

APRIL 1956

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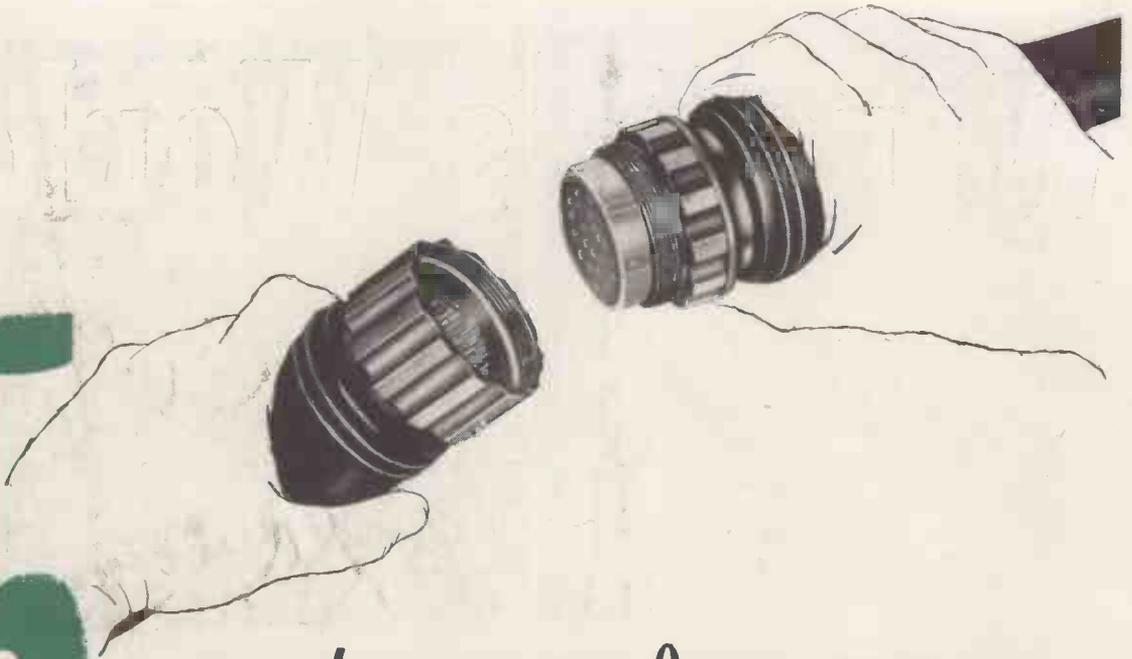
# Wireless World

**ELECTRONICS**

**Radio · Television**



**FORTY-SIXTH YEAR OF PUBLICATION**



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# Wireless World

ELECTRONICS, RADIO, TELEVISION

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

Editor: H. F. SMITH

Assistant Editor: F. L. DEVEREUX, B.Sc.

APRIL 1956

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## Why 625 Lines?

THERE seems to be a growing belief that colour television for this country should be based on the continental 625-line system rather than on our present standards. This idea was given public expression at the opening of the recent components exhibition, when Sir Robert Renwick, president of the Radio and Electronic Component Manufacturers' Federation, strongly criticized the B.B.C. for spending "vast sums of money" on the development of a colour television system on 405 lines. Sir Robert's advocacy of a 625-line system was based on his belief that "the B.B.C. are developing a system which can only be manufactured for the home market, thus making the cost of manufacturing [receiving] sets for export on 625 lines quite prohibitive." It should be added here that Sir Robert was voicing personal opinions not necessarily endorsed by the radio industry organizations.

*Wireless World* is not convinced that 625 lines offers any particular advantages—technical, economic or commercial—for colour television. Nobody yet *knows* whether the countries at present committed to that standard for monochrome pictures will ultimately adopt a colour system compatible with it. And, if they do so, a rich export market in receivers will *not* automatically be opened up: experience suggests that most countries sufficiently developed industrially to embark on any kind of television service are likely to be able to assemble their own receivers—perhaps, though, from imported components.

In spite of all that has been written on the subject in this journal and elsewhere there is still a tendency in some quarters to make a fetish of multiplicity of lines. Sometimes it is even thought that a lineage of 625 is, as a matter of simple arithmetic, bound to be about 50 per cent better than 405. So far as monochrome is concerned, this fallacy has been largely dispelled; in relation to colour, the argument is brought up to date in an article on p. 173. Our contributor confines himself mainly to the technical and economic aspects. Broadly speaking, he reaches the conclusion that, just as 625 lines offers no decisive advantages for monochrome, it is even less attractive, in relation to our present standards, for transmissions in colour.

After attending the demonstration of colour tele-

vision reported on p. 181 we reached the conclusion that lineage was relatively unimportant in comparison with the need for devising a basically cheaper and simpler system. Colour television for Britain—or the Continent—still looks, economically speaking, a long way ahead.

## Audio Exhibitions

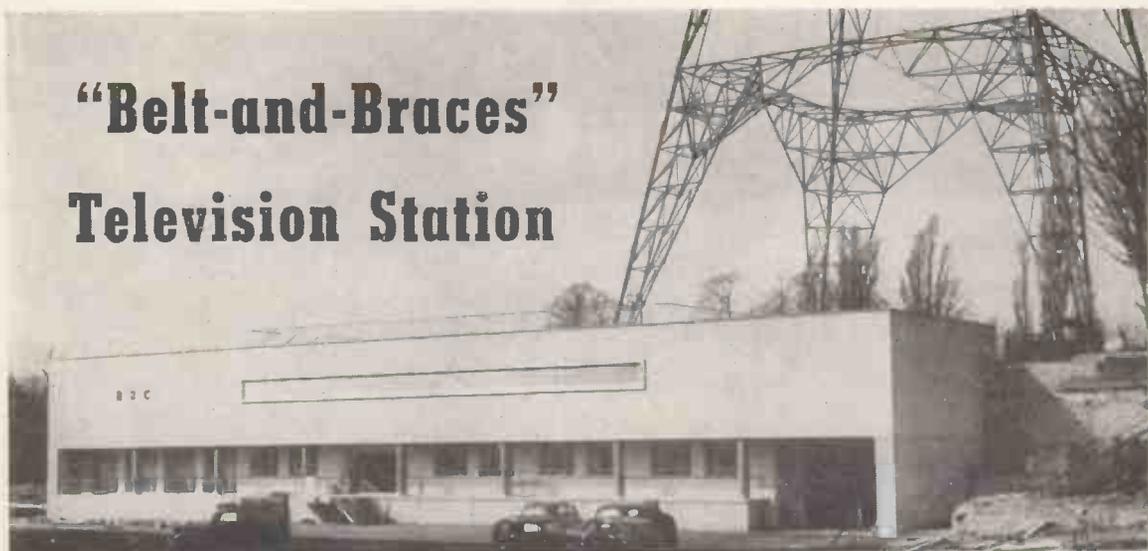
FOR many years the annual exhibition organized by the British Sound Recording Association has had to turn away potential exhibitors—including many influential firms—for lack of space. The London Audio Fair\* held this month found room for most of the big firms in the industry, but was still not big enough for the comfort of the 23,000 people who turned up during the three days of the show. In spite of resourceful and imaginative handling of the crowds there were queues for admission and many demonstrations were fully booked hours in advance. Further expansion both in space and time is clearly indicated.

Both these exhibitions are held in hotels—as are the Audio Fairs in America—and it cannot be denied that an hotel with its numerous rooms and soundproof party walls is ready-made for comparative audio demonstrations. The corridors, too, are carpeted to deaden sound, though they are hardly designed to carry the counter-streams of purposeful enthusiasts in transit from one aural judgment to another.

Anything comparable with Television Avenue at the Radio Show is, of course, impracticable, but we do suggest that a standardized test piece might be made available to all exhibitors, either on tape or disc, to be played on demand for the benefit of those cynics who may think that demonstration pieces are invariably chosen to enhance the merits and obscure the faults of equipment. If the idea is acceptable in principle a sub-committee should be appointed without delay, for 12 months is all too short a time in which to reach agreement on what the test record should contain.

\*A report on sound reproducing equipment shown at this and other exhibitions will appear in an early issue.

# "Belt-and-Braces" Television Station



FEATURES OF THE NEW LONDON TRANSMITTER AT CRYSTAL PALACE

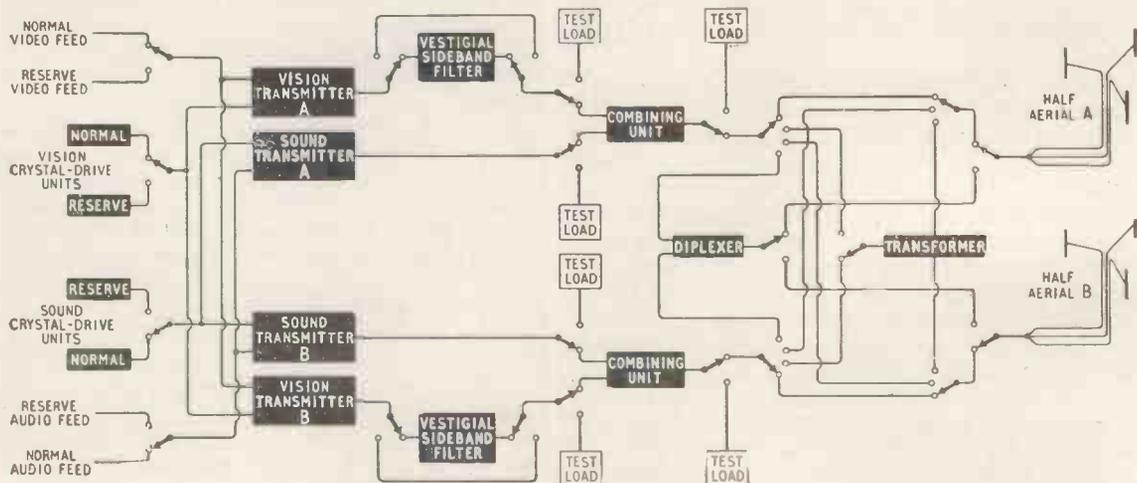
THE most noticeable thing about the design of the B.B.C.'s new television station at Crystal Palace is the elaborate precautions which have been taken to ensure continuity of service in the event of faults occurring on the equipment. Practically everything is duplicated. As can be seen from Fig. 1, there are two vision transmitters and two sound transmitters and two sets of crystal-drive equipment and video and sound input circuits. Even the aerial is arranged as two independently fed sections (it is actually a temporary aerial but the permanent one will be constructed on the same principle).

