AUTO-CHANGER. We have just purchased a very limited quantity only of these small A.C. Mixer changers. Require only 5in. above and 2½in. below motor board. Complete with turnover crystal head, £9/19/6 only, tax paid.

TESTMETER—EX-ARMY. Direct readings 15 v. and 3 v. D.C. 6 mA. and 60 mA. D.C. current, 500 ohm and 5,000 ohm resistance ranges. Complete in bakelite case with web carrying strap. 19/6, plus 1/6 P. & P.

T1154 TRANSMITTER UNIT. Medium/high powered for C.W.-M.C.W. R/T. 3 ranges, 10-5.5 Mc/s. [illegible] Mc/s., 500-200 Kc/s. Absolutely complete; 4 valves, 2 meters, hundreds of resistors, condensers, etc., in wooden transit case. Price 39/6, plus 7/6 carriage and packing.

THE R.C. GRAM REPLACEMENT CHASSIS KIT

To meet the very great demand for this type of receiver, we have produced this unit. For Long, Medium and Short Waves. Valve line-up: 6K8 Frequency changer, 6K7, I.F. Amplifier, 6Q7, 1st Audio, Detector and A.V.C., 6V6 Output, 6X5 Full-wave rectifier.

For A.C. mains 200/250 volts. 4 watts output. Excellent quality, High sensitivity, Provision for gram. Attractive illuminated black, red, green and gold dial, for horizontal tuning. Four controls are: Tuning, L/M/S/Gram. Vol/on/off, Tone (variable). Chassis size: 13½in. × 5½in. × 2½in. Dial size: 10in. × 4½in. Assembly is simplified by the use of a 3 waveband coil pack, and pre-aligned 465 Kcs. I.F. transformers—high-grade drop-through half-shrouded Mains Transformer, with voltage adjuster panel. This chassis can easily be assembled in one evening. Illustrated pamphlet with full assembly instructions, practical and theoretical wiring diagrams and itemised price list, 1/6 post free.

The main items for this receiver can be supplied separately, as under.
Drilled chassis, complete with valve-holders, A/E panel, P/U panel, tuning condenser and ready-assembled dial and drive at 39/6. 3 waveband coil pack with gram position, 39/6 tax paid. Pair of 465 Kcs. I.F. Transformers, 9/6 pair. Half-shrouded drop-through Mains Transformer, 22/6. The total cost of ALL items purchased separately is nearly £10, but we shall be pleased to supply all the required components right down to the last nut and bolt, at a special inclusive price of £8/8/-, plus 2/6 packing and postage. A set of four small brown or cream engraved knobs to suit is available at 1/2 each knob. This chassis is a professional job in every respect, and can be seen and heard at our premises. This chassis can also be supplied, ready assembled, in very limited quantities, at £9/19/6 plus 5/- carriage and packing.

THE "SUPERIOR FOUR" KIT. Our new four-valve receiver. A.C. mains. 200/250 v. M. and Long Waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6SG7, 6X5GT and 6V6GT. Chassis ready drilled. Cabinet size: 10½in. high × 10in. wide. Maximum depth at base, 5in., tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete Instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6, post free. Our price for complete kit, £6/9/6!!! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and back, drilled chassis and bracket wavechange switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at 45/-, plus 2/6 packing and carriage.

N.B.—Our Kits are even supplied with sufficient solder for the job!

Please add postage under £1. C.O.D. or Cash with order. C.O.D. charge extra—Open 9 a.m.-6 p.m., Monday to Friday. Sorry but we close at 1.0 p.m. on Saturday.

GEE Bros RADIO

VALVE TESTER TYPE 4. 200-230 v. A.C. Input. Ex-Govt., in good condition, with descriptive book containing circuit diagram of instrument and how to test valves from 1.4 v. to 40 v. With valve-holders for Brit., 4, 5, 7 pin and Octal, U.S., 5 and 7 pin, I/Octal, side contact, large Brit., 4 and 9 pin. Acorn and diode. Housed in substantial wooden case. Price **£7/19/6**, carriage 10/- extra.

WESTON ALL-PURPOSE A.C./D.C. TEST METER MODEL E.665. New and unused, complete with leads and batteries, £8 only, p.p. 3/6; Also:

WESTON BATTERY OSCILLATOR MODEL E.692. TYPE 2. Also new and unused. Coverage 100 kc/s.-26 Mc/s. Audio output approx. 400 c/s. Available at the ridiculously low price of only **£5/19/6**, p.p 4/6. (Oscillator complete with instruction booklet.)

BATTERIES H.T. AND L.T. Heavy duty layer type. 150v. tapped at 87v. H.T. L.T. 4½v. Perfect condition. Size 9½in. x 4½in. x 4½in., **4/6** each, p.p. 2/- on each battery. Also 90v./1½v. Ditto as previously advertised, 4/6, p.p. 1/8 each.

AMERICAN DYNAMOTOR, TYPE PE.103A. Heavy duty power supply. Input 6 v. at 21 amps. or 12 v. at 11 amps. Output 500 v. at .16 amps. Rating continuous. Made by Crosley Corp., Ohio. New and unused, complete with connection cable and mounting rack. Price quoted against enquiries.

42in. **EXPONENTIAL HORNS.** 1⅛in. fitting. These horns have a 28in. square flare, weigh approx. 25 lb., and measure 44in. from top to bottom, **£2/19/6**, carriage 7/6.

VITAVOX PRESSURE UNITS. Heavy duty P.M., 20 watts. To fit the above horns, **£4/9/6**, carriage 5/-.

ROTARY CONVERTERS. 230 v. D.C. to 230 v. A.C. at 110 watts. Complete with voltage controlling sliding resistor, **£7/10/-**, carriage 10/-.

ROTARY CONVERTERS. 12 v. D.C. input 230 v. A.C. output at 100 watts. Brand new, **£4/17/6.** Ditto, 24 v., same price, carriage 7/6.

R.1155 COMMUNICATION RECEIVERS. Individually tested and despatched in good working order. Cases slightly soiled, **£8/19/6**, carriage 10/-.

R.1132A RECEIVERS. In good condition, **£2/19/6**, carriage 10/-.

POWER UNIT, TYPE 3. Made for use with the R.1132A, this is a standard rack mounting job to match the receiver and is for 200/250 v. 50 cycle mains with outputs of 250v. D.C., 100 mA., L.T. 6.3v. 4 amps. Price **£3/10/-**, carriage 5/-.

RECEIVER, TYPE 109. An 8-valve ex-Army receiver, in good condition, complete with built-in power supply, loudspeaker and four spare valves. Frequency range on 2 bands, 1.8-3.9 Mc/s., 3.9-8.5 Mc/s. 15-168 metres continuous and covers some of the shipping band. This unit can be operated from a 6 v. battery. Price **£3/10/-**, carriage 5/-.

HOOVER 1/6TH H.P. MOTORS. 400/440 v. Three phase. Standard shaft. 1,425 r.p.m. Brand new in original maker's cartons, **£3/10/-**, carriage 5/-.

VARIABLE VOLTAGE REGULATOR TRANSFORMERS. Input 230 v. A.C. at 21 amps. Output 57.5 in 16 equal steps to 230 v. at 21 amps. Ex-Govt., in perfect condition, **£15**, carriage 5/-.

TRANSFORMERS. Input volts 0-10, 20, 30, 50, 100, 150, 200 and 240 v. Output 2000-0-2000 at 450 mA., **£5/10/-**, carriage 10/-.

TRANSFORMERS. Heavy duty, suitable for welding. 230 v. Prim. 50 cycles. L.T. variable, 11½ v.-13½ v. 60-70 amps., **£3/19/6**, p.p. 5/-.

TRANSFORMERS. 12 v. Car Radio, ex-Philco, 300 v. H.T. 90 mA. Brand new and unused, only **12/6**, p.p. 1/6.

TRANSFORMERS. Auto., 110 or 230 v., in or out, for stepping up or down. 750 watt, switched and fused. By B.T.H., **£4/15/-**, carr. 5/-.

HALF MILE OF TWIN DON "8" TELEPHONE WIRE. Brand new. On wooden drums, **£2/12/6** per drum, carriage 8/6.

SIEMENS HIGH-SPEED RELAYS. Twin 1,000 ohm. coils, as new, **15/-** each, p.p. 1/-.

PHOTO-ELECTRIC MULTIPLIER CELLS, TYPE 931A, £2/10/- p.p. 1/-.

813 **CERAMIC VALVE HOLDERS,** brand new, **9/6**, p.p. 6d. Ditto 832 valve holders, used but in good condition, **5/-**, p.p. 6d.

TELESCOPIC AERIALS. Chromium plated. Min. length 12in., max. length 48in. Ideal for Car Radios, 8/6 each, p.p. 9d.

METERS.

0-1 mA., 2½in. F/Mounting, new and boxed	**21/-**, p.p. 1/-
0-1 mA., 2in., R.F. Round	**5/9**, p.p. 1/-
0-30 mA., 2½in. F/Mounting	**12/6**, p.p. 1/-
0-30 mA. 2in. Round, new and boxed	**7/6**, p.p. 1/-
0-200 mA., 2½in. F/Mounting	**12/6**, p.p. 1/-
0-10 amps. D.C., 3½in. F/Mounting	**15/-**, p.p. 1/6

REFLEXED SOUND PROJECTORS—HAILING LOUDSPEAKERS. 10 watts output. Size 14½in. round flare, length 12in. Perfect condition, **£5/9/6**, carriage 5/-.

PARMEKO OUTPUT TRANSFORMERS. 25 Watts. for 6L6 valves. To match, 3, 8 and 15 ohms. New and unused, **29/6**, p.p. 3/6.

CAMERA CONTROL UNIT, TYPE 35. 24 v., **25/-**, p.p. 2/6.

MANY OTHER LINES IN STOCK; YOUR ENQUIRY INVITED; QUOTATIONS GLADLY GIVEN BY RETURN.

15 LITTLE NEWPORT ST., LONDON, W.C.2

GERrard 6794/1453.

MIDLAND INSTRUMENT CO.

P.M. SPEAKERS, all brand new, less transformer, Elac 6½in. dia., **12/6**, post 1/6. Goodmans 6½in. dia. wafer type, **10/-**, post 1/3. Elac 3½in. square front, **10/-**, post 1/-. Plessey 3in. dia., **8/6**, post 9d.

SANGAMO WESTON AIRCRAFT INSTRUMENTS, each contains 2 separate and easily removable moving coil microampere meters, 1¾in. movement edgewise pointer scale, less the 2 neon lamps usually fitted, **7/6**, post 1/-.

BECK PRISMATIC PERISCOPES, 6x magnification, adjustable eyepiece at right angles, length 17in., extends to 23in. Detachable handgrip, perfect condition, in leather carrying case, bargain, **25/-**, post 1/6.

VENNER TIME DELAY SWITCHES, 24-v. operation, consists of a high grade clockwork movement, with external press button wind, 2 electro magnets with 5-pole cam operated contacts, in smart metal case size 3½in. × 2¾in. × 2¼in., fitted 4-way terminal block, new boxed, fraction of original cost, **7/6**, post 1/3.

HOOVER BLOWER MOTORS, dual voltage, with terminations for 12 or 24-v. D.C., otherwise suitable for 20 or 40-v. A.C., length 5½in., dia. 3in., fan casing 4½in. dia. inlet and outlet ports 1¼in. dia., the most useful and versatile blower offered, suitable for car heaters, air conditioning and cooling purposes, new, unused, **25/-**, post 1/6.