Under normal conditions all four transmitters are working simultaneously. The outputs of vision transmitter A and sound transmitter A are combined and fed to one section of the aerial, while the outputs of vision transmitter B and sound transmitter B are combined and fed to the other section. If there is a breakdown in one half of the system the other half continues operating—but giving, of course, a reduction in output power from the station of 6dB. In addition, however, there is a most elaborate switching system which enables various combinations of the pairs of transmitters and aerial

TECHNICAL DATA ON THE STATION	
<b>Vision Equipment (2 transmitters)</b>	
Frequency	45 Mc/s
Output power (each)	15 kW (peak white)
Frequency characteristic	vestigial upper sideband
Frequency response	< 1dB down at 2.75 Mc/s
Black level stability	better than $\pm 2\%$
<b>Sound Equipment (2 transmitters)</b>	
Frequency	41.5 Mc/s
Output power (each)	3.75 kW
Distortion	< 1% at 95% modulation
<b>Present Aerial (temporary)</b>	
Mast height	250ft.
Height of site	360ft. above sea level
Radiators	6 dipoles in two tiers of 3 (at 120° spacing)
Aerial gain	approximately 2:1
Effective radiated power	60 kW (vision), ultimately 200 kW

Our title picture shows a general view of the station with the permanent mast to the right. The building is actually sunk below the ground level of the Upper Terrace and looks on to the Lower Terrace of Crystal Palace.

Below: Fig. 1. Schematic diagram of the duplicate chains of transmitting equipment and switching arrangements.



sections to be made. This is brought into action if the fault cannot be cured quickly, the idea being to permit a combination of transmitters and aerial sections that will give an output power reduced by only 3dB instead of 6dB. For example, both pairs of transmitters can be switched to either half of the aerial *via* the diplexer, or one pair of transmitters can feed both halves of the aerial *via* the transformer.

It can be seen that each transmitter has a test load, and this is used to enable any fault to be located and put right under running conditions while the rest of the station continues in operation. Also, the vestigial sideband filters can be short-circuited out if any trouble develops in them.

Incidentally, although both vision transmitters are fed from the same crystal drive unit (and likewise the sound transmitters), this in itself does not ensure that both r.f. outputs will arrive in their respective half-aerials in phase. So to prevent the embarrassing situation of one transmitter "pushing" while the other is "pulling," a phasing system has to be included in the equipment. This consists of a phase comparator working from pick-up points on the output feeders of both vision transmitters, A and B, and manual phase-shift controls in the drive inputs to the transmitters (with a similar arrangement on the sound transmitters). Any phase discrepancy between the two is indicated by a centre-zero meter in the phase comparator, and appropriate adjustments are made to the phase-shift controls to correct it.

Apart from the "belt-and-braces" system of operation the station has several other interesting features. It is rather surprising, for example, to find that the vision modulation, which is done at high level on the grids of the push-pull output stage, is achieved entirely with receiving-type valves! Until recently it was only possible to use such small valves for low-level modulation, but the situation has been changed in the Crystal Palace transmitter by the use of high-gain tetrodes for the output stage (two CR192s) which do not require a very large input. Previously grid-modulated triodes have been the rule. The higher gain of these tetrode output valves (coupled with the use of other tetrodes throughout the r.f. section) has also made possible a reduction in the number of r.f. stages required, and in fact the whole of



Main control desk, with a view through the window of the transmitter hall. The cubicles on the right contain the crystal-drive and phasing equipment.

the r.f. amplifying equipment is housed in a single cabinet only 2ft 6in wide and 7ft high. For obtaining the necessary bandwidth in the output stage a triple-tuned circuit is used in the anodes of the CR192 valves.

The output stage of the modulator actually uses KT67 receiving-type tetrodes in a "shunt-regulated" cathode-follower circuit. The purpose of the shunt regulation system is to maintain the linearity and frequency response of the modulator when it is working into the fluctuating load presented by the CR192 grid circuits of the modulated r.f. amplifier. This load consists of a capacitance and a shunt resistance which varies according to the grid current with different amplitudes of signal.

Another form of regulation in the vision transmitters is for stabilizing the black level of the radiated signal. This is a feedback system working from the transmitter output, and it uses the amplitude of the radiated sync pulses as a measure of black-level variation to apply a correcting signal to the "clamp" circuit which normally sets the black level in the modulator.

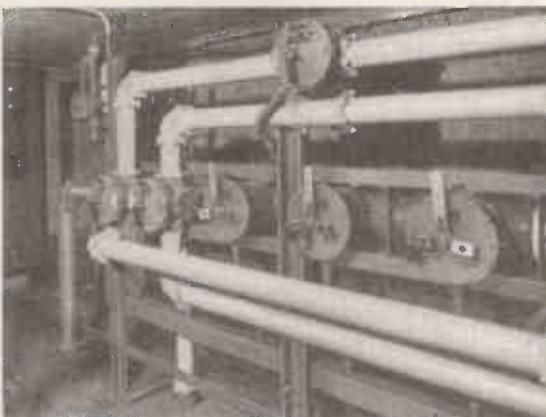
All the transmitters, drive equipments, combining units and feeders have been supplied by Marconi's.

## Amateur Colour Transmissions

THIS month British radio amateurs established what is believed to be a record by transmitting colour television signals over a 13-mile path. The colour equipment, built by C. G. Dixon, of Ross-on-Wye, has already been described in *Wireless World*.<sup>\*</sup> For this experiment, Mr. Dixon brought his colour monitor to the amateur receiving station G3CVO/T at Great Baddow, Essex, and left a colour-bar generator and control rack at the transmitting station G2WJ/T at Great Canfield, near Dunmow. The colour-bar generator produced vertical bars in green, black, red, yellow, cyan, blue, magenta and white.

For reception a converter was used to change the signal from 436Mc/s to 45Mc/s, this output being fed to a 9in television receiver for monochrome work, and into a "Pye strip" 45Mc/s amplifier and thence into the colour monitor. Mr. Dixon's equipment is field sequential, and runs at 150 lines, 100 fields per second, and thus is not compatible. The transmission path was established in monochrome on 405 lines, with two-way sound communication on 145.7Mc/s and 1.98Mc/s, and then switched to colour.

<sup>\*</sup> "Amateur Colour Television," *Wireless World*, April, 1954.



Coaxial feeder switching equipment in an upper room of the station. The functions of the coaxial switches here can be seen in Fig 1.

# WORLD OF WIRELESS

## Organizational, Personal and Industrial Notes and News

### National Electronics Show?

THE idea of a large-scale "professional" electronics exhibition covering all aspects of radio and its offshoots—except domestic broadcast receivers—has frequently been advocated by *Wireless World*. It is therefore gratifying to learn from the Radio Communication and Electronic Engineering Association that an Electronic Exhibitions Joint Association Committee has been formed to consider the whole question of national exhibition policy in the industries concerned.

The secretariat of the R.C.E.E.A. (11, Green Street, London, W.1) is acting for the committee on which is also represented British Electrical and Allied Manufacturers' Association, British Radio Valve Manufacturers' Association, Radio and Electronic Component Manufacturers' Federation and Scientific Instrument Manufacturers' Association.

### Physical Society Exhibition

ON May 14th the 40th exhibition of scientific instruments and apparatus, organized by the Physical Society, opens at the Royal Horticultural Society's Old and New Halls, Westminster, London, S.W.1. The number of exhibitors (131) is approximately the same as last year but, by utilizing both halls, there will be more space for visitors—a welcome change.

The exhibition opens on the first day at 10.30, but admission is limited to members and the Press until 2.0. On the 15th, 16th and 17th it opens at 10.0. Except on the last day when it closes at 5.0, it will remain open daily until 8.0.

At 6.15 on May 16th, G. G. Gouriet (B.B.C. Research) will give a lecture-demonstration on colour television.

Visitors' tickets are obtainable from the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7; a stamped addressed envelope should be enclosed.

### B.S.R.A. Show

THERE will be a 60% increase in the number of exhibitors at this year's show of sound recording and reproducing equipment organized by the British Sound Recording Association for May 26th and 27th at the Waldorf Hotel, Aldwych, London, W.C.2. Moreover, 25 of the 38 exhibitors listed below have this year booked individual demonstration rooms instead of sharing a communal demonstration room as has been done in the past.

Acoustical Manufacturing	Leevers Rich
Ariel-Sound	Lowther Manufacturing
Armstrong	Lustraphone
B-K Partners	Minnesota Mining & Mfg.
Beam-Echo	M.S.S. Recording
British Ferrograph	R.C.A. Photophone
Collaro	Reslosound
Cosmocord	Rogers Developments
C. T. Chapman (Reproducers)	Rudman Darlington
E.M.I.	Simon
G.E.C.	Specto
Garrard	A. R. Sugden
Goldring	Tannoy
Goodmans	Thermionic Products
Goodsell	Truvox
Grundig	Vitavox
Kelly Acoustics	Wharfedale
H. J. Leak	Whiteley Electrical
Lockwood.	Wireless World

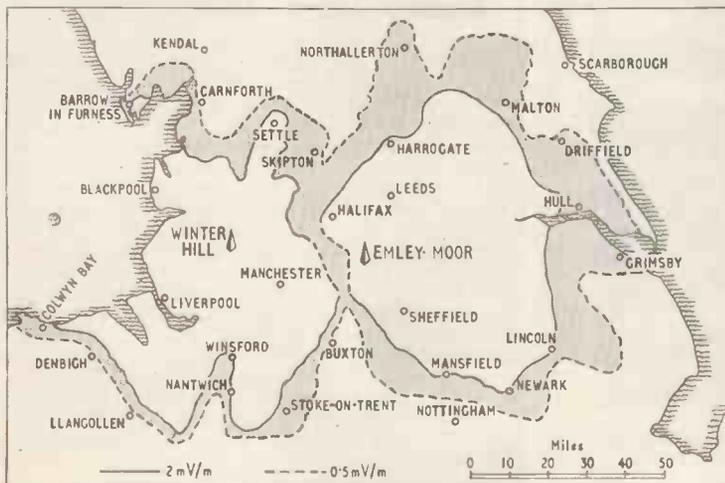
The exhibition, which is the eighth organized by the Association, opens at 10.0 on both days and closes at 6.45 and 6.0, respectively. Admission is by catalogue, price 2/-, obtainable from S. W. Stevens-Stratten, 3, Coombe Gardens, New Malden, Surrey, after May 14th, or at the exhibition.

### 5,000,000 Components a Day

PRODUCTION of radio and electronic components, which last year rose by 30% compared with 1954, has doubled during the past four years and is now seven to eight times the pre-war level. Five million components are now made every working day, according to 23rd annual report of the Radio and Electronic Component Manufacturers' Federation.

Exports, including components for sound reproduction equipment, were valued at £13.4M in 1955, an increase of nearly 23% on the previous year. The United States is now the principal British market for high-quality sound reproduction equipment and India the largest purchaser of components.

The report points out that while



THE FIRST of the I.T.A.'s northern transmitters—at Winter Hill, Lancs. (channel 9)—opens on May 3rd. The anticipated overall coverage in the northern region when the second station—on Emley Moor, Yorks. (channel 10)—opens in the autumn, is shown on this map.

the sound and television receiver industry remains the principal single consumer of components (amounting to 48.5% in quantity and 42.2% in value) there is a rising demand in all sections of the industries served. Radio communications and radar gear take 14.8% of the output of component manufacturers, telecommunications gear 5%, sound reproduction equipment 4.4% and defence, instrumentation and industrial electronics, etc., 8.8%. The remaining 18.5% is exported.

## PERSONALITIES

**S. M. Aisenstein**, a pioneer of wireless and one of the world's foremost valve designers, has retired from the position of general manager of the English Electric Valve Company, which he has held since the company was formed in 1947. He is being retained as a consultant on vacuum physics by the English Electric Group. A native of Kiev, he formed a wireless company in Russia in 1907 and at Guglielmo Marconi's invitation came to England in 1908. Three years later the Russian company, with Mr. Aisenstein as director and principal technical adviser, coalesced with the Marconi Company. In 1922 he was appointed to a company established by Marconi's in Poland and three years later went to Czechoslovakia, where he set up a valve manufacturing company. For some years prior to the formation of the English Electric Valve Company he was in charge of the Marconi valve laboratories at Chelmsford.

**Dennis Gabor, Dr. Ing., M.I.E.E., F.Inst.P.**, Mullard Reader in Electronics at the Imperial College of Science and Technology, London, has been elected a Fellow of the Royal Society "for his work on transient electric phenomena, electron microscopy, the theory of communication and the electric arc plasma." Dr. Gabor was born in Hungary, studied in Budapest and at the Technische Hochschule, Berlin-Charlottenburg. His thesis, in 1927, was on one of the first high-speed cathode-ray oscillographs with internal photography—the first in which transients photographed themselves by releasing a bistable electronic circuit. Incidentally, the name "Kipprelais" which he gave to the circuit caused many English readers to think that it was invented by a Dr. Kipp but, of course, in German "kippen" means toggling or tumbling. He came to this country in 1934 and worked until the end of 1948 in the research laboratory of the British Thomson-Houston Company, Rugby, during which time he was engaged on communication theory and speech frequency band compression. Dr. Gabor has been at Imperial College since 1949 and has recently been developing a flat, thin, neckless tube for monochrome and colour television, details of which we hope to be able to publish in the near future.

**H. A. Fairhurst**, who in this issue contributes the concluding part of his article describing an experimental colour receiver, has been with Murphy Radio since 1936 and is at present head of the television research section of the company's electrical design laboratory. He has done original work on a method of producing framing pulses for interlaced scanning and on the suppression of the effects of impulsive interference on television sound reception. Mr. Fairhurst graduated from the Royal School of Mines in 1925 and was working as an exploration geologist in Mexico before turning to radio research in the early 'thirties.

**R. W. Addie, M.A.**, who for the past five years has been manager of the technical-commercial department of Philips which he joined in 1946, has been appointed assistant commercial manager. He will act as deputy to **A. L. Sutherland**, director in charge of television and radio. Mr. Addie, who graduated from Cambridge in 1939 with a degree in engineering, has for the past few years been largely responsible for the sound and television relay installation at the National Radio Show.



R. W. ADDIE.



M. A. E. BUTLER.

Philips' new technical-commercial manager is **M. A. E. Butler, M.A.**, who joined the company as an engineer in 1951. He was educated at Oxford and holds an honours degree in physics and a degree in mathematics. After service as signals officer in the R.A.F. he joined the staff of the research laboratories of Standard Telephones and Cables before going to Philips.

**J. A. Pim, B.Sc.(Eng.), Ph.D., M.I.E.E.**, has been appointed chief engineer of the new telecommunication transmission division of Siemens Brothers (see "Business Notes"). Dr. Pim joined the company in 1948 from University College where he had been engaged in research for two years. He was, from 1942 to 1946, at the Royal Aircraft Establishment, Farnborough.

## OBITUARY

**Norman C. Robertson, C.M.G., M.B.E.**, deputy managing director of E. K. Cole, Limited, and a director of Ekco Electronics, Limited, died on April 1st, aged 47. Before going to Ekco in 1930 as chief of test, he held a similar position with Kolster-Brandes and had for a short while been with Marconi's. He had been deputy managing director since 1945, having successively been production manager and works manager. In 1951 Mr. Robertson accepted the then newly-created position of director-general of electronics production at the Ministry of Supply. He returned to E. K. Cole in 1953 and the following year was appointed C.M.G. for his two years' voluntary service with the Ministry.

**Harold E. Penrose, A.M.I.E.E.**, who died recently at the age of 69, started his radio career with the Marconi Company as marine operator. For a short while immediately after the first world war he was on the editorial staff of *Wireless World*. He went into the broadcast receiver industry in 1929 as sales supervisor, H.M.V., and had since then held positions with a number of companies, including E.M.I. and Rediffusion.

## IN BRIEF

During February the number of television licences in the United Kingdom increased by 110,654, bringing the total to 5,649,266. The total number of broadcast receiving licences in force at the end of February, including those for television and 291,740 for car radio, was 14,230,519.

In a breakdown of television licence figures for the

We regret that publication of this issue has been delayed. Subsequent issues will appear at intervals of less than a month until the normal time of publication is resumed.

end of December, issued by the G.P.O., 34 towns and districts showed an excess of television licences over sound licences, 19 were around London, 11 in the Midlands and four in the North. Of the English counties, Lancashire and Yorkshire lead with 682,579 and 550,904, respectively. In the London Postal District there were 632,703.

**Demonstrations** are being given at various harbours in the United Kingdom by Elliott Brothers of a commercial version of the microwave course beacon described in our November, 1955, issue. Forthcoming demonstrations are: Lossiemouth—April 30 and May 1, Whitehaven—May 3 and 4, Fleetwood—May 7 and 8.

**Brigg's Festival Hall Concert.**—In addition to the advertised programme of live and recorded music, a demonstration of stereophonic reproduction using British and American tapes will be included in the concert on May 12th. At the time of going to press all the cheaper seats had been sold, but tickets at 8s 6d were still available from "hi-fi" dealers in London, the Royal Festival Hall box office or direct from Wharfedale.

**B.B.C. Moscow Visit.**—In May a B.B.C. delegation is going to Moscow at the invitation of the Soviet broadcasting authority. It will be recalled that a Soviet broadcasting delegation visited this country at the invitation of the B.B.C. last autumn. R. T. B. Wynn, B.B.C. chief engineer, is a member of the seven-man delegation.

**Morse Test Fees.**—The fee chargeable by the Post Office to prospective amateur licence holders for a morse test has been increased from 7s 6d to 10s. Tests are conducted on request at the G.P.O. headquarters (St. Martin's-le-Grand, London, E.C.1), Post Office coast stations and at the radio surveyor's office at certain ports.

**Transistor sales in the United States** trebled in 1955 by comparison with the previous year. Figures issued by the Radio-Electronics-Television Manufacturers' Association of America are: 1954—1,317,327; 1955—3,646,802.

**I.T.A. over the Border.**—The Independent Television Authority has selected a site for its first Scottish transmitter, although authority to erect the station has yet to be granted. The site is at Black Hill, Lanarkshire, midway between Edinburgh and Glasgow and about two miles from the Kirk o' Shotts transmitter of the B.B.C. It is about 800 feet above sea level.

**R.E.C.M.F. Council.**—At the annual general meeting of the Radio and Electronic Component Manufacturers' Federation on March 21st, the following member firms were elected to form the council (names of the companies' representatives are in parenthesis): Garrard (H. V. Slade), A. H. Hunt (S. H. Brewell), Morganite Resistors (E. T. Treganza), Multicore (R. Arbib), Plessey (P. D. Canning), Standard Telephones and Cables (E. E. Bivand), Telegraph Condenser Company (W. F. Taylor), Telegraph Construction and Maintenance Company (W. F. Randall) and Henry Wiggin (J. S. Mason). In addition Giesham Transformers (J. P. Coleman), N.S.F. (K. G. Smith), and Reliance Electrical Wire (C. H. Davis) were co-opted to the council. The new chairman is S. H. Brewell and the vice-chairman Richard Arbib.

**R.C.E.E.A. Council.**—There is no change in the representation of member companies on the council of the Radio Communication and Electronic Engineering Association. The member firms and, in parenthesis, their representatives forming the 1956-57 council are: B.T.H. (V. M. Roberts), Decca Radar (C. H. T. Johnson), E.M.I. (S. J. Preston), G.E.C. (M. M. Macqueen), Kelvin & Hughes (C. G. White), Marconi's (F. S. Mockford), Metrovick (L. H. J. Phillips), Mullard (T. E. Goldup), Murphy (K. S. Davies), Plessey (P. D. Canning), Redifon (B. St. J. Sadler) and S.T.C. (L. J. I. Nickels). Last year's vice-chairman, C. H. T. Johnson, is now chairman and the new vice-chairman is S. J. Preston who was chairman last year.

## EXHIBITION NEWS

One hundred firms had taken all the available space for the National Radio Show (Earls Court, August 22nd to September 1st) over four months before the opening.

Electronics as an aid to materials handling will be exhibited and demonstrated by a number of firms at the Mechanical Handling Exhibition at Earls Court, London, from May 9th to 19th. Admission to the exhibition, organized by *Mechanical Handling*, and the international convention held in conjunction with it, costs 2s 6d. It is open daily, except Sunday, from 10 to 6.

A v.h.f./u.h.f. convention is being organized by the Radio Society of Great Britain and the London U.H.F. Group for May 26th at the Bonnington Hotel, Southampton Row, London, W.C.1. It will include an exhibition (which opens at 10), technical lectures, discussions and a dinner in the evening. Among the lectures, which begin at 2.30, is one on "Some aspects of forward scatter." Tickets, price 3s 6d, for the exhibition and convention, may be obtained from F. G. Lambeth (G2AIW), 21, Bridge Way, Whitton, Twickenham, Middlesex, from whom tickets for the lunch and dinner are also obtainable.