ELECTROLYTIC CONDENSERS, 32-mfd. 450-v. D.C., by Zenith, Micamold etc., new and guaranteed, cartons of 25 condensers, **20/-**, post paid.

ANTI-VIBRATION MOUNTINGS, floats on 16 tension springs, 10lb. stress, 4 equals 40 lbs., brand new, sample 6d., post paid; cartons of 48 mountings **7/6**, post 2/4, reduction for quantity.

CHARGING KITS, consists of a G.E.C. 12-v. 1½-amp. selenium full-wave rectifier, and a Douglas 200/250 v. transformer, specially wound for this rectifier, with requisite voltages to charge a 2, 6 or 12-v. battery at 1½ amps., 2 brand new components, with circuit diagram and instructions, **25/-**, post 1/8.

PROJECTION UNITS, consists of an optical mount, fitted with a bloomed f/2.2 Achromatic lens, 3½in. focal length, at one end, also a convex/concave ground glass at the other, attached to an enclosed lamphouse, fitted with a 24 v. 15-watt lamp, and polished reflector, fraction of original cost, **10/-**, post 1/-.

ARROW SWITCHES, 250 v. 25 amp., rotary 4-position, 3-heat and off series parallel, panel mounting, complete with pointer knob, new boxed, worth 15/-, our price **2/6**, post 1/3; **24/-** doz., carriage 5/-.

AMPLIFIERS TYPE A-1271, consists of a VR-56 valve, type P-3000 relay, 400-ohm 6-pole, 4-make, 2-break, 2 transformers, potentiometer, various resistors and condensers, cannon plugs, in metal case size 5in. × 5in. × 5in., perfect condition, **10/-**, post 1/10.

PERMANOID (P.V.C.) covered connecting wire, single 1/032 tinned copper, .030 insulant, brand new 250-yd. coils, in red, yellow, green, brown or purple, **12/6** coil, post 2/-. 5 coils, one of each colour, **50/-**, carriage 6/-. Samples on request.

WIRE STRIPPERS, strips the insulation from flexes and cables up to ⅜in. dia., micrometer adjustment, brand new boxed, toolshop price 15/-, our price **5/-**, post 6d., 2 for **10/-**, post paid.

U.S. RELAYS, Leach pattern by G.E., 200-ohm, 2-pole changeover, **1/6**, post 4d.; **15/-** doz., post 1/8. Ditto, 3-pole changeover, **1/9**, post 4d.; **18/-** doz., post 2/-. Taken from new equipment, reduction for quantity.

VARIABLE RHEOSTATS, wire-wound on ceramic, 50-ohms at 1-amp., laminated wiper arm, bakelite knob control, in diecast cases size 5¾in. × 4¾in. × 2¼in., fitted on/off toggle switch and 2 cannon plugs, new, boxed, **7/6**, post 1/6.

V.H.F. SWITCHES, an ideal switch for use when one aerial feeds two T.V. etc., sets 4-position switch gives the following conditions, both off, No. 1 on only, No. 2 on only, both on, in base mounting metal cases size 4in. × 2¾in. × 1½in., fitted 3 Pye sockets, new, unused, worth 20/-, our price **3/6**, post 1/-.

Many other bargains; send 3d. with S.A.E. for current lists.

MIDLAND INSTRUMENT CO., MOORPOOL CIRCLE, BIRMINGHAM, 17

Tel.: HAR 1308

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1 KW TELEGRAPH TRANSMITTERS. Two HF 300's output. Operation 3.5 mc. to 16 mc.

BC610 TRANSMITTERS with speech amplifier, aerial tuning unit, etc. Brand new.

RCA TRANSMITTERS. Type ET-4336. Complete with original speech amplifier, crystal multiplier and VFO units. Unused and reconditioned. Can be supplied with very large quantity of spares.

RCA TRANSMITTERS. Type ET-4332 modified by R.A.F. for use on crystal or master oscillator. Complete with speech amplifier.

MAGNETO 10 LINE U.C. TELEPHONE SWITCHBOARDS (complete).

SCR510's, complete with Power Pack and telescopic aerial.

SCR536 (BC611) in excellent condition.

A.R.88D's, A.R. 88LF's, A.R.77's, S27's, HRO, R.109 and others.

METAL RECTIFIERS, Type 1B, D.C. output 10 amps at 22v. input 220/250v., 50 c/s.

All above items in excellent working condition.
Working demonstration upon request.

SPARES A large selection available for SCR399 (BC610), ET4336, SCR610, EE8 Telephones, and Teleprinters type 7B.

TX VALVES 805, 807, 813, 861, 866A, 100TH, 250TH, and many others.

Large stock of Tx condensers, crystals and other components. Alignment and repair of communication receivers and all other short-wave equipment undertaken.

P.C.A. RADIO

New Address, Offices and Works:

BEAVOR LANE, HAMMERSMITH, LONDON, W.6

Telephone: RIV 8006

12 VOLT-4 WATT MOBILE AMPLIFIERS. BRAND NEW AND UNUSED.

In Original Cartons. KT.61 output. Complete with power unit and synchronous vibrator (Wearite type QFA/12), and all valves. Fitted with rubber covered heavy duty battery lead.
By famous manufacturer, in handsome metal cabinet, grey crackle finish. Size: 10in. × 6½in. × 8in. Output impedance 3 ohms. With the addition of a suitable loudspeaker, this is ready for operation. Finest quality components throughout. Robustly constructed for rough handling. Complete with carbon hand-microphone with screened lead.
LASKY'S PRICE COMPLETE .. £7 . 19 . 6
OR LESS MICROPHONE .. £6 . 19 . 6
Carr. 5/- per unit extra.

R.1155 RECEIVERS BRAND NEW—AERIAL TESTED BEFORE DESPATCH

These well-known ex-Air Ministry Receivers need no further introduction. Supplied complete with 10 valves and full circuit data.
LASKY'S PRICE £11 . 19 . 6
USED MODELS £7 . 19 . 6
Carriage 12/6 per unit extra, including 10/- returnable on packing case.

FULLY ASSEMBLED POWER PACK AND OUTPUT STAGE

for R1155 Receiver. For use on 200-250 volts. A.C. mains.
LASKY'S PRICE 79/6. Carriage 5/- extra.
The above power pack fitted with 6½in. speaker.
LASKY'S PRICE £5/5/-. Carriage 5/- extra.

PORTABLE RECORD PLAYERS

Containing a new Plessey single speed automatic record changer (78 r.p.m.). Magnetic pick-up and 2-valve amplifier, with metal rectifier. For use on 200-250 v. A.C. mains. Amplifier uses EF.36 and EL.32 giving 3-watts output, tone and volume controls, 5in. speaker. In rexine-covered cabinet. size: 17 × 17 × 8in. With carrying handle. Though store soiled, these players are new and every one is fully tested before despatch. LIMITED QUANTITY.
LASKY'S PRICE £10.19.6
Carriage 10/6 extra.
The cabinet available separately, soiled. PRICE 25/-. Carriage 5/- extra.

HEARING AIDS

In metal case, 2½ × 4½ × 1in. Self-contained with batteries and 3 sub-miniature valves. Volume control and on/off switch, internal crystal microphone. Perfect working order. Soiled.
LASKY'S PRICE 49/6. Postage 2/6.

MINIATURE SINGLE HEADPHONE

On spring steel headband. Diam. ⅞in. Resistance 200 ohms. With 30in. twin cord PRICE 17/6.

TANNOY PRESSURE UNITS

10 watts, 7.5 ohms amp. PRICE 59/6. Carriage 4/6 extra.

1-lb. REELS OF RESIN CORED SOLDER. LASKY'S PRICE 7/6.

AERIAL ROD SECTIONS

Steel, heavily copper plated. 12in. long, ⅜in. diameter. Any number may be fitted together.
PRICE 2/6 per doz. POST FREE.

MANUFACTURERS' SURPLUS T.V. COMPONENTS

Wide Angle Scanning Coils. Low imp. line and frame .... pair	19/6
Scanning Coils. 35 mm. Low imp. line and frame	12/6
Frame output transformer. Standard	10/6
Focus Coil. 35 mm. electro magnetic	12/6
Line or Frame B.O. transformer. Auto	4/6
Wide Angle Frame B.O. trans. ...	10/6
P.M. Focus Magnets. With vernier, 35 mm.	
Tetrode	15/-
Triode	17/6
Wide Angle P.M. Focus Unit. For all 38 mm. tubes. With vernier and picture shift, Ferroxdure	25/-

PLESSEY

Scan coils per pair	25/-
Width Control	6/6
P.M. Focus magnet	12/6

CAR RADIO SPECIAL—PARTLY ASSEMBLED CAR RADIOS

Small size case, 12 × 4 × 6in. Will fit most cars. For either 6 or 12 volts, depending on vibrator. Chassis supplied with 5 octal valve holders, medium wave aerial and oscillator coils, output transformers, volume control, sundry resistance and condensers, dial and knobs. Case finished in brown crackle. Dial calibrated 150-550 metres, 5 valves to suit. One each, either GT or metal: 6SA7, 6R7, 6V6, 6K7, OZ4.
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Or less valves, 69/6. Carriage 5/- extra.
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CIRCUIT for 5 valve car radio, using above chassis. PRICE 1/6.

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Chrome 2 section telescopic. Extends to 75 inches. 2 bolt side fixing. Complete with 48 inches of co-axial cable. Suitable for T.V. use.
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Our new 1954 Mark II model. For 12in. c.r. tubes. Finished in beautiful figured walnut veneer, with either light, medium or dark polish. Supplied complete with mask, glass, back, speaker-baffle and fret, castors and c.r.t. neck protector. Inside dimensions: 16½in. deep, 17½in. wide, 28in. high. Overall height 32in. and width 18½in.
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This cabinet can be supplied with aperture for 16in. or 17in. c.r.t. at no extra charge.

COLLARO 3-SPEED AUTO CHANGERS. Model 3RC/521. New and unused in maker's carton.

Cream or fawn finish Complete with hi-fidelity "studio" turn over crystal pick-up.
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Wire ends, 1/6 each.

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R.M.1	3/10	K3/40, 3.2 kV.	6/-
R.M.2	4/3	K3/45, 3.6 kV.	8/2
R.M.3	5/-	K3/50, 4.0 kV.	8/8
R.M.4	18/-	K3/100, 8.0 kV.	14/8
		K3/160, 12.8 kV	21/6

METAL RECTIFIERS

6 or 12 volt F.W. Bridge

2 amps.	9/-	6 amps.	21/-
3 amps.	9/11	10 amps.	32/6
4 amps.	12/11		
6 volts		**12 volts**	
½ amp.	2/6	½ amp.	3/11
1 amp.	4/6	1 amp.	6/6

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PUSH PULL, VERY HIGH GAIN.

4 valves: 2 UL41 in push pull, 1 UCH42 and 1 UAF42. Input voltage 100/110 AC/DC. Very easily converted to 230 volts. Supplied with circuit diagram and full details. Size:—9 × 4 × 4 inches. Uses 2 metal rectifiers, 1 each RM2 and RM3. Ideal for ships record players, tape recorders, home record players, baby alarms, etc., etc. Supplied complete fully assembled and wired, with 4 valves. 60 M/A smoothed output for radio tuner, etc.
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Full circuit and data supplied.
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With circuit. 4/6 pair.

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Aerial and Oscillator. 5/11 pair.

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Plastic Tape by famous British manufacturer On Cyldon metal spools. 600ft. 6/11. Postage 1/6 per reel extra.