Twenty-nine firms are participating in the exhibition, "Atoms, Electrons and Industry," which the electronics section of the Scientific Instrument Manufacturers' Association is organizing for June 6th to 8th at the Royal West of England Academy, Bristol. Admission is by ticket obtainable free from S.I.M.A., 20, Queen Anne Street, London, W.1.

The products of over forty companies, the majority foreign, will be shown at the second International Instrument Show which is being organized by B & K Laboratories Limited at Denison House, Vauxhall Bridge Road, London, S.W.1, from May 7th to 18th. The firms exhibiting are: U.S.A.—Advance Electronics, Allen-Bradley, Ampex, Brush, Electrical Industries, Electro-Voice, Electronic Tube Corp., Heath, M.B. Mfg. Co., Narda, New London Instrument Co., Polarad, Polytechnic R. & D., Raytheon, Sperry, Sprague, Sylvania, Varian; Switzerland—Metrohm, Muller-Barbieri, Vibrometer; Denmark—Bruel and Kjaer; Holland—Peekel Laboratories; Sweden—Sivers Lab.; Italy—Firar; France—Detetron; Germany—Hackethal, Linde, Belzer, Grundig; U.K.—Avo, Advance Components, G. & E. Bradley, Cinema Television, Clarke and Smith, Cossor, Furzehill, Grayonics, Kelly, Microwave Instruments. Tickets are obtainable from the organizers at 57 Union Street, London, S.E.1.

The system of electronic machine tool control, which was mentioned in our February issue, is being featured by E.M.I. Electronics at the Production Exhibition which opens at Olympia, London, on May 23rd for eight days. A number of other applications of electronics to production will be included in this second exhibition sponsored by the Institution of Production Engineers.

## BUSINESS NOTES

Siemens Brothers have formed a telecommunication transmission division which will be responsible for the development, manufacture, sales and installation of all radio-line terminal equipment, multi-channel carrier telephone and voice-frequency equipment and voice-frequency telegraph apparatus. Dr. J. A. Pim is chief engineer (see "Personalities").

The B.B.C. has ordered 17 of the new Emitron television cameras which are mentioned in our review of the Television Society exhibition (see page 164). To enable the operator to maintain a comfortable stance the electronic view-finder can be kept horizontal when the camera is tilted for high- or low-angle shots.

The entire fleet of Bristol Britannia aircraft operated by B.O.A.C. is to be fitted with Ekco search radar for the detection of turbulent cloud formations.

**H.M.V.-R.C.A. Break.**—As from May next year new H.M.V. recordings will be released in the United States and Canada by Electric and Musical Industries Limited through their own companies. From that date new recordings issued in the United States by Radio Corporation of America will no longer be released in the United Kingdom by the Gramophone Company.

**Decca-R.C.A. Agreement.**—Following the above announcement the Decca Record Company stated that they had acquired the right to manufacture and sell as from May 1st, 1957, all new R.C.A. Victor recordings. A year later all R.C.A. Victor records will be available for manufacture and sale by Decca under the R.C.A. label.

A company under the title of **Siemens-Ediswan Limited** has been formed to fuse the interests of Siemens Brothers and Company with those of the Edison Swan Electric Company. The two companies will continue to trade as independent concerns but matters relating to research, development, manufacture and distribution will be co-ordinated. Dr. J. N. Aldington has been appointed managing director of Siemens-Ediswan.

**Marconi-A.T.&E. Co-ordination.**—The Automatic Telephone & Electric Company and Marconi's Wireless Telegraph Company have concluded an agreement for co-operation in the field of telecommunications. The development, production, planning, installation and maintenance resources of the two companies will be co-ordinated, to enable them jointly to meet the widest possible range of telecommunications requirements.

All valves previously sold by the General Electric Company under the trade mark **Osram** will in future bear the trade mark **G.E.C.** This change applies only to valves and not to other products using the Osram trade mark.

An agreement between **E.M.I. Electronics Ltd.**, of Hayes, and **Industrial Electronics**, of Magnet Works, Derby Road, London, S.W.14, provides for E.M.I. to act as sole selling agents at home and overseas for the instruments produced by Industrial Electronics.

Cossor announce the signing of an agreement between themselves and **K.G.H. (Holdings) Pty. Ltd.**, of Sydney, Australia, whereby "the Australian company obtains the full present and future know-how of the English company in the design and production of television receivers." Cossor television receivers will be marketed in the Commonwealth by Jacoby, Mitchell and Co. Pty. Ltd. (Cossor agents) and Titanvision receivers by K.G.H.

A substantial interest in **W. Watson and Sons, Ltd.**, of Barnet, the manufacturers of the zoom lens used in television cameras, has been acquired by **Pye Ltd.** Founded in 1837, Watson's are primarily optical and scientific manufacturers.

**Honeywell-Brown Ltd.**, of 1, Wadsworth Road, Perivale, Middlesex, are to manufacture and market the micro-switches developed by the Minneapolis Honeywell Regulator Company, their American associates. The overall size of one type, which will carry 5 amps at 250 volts A.C., is approx.  $\frac{3}{16} \times \frac{1}{16} \times \frac{1}{16}$  in.

**Pye telecommunications equipment** was used for ground-to-air communication during the record breaking flight of the **Fairey Aviation Company's Delta 2**. The aircraft was tracked by radar and the pilot informed by radio when he was entering and finishing the measured course.

**E. K. Cole Limited** announce that **Ekco electronic equipment** plays an important role in the "Fairey Fire-flash" guided weapon system, which is now in production for the R.A.F.

Cable markers, or printed sleeves, in rubber, synthetic rubber or P.V.C., indelibly printed with any wording, are now available from **Creators Limited**, Plansel Works, Sheerwater, Woking, Surrey, at twenty four hours notice.

**A.E.I.-Ekco Link.**—Negotiations are under way for the formation of an Australian company to be owned jointly by Associated Electrical Industries Limited and E. K. Cole Limited. The new factory will be at **Yennora**, near Sydney, and is expected to be producing receivers by the time a television service is started in the Commonwealth.

**Lithgow Electronics Limited**, of 1, Grange Court, Sudbury Hill, Harrow, Middlesex, have been appointed sole representatives in the United Kingdom and Eire of the **Hewlett-Packard Company**, instrument manufacturers, of California, U.S.A. The servicing of the equipment will be undertaken by **Livingston Laboratories Limited**, of Retcar Street, London, N.19.

## OVERSEAS TRADE

**January Exports.**—After a record-breaking year in 1955—as reported last month—exports of radio equipment of all kinds in January were valued at £2.9M, a record for the first month of a year. Export figures for each section of the industry were higher than the corresponding values for January, 1955.

**Canada.**—Contracts valued at \$200,000 for the supply of telecommunication measurement equipment to the Canadian Department of Defence have been awarded to **Marconi Instruments**. The contracts, which were secured in conjunction with the Canadian Marconi Company "in face of severe competition from American organizations," are for frequency meters, wattmeters, universal bridges and signal generators—one f.m. signal generator having been specially designed to conform to North American standards.

**Switzerland.**—Under a contract recently concluded between **20th Century Electronics**, of New Addington, Surrey, and **Landis and Gyr**, of Zug, Switzerland, 20th Century cathode-ray and geiger tubes will be marketed exclusively in Switzerland by the Swiss company and in Western Germany by their associates, **Paul Firchow Nachfolgen**. The licence also provides for the British company to train foreign engineers and allows the overseas parties the right to use British designs and patents.

**Paris.**—Radio-telephone equipment for fifty Parisian taxis—said to be the first radio-equipped taxis in the city—has been supplied by **Pye Telecommunications**.

**Iraq.**—**Redifon** radio-telephone equipment has been installed at Iraq's Kirkuk oil-field and the refinery at Daura, near Baghdad. This will enable information on tankage capacity and the different kinds of oil being pumped to be passed continuously between the two centres.

Only three of the eighty or so British manufacturers who exhibited at the **Lyons International Fair** (April 7th to 16th) are in the radio industry. They are **Erie, G.E.C.**, and **S.T.C.**

**Hungary.**—Television outside broadcasting equipment is being provided by **Pye** for the Hungarian television service which is to be inaugurated later this year.

**Norway**, which has had an experimental v.h.f. broadcasting station operating for some time, has recently ordered eleven 5-kW f.m. transmitters from **Marconi's**.

**Canada.**—**Decca surveillance radar equipment** is being supplied to the Canadian Department of Transport for the airports at Toronto, Montreal, Winnipeg and Vancouver.

**Borneo.**—A v.h.f. radio-link has been supplied by **Automatic Telephone & Electric Company** to the broadcasting organization in British Borneo to feed **B.B.C.** news bulletins, received at **Batu Kawa**, to the main studios at **Kuching** five miles away.

**Karachi.**—Equipment for a number of fixed and mobile radio-telephone stations has been supplied by **Intercommunications Equipment Company**, of 286-288, Leigh Road, Leigh-on-Sea, Essex, to the police force in **Karachi, Pakistan**.

# Low-Distortion F.M.

## Resistance-Coupled Pulse-Counting Circuit Needing No Alignment

**I**N the July 1955 issue there was a letter from J. K. Carter entitled "F.M. Receiver Design" in which he inquired "What has happened to Thomas Roddam's circuit? Does it really work?" The circuit to which he referred was described in the July 1948 issue under the title "Why Align Discriminators?" and took the form of a simple pulse counter instead of one of the usual phase discriminators with their need for accurate and skilled alignment.

Investigation of this circuit supplies the answer, which is a definite "Yes." It works very well. It gives the home constructor f.m. reception without the daunting problem of aligning discriminators and i.f. amplifiers and also without the 3% distortion of which Mr. Carter complained. And a receiver incorporating it can be actually cheaper and simpler than conventional designs. As Mr. Roddam pointed out, however, its advantages are at the expense of efficiency (in the technical sense), so are most readily obtainable where there is a fairly strong signal, say within the 1 mV/m contour. There seems to be no reason, however, except for some sacrifice of simplicity, why this discriminator should not be used in a highly sensitive receiver.

In order to understand clearly what is involved in its design, let us begin at the beginning.