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.0005 mfd., 15 Kv.	6/6
.0005 mfd., 10 Kv.	3/6
.04 mfd., 12.5 Kv.	7/6
.1 + .1 mfd., 3.5 Kv.	5/11

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All with 3 ohm speech coil.

2½in.,	15/-	5in.,	14/6	8in.,	19/11
3in.,	14/6	6½in.,	15/-	10in.,	19/6
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RF.EHT for line flyback. 6-8Kv. with EY51 heater winding. Suitable for home construction T.V., 19/6 each.

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ALL COMPONENTS IN STOCK.

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Carriage 5/- extra.

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Uses 4 valves, vibrator and metal rectifier. Valve line up: ECH35, EF39, EBC33, EL32. 8in. P.M. Speaker fitted. In attractive polished walnut veneer cabinet. Size 19 × 8 × 15in. Full vision dial, battery economy switch, p-u. sockets, tone control. Superhet. Wavebands: 200-500 metres; 50-120 metres; 20-50 metres; 10-20 metres.
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TRANSMITTERS 1154, 30/-.
TRANSMITTER-RECEIVERS TR/9, 47/6.
POWER units (motor generator type), 20/-; and a host of other ex-aircraft radio and electrical items; send your enquiries.
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EDDYSTONE 640 receiver, as new; £15.—Martin, 15, Reigate Rd., Pomphlett, Plymouth. [2918

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HALLICRAFTER SX28, recently overhauled, recalibrated Webb's Radio regardless of cost, offered at £45.—James, Wireless College, Colwyn Bay. [2902

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R.F. Units, types 26 @ 37/6, 25 @ 17/6, 24 @ 12/6, brand new in original cartons.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [2877

FOR sale, new, war surplus AR88D SX28 and H.R.O. receivers, with bandspread coils, etc., view and trial.—Westlon Radio, 103, Claybrook Rd., Hammersmith, London, W.6. [2903

VORTEXION 15-watt amp, complete with gramo, motor and turntable, two 12in Rola speakers on baffles and microphone on adjustable stand, in perfect order; £25.—Box 5709. [2985

H.R.O. Senior Receiver, p.p. and 7 coils, good condition, offers over £24; 19in self-standing 5ft 5in rack; R.C.A.-R.V.T. 15B aircraft 'phone, X.T.R.—Cyril Hunt, Sheringham, Norfolk. [2919

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TAYLOR 6SB sig.-gen., as new, instructions, spot-freq. I/F's; first £6/10 secures.—D. & J. Draper, 4, Empress St., Accrington. [2939

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters multi-range meters in stock; your enquiries are invited.—Requirements to R.T. & I. Service 254, Grove Green Rd., London, E.11. Ley. 4986 [0056

The
PARTRIDGE
Output Transformer UL2

A 'C' Core Transformer
for use in
HIGH QUALITY A.F.
REPRODUCING EQUIPMENT

This new Partridge p.p. output Transformer reproduces full A. F. range with very low distortion. **Each half primary is brought out to terminals as a separate winding and is tapped at 45% of the turns.** Characteristics of the UL2 permit considerable negative feedback being taken from the secondary and fed to a point three or four stages back. The unit is hermetically sealed.

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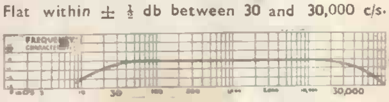

★ **POWER RATING**: *50 watts at 60 c/s. 14 watts at 30 c/s for less than 0·5% harmonic distortion.*

★ **FINISH**: *Bronze coloured stove enamel.*

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TOLWORTH SURREY

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SPECIAL rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb, d.c. input 12v 200va, out, 24v, 32v, 50v, 110v, 230v d.c. to 230v, out, 250va, £28/10 del.; also converters for radiogram and general use, inputs, outputs and prices as above; the above also supplied without smoothing, £25 del, immediate despatch; trade supplied.
AT a purchaser's home 60 mls. S.W. of Sutton Coldfield a 24v.
TELEVISION converter was tested on Ekco television, 12in tube, stated consumption 135 watts d.c. current from battery only 9½amps, picture and sound were perfect and completely free of interference or flutter.
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FERROGRAPH magnetic tape recorder, 76gns.
WEARITE tape decks and component parts.
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LEAK amplifiers, 10w £17/17; preamp £10/10.
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EVERYTHING for the professional recording studio and quality dealers.
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HIGH fidelity, v.h.f., F.M. tuner units, a new receiver, entirely self-contained, mains driven, 8-valve miniaturized chassis, 2 watts output at extreme ranges, price includes aerial and new type H.F. 810 W.B. speaker; £25; demonstration daily; see also display advert. page 134.—Bel, Marlborough Yard, Archway, N.19. Arc. 5078. [0185

CINE-VOX disc recording equipments, type C7J for high-quality recordings from existing microphone equipment; price from 28gns; also available as a complete channel inclusive of mic., amplifier and playback equipment, at 70gns; type C7, for highest quality professional requirements—recorder mechanism at 48gns, or complete channel at 110gns; demonstrations arranged in London.
PLEASE write for details to K.T.S., Ltd., "Coplow," Park Rd., Braunton, N. Devon. Tel. Braunton 224. Callers by appointment only. [0209

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E.M.I. disc recorder model 2300, two mikes, blanks, new condition; £65; buyer collects.—Davies, 26, Pier St., Aberystwyth.

CHANCERY G33 LP gramophone attachments, quantity about 1,000, unused, lying in Australia, for sale, what offers? freight paid.—Box 5711. [2988

TRUVOX Tape Deck Mark III (latest model), unused, in maker's sealed carton; genuine bargain, 19gns.—Dumville, 11, King's College Rd., N.W.3. [2931

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SURPLUS to requirements: new, unused, 1954, 2 Brierley microarmature pick-ups, diamond points, one 78, one L.P.; £15 pair (without transformer).—Ormerod, 21, Tewkesbury Ave., Blackpool, S. [3024

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SCR522, ET4332B T.U.s for BC375, T1131, TR1430, TR1143A offered.—E.W.S. Co., 69, Church Rd., Moseley Birmingham. [2708

NEW COMPONENTS

CRYSTAL microphone inserts (Cosmocord Mic-6), guaranteed brand new; 15/6, post free.—Radio-Aid, Ltd. (Retail Dept.), 29, Market St., Watford. [0036

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NORTHERN TRANSFORMER CO.
215 BARKEREND ROAD
BRADFORD, YORKS

TR1154/55 RECTIFIERS
Input:—200/250v., 50~S.P. Output:—6.3v., 13A.—220v., 110m.a.—1200v., 200ma.
NEW CONDITION—TESTED—GUARANTEED
£17-10-0 per set. Carriage extra.
A. J. WHITTEMORE (Aeradio) LTD.
Croydon Airport, Surrey. Tel: Croydon 5791, 4383, 7744. Grams: Aeradio, Croydon.

Introducing the:—
TYANA TRIPLE THREE

Reg. Design, No. 867884
MAKE SOLDERING A PLEASURE
SMALL SOLDERING IRON
Complete with detachable BENCH STAND **19/6**
The smallest high-power soldering iron. Length only 8½in.; adjustable long bit dia. 3/16; mains voltages 100/110, 200/220, 230/250.

The "STANDARD"
Popular Soldering Iron

now reduced to 14/11
Replacement Elements and Bits for both types always available.
KENROY LIMITED
152/297 UPPER ST., ISLINGTON, LONDON, N.1.
Telephone: Canonbury 4905-4663

BUSINESS OPPORTUNITIES

OLD-ESTABLISHED firm of exporters in the electronic field, invite manufacturers seeking overseas sales to communicate Box 0239.

FOR sale, name and goodwill (4 years display advertising in "Wireless World") of radio business; suit enthusiasts; £250.—Box 5626. [2962

GENUINE offer for Radio/TV engineer with ambitions, stock data, equip., transport, 'phone workshop and clients; £200; help given. N.W. dist.; reason sale age.—Box 5556. [2945

WORK WANTED

ASSEMBLY, wiring of all types of electronic eqpt., control panels, switchboards, etc.—R.A.E., 377, High Rd., London, N.2. [0219

AID approved contractors for machining, assembly coilwinding, speciality, distrene work, and toroidal winding.—Bel Sound Products Co., Marlborough Yard, N.19. [0183

ELECTRONIC sub-contracts and prototypes; modern miniature technique, exp. government work, skilled labour only.—Astra Radio and Television, Electra House Haslemere, Surrey. Tel Haslemere 1134 [2833

MACHINERY FOR SALE

TRANSFORMERS, Metrovick, oil filled, 230/18,000v, 4kva, 50 cycles, brand new ex-Govt. surplus; to clear £15 each, plus 17/6 carriage; or invite offers for 200 lot.—Wireless Instruments (Leeds), Ltd., 54-56, The Headrow, Leeds, 1. Tel 22262. [2982

MISCELLANEOUS

COIL winding machines; from £15.—Hawkins, 170, Witton Rd., Birmingham, 6. [2879

FREE list; sensational prices; valves, components.—Jack Porter, Ltd., College St., Worcester. [2974

DURALUMIN rod, ½in dia., in length up to 5ft 6d per foot; min. orders 15ft; carriage extra.—Estlo Trading Co., Bangor, Caerns. [3018

METALWORK, all types cabinets, chassis, racks, etc., to your own specifications; capacity available for small milling and capstan work up to 1in bar.
PHILPOTT'S METAL WORKS, Ltd. (G4B1), Chapman St., Loughborough. [0208

GESTETNER (hand) rotary duplicator, Ream model, oak cabinet on metal legs, many accessories, perfect condition; £17/10.—Box 5710. [2986

YOUR own tape recording transferred to disc.—Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio recordings, tape recording service. [2507

PLYWOOD—Hardboards. Send s.a.e. for free price lists and samples, including 3/16in mahogany ply 10d sq ft, sheets 72in×36in; hardboard all sizes, from 6d sq ft; free delivery (100 miles).—N. Gerver, 2-10, Mare St., London, E.8. Amherst 5806. [0027

ENGRAVING amateurs and trade could take the opportunity of engraving problems in the future by getting in touch with A.G. Engraving, 19a, Windmill Rd., London, S.W.18. Bat. 5793. Brass, bronze, erinoid, Perspex dials; one knob or repetition equally entertained. [0034

COPPER wires enamelled, tinned, Litz. cotton, silk covered, all gauges; B.A. screws, nuts, washers, soldering tags, eyelets, ebonite and laminated bakelite panels, tubes, coil formers; Tufnol rod, headphones, flexes, etc.; latest radio publications, full range available; list, s.a.e.; trade supplied.—Post Radio Supplies, 33, Bourne Gardens, London, E.4. [0138

YOUR tapes to disk (78 & L.P. Microgroove, genuine), tape, disks, accessories; trade terms on above; E.M.I. & Ferrograph Recorders; studio and mobile service, professional standards, "Eroica" Recording Services (Regd. 1949), Peel St., Eccles, Manchester, Eccles 1624, Musical Director Thurlow Smith, A.R.M.C.M. [0121

NOTICES

HI-FI demonstrations at Electronics Exhibition, Manchester, 14th-20th July, by H. & H.—Free admission, tickets only (s.a.e.) from Holiday & Hemmerdinger, Ltd., 74, Hardman St. Manchester, 3. [3005

BRITISH SOUND RECORDING ASSOCIATION. Details of membership, open to the professional sound recording engineer and all others interested in recording high quality reproduction and other branches of audio engineering, together with details of the London lecture programme and the Manchester, Portsmouth and Cardiff Centres, may be obtained from the Hon. Membership Secretary, H. J. Houlgate, A.M.I.E.E., 12, Strongbow Rd., Eltham, S.E.9. [0031

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

KENT EDUCATION COMMITTEE.
MEDWAY College of Technology.
RADIO technician required for maintenance of receivers and test gear and for construction of prototype apparatus.
SALARY £350 to £410 according to age and experience.
APPLY by letter stating age, qualifications and experience, to the Principal, Medway College of Technology, Horsted, Maidstone Rd., Chatham. [2972

FINISHED BUILDING THAT CHASSIS?

Why not have the cabinet made to your own specification!

Send sketch and full details—we will quote by return. Or send 1/- for our latest illustrated catalogue of T/V, Radiogram, Table, Corner Baffle Cabinets, etc., in all of which the radio panel, motor and baffle boards may be cut to suit your own requirements.

Components
We hold extensive stocks of Radio and T/V components. No list available.

Chassis
Send for free leaflet on our latest 5 valve, 3 waveband superhet radiogram chassis.

Amplifiers
Send for details of our domestic 4½ and 5 watt amplifiers.

Tape Recorders
The latest 2-speed "ELIZABETHAN" model available at 48 gns. Send for details.

LEWIS RADIO CO.
Dept. 754, 120, Green Lanes, Palmers Green, London, N.13
Tel.: BOWes Park 6064

MALVYN ENGINEERING WORKS
[illegible]cision Engineers
Manufac[illegible]ers of: Chassis, Small Press[illegible]gs [illegible]achined Components, Wiri[illegible] Mechanical Assemblies [illegible] specification.
[illegible] Quantities. Enquiries Invited.
[illegible] ROAD, WARE, HERTS.
[illegible]ne: Ware 465

SAMSON'S SURPLUS STORES

30ft. AERIAL MASTS, TYPE 55. Comprising 9 ashwood sections and 1 metal mast top section with aerial clamp attachment. Complete with base plate, guys and rings. Dia. of first section 1¾in. Dia. of top section ¾in. Supplied new in maker's transit cases with instructions, 65/-, carr. 5/-.

12in. COPPER-PLATED AERIAL RODS. Push-in sleeve joint, 8/6 per half gross; 15/- per gross; £2 per 1,000; plus carr. These rods are very useful to gardeners and farmers.

AMAZING OFFER—MINIATURE ACCUMULATORS, by Willard Co. 36 v. 0.2 amp. Size 3⅜×1⅜×⅞in. Weight 5½ oz., 5/-, P.P. 6d. [illegible] v. 1.2 amp. Size 3⅜×1½×⅞in. Weight 4½ oz., 7/6, P.P. 6d. Or set of three 36 v. and one 6 v. in sealed container, £1, P.P. 1/3. Brand new and uncharged. Easily filled with hypodermic syringe.

BRAND NEW EX-ARMY MEDICAL HYPODERMIC SYRINGES. 1 c.c., complete with needle, 4/9, P.P. 6d. 10 c.c., with needle, 7/6, P.P. 6d. Extra needles 5 for 2/-, P.P. 6d.

BRAND NEW A.M. METERS. All by famous makers. 0-500, 0-100, 0-30 mA., 2¼in. D.C.M.C. panel mounting, 15/-, P.P. 1/-. 500-0-500 microamp blank scale 2¼in. panel mounting, 25/-, P.P. 1/-. 20-0-20 amps. 2in. sq. D.C.M.C. panel mounting, 8/6, P.P. 1/-. Master Voltmeter, 0-20 v. A.C. 50 cy. M.I. 6in. mirrored scale, 27/6, P.P. 1/6.

169/171 Edgware Road
London, W.2. Tel.: PAD 7851
125 Tottenham Court Road, W.1.
Tel.: EUS 4982
All orders and enquiries to our Edgware Road branch, please. This is open all day Saturday

SITUATIONS VACANT

GUIDED weapons.

THE Guided Weapons Department of Vickers-Armstrongs, Ltd., Weybridge, has vacancies for the following staff:—

GRADUATE engineers, with degrees in engineering, physics or mathematics, and 3 to 5 years' experience in one of the following categories:—
E.1. DESIGN and development of high pressure hydraulic or pneumatic systems and components.
E.2. DEVELOPMENT of techniques for vibration and/or climatic testing as applied to electronic equipment and design of associated test gear.
E.3. DEVELOPMENT work on reinforced plastics.
E.4. DESIGN of missile autopilots, simulators and computors.
E.5. DESIGN of U.H.F. and micro-wave transmitters and receivers.
E.6. DESIGN of transformers and magnetic amplifiers, with good general knowledge of electrical properties of materials.
E.7. DESIGN of electronic circuits and servo mechanisms.
E.8. ENGINEERING development of missile electronic equipments.

TECHNICAL assistants, with degree, Higher National Certificate or equivalent, and experience in one of the following categories:—
T.1. DEVELOPMENT and test of high pressure hydraulic or pneumatic systems and components.
T.2. ENVIRONMENTAL testing of missile components.
T.3. MANUFACTURE of prototype missile electronic equipments to M.o.S. specifications.
T.4. MANUFACTURE of reinforced plastic components and potting of electronics.
T.5. DEVELOPMENT and test of instrumentation for missile trials.
T.6. DEVELOPMENT of missile autopilots and analogue computers.

LABORATORY assistants, preferably with O.N.C. or equivalent.
L.1. ASSEMBLY, test and maintenance of hydraulic and pneumatic systems and components.
L.2. DRAWING and constructing test rigs used for mechanical and environmental testing.
L.3. MANUFACTURE of prototype electronic equipment and electro-mechanical devices. Layout and wiring from circuit diagrams and sketches, chassis work and simple machining.

DRAUGHTSMEN, with 2 years' experience or more, as follows:—
D.1. DESIGN of ground, airborne or missile types of radar equipment.
D.2. DESIGN of small mechanisms such as missile autopilots, and electro-mechanical computors embodying gyroscopes, accelerometers, small motors, gear boxes, etc.

APPLY to Employment Manager, Vickers-Armstrongs, Ltd. (Aircraft Division), Weybridge, Surrey, giving full particulars and quoting reference EO/G.W./reference number above.

WEYBRIDGE station 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. [2996

CITY OF LIVERPOOL
EDUCATION COMMITTEE.
RIVERSDALE Technical College, Riversdale Rd., Liverpool, 19.
PRINCIPAL: A. R. Kinsman, B.Sc.(Eng.), A.M.I.Mech.E., A.M.I.E.E.
APPLICATIONS are invited for the appt. of two Assistants (Grade A). Duties to commence Sept., 1954
SALARY: £415×£18—£670 p.a., plus allowances for training and graduation. Increments allowed for industrial experience and War Service. (Burnham Tech. Award.)
APPLICANTS must have seagoing experience and possess a good knowledge of technical electricity, to teach mainly radio telegraphy and procedure to students preparing for the P.M.G. Certificate Examinations.
THEY should possess the P.M.G. First Class Certificate and have had recent operating experience.
APPLICATION forms (and further particulars) obtainable from H. S. Magnay, M.A., Director of Education, 14. Sir Thomas St., Liverpool, 1. should be returned to him within two weeks of the appearance of this advertisement.
THOMAS Alker, Town Clerk and Clerk to the Local Education Authority. (JA.3563). [2948

RADIO and Television Engineers.
FIRST-class openings for an experienced Car Radio Engineer, Television Engineers and Senior Design Draughtsmen will shortly become available with a firm of repute in the London area.
ENGINEERS able to undertake immediately development work on Broadcast Radio and Television Apparatus would be offered an attractive salary
THE successful candidates will be eligible for Company Superannuation and Insurance schemes.
PLEASE reply, giving full details of experience, to Box 5289. [2917

HIGH Voltage Insulation Engineer.
THE ENGLISH ELECTRIC Co., Ltd., at Stafford have a vacancy for an engineer preferably with post-graduate experience in high-voltage engineering, to undertake investigations and development work in high-voltage insulation — Applications should be submitted to the Chief Insulation Engineer, Dept. C.P.S., 336-7, Strand, W.C.2, quoting Ref. 1329. [3032

SITUATIONS VACANT

ENGINEER required to take charge of

ENGINEERING Department of Factory manufacturing Quartz Crystals. University Degree and some experience of industrial or service electronic equipment essential. Rudimentary knowledge of chemistry an advantage. Reference E.

ENGINEER required in Development Laboratory engaged in frequency control systems. Combined knowledge of physics, mathematics and electronics required, and ability to work alone from fundamental ideas. Honours degree in physics necessary, and preferably some experience of industrial electronics an advantage. Reference D.

HOUSES can be made available to successful applicants in both vacancies.

APPLY in writing quoting reference letter, to PERSONNEL Manager, Standard Telephones & Cables, Ltd., Crystal Factory, Industrial Estate East, Harlow, Essex. [2905

FAULT finders and testers.

A LARGE electronic engineering company invite applications from

FAULT Finders

POSSESSING a good technical background of V.H.F. transmitter receivers employing frequency control, automatic modulation, A.G.C. automatic frequency systems. Knowledge of M.O.S. inspection procedure and requirements an advantage.

RATES of pay ranging from 4s 2d to 4s 11d per hour according to qualifications and experience.

APPLICATIONS are also invited from

SKILLED electronic wiremen and

ELECTRO-Mechanical instrument makers.

EAST London area.—Please reply, giving full details of experience, to Box 5542. [2944

WIRELESS Station Superintendent required by the

GOLD Coast Government Posts and telecommunications Department for two tours of 18 to 24 months in the first instance. Salary, etc., according to qualifications and experience in consolidated scale £990 rising to £1,230 a year, with gratuity of up to £150 a year. Outfit allowance £60. Liberal leave on full salary. Free passages. Candidates should possess a Higher National Certificate or equivalent, and have had practical experience in two or more of the following fields: V.H.F. link systems; H.E. communication network; frequency shift keying and teleprinter maintenance; V.H.F. and H.F. direction finding systems; aeronautical navigation aids (ground); manufacture of light engineering equipment. Candidates from the British Post Office should apply through departmental channels.—Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/29100/WF. [2980

E. K. COLE, Ltd. (Malmesbury Division):

THE Malmesbury Division of E. K. Cole, Ltd., is engaged in the development and production of radar and communication equipment associated with high priority defence projects. Vacancies exist in the Development Department for project engineers, engineers and assistant engineers with training and experience in the following fields:—

PULSE circuits.

Pulse modulators, strobe systems, Video amplifiers, time base generators, etc.

MICROWAVE technique.

Aerial design for radar scanners and waveguide components for high power T/R units. H.F. and V.H.F. Communication.

Airborne and ground receivers, transmitters and aerial systems.

TRANSFORMER design.

High frequency power transformers for airborne equipment.

MECHANICAL engineering.

Light mechanisms and structures for radar scanners.

APPLICANTS should have had technical training to Degree or Higher National Certificate standard, and in the case of project engineers and engineers appropriate technical design experience is necessary. Commencing salaries will be dependent on qualifications and experience, and will compare favourably with scales prevailing in the radio industry. Housing accommodation may be available in the near future for successful married applicants. A superannuation scheme is in operation, together with canteen and full welfare facilities. Applicants should apply in the first instance for a technical staff application form to Personnel Manager, E. K. Cole, Ltd., Malmesbury, Wilts. [2792

MOUNT VERNON HOSPITAL, Northwood, Middx

TECHNICIAN, with experience in electronics and workshop practice, required for the physics department; a first-hand knowledge of microwave and/or pulse circuit techniques would be an advantage; salary within the scale £450×£15 (3)×£20 (1)—£515 p.a. plus London weighting; N.H.S. superannuation scheme.—Applications to the Secretary and House Governor as soon as possible. [2971

ELECTRICIANS are required for work on industrial electronic equipment by the Steel Company of Wales, Ltd., Port Talbot.