The process of frequency modulation varies the number of signal cycles entering the receiver per given small period of time. Fig. 1(a) shows (somewhat exaggeratedly) two such periods, at opposite peaks of modulation. The problem is to derive an output signal that is continuously proportional to the number of cycles. It is not enough simply to rectify the incoming signal, as at (b); the rectified output is constant, because each increase in number of cycles is exactly balanced by their reduced duration. But if the signal cycles are employed to generate pulses all of equal size, as at (c), their mean value over the period (indicated by the height of the dotted line) is exactly proportional to their frequency, which is the same as that of the f.m. signal, and so the requirements of a discriminator are fulfilled.

The first practical problem is to ensure that the pulses are all the same size, regardless of frequency and amplitude of the signal. This is easier than might be expected. Their "size" is the number of volt-seconds, represented on voltage/time graphs

such as Fig. 1 by area. If the voltage is caused by a quantity of electricity passing through a resistance, then (since quantity is the number of amp-seconds, called coulombs) all that is necessary is to ensure that the resistance and the quantity are the same for each.

If, in Fig. 2, the slider is moved from  $V_1$  to  $V_2$  the difference  $V_2 - V_1$  being  $V$  volts, then the quantity of electricity flowing through  $R$  during the time necessary for this difference to occur across  $C$  is  $VC$  coulombs, and the size of the voltage pulse across  $R$  is therefore  $VCR$  volt-seconds. There is of course no difficulty in keeping  $C$  and  $R$  constant; and  $V$  can be made the same each time, in spite of variations in signal amplitude, by deriving it from a limiter stage, as in receivers employing the Foster-Seeley discriminator.

Note that the size of the pulse does not depend on the time taken for the voltage change to take place at the source. But time must be allowed for the pulse to be practically completed before the source voltage starts to reverse. A sinusoidal signal, as in Fig. 1(a), would not do, because it starts to reverse immediately it reaches its peak in either direction. But the limiter can be used to distort the sine wave into something nearer a square wave, whose flat top allows some time for the charging of  $C$ , delayed by  $R$ , to continue. The important thing is that it should always allow enough time. If the longer cycles on the left of Fig. 1, corresponding to negative peak modulation, did allow enough time, and the shorter pulses on the right, corresponding to positive peaks, did not, the pulses would not all be exactly the same size, so the mean value would not be exactly proportional to frequency and the a.f. output would be distorted.

Fig. 3 shows the pulse-forming circuit driven by a limiter stage of the type proposed by Roddam. When an adequate signal is supplied to the grid, the valve alternately "bottoms" and is cut off. In the bottomed condition the anode voltage is quite low, and when cut off it rises to the full supply voltage  $V_b$ . It cannot do so instantaneously, however, even if for simplicity we suppose that the anode current is cut off instantaneously. Let us follow the action in detail, beginning with the bottomed condition. Assuming it has lasted long enough for the

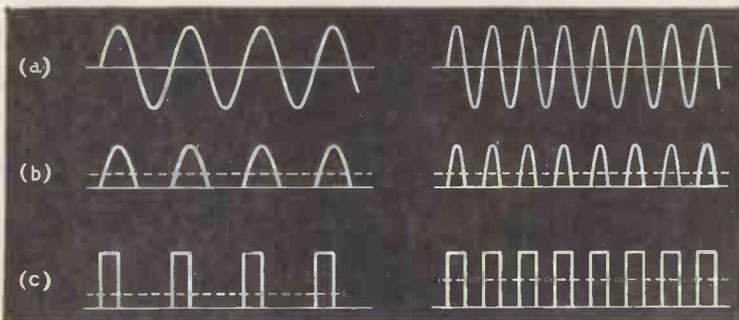


Fig. 1. At opposite peaks of modulation, a f.m. carrier wave has different numbers of cycles in a given period of time, as shown at (a). The rectified and smoothed output (b) is the same for both, but if pulses of constant size are substituted (c) the output, shown dotted, is exactly proportional to frequency.

# Discriminator

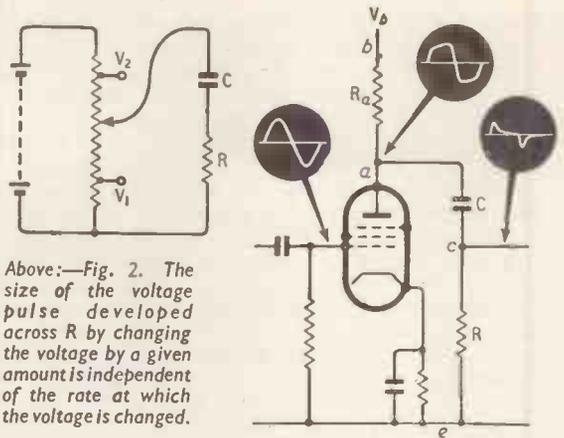
By M. G. SCROGGIE, B.Sc., M.I.E.E.

voltage across C to become constant, there can be no current flowing through R and so no voltage across it, and point *c* in Fig. 3 must be at the same potential as *e*, as shown at the start of Fig. 4. The large anode current through  $R_a$  brings the anode *a* down to, say, 25 volts, which is therefore the voltage across C.

Now suppose the anode current is instantaneously cut off. The voltage  $V_b$  from *e* to *b*, being kept constant by a smoothing capacitor, remains unchanged, say at 125 volts. The voltage across C cannot alter instantly so is still 25, therefore the remaining 100 must divide between  $R_a$  and R in proportion to their ohmages. It is this that gives the sudden voltage peak across R. Roddam calculated it to be 50 volts, but this is impossible with the values he chose ( $V_b = 70$ ,  $R_a = 10 \text{ k}\Omega$  and  $R = 1 \text{ k}\Omega$ ). The current now flowing through  $R_a$  and R proceeds to charge C towards 125 volts. The nearer it approaches, the less the voltage left to drive the charging current through  $R_a$  and R, so the charging current and the voltage across C die away in the manner called exponential, as shown by *c* in Fig. 4. The anode potential *a* meanwhile rises in the same manner towards *b*. Theoretically this process goes on for ever, and as we cannot wait so long we have to decide on the stage at which it can be deemed to be finished.

The rate of decay is determined by C and the resistance through which it is charged ( $R_a + R$ ). In the period known as the time constant,  $= (R_a + R)C$ , the voltage has dropped to 36.8% of its starting value. With this particular shape of curve, the percentage of pulse "area" that remains to come (if it went on for ever) happens conveniently to be equal to the percentage of voltage remaining at that point; 36.8% is of course far too much to neglect. Roddam chose four times the time constant, on the supposition that by then the voltage had dropped below 1%, but this is incorrect; it is still 1.8%. Suppose we decide on five times, at which only 0.7% of the pulse is left. This, then, is the minimum allowable time for the positive half of the square wave. Assuming that it actually is a half, then the shortest whole cycle is  $10(R_a + R)C$  and the highest allowable signal frequency is therefore  $1/10(R_a + R)C$ .

To obtain proper limiting action,  $R_a$  ought not to be too small; neither ought R if a reasonable output is to be obtained. So one would be inclined not to go below  $10 \text{ k}\Omega$  for  $R_a + R$ . C ought to be sufficiently large for stray capacitances not to matter; say, not much less than about 40 pF. Filling in these values, we get as the highest frequency 250 kc/s. This being at the positive peak of modulation, the carrier frequency for a deviation of 75 kc/s would be 175 kc/s, and the minimum 100 kc/s. One could go somewhat lower, say 50 kc/s, without running into difficulty in separating it from the highest a.f., and a margin at least as wide as this is most desirable in order to allow for inaccuracy or drift of tuning. "Carrier frequency" through-



Above:—Fig. 2. The size of the voltage pulse developed across R by changing the voltage by a given amount is independent of the rate at which the voltage is changed.

Above right:—Fig. 3. Outline of circuit for producing equal voltage pulses from a signal of varying frequency.

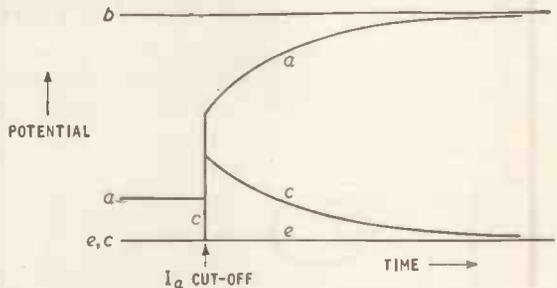


Fig. 4. If the anode current in Fig. 3 is cut off instantaneously by the down swing of a large input signal, the potentials of the various points are affected as shown. The desired voltage pulse is obtained at *c*.

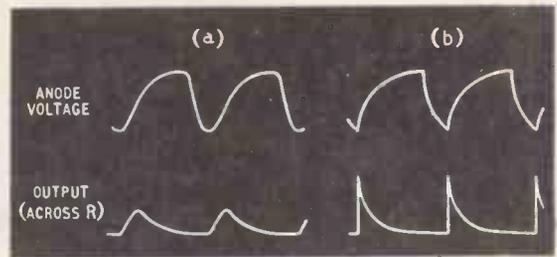


Fig. 5. Actual waveforms obtained in a circuit of the Fig. 3 type (with rectifier added to remove negative pulses), with (a) small and (b) large input signal amplitudes. Despite the very different peak values and shapes of the output pulses, they are equivalent, thanks to the principle illustrated in Fig. 2. The output pulses at (b) are very close to the theoretical shape—*c* in Fig. 4.

out this article refers, of course, to the frequency to which the carrier actually broadcast is reduced by means of the receiver's frequency changer. It occupies the centre of the i.f. band, which, as we have just found, extends in this type of receiver from about 50 to 250 kc/s.

It may be objected that the foregoing calculation is unsound, being based on the assumption of a perfect square wave, allowing a complete half-cycle for dying-away purposes. But the larger the proportion of the half-cycle occupied by the sloping rise, the greater the proportion of the pulse that

occurs before the exponential tail, and the less it matters if that tail is slightly clipped. Moreover, if the limiter circuit is as shown (Fig. 3), without series grid resistance, grid bias is automatically developed which extends the cut-off period well beyond half the cycle, allowing more time for the pulse. Fig. 5 shows actual waveforms with small (a) and large (b) inputs. In spite of their greatly different shapes and peak values, the mean values of the two lots of output pulses are the same within very close limits over a 100-to-1 input voltage ratio. This perhaps rather surprising result is due to the simple basic principle with which we began, that the quantity of electricity required to charge a given capacitance to a given voltage is quite independent of the time and rate of charging.

Another objection that will no doubt be raised—and this time rightly—is that the circuit so far shown would on the down swings produce negative pulses, and these are not shown in Fig. 5. They can be eliminated by cutting off R from negative voltages by a diode,  $D_2$  in Fig. 6. C is meanwhile

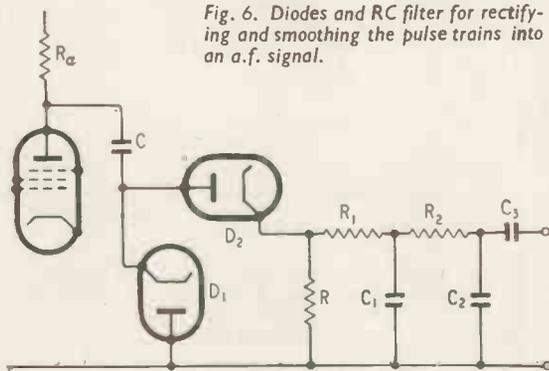


Fig. 6. Diodes and RC filter for rectifying and smoothing the pulse trains into an a.f. signal.

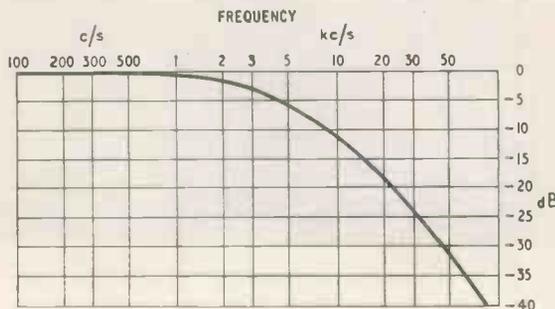


Fig. 7. Measured frequency characteristic of output filter with component values as in Fig. 9.

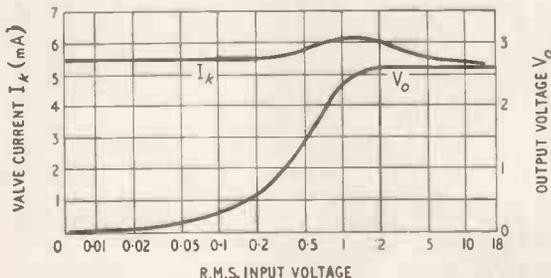
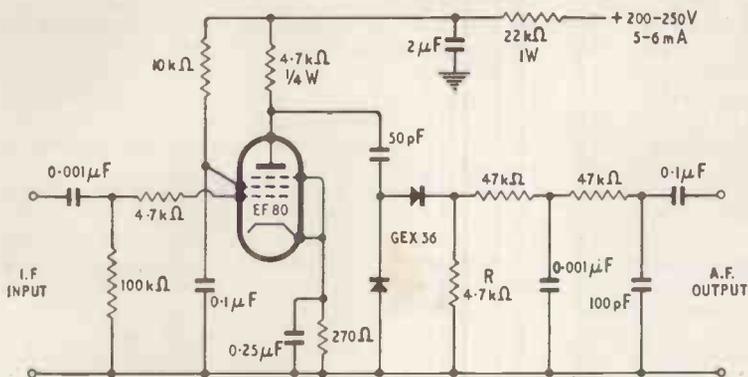


Fig. 8. Z.f. output across R ( $V_o$ ) and cathode current ( $I_k$ ) against r.m.s. input voltage: circuit as in Fig. 9.

being discharged via  $D_1$ . Obviously these diodes should have as low forward resistances as possible, so as not to increase the time constants appreciably. Satisfactory results have been obtained both with an EB91 thermionic double diode and a pair of GEX36 germanium diodes, the latter being of course neater and more convenient. Care should be taken to connect them as shown, so that the positive pulse is the one used; this is to allow it the longer "half"-cycle in which to take place. The negative pulse can make do with the shorter half because it has a shorter time constant, R then not being in circuit.

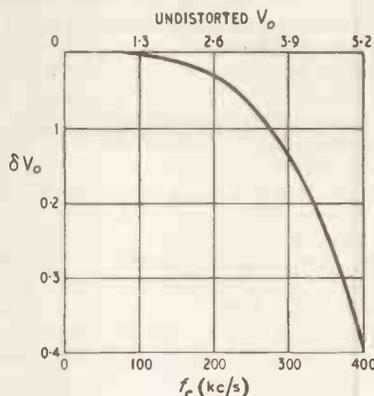
As the received signal is modulated, the pulses across R alternately close up and open out their ranks, so the average voltage across R rises and falls at modulation frequency. To prevent the relatively high peak voltages reaching the a.f. amplifier, some filtration is needed. An elaborate inductive filter is unnecessary, for a good start is made by the de-emphasis circuit that would in any case be needed to reduce the upper audio frequencies deliberately over-emphasized at the transmitter. The correct amount is provided by a CR potential divider having a time constant of  $50 \mu\text{sec.}$ ; that is to say,  $C_1 R_1 = 50 \times 10^{-6}$ . At the same time  $R_1$  must be large enough not to shunt R heavily; about  $50 \text{ k}\Omega$  is suitable, in which case  $C_1$  would be  $50 \times 10^{-6} / (50 \times 10^3) = 10^{-9} \text{ F}$  or  $1,000 \text{ pF}$ . As this alone gives only a 6-dB per octave slope-off, which is scarcely enough for filtration, it may be supplemented by  $R_2$  and  $C_2$ , designed not to increase the a.f. cut-off appreciably but to reduce the lowest i.f. If  $R_2$  is also  $50 \text{ k}\Omega$  and the cut-off frequency ( $-3 \text{ dB}$ ) is  $30 \text{ kc/s}$ ,  $C_2$  works out at about  $100 \text{ pF}$ . The two-stage filter just specified gives slightly more cut than that calculated on a separate-stage basis, and the standard values  $47 \text{ k}\Omega$  were in fact adopted. The filter is suitable for connecting through a blocking capacitor  $C_3$  to an a.f. amplifier having an input resistance not much below  $0.5 \text{ M}\Omega$  and capacitance not much more than  $10 \text{ pF}$ . Fig. 7 shows the measured voltage/frequency characteristic.

We have estimated that  $R_a + R$  should preferably not exceed about  $10 \text{ k}\Omega$ , but the best individual values have yet to be settled. We know that for a given V—the difference in anode voltage between the bottomed and cut-off states—the output is proportional to R. If  $R_a + R$  is kept constant and R is increased from zero, the output is at first proportional to R; but as  $R_a$  falls, V falls at an increasing rate until at a certain ratio of  $R:R_a$  it balances the increase due to R. That is the optimum as regards magnitude of output, and with an EF80 high-slope pentode at  $V_b$  equal to 80 to 100 volts it turned out to be  $6.5 \text{ k}\Omega$  for R to  $3.5 \text{ k}\Omega$  for  $R_a$ . As  $R_a$  is reduced, however, the limiting action becomes less good and valve currents increase; so, since  $5 \text{ k}\Omega:5 \text{ k}\Omega$  gives nearly as much output that ratio was adopted. It gives about four times the output of the  $1 \text{ k}\Omega:10 \text{ k}\Omega$  ratio, the five-fold increase in R being offset by only a 20% reduction in V due to the halving of  $R_a$ . Indirectly, the increase in  $R:R_a$  ratio yields a further increase in output, because the difference between the time constants  $(R_a + R)C$  and  $R_a C$  for positive and negative pulses respectively enables a larger proportion of the cycle to be allowed for the positive pulse and hence a greater mean pulse voltage. It

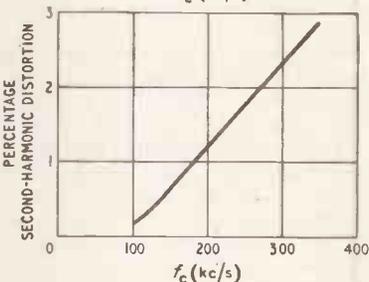


Above:—Fig. 9. Recommended circuit of limiter and discriminator.

Above right:—Fig. 10. Departure of  $V_o/f_c$  curve from linearity in Fig. 9 circuit. The values of  $V_o$  if linearity were perfect, from which  $\delta V$  must be subtracted to give the actual curve, are shown along the top.



Right:—Fig. 11. Second-harmonic distortion due to non-linearity shown in Fig. 10, for 75 kc/s deviation, plotted against carrier frequency,  $f_c$ . All other harmonics are extremely small.



has, in fact, been found quite feasible to raise  $C$  to 50 pF, giving a proportionate increase in output.

These benefits in output are welcome, because the efficiency of this type of discriminator is admittedly low. The output can easily be calculated, by assuming instantaneous  $I_a$  cut-off and making use of the fact that the pulse is then equivalent to one maintaining the same peak value for  $(R_a + R)C$  seconds. The peak output voltage is  $VR/(R_a + R)$ , and its mean value  $V_o$  is given by multiplying this by the ratio of  $(R_a + R)C$  to the period of one signal cycle, which at the carrier frequency  $f_c$  is  $1/f_c$ . So

$$V_o = VRCf_c$$

Taking  $V = 60$ ,  $R = 5 \text{ k}\Omega$ ,  $C = 50 \text{ pF}$ , and  $f_c = 150 \text{ kc/s}$ ,  $V_o$  (which is the z.f. output across  $R$ ) is 2.25 volts.

It follows that the r.m.s. audio voltage with deviation  $f_d$  is

$$V_{rms} = \frac{VRCf_d}{\sqrt{2}}$$

so with the values given and 75 kc/s deviation it would be 0.8 volt. This compares with 0.17 volt for  $R = 1 \text{ k}\Omega$ ,  $C = 40 \text{ pF}$  and  $V = 80$ ; an advantage of 13.5 dB.

It is convenient to have a  $V_o$  of several volts, for operating a tuning indicator and/or automatic frequency correction. The output being proportional to  $V_o$ , which is roughly proportional to  $V_b$  within practical limits,  $V_o$  can be matched by a point on a potential divider across  $V_b$ . Any difference between  $V_o$  and the potential of this point will therefore be due to a change in  $f_c$ , the carrier frequency. By adjusting the frequency-changer oscillator—manually or automatically—to bring the potential difference to zero, correct tuning is ensured.

Incidentally, the fact that the output depends on  $V_b$  points to the need for good smoothing in the supply system, because residual hum there would be reproduced in the output.