APPLICANTS should have previous experience and/or good technical background as basis for period of training.

THOSE wishing to apply should write, giving full particulars of age, experience, qualifications, etc., to the

PERSONNEL Superintendent, The Steel Company of Wales, Ltd., P.O. Box No. 3, Port Talbot, Glam. [3030

SITUATIONS VACANT

APPLICATIONS are invited for the following additional vacancies:—
1. A YOUNG Engineer to work in a team engaged in design and development of electro-mechanical and electronic equipment for aircraft. Qualifications required are: (a) sound technical background in light electrical or electronic engineering. (b) Imagination, initiative and energy. (c) Inter B.Sc. or H.N.C. B.Sc. would be an advantage. Ref. Y.E.
2. A MAN to act as Senior Laboratory Technician in a team engaged in the development of electro-mechanical devices for aircraft. Essential qualifications are: (a) sound practical experience in light electrical, electronic or allied engineering. (b) Ability to express a theoretical design in terms of a good practical layout. (c) Ability to control and supervise laboratory assistants and wiremen in the execution of the above designs. An ex-R.E.M.E. A.S.M. with some civilian experience or a senior radio service engineer with the ability to adapt himself to this more varied type of work would be acceptable. Ref. S.L.T.
3. LABORATORY Technicians with the following qualifications: (a) practical experience in light electrical, electronic or allied engineering; (b) ability to wire-up neatly equipment from a theoretical circuit and test same intelligently; radio service engineers with a desire to engage in more interesting and varied work would be acceptable. Ref. L.T.
PLEASE apply in writing, giving full particulars, to: Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, quoting the appropriate reference. [2827

THE ENGLISH ELECTRIC Co., Ltd., have vacancies at
LUTON and in Australia for
JUNIOR Engineers and
LABORATORY Assistants.
APPLICANTS should have a sound knowledge of electronic circuitry with preferably some radar experience.
THESE positions are permanent and progressive and attractive salaries are offered for able and experienced men.
ASSISTANCE with housing for some of the posts may be given, and a staff pension scheme is in operation.
APPLICATIONS to Dept. C.P.S., 336-7, Strand, W.C.2, quoting reference 456V. [2810

WIRELESS Station Superintendent required by the NIGERIA Government Posts and Telegraphs Department for one tour of 18 to 24 months in the first instance. Option of appointment (a) on temporary terms with salary, etc., in scale £864 rising to £1,392 a year and gratuity of up to £150 a year, or (b) with prospect of pensionable employment with salary, etc., in scale £750 rising to £1,175 a year. Outfit allowance £60. Free passages for Officer and wife. Assistance towards cost of children's passages or grant of up to £150 annually for their maintenance in U.K. Liberal leave on full salary. Candidates must have had wide practical experience of modern radio techniques and equipment, in particular V.H.F. equipment, and preferably also V.H.F. multi-channel equipment.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/30086/WF. [2979

WIRELESS Operator Mechanics required for the FALKLAND Islands Dependencies Survey for service in the Antarctic for tour of 18 or 30 months in the first instance. Salary in scale £330 rising to £420 a year plus free quarters, subsistence, clothing and liberal canteen stores while in Dependencies; it is possible to save almost all emoluments. Liberal leave on full salary. Candidates must be able to transmit and receive morse at 20 words a minute (plain language or code) and be capable of elementary maintenance of wireless transmitting and receiving equipment.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/30572/WF. [2978

BUSH RADIO, Ltd., require for their development laboratories at Chiswick, W.4:
1. DEVELOPMENT engineers with at least 5 years' practical experience of domestic radio, television or communications circuit development; should be familiar with mechanical layout for production.
2. ASSISTANT development engineers with 2 years' practical experience of radio or television development and sound knowledge of measurement technique.
3. TECHNICAL assistants. Should have some practical experience and a real interest in radio and television. Preferably with technical knowledge to Inter. B.Sc. standard.
FOR Grades 1 and 2 it is desirable that applicants hold a degree or its equivalent qualification in engineering.
ALL the above positions are progressive and offer excellent prospects to men with ideas and the initiative to carry them out.
WRITE, giving full details of career to date and salary expected to: The Chief Engineer, Bush Radio, Ltd., Power Rd., Chiswick, W.4. [2806

SERVICE engineer, Glasgow, for amplifiers and recorders, mechanical dexterity advantageous; experience of TV neither necessary nor desirable.—Box 5625. [2964

ELECTRONIC engineer required immediately for development work on deaf aids.—Thomas Thirsk, 41, Lodge Rd., Croydon, Surrey. Thornton Heath 2165. [2824

HIGH - FIDELITY FREQUENCY MODULATION

REALISE THE FULL COMPASS OF YOUR EQUIPMENT.

OUR "WW" DESIGN FM AM VHF RECEIVER is available for EX-STOCK DELIVERY FIELD-PROVEN RELIABILITY AND SENSITIVITY.

Chassis with power supply..	£15.0.0
Less P/S	£11.17.6
Complete kits	£7.5.0

Leaflet 1/0.

Ring ARC 5078 for a demonstration.

Trade enquiries invited.

BEL SOUND PRODUCTS CO., Marlborough Yard, Archway, London, N.19.

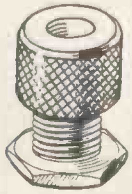
LARGE SPEAKER CABINETS

15" Walnut Veneered Sandfilled Enclosure with top baffle £18.0.0. Walnut Veneered Corner Cabinet Goodmans Axiom 150 Mk. II with super-imposed grill on front £16 0.0.

ALAN CRANSTON, (*Cabinet Makers*), 20, Lorrimore Bldgs., Olney Road, Walworth, LONDON, S.E.17.

PRE-SET CONTROL LOCK

Designed to lock the spindles of pre-set potentiometers or trimmers without rotational or lateral displacement of shaft.

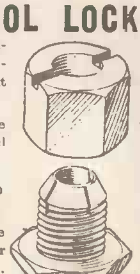


Will accept wide range of panel thicknesses.

TYPE CH2 (*right*)

TYPE PK2 (*left*)

Very attractive appearance for panel mounting.



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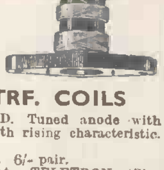
SUTTON COLDFIELD ELECTRICAL ENGINEERS

Clifton St., Sutton Coldfield, phone 5666

TELETRON SUPER INDUCTOR COILS

WITH MINIATURE DUST CORES

Type HAX. RF. Transformer, Triple wound for Xtal diodes. Extensively used as Radio "Head" for Recording and Quality amplifiers. 3/- each. Free from overlap.



DUAL WAVE TRF. COILS

Type TRF.A/HF. and TRF.A/D. Tuned anode with reaction. Ae.Pri. Windings with rising characteristic. Pre-aligned. 7/- pair.
S/Het. Range for S. M. and L.W. 6/- pair.
IFT's filters, etc. Stamp for data. TELETRON utilise all the features you expect from a good RF. Coil.

THE TELETRON CO., 266, Nightingale Road, London, N.9.

Trade enquiries to sole distributor. **SAM MOZER**
59, Kendal Avenue, N.18. Edm. 7707

SITUATIONS VACANT

THE English Electric Valve Co., Ltd., Chelmsford, requires the following technical staff for their camera tube division:—
(a) TEST ROOM SUPERVISOR.
(b) TEST CAMERA OPERATOR. Applicants should have H.N.C. in radio engineering or its equivalent, and some experience would be desirable.
(c) INSPECTOR. Experience of valve assembly and process detail is necessary and a science degree would be a considerable advantage.
(d) TECHNICAL ASSISTANT. H.N.C. is necessary for this vacancy, together with some knowledge of vacuum/chemical processing.
(e) CIRCUIT MAINTENANCE ENGINEER. Some experience in this field is highly desirable, together with suitable technical qualifications.
IN certain cases housing assistance may be provided.
WRITE with full details of qualifications and experience and quoting relevant vacancy and Ref. SA52, to Dept. C.P.S., 336/7, Strand. W.C.2. [3009

THE McMurdo Instrument Co., Ltd., Ashtead, Surrey, have the following vacancies in their Development Group. Applicants must be of British birth.
(a) ELECTRONIC Development Engineers (2) for circuit and test gear development work. Applicants should have an engineering degree. H.N.C or A.M.I.E.E. and be capable of working on their own initiative under the general guidance of a section head.
(b) TECHNICAL Assistants (2) required for general development work on mechanical and electro-chemical development. Applicants should preferably have O.N.C. or equivalent in an engineering subject, and should be capable of making up development samples from rough sketches and sorting out experimental results, etc.
(c) LABORATORY Assistants to assist Development Engineers on electrical and mechanical work
(d) A DETAIL draughtsman with experience in design of small electrical components, etc.
APPLY in writing to the Personnel Manager. [3010

ELECTRONIC Engineer required for development work on capacitance bridges and associated equipments, experience in this field essential, London area.—Write Box 5688. [2976

CHARGEHAND required for final test of radio and television; previous experience in a similar capacity essential.—Apply to Box 5495. [2934

ELECTRONIC engineers required by the General Electric Co., Ltd., Brown's Lane, Allesley, Coventry, in their development laboratories for work on the following items:—
(A) Application and circuit theory of transistors.
(B) Design of R.F. modulators.
(C) Investigation into valve parameters.
(D) Design of valve test apparatus associated with (C) above.
(E) Trials team in connection with guided weapons.
(F) Development of pulse circuitry techniques for guided weapons.
(G) Servo-mechanisms.
(H) Microwave development.
(I) Test equipment.
(J) General Radar circuit development.
(K) Power units including electronic stabilizers and rectifier systems.
(L) Magnetic amplifiers.
APPLICANTS, preferably with a degree or an equivalent qualification, should have had at least two years' experience in the development and engineering of service equipment as well as experience in one of the above.—Reply stating age, qualifications and experience to the Personnel Manager. Ref. R.G [2990

ELECTRONIC engineer required by capacitor manufacturers (East London) for development work on test instruments and electrical research; opportunity for young engineer with some years' experience.—Write Box 5810. [3029

RADIO service mechanics required by Smiths (Radiomobile), Ltd., for many parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [0342

DRAUGHTSMEN: vacancies for senior draughtsmen with experience of electronic and/or electro-mechanical engineering required preferably with experience of Ministry requirements.
EXCELLENT prospects with good commencing salaries; non-contributory pension scheme in operation; applications will be treated in strict confidence and should give full chronological details of qualifications, experience and age to JOHN A. SMITH, Ltd., 24, Lichfield St., Wolverhampton. [2938

EDITOR for technical publications dept. dealing with wide range of electronics and allied apparatus, exp. of handbook production essential; N. London area; £750-£900 p.a.—Write. Box 5557. [2946

TELEVISION/Radio service engineer, fully experienced all makes; good references; able to drive, permanent position.—A. G. Allen & Co., Ltd., 3-4, Bridge Rd., Wembley Park. (Arnold 2261.) [2968

TECHNICAL Writer (Electronics) required. Applicants must have similar previous experience, including editing and layout, and have ability to write on electronic and radar equipment.
GOOD salary and conditions. Pension Scheme.
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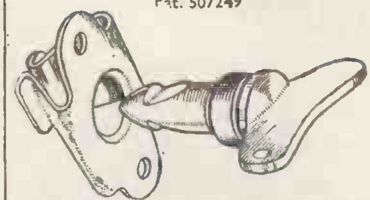

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SENIOR Mechanical Designer/Draughtsman required to lead a newly formed section engaged on special machine and equipment development required for the manufacture of paper dielectric capacitors.
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COMPETENT radio and television engineer required to take charge of a manufacturer's service department; ability to control staff and deal with telephone inquiries and correspondence, etc., essential.—Apply to Box 5496. [2935

AN outstanding opportunity is offered to an electronics liaison engineer in the new electronic equipment division of an old-established electrical company who are expanding to a South Coast area.
THE qualifications for this post are a sound technical background, considerable knowledge and experience of centimetric radar systems, pulse and microwave techniques; applicants should also be capable of co-ordinating the work of design and production authorities, and be able to acept the responsibility for assessing test equipment and specification requirements for radar production projects.
THE salary for this post will be commensurate with ability.—Interested applicants should write giving full details of the above experiences and age to Box 4830. [2817

ELECTRONIC Functional Test Dept. of The English Electric Co., Ltd., Luton, require additional staff with experience in radio and radar techniques and testing, or electronic sub-assemblies and systems.
HOUSING assistance available to successful applicants from the Greater London area. Write, stating age, qualifications, experience, present salary and Ref. S.A.38A, to the Personnel Manager, The English Electric Co., Ltd., The Airport, Luton, Beds.

BRITISH INTERNATIONAL AIRLINES, Ltd., Kuwait, invite applications from single men holding a radio engineer's licence, categories A and B or those prepared to accept separation from their families.
PREFERENCE will be given to applicants with Dakota aircraft radio installation experience.
EMOLUMENTS, free of local taxation, and conditions of service include:—
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5. FREE medical service, and home leave at the rate of eight weeks for each year's service in Kuwait.
6. THREE-YEAR contract, subject to normal termination clauses.
APPLICATIONS should be addressed to the Staff Manager, Subsidiaries, British Overseas Airways Corporation, Airways House, Great West Rd., Brentford, Middlesex. [2993

SENIOR and Junior Electronic Engineers required for audio and acoustic projects. Applicants should give full details of qualifications and experience by letter to—Personnel Manager, Pye, Ltd., St. Andrew's Rd., Cambridge. [2812

TECHNICAL writer (male or female) holding B.Sc. or similar degree, required to prepare instructional handbooks for complex electronic equipments.—Apply, stating qualifications, to Cinema-Television, Ltd., Worsley Bridge Rd., Lower Sydenham, S.E.26. [2987

TECHNICAL author for several interesting projects in North London area; exp. of electronics and communications desirable; perm. position for suitable applicant; salary scale £650-£800 p.a. depending on exp.—Write, Box 5558. [2947

TEST Room Supervisor required by electronic and radar firm of international repute for appointment which will provide an outstanding opportunity to the successful applicant in an entirely new production group located in the South Coast area.
ESSENTIAL qualifications are:—
(a) GOOD technical background.
(b) EXPERIENCE of the testing requirements associated with the production of microwave radar, servo and pulse equipment.
(c) ABILITY to organise and control staff.
SUPERANNUATION scheme exists and housing assistance may be given. Write fullest details of education, experience and age, to—Box 4907. [2832

EXPERIENCED radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wirers and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238

CHARGEHAND radar mechanic required to supervise a small maintenance section responsible for servicing microwave test equipment, previous experience of microwave equipment essential; applicants should have C. & G. Telecoms. III or National Certificate in Electrical Engineering.—Apply in confidence, to Personnel Supervisor, Ferranti, Ltd., King's Cross Rd., Dundee. [2961

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CONVERTORS, 400 watts output, 24 volts D.C. input, 50 volts 50 cycles 1 phase output. Complete with step-up transformer from 50 volts to 230 volts at 400 watts. **£12/10/-** each C/F.
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HEAVY DUTY CHARGERS. 200/250 volts A.C. Input 36 volts at 36 amps. Output D.C. £25, C/F.

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SITUATIONS VACANT

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TELEVISION engineers required for demonstration installation unit (T.V. transmission equipment); must be willing to travel overseas.—Apply by letter in first instance to: Engineer-in-Charge. Demonstration and Installation Section, Pye, Ltd., Cambridge. [2761

ELECTRONIC technician required for testing special equipment; sound basic knowledge of electronic instrument, radio or television circuitry essential; excellent prospects for successful applicant.—Econtrol, Ltd., Wilbury Way, Hitchin Herts. Tel. 1598. [2928

PARTRIDGE TRANSFORMERS, Ltd., require junior designs engineer; young man having slight experience of transformer designing preferred; very good salary; permanent position.—Apply in writing, Chief Engineer, Partridge Transformers, Ltd., Tolworth, Surrey. [3022

ELECTRONIC or electrical engineer required for senior post in development laboratory of capacitor manufacturer; excellent scope for man under 35 with experience in capacitor, insulation or cable industry; works East London.—Write in confidence Box 5271. [2907

PYE, Ltd. require experienced development engineers for radio receiver development in Cambridge; salaries in the range of £400 to £800 according to qualifications.—Apply Personnel Department, Pye, Ltd., St. Andrew's Rd., Cambridge. [2997

LEADING capacitor manufacturer requires technical sales assistants for internal vacancies; salaried position pension scheme; electronic/electrical experience essential.—Write, setting out full details of age, experience and salary required, to Box 5266. [2910

FULLY experienced Radio/Television Engineer, able to drive, required by Relay Radio and Television Rental Company, who are extending and developing in the West Midlands, living accommodation available; commencing salary from £550; excellent prospects for progressive man.—Box 5689. [2977

ELECTRONIC Engineer (about 30 years) required by Scientific Instrument Makers for servicing photo-electric instruments. Good prospects for keen man. Camden Town district. Five-day week, superannuation, good welfare facilities.—Please apply, stating age, experience and salary required to Box 5084. [2876

ELECTRONIC development engineer required for firm in S.E. London; H.N.C. or equivalent standard with some electronic test laboratory practice, and a flair for design work; commencing salary in the neighbourhood of £600.—Write, giving full particulars, to Box 5769. [3015

DECCA RADAR, Ltd., require technical electronic inspectors for permanent and progressive staff posts; wide practical experience in a similar field is desirable, backed by a sound technical training.—Apply to the Personnel Officer, Decca Radar, Ltd., 2, Tolworth Rise. Tolworth, Surrey. [2963

SERVICE engineer required, good remuneration, illness and accident benefit, good prospects, furnished flat available if required; no T/V servicing after 6 p.m.; able to drive; only first-class men capable of working without supervision need apply.—N. E. Chapman, 48. New Rd., Peterborough. [2994

SENIOR Development Engineer required for work on impregnated and other dielectrics; the applicant should be a physicist, physical chemist or electrical engineer of Degree standard, and will be required to initiate and supervise the development through all its stages.
THE position offers exceptional scope to a man of better than average capabilities; well-equipped laboratory available, but successful applicant will be required to improve facilities as need arises.
APPLY to Box 5770, quoting B.H.1. [3016

TECHNICAL Translator (British born) with fluent Dutch and/or German or French for international electrical concern in Holland; sound knowledge of electronics and television; preferably unmarried and willing to live abroad; salary according to qualifications.—Full details to Box 5778. [3025

TRANSFORMER Designer required for development projects involving audio-frequency power transformers, pulse transformers, oil-filled units, etc.—Apply stating age, qualifications and experience, to The Personnel Manager (Ref. R.G.). The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [0260

RADIO and radar testers; first-class men required for work on V.H.F. communication gear and Government contracts for radio and radar equipment by Midland manufacturers.—Men with wide experience of fault finding in any of the fields mentioned should write, giving full details, to Box 4508. [2755

EXPERIENCED fault-finders wanted by Midland manufacturers of radio equipment; permanent posts located in the Midlands are offered to men with experience of radar, radio control, V.H.F. equipment.—Write, stating fully experience and salary required, to Personnel Manager, Box 4509. [2756

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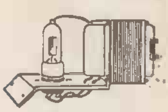

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A VACANCY occurs with a leading manufacturer for a man experienced in waveguide measurement: an ex-Serviceman with the necessary experience of testing and fault finding on radar gear would be considered.—Write stating age, experience and salary required to Box 5564. [2953

SENIOR draughtsmen (electrical) required by aircraft company; applicants should have considerable experience in latest types of aircraft electrical installations; progressive and pensionable position; write with full personal particulars to—Box No. 5497, and quote reference H.231. [2936

MALE Trainee, aged 25-35 required with sound basic knowledge of electricity for work in connection with specialised electrical equipment and installations in operating theatres. Salary accordig to age and experience. Apply in writing to Secretary, The London Hospital, Whitechapel, E.1. [3011

SENIOR Mechanical Designers and Draughtsmen required for Radio and Television Design Department. Apply in writing, giving full details of age, experience and qualifications, to Personnel Department, Murphy Radio Ltd., Welwyn Garden City, quoting "Design Department." [2852

ENGINEER, experience of mechanical design of subminiature electronic equipment. Applicants should be familiar with layout and wiring to interservice standards, design and manufacture of mechanical parts and preparation of working drawings. Degree not essential, preference given to persons with good practical experience. (Ref. 86.)
EXPERIENCED Wiremen for work on experimental subminiature electronic equipment. Applicants should be used to working direct from circuit diagrams and be familiar with workshop practice. Ability to prepare drawings an advantage. (Ref. 87.)
PLEASE write in detail, quoting reference number of position sought, to: The Personnel Manager (Technical Employment), De Havilland Propellers, Ltd., Manor Rd., Hatfield, Herts. [2892

SCIENTIFIC Instrument Makers in North London have a few vacancies for skilled laboratory assistants and wiremen for the development and production of high quality electrical and electronic apparatus. Five-day week, canteen, good welfare facilities.—Please apply, stating age, experience and salary required, to Box 5083. [2875

ELECTRONIC draughtsmen with good experience in layout work are required by the Nelson Research Laboratories, Stafford, for work on prototype equipment; this post offers scope for advancement to men of initiative; only men with experience will be considered. —Reply quoting Ref. 1243A, to Dept. C.P.S., 336-7, Strand, W.C.2. [2937

WANTED, top grade television service engineers with first-rate practical experience over a wide range of makes. Able to drive and must have real ability to diagnose faults and effect repairs quickly. Greater London area. Commencing salary £700-£800 per annum. Pension scheme. Only really first-grade men should apply.—Please telephone Museum 6888, Ext. 201. [3033

AN opportunity for young, versatile and ingenious electronic engineers to gain experience in the application of transistors to a wide variety of circuits is offered by the English Electric Company, Ltd., Luton. Interviews may be arranged locally to suit applicant's own convenience.—Write with full details, to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. 1325. [3008

PHILIPS BALHAM WORKS, Ltd., 45, Nightingale Lane, Balham, S.W.12, require graduate in electrical engineering or physics, preferably with experience in electronics, for development of nucleonic and radiation instruments; permanent appointment with excellent prospects.—Write, giving full details of age, experience, etc. [2914

ASSISTANT required to electronic engineer for servicing of low frequency equipment used for the measurement of stress and vibration and to assist in its development; progressive staff appointment with pension scheme.—Apply in writing to the Personnel Manager, The Fairey Aviation Co., Ltd., Hayes, Middlesex, quoting reference SG/T. [2966