Next, there are the questions of whether to run the screen grid at a lower potential than  $V_b$ , and how much cathode resistance to use, if any. The many measurements that have been made can be summarized by saying that neither has much influence on performance and current taken under working conditions—i.e., with sufficient signal to cause limiting—but that  $R_{g2}$  and  $R_k$  both reduce  $I_a$  and  $I_{g2}$  considerably when there is little or no signal. By a suitable choice of  $R_k$ , the total current ( $I_k = I_a + I_{g2}$ ) can be kept fairly constant for all signal amplitudes. Fig. 8 shows the results with  $V_b = 120$ ,  $R = R_a = 4.7 \text{ k}\Omega$ ,  $R_{g2} = 10 \text{ k}\Omega$ , and  $R_k = 250 \Omega$ . Note that output is substantially constant for all signal input voltages above 1.5 r.m.s. Similar constancy of  $I_k$  was obtained, and about 5% greater output, with no  $R_{g2}$  and  $R_k = 470 \Omega$ , but the minimum signal input for limiting was raised about 25%.

These results refer to a carrier frequency of 200 kc/s, which is within the reasonably linear range. It is obviously desirable for this range to be considerably wider than the f.m. deviation, in order that great precision and constancy of tuning is not necessary to ensure a low level of distortion. While this was being investigated it became clear that when the signal amplitude was large the ratio of positive to negative epochs in the cycle was excessive and was the first cause of non-linearity at the high-frequency end. The optimum ratio is given by the ratio of the time constants during the positive and negative pulses, which is  $(R_a + R):R$ , or 2:1 in the circuit under consideration. Inserting a 4.7 kΩ resistor in series with the grid of the limiter valve enables a wider frequency range to be obtained at large signal amplitudes. This was included for the plotting of Fig. 8. Fig. 9 shows a recommended practical circuit, following closely the foregoing lines.

Although the useful range of signal amplitude is very wide, 5-20 volts is a suitable order of magnitude.

Linearity is so good, even with the circuit values shown, chosen more for output level than for extreme linearity, that it is not at all easy to measure the distortion. In the absence of a f.m. signal generator modulated  $\pm 75$  kc/s with less than 0.1% total harmonic distortion, the z.f. output voltage ( $V_o$ ) was plotted against frequency by a method designed to exclude voltmeter error, and the curve of departure from linearity (Fig. 10) analysed in two different ways to determine the harmonic distortion at 100% modulation ( $\pm 75$  kc/s). One way was by measuring the vertical differences at selected points between the curve and a straight line and calculating the percentage harmonics from them as described in *Radio Laboratory Handbook*, 6th edition, p. 302. The other was to devise an equation giving a curve close to that of Fig. 10 and calculate the outputs at fundamental and harmonic frequencies for various values of  $f_c$  when  $f = f_c + 75 \cos \omega t$ . The results of these two methods agreed well, and Fig. 11 shows percentage second harmonic as a function of the carrier frequency  $f_c$ . Third harmonic is of the order of 0.1%, and higher harmonics negligibly small.

If the lowest allowable instantaneous frequency to keep well clear of the highest modulation frequency is taken as 25 kc/s, this puts the lower limit of  $f_c$  at 100 kc/s, at which the second harmonic is barely 0.2%. The designed  $f_c$  is 150 kc/s, but Fig. 11 shows that this can be considerably exceeded before distortion is as great as with other types of discriminator at their very best. And whereas these other discriminators can very easily fall much below their best, even if they were sufficiently well adjusted in the first place ever to have attained it, the counter discriminator can hardly give bad linearity, short of gross errors in component values. And whereas conventional discriminators have modulation characteristic curves with comparatively sharp bends at both ends, capable of giving large amounts of the most objectionable kinds of distortion if traversed, the counter discriminator (once the audibly obvious clash of i.f. with a.f. has been cleared) has a wide range of adjustment within which distortion consists almost exclusively of a small percentage of second-order, which is relatively innocuous. It should be

remembered that Fig. 10 refers to 100% modulation, and at the lower depths that prevail nearly all the time the distortion is far lower still. In other words, it is probably fair to say that discriminator distortion is negligible, even by high-fidelity standards. But if anyone is really fussy, he can reduce what distortion there is as much as he likes, by reducing the time constant.

This ordinarily means reducing output in proportion, but an interesting possibility is the use of a cathode follower between the limiter and discriminator proper. This is actually shown in a description of a receiver to which the writer's attention was drawn after the work described here had been done.\* This receiver was for rather special duties, using a 1-Mc/s carrier modulated up to 150 kc/s at  $\pm 250$  kc/s deviation, and required as much as 0.1 V signal at the input to six limiter stages! Another receiver†, this time for broadcast transmissions, was also designed for a comparatively high i.f. (500 kc/s) with the object of rendering tuning non-critical, and uses the same kind of double-triode coupled-cathode limiter stages, four in number, with 2.5 mV input. The same article suggested the use of the double superheterodyne principle for achieving a high sensitivity in a receiver using a counter discriminator.

What appears to be the first description of the counter discriminator‡ made use of it for measuring distortion elsewhere, and therefore had to be virtually distortionless itself; its z.f. output/frequency characteristic is claimed to have departed less than 0.02% from perfect linearity from 50 to 250 kc/s. For the purpose in view, sensitivity was unnecessary, and in fact the 40 Mc/s input to the complete receiver was at the level of 1 to 25 volts!

As mentioned at the start, however, the great advantages of the counter discriminator can be obtained in a simple and practical receiver for broadcast reception, and in a later article it is hoped to give details of this.

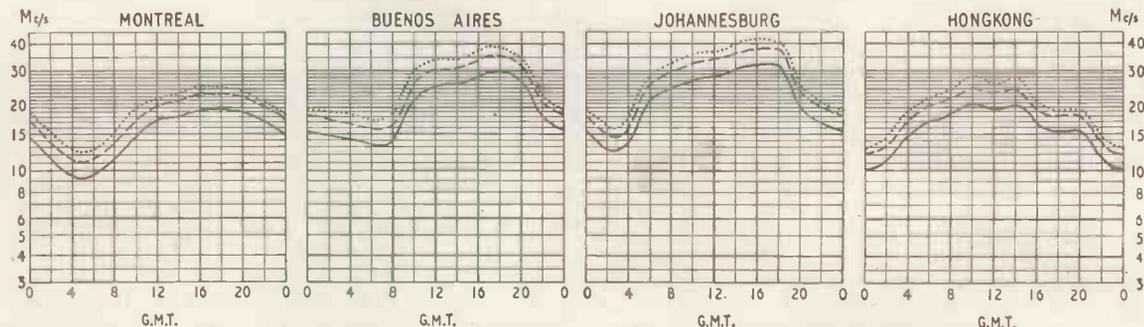
\*"Counter-Circuit Multiplex Receiver," by Vallarino, Snow and Greenwald, *Electronics*, July 1953, p. 178.

†"Mobile F-M Broadcast Receiver Design," by K. Onder, *Electronics*, May 1954, p. 130.

‡"Generation and Detection of Frequency-Modulated Waves," by Seeley, Kimball and Barco, *R.C.A. Review*, Vol. 6 (1942), p. 269.

## SHORT-WAVE CONDITIONS

Predictions for April



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 April.

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

- ..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME
- - - - - PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

# Television Society's Exhibition

**I**NSTEAD of being an evening affair only, this year's exhibition was held on three consecutive days, March 6-8, mainly during the daytime. The longer hours so spread out visitors that it was much easier to see the exhibits, and the change has been a great improvement. In its new home at the Royal Hotel, Woburn Place, too, more space was available.

Several exhibits dealt with the transient-response testing of television receivers. G.E.C. showed apparatus generating a sine-squared pulse of  $0.2 \mu\text{sec}$ . duration with a repetition frequency of  $70 \text{ kc/s}$ . The receiver output is displayed on a c.r. tube and the effects of receiver bandwidth on its shape are reflected in the curve traced upon the tube screen. The characteristic broadening of the pulse by too narrow a bandwidth, and the ringing following the pulse caused by unsuitable phase characteristics, were well in evidence in the demonstration.

Ferguson showed simplified transient test apparatus for use in production testing. A square-wave modulation of the r.f. signal is used and the receiver output is applied directly to the Y plates of a c.r. tube. The timebase voltage for the X plates is obtained by filtering the square wave to obtain its sinusoidal fundamental. A switched delay line enables the relative timing of the two to be varied in steps of  $0.05 \mu\text{sec}$ .

More in the field of measurement than testing is the Leland Group-Delay measuring set, Model 98, Mark II. This can be used for any transmission system operating in the  $50\text{--}70\text{-Mc/s}$  band. It can be used to measure group delays of up to  $200 \text{ m}\mu\text{sec}$  with an accuracy of  $\pm 0.5 \text{ m}\mu\text{sec}$ , and the amplitude response from zero to 20 dB. The apparatus has an oscillator sweeping from  $50 \text{ Mc/s}$  to  $70 \text{ Mc/s}$  with a repetition rate of  $50 \text{ c/s}$ . It is frequency modulated at  $1 \text{ Mc/s}$  with a deviation of  $0.5 \text{ Mc/s}$ . After passing through the network under test, and being delayed by it, this signal is compared with the original  $1\text{-Mc/s}$  modulation. From the comparator, an output at  $1 \text{ Mc/s}$ , amplitude-modulated in accordance with the delay, is obtained. After demodulation, this provides a voltage proportional to the group delay and is applied to the Y plates of a c.r. tube, to the X plates of which the  $50\text{-c/s}$  sweep is applied. The group-delay characteristic is thus displayed in much the same way as the more usual equipment depicts the amplitude-response characteristic. The apparatus can also produce such an amplitude characteristic and marker "pips" are provided.

A wide range of foreign, and some British, measuring apparatus was shown by Livingstone Laboratories. Among this, the Heinz Gunther Neuwirth f.m. signal generator is noteworthy in having a range of  $19\text{--}230 \text{ Mc/s}$  of fundamental frequencies; there is an i.f. range covering  $9.5\text{--}12 \text{ Mc/s}$  operating on the b.f.o. principle. The maximum deviation is  $110\text{-kc/s}$  and amplitude

modulation can be applied from an external source simultaneously with the f.m.

A French television pattern generator, the S.I.D.E.R., produces a waveform in accordance with the 625-line C.C.I.R. standard. The pattern includes a series of  $5\text{-Mc/s}$  bars.

A compact direct-reading frequency-meter by Gertsch Products of Los Angeles covers  $20\text{--}1,000 \text{ Mc/s}$  and an accuracy of one part in 100,000 is claimed.

In the serviceman's category is the Avo signal-generator Type III, which covers  $150 \text{ kc/s}$  to  $220 \text{ Mc/s}$ . A prototype of the same firm's T.F.M. was also shown; this has one f.m. band in addition to a wide coverage with a.m.