RADIO testers required, some V.H.F. experience desirable together with some servicing knowledge on domestic or service equipment. —Applications, giving full details of previous experience and qualifications, should be submitted in writing to the Personnel Manager, Pye Telecommunications, Ltd., Newmarket Rd., Cambridge [2965

MITCHAM WORKS, Ltd., have vacancies for technical assistants, able to carry out without close supervision, measurements on radio and/or television receivers and associated components. These posts offer excellent opportunities for young men to enter the factory laboratory of a leading receiver manufacturer.
COMMENCING salaries in accordance with age, experience and qualifications.—Candidates, who should have academic qualifications in radio to the standard of H.N.C., should apply in writing to the Personnel Officer, Mitcham Works, Ltd., New Rd., Mitcham Junction, Surrey, quoting reference G.1. [2989

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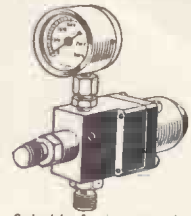

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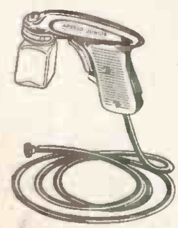
9 drills, 1/16—¼in., complete with plastic case and stand. Brand new **4/6**



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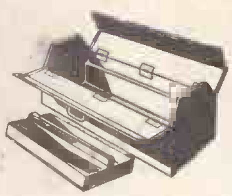

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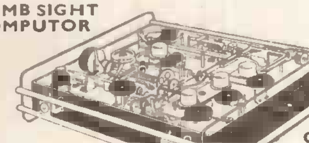

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FERRANTI, Ltd., Dundee, have a staff vacancy for an assistant test supervisor to control a department engaged in testing microwave devices; qualifications for this vacancy include a degree in electrical engineering or equivalent; previous experience in this type of work is an advantage but is not essential.—Apply in confidence to Personnel Supervisor, Ferranti, Ltd., King's Cross Rd., Dundee. [2960

SENIOR laboratory engineer required for work on television and sound wire broadcasting systems, duties include supervision of experiments and co-ordination of laboratory work with production of prototypes, good opportunities for advancement in expanding organisation; applicants should state age, qualifications, experience and present salary.—Box No. (London) 5577. [2958

ASSISTANT Engineers required in an electrical laboratory in West Surrey; preference will be given to those holding a degree or H.N.C., with experience in design and development of electrical relays for aircraft and other uses.—Apply in writing to the Chief Development Engineer, Waymouth Gauges and Instruments, Ltd., Station Rd., Godalming, Surrey. [2949

AN electronic engineer, possessing an academic or industrial degree and having at least 5 years' practical experience, is required for development work on a wide range of electronic instrumentation; the position offers ample scope for advancement in a rapidly expanding department.—Applicants should be 25 to 35 years of age, and should write giving full details, to Box 5287 [2915

EX-SERVICE radio-radar mechanics. A leading company in the electronic field has vacancies for men interested in manufacture and maintenance of radar equipment; opportunities occur in the factory and in the outside maintenance field for men who have had service training and some theoretical knowledge. Applicants should write giving full details of their experience, etc., to Box 5563. [2952

E.M.I. RESEARCH LABORATORIES, Ltd. invite applications from engineers with audio design experience, for posts involving interesting and varied work in the audio/video field. Applicants should have a University Degree in engineering or physics or equivalent professional qualifications.—Please write full details to the Personnel Dept. (RL/7), E.M.I., Ltd., Hayes, Middx. [2999

APPLICATIONS are invited from suitably qualified engineers for senior positions in the television and domestic broadcast receiver development laboratories; the vacancies offer considerable scope in the application of transistors and printed circuitry to this field.—Applications, stating fully age and experience and salary required, should be sent to The Personnel Manager, Box 5562. [2951

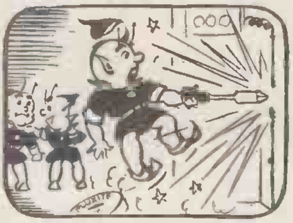
RADIO and television service engineer required by old-established dealer handling all first-class makes; permanent and excellent conditions with good pay and suitable accommodation available; only applicants from fully experienced engineers will be considered.—Apply, stating age, experience and salary required; if required for interview expenses will be paid.—A. E. Hughes & Sons, 28, Clarence Place, Newport, Mon. [3013

McMICHAEL RADIO, Ltd., require senior and junior engineers in their equipment division laboratory at Slough; training and experience in the field of applied electronics (including communications) and experience of working with Government Departments are the chief qualifications required.—Write, stating age and full details of training, qualifications and experience, to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks. [0198

PHYSICIST or electrical engineer for development work on transmission devices, miniature motors, and instrument servomechanisms; candidates aged 22/35 should have either (a) University degree in Physics or Electrical Engineering, (b) qualifications exempting from Grad. I.E.E. exam.; laboratory experience in light electrical engineering desirable.—Written applications, with full particulars, to Personnel Manager, Muirhead & Co., Ltd., Beckenham, Kent. [2929

ELECTRONIC engineer to work within our trials division at Edinburgh; the nature of the work involves conducting trials and evaluating the performance of fire control; navigational and landing systems under development; applicants should possess a physics degree or considerable recent practical experience in this field; good opportunity in expanding department; staff pension scheme.—Apply, quoting Ref. EE/TID and giving full details of qualifications and experience, to the Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5. [2799

JOSEPH LUCAS (GAS TURBINE EQUIPMENT), Ltd., invites applications for electronic engineers. Some knowledge of servo mechanisms would be an advantage. Should have university degree. These appointments are pensionable and offer good prospects to individuals with initiative and technical ability. Salary will be in accordance with experience and qualifications.—Details of experience and qualifications should be sent to Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham, 28. [3031



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SITUATIONS VACANT

DEVELOPMENT engineers, senior and junior, required for interesting work on new radio and television projects by leading manufacturers in W. London; applicants should have suitable academic qualifications and, for the senior posts, some previous experience; please write, in confidence, stating age, experience, qualifications and salary desired to—Box 5494. [2933

WIREMAN for modern research laboratory, capable of working to verbal instruction and able to do original layouts; City and Guilds or National Certificate an advantage, at least 3 years' experience imperative.—(Ref. 71) Write in detail, quoting reference No. of position sought to: The Personnel Dept. (Technical Employment), De Havilland Propellers. Ltd., Hatfield. Herts. [2818

TELEVISION and radio service department manager required in Liverpool district: staff appointment, pension scheme; applicants must have first-class qualifications technically and considerable administrative ability; salary £700 to £850; applications should give full particulars of age, training, technical qualifications and experience; letters should be clearly marked "Service Manager"; expenses in connection with interviews will be paid.—Box 4742. [2815

SENIOR coilwinding planning engineer required, experienced in the planning of radio and television coils; the selected candidate will have the drive and initiative necessary to deal rapidly with the day-to-day electrical and mechanical problems on the shop floor; East London area; this vacancy, for which a good salary will be paid, presents ample scope and opportunity to a man of first-class ability.—Please reply, giving full details of experience, to Box 5631. [2969

SENIOR design draughtsmen required by a large engineering company due to expansion of company's services and commercial business; applicants should have a comprehensive knowledge of mass production of radio, television and electronic equipment; salary up to £700 per annum, monthly status; the vacancies are of a permanent and progressive nature; company superannuation and life assurance schemes in operation.—Please reply, giving details of experience, to Box 5632. [2970

GROUND radio operators required for overseas service with International Aeradio. Limited; single men preferred; station allowance according to location; minimum total emoluments present posts, single staff £716 p.a., tax free; furnished quarters provided; generous U.K. leave; free air passages; kit allowance; possibilities of promotion.—Qualified candidates to whom replies only will be sent please write full particulars quoting GRO to Personnel Officer, 40, Park St., W.1. [2992

THE TELEGRAPH CONSTRUCTION & MAINTENANCE Co., Ltd., cable manufacturers, require a qualified electrical engineer to work on the design of cable fittings; the work involves the development of fittings for polythene insulated high voltage cables; practical experience of cable accessories desirable; this post is pensionable and carries a salary of £550-£600 upwards according to qualifications and experience.—Write, quoting reference RG/2 to Staff Officer, Telcon Works, Greenwich, S.E.10. [3000

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Coventry, requires senior and junior electronic development engineers for work on guided weapons and like projects, particularly in the field of microwave and pulse applications; mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments, also required for the above projects; salary according to age, qualifications and experience. —Apply by letter, stating age and experience, to the Personnel Manager (ref. R.G.). [0259

ELECTRONIC engineers to work within our trials division at Edinburgh; the nature of the work involves conducting trials and evaluating the performance of fire control; navigational and landing systems under development; applicants should possess a physics degree or considerable recent practical experience in this field; good opportunity in expanding department, staff pension scheme.—Apply, quoting Ref. EE/TID and giving full details of qualifications and experience, to the Personnel Officer, Ferranti, Ltd., Ferry Rd., Edinburgh, 5. [2857

WAR OFFICE require assistant mechanical engineering officer (Recruitment Grade Professional) at Donnington, Salop, to organize, control and supervise a workshop sector employing 30 to 40 civilians engaged on repair and calibration of electrical and electronic test equipment. Inclusive salary range £645 to £960 (provincial). Applicants must be British, of British parentage, and be Corporate Members of the Institution of Electrical Engineers, or have passed or be exempt from Sections A and B of their membership examination, or possess a University Engineering degree. Starting salary fixed according to age, qualifications and experience. Annual increments subject to satisfactory service. Posts temporary but long-term possibilities. Application forms, quoting reference D423/53A from M.L.N.S., Technical and Scientific Register (K), Almack House, 26, King Street, London, S.W.1. [2925

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THE TELEGRAPH CONSTRUCTION & MAINTENANCE Co., Ltd., cable manufacturers, require an estimator; experience of cable estimating preferred, but applicants with sound knowledge of cable manufacturing methods would be carefully considered; must have completed National Service. Educational standard: G.C.E. (ordinary level) would be an advantage). Pension scheme, five-day week and all welfare facilities; salary in accordance with qualifications and experience.—Write details quoting reference CD/3 to Staff Officer, Telcon Works, Greenwich, S.E.10. [3002

B.B.C. requires engineer with university degree in electrical engineering or physics or equivalent, for field strength section of research department at Kingswood, Surrey, but involving frequent and long absence for radio frequency measurement throughout British Isles; experience of transmitters, aerials, measurement and use of receiving equipment desirable, knowledge of V.H.F./U.H.F. techniques an advantage; salary £645 rising to £880 p.a. in 5 years.—Applications stating age, education, qualifications and full details of experience, to E.E.O., B.B.C., London, W.1, quoting E.923, within 7 days. [3027

THE TELEGRAPH CONSTRUCTION & MAINTENANCE Co., Ltd., cable manufacturers, wish to appoint a technical assistant to be concerned primarily with the design of all types of cable; candidates must have previous experience of manufacture of cables, and some experience of cable estimating would be a distinct advantage; Inter-B.Sc. or at least National Certificate in Electrical Engineering; commencing salary £550 upwards according to qualifications and experience; pension scheme, five-day week and all welfare facilities.—Write details quoting reference CD/5 to Staff Officer, Telcon Works, Greenwich, S.E.10. [3001

BRITISH EUROPEAN AIRWAYS require engineers for the maintenance, overhaul and development of electronic flight simulators; applicants must have a fundamental knowledge of electronics, experience in the field of servo mechanisms, repeaters and in dealing with large-scale equipments is desirable; salary during a familiarisation period of six months will be £569 per annum, rising to range £608-£725 p.a.; additional payments made for any required shift working.—Written applications to Personnel Officer, Flight Operations Department, B.E.A., Keyline House, Ruislip, Middlesex. [2932

DRAUGHTSMEN are required for permanent posts in the field of Radar Engineering. Excellent opportunities for advancement. Salaries beyond A.E.S.D. rates to suitable applicants. Staff pension scheme and canteen facilities. 5-day week. British Nationality essential. Posts to be filled in the following grades: Senior Section Leader, Checker Draughtsman and Senior Design Draughtsman, intermediate Draughtsman; Circuit Draughtsman, Installation Draughtsman.—Apply, quoting Ref. RLA/21, Chief Draughtsman, Decca Radar, Ltd., Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [2656

RADIO (Meteorological) Mechanics required by Meteorological Office. Qualifications:—Basic knowledge of radio and radar and experience in maintenance/operation of radar equipment including oscilloscopes. Successful applicants serve in United Kingdom and overseas. Commencing London salary £445 at age 25 or over rising annually to £540 subject to deductions for each year below age 25. Provincial salary £20 to £30 lower. Overtime, night duty allowance, etc. Promotion prospects.—Apply to Borough Employment Exchange (Dept. W.W.4), 236, Walworth Rd., London, S.E.17. [2872

MARINE radar and radio service engineer. Applications from candidates with several years' experience in the maintenance of marine radar, radio and echo sounder equipment will be considered for the post of resident engineer in Port Said. The post, which is for a minimum tour of two years, will become vacant mid-summer and the suitable applicant will be required to commence training in England as soon as possible. The post provides free accommodation, all household expenses, houseboy, medical charges and passage for engineer and family.—W. H. Smith & Co., Electrical Engineers, Ltd., 68, Grosvenor St., Manchester, 1. [2941

MINISTRY OF TRANSPORT AND CIVIL AVIATION. Radio technicians (men only) required at aerodromes and radio stations in U.K. Special training courses for keen technicians with basic quals. Interesting work in progress providing electronic aids to navigation. Prospect of permanent pensionable posts. Rates of pay (London) from £330 p.a. age 19, to £445 at 25, rising, subject to qualifying test to £540. Rates slightly lower for provinces. Candidates aged 19 or over with practical experience in maintenance of radio or radar equipment should apply to Ministry of Labour and National Service, Chadwick St., London, S.W.1, quoting Order No. 6627. [2943

A SENIOR appointment will shortly be filled in the London laboratory of a firm holding contracts in guided weapon and kindred fields; engineers who wish to be considered for this vacancy should be graduates and should have had some experience in industrial engineering laboratories; some production engineering experience in addition to microwave electronic and/or servo experience would be an advantage; starting salary will range according to age and experience and will be on a generous scale and will be subject to good increases, according to merit; pension and life assurance schemes are in operation.—Write, giving full details in confidence, to Box 5288 [2916

SITUATIONS VACANT

MINISTRY OF SUPPLY requires radio/radar technicians at Medmenham, Bucks, and Watton, Norfolk, to prepare schedules of radio/radar equipments and breakdown into assemblies, sub-assemblies and components. Quals. British of British parents. Recognized apprenticeship or equivalent. Appropriate experience. Able interpret drawings, circuit diagrams and specs. essential. O.N.C. or equivalent and practical experience R.A.F. equipments desirable. Salary. Within £480 (age 26)—£597 p.a. Not established but opportunities to compete for establishment may arise.—Apply nearest Employment Exchange quoting Order No. Westminster 2852. [2995

MARCONI'S WIRELESS TELEGRAPH Co., Ltd., Chelmsford, require research and development engineers for work on special applications of high power transmitters operating in the U.H.F. spectrum. There are vacancies for Senior and Junior Graduate Engineers with experience of the generation and transmission of microwave powers. The posts are permanent and pensionable and carry salaries in the range £600-£1,400 according to qualifications and experience. Five-day week. Canteen facilities, etc. Please write, giving full details of age, qualification, experience and present salary, and quoting reference 1117B, to—Marconi's Wireless Telegraph Co., Ltd., Dept. C.P.S., 336-7, Strand, W.C.2. [2811

ELECTRONIC engineers, senior and junior required; vacancies arise from an expansion of the company's business, which covers a wide field; applications are particularly welcome from young graduate engineers who have had some industrial experience; for the junior vacancies the minimum technical qualification required is the City & Guilds Certificate in Telecommunications; applications will be treated in strictest confidence; near city centre and all amenities; Saturday interview if required.—Apply Marconi Instruments, Ltd., Longacres, Hatfield Rd. St. Albans. [2766

AN electronic engineer, aged 25 to 35, is required to fill an interesting appointment in the Development Laboratory of the General Electric Company, Ltd., at Stanmore. Work involved will include development of airborne radar equipment and a knowledge of aircraft electrical installation would be useful. Possession of a University Degree is desirable and a working knowledge of elementary physics would be advantageous. Applications should be made in writing to the Staff Manager (Ref. WW/AMMV) Brown's Lane Division, The General Electric Co., Ltd., Stanmore Laboratories, The Grove, Stanmore Common, Stanmore, Middlesex. [3012

JUNIOR development engineers are urgently required to assist in the development of precision electronic laboratory instruments. Successful applicants will be engaged on interesting long-term projects concerned with the development of a wide range of equipment. The appointments are permanent and carry considerable technical responsibility. Applicants should have had previous development experience, preferably in the instrument field. Academic qualifications ranging from O.N.C. to degree standard are acceptable. Salaries are dependent upon age, qualifications and experience.—Apply, stating full [illegible], to the Chief Engineer, Messrs. Furzeh[illegible] Ltd., Shenley Rd. Boreham W[illegible]

ELECTRONICS engineers and physicists required by Ministry of Supply experimental establishments at Farnborough, Hants, Malvern, Worcs., Sevenoaks, Kent, and elsewhere, mainly in Southern England; duties inclu[illegible] research development or design of telecommunications and radar equipment, guidance and control systems, instrumentation for variety of research problems; experience of V.H.F., pulse techniques, display systems, etc., desirable for some posts; appointments according to qualifications and experience as scientific officer (1st or 2nd class honours degree or equivalent) £445-£815; assistant experimental officer (Higher School Cert (science) or equivalent degree or H.N.C. may be an advantage and technical experience in Forces or industry desirable) £[illegible]76 (age 18)-£615; experimental officer (H.S.C., etc., but min. age 26) £690-£850; women somewhat less; appointments unestablished; F.S.S.U benefits may be available [illegible] O. class.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D296/54A. Closing date 13 July, 1954. [2981

WAR OFFICE require 3 technical assistants Grade II (unestablished) for Electronics Wing, R.E.M.E. Establishment, Malvern, Worcestershire. Duties are to collect and collate data for use in preparation of reports on newly developed electronics equipments and to write technical handbooks covering maintenance and repair of Army electronic equipments. Applicants must be British, of British parentage, possess an Ordinary National Certificate (or its equivalent), and have served suitable apprenticeship and have sound electronic knowledge. Experience of writing reports is desirable but not essential. Salary in range £592-£702 p.a. (at age 30), less £20 p.a. for every year under 30. Starting according to age, qualifications and experience. Annual increases subject to satisfactory service.—Write, giving date of birth, education, full details of qualifications and experience of posts held (including dates) to Appointments Officer, Ministry of Labour and National Service, 1-6, Tavistock Square, W.C.1, quoting E.C.214, by July 12th, 1954. No original testimonials should be sent. Only candidates selected for interview will be advised. [2922

SITUATIONS VACANT

AIR traffic control officers with experience offered permanent and pensionable posts at overseas airports, initial basic salary for licensed staff £500×£25 to £600 p.a. (unlicensed staff slightly lower) station allowance according to location, marital status, minimum total emoluments present posts, single staff £960 p.a., married staff £1,250 p.a., inclusive salary tax free, furnished quarters provided, generous paid U.K. leave, free air passages for staff and family, kit allowance, possibilities of promotion.—Qualified candidates, to whom replies only will be sent, write full particulars quoting A.T.C. to Personnel Officer, International Aeradio, Ltd., 40, Park St., W.1. [2991

MINISTRY of Supply requires experimental officers in guided weapons divisions of Royal Aircraft Establishment at Farnborough, Hants, and Aberporth, S. Wales; work concerned chiefly with design, development and performance of new weapons and associated guidance and control systems, instrumentation of flight trials and investigation of trials results; minimum qualification is Higher School Cert. (science) or equivalent, but further qualifications in mechanical, electrical or electronic engineering physics or maths. may be an advantage; appointments graded according to age, experience, etc., within ranges, experimental officer (min. age 26) £690-£850, or assistant experimental officer £276 (age 18)-£615; women somewhat less; appointments unestablished.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting C.296/54A. Closing date July 13, 1954. [2906

AIR MINISTRY requires experimental glass officers at establishment near Marlow, Bucks. Duties concern installation design of static and mobile radar and radio systems used by R.A.F. Work of engineering rather than laboratory type, covering wide range of application of electronic engineering to meet operational needs of R.A.F., with which very close contact is maintained. Accepted candidates are eligible for nomination for membership of Officers' Mess, offering recreational facilities in congenial surroundings. Qualifications—at least Higher School Cert. (Science) or equivalent, although higher qualifications in Physics or Electrical Engineering may be an advantage. Salaries within ranges: Experimental Officer (min. age 26) £690-£850 (male), or Assistant Experimental Officer £276 (at age 18) to £615 (male). Appointments unestablished. Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D290/54A. Closing date July 13, 1954. [2926

MINISTRY of Supply. Radar Research Establishment, Malvern, Worcs, requires: ELECTRICAL Engineers and Physicists for research and development work on radio and electronic equipment; work ranges from fundamental research on circuitry and physics of solids, to devising and developing, in collaboration with industry, electronic devices for the Army, R.A.F. and Naval Aviation. Ample scope for initiative and originality over very wide field concerned mainly with electronics. Minimum qualification—Higher School Cert. (science) or equivalent, but further training in physics or elec. eng. to H.N.C. or degree standard may be an advantage. Salaries within ranges, Experimental Officer (min. age 26) £690-£850, or Assistant Experimental Officer £276 (age 18)—£615. Women somewhat less. Appointments unestablished.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A121/54. Closing date July 13, 1954. [2909

SITUATIONS VACANT

THE TELEGRAPH CONSTRUCTION & MAINTENANCE Co., Ltd., cable manufacturers, have a vacancy for a technical assistant to be concerned with the development and manufacture of cable accessories; an important duty will be the preparation of technical information for commercial purposes; previous practical and commercial experience of cable accessories essential; salary range £550-£600 upwards according to qualifications and experience; pension scheme, five-day week and all welfare facilities.—Details to Staff Officer, Telcon Works, Greenwich, S.E.10. [2967

MINISTRY OF SUPPLY requires assistant foremen at Bickley, Kent, to assist development, supervise manufacture of special electronic test gear; quals. British of British parents, recognised apprenticeship or equivalent training in electronics, knowledge pulse techniques, UHF oscillators, oscilloscopes, high voltage measurement, ONC, City & Guilds or equivalent desirable; salary: within £506 (age 26)-£629 p.a.; not established but opportunities to compete for establishment may arise.—Apply any Employment Exchange quoting Order No. Westminster 2856. [3007

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