Cossor showed the well-known Telecheck, covering Bands I and III, and had a new oscilloscope, Model 1058, with a d.c.-coupled signal amplifier having an upper limit of response of  $6 \text{ Mc/s}$ . It has a 4-in. tube with post-deflection acceleration of the electron beam.

There were a good many oscilloscopes and associated equipment on view. Among the latter, the Mullard television line selector can be used with any triggered oscilloscope. It enables any line of a television picture to be selected at will and displayed on the oscilloscope. In addition, at  $50 \text{ c/s}$ , both odd and even frames can be displayed superimposed upon each other so that differences between them can readily be seen.

Several picture monitors were on view. The Cintel has a 14-in. tube and especial care has been taken in the design of the focus and deflector coils in order to secure good focus over the whole picture area. The associated amplifier has a response flat within  $\pm 0.5 \text{ dB}$  up to  $3 \text{ Mc/s}$  and is phase corrected. The Murphy Radio monitor includes a two-band receiver. It has a 9-in. tube with a wideband video amplifier arranged to accept an input either from the internal receiver or from any external source.

Ediswan demonstrated equipment for determining the optimum grading of turns in a deflector coil. The assembly is made with a normal frame winding and a line coil split into two parts. All windings are fed at  $50 \text{ c/s}$  and the grid of the tube is pulsed



H. G. Neuwirth f.m. signal generator.

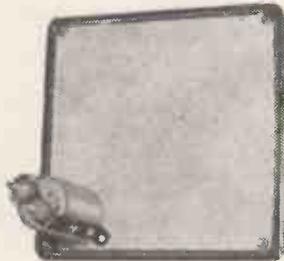
Left: Avo Type III signal generator.



20th Century Electronics series D6 square-face tube with two guns.



New Emitron camera with electronic viewfinder.



Rear view of Leland meter showing the movement in one corner at the back of the scale.

at the peak of the deflecting wave so that only a spot appears on the screen. This can be moved to any part of the screen by adjusting the currents, and changes in its shape are at once evident. A control enables the ratio of the currents in the two parts of the line coil to be adjusted and, by determining the optimum ratio, the proper grading of turns in the winding can be deduced.

Ediswan also showed the use of an electrostatic lens between the mask and the screen of a colour c.r. tube. By giving some focusing action, it improves efficiency by permitting the use of larger holes in the mask and it also improves the deflection sensitivity.

The large and the small in c.r. tubes was in evidence here also. The new 24-in. tube for operation at 20 kV was shown, as well as a 9-in. with tetrode gun and ion trap.

20th Century Electronics showed their well-known range of precision oscilloscope tubes with up to four guns. Some new types are built with square and rectangular faces in order to reduce the space. Mumetal screens for tubes of these new shapes were displayed by T.M.C.

The G.E.C. exhibit took the form of a series of demonstrations of an experimental nature. One showed the use of a transistor as a sync separator in a television receiver. Another illustrated a special circuit designed to keep the black level of a television picture at a fixed value despite variations in

the e.h.t. supply. It does this by appropriately changing the d.c. gain of the amplifier. It includes a gated a.g.c. system.

The printed circuit is gaining in popularity and T.C.C. exhibited many examples of it in the form of i.f. filters and aerial crossover networks. It is being applied also to television tuners where the rigid and consistent placing of connections is very helpful in enabling consistency of performance to be secured. It is even being applied to aerials! T.C.C. showed some Band III V-dipoles for building into a receiver; in one example, the dimensions were reduced by centre loading, the "coil" for this being printed with the aerial "rod".

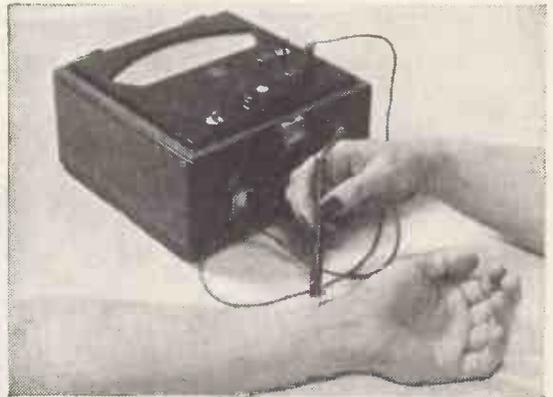
Belling-Lee displayed a rotating aerial mechanism with electrical remote control of its orientation. It can be used, and was so demonstrated, in continuous rotation in plotting the directional characteristics of an aerial. A calibrated v.h.f. receiver for field-strength measurement was also shown.

Another instrument of this character is the J.S.F. field-strength meter shown by Fielden. It is claimed to have an accuracy of  $\pm 10\%$  on Band I and  $\pm 25\%$  on Band III; it is intended for checking aerial performance.

An unusual form of meter movement for pointer instruments was to be found on the Leland stand. It is enclosed in a cylindrical case and is of the Brion Leroux type with the moving coil *outside* the field magnet. It is very compact and the same basic movement is used for all scale sizes.

In addition to a range of measuring apparatus, E.M.I. were showing a new television camera with control desk and associated equipment. The camera is built around a new Emitron tube which is claimed to provide a superior performance. It is of the "cathode potential stabilized" type.

A newcomer in the television camera field is Peto Scott, whose camera was demonstrated by Livingstone Laboratories on a test card. The tube is of the photo-conductive type and results in a very compact and light camera.



A THERMISTOR probe, a bridge circuit and a pointer indicating instrument are the essential parts of this new medical thermometer designed for measuring small changes in skin temperature. Made by the Vibro-Ceramics Corporation of Metuchen, New Jersey, U.S.A., it is said to be instantaneous in operation and to be particularly suitable for measuring capillary temperature, which gives a great deal of information about the circulatory system.

# Phase Shift and Sound Quality

Experiments to Determine How Much Can Be Tolerated

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

**M**ANY recent amplifier designs have included among their claims to fame in the high-quality sound reproducer field, such statements as "zero phase shift down to 10 c/s or up to 100 kc/s." It is proposed in this article to discuss briefly the meaning of phase shift, to consider the circuit elements responsible and then to examine its effect on the quality of sound reproduced by loudspeakers, to see whether figures for phase shift are worth including in an amplifier specification.

In any circuit that includes a reactive element such as a capacitor or an inductor the alternating current will not reach its maximum value at exactly the same instant as the voltage reaches a maximum. If the circuit includes inductance and resistance only, the current lags, as indicated by the curves of Fig. 1; but if the circuit is composed of capacitance and resistance the current will lead the voltage under steady-state conditions.

The time difference between voltage and current maxima is a significant indication of circuit conditions, but it has become conventional to indicate the time difference not in seconds but as a fraction of the time (period) of one complete cycle at the frequency being considered. Thus the phase shift is one quarter cycle when the circuit is composed entirely of inductance (Fig. 1) or capacitance. Alternatively the difference may be expressed in degrees, and a quarter-cycle phase shift then corresponds to a 90° phase shift. There are other methods of specifying the time difference, but as amplifier designers appear to favour the use of degrees this convention will be generally used in the ensuing discussion. The reasons for the displacement in time of the voltage and current maxima will not be discussed here, our present concern being the final acoustic effects.

The phase shift introduced by a simple circuit of one reactive element and one resistor can never exceed one quarter cycle or ninety degrees, and can only reach this value when the resistor is reduced to zero. The phase difference between voltage and current for a simple combination of resistance and capacitance is plotted in Fig. 2(a) as a function of the ratio of circuit resistance to circuit re-

actance. This dependence on circuit reactance makes any particular pair of components introduce a phase shift which varies with frequency in exactly the manner shown in Fig. 2(a) if  $f_0/f$  is substituted for  $X_c/R$  and  $f/f_0$  for  $R/X_c$ ,  $f$  being the frequency under consideration and  $f_0$  the frequency at which  $X_c=R$ .

These simple circuits of Fig. 2(b) will be recog-

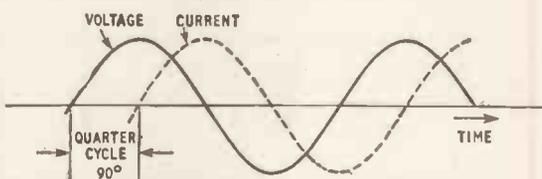
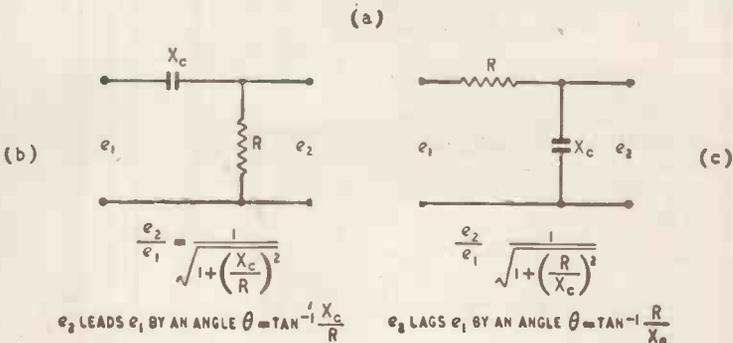
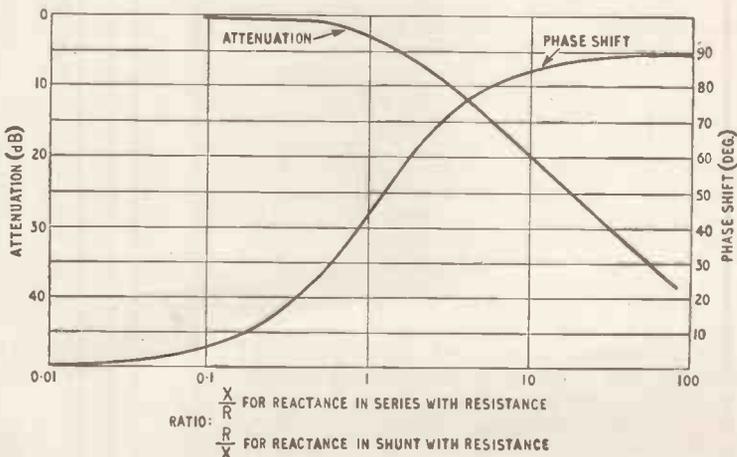


Fig. 1. Conditions in a reactive circuit with voltage and current waves displaced by 90° or one quarter cycle.

Below: Fig. 2. (a) Phase shift and attenuation introduced by single combinations of reactance and resistance such as those at (b) and (c).



\* Electronics Engineering Dept., British Thomson-Houston Co., Ltd.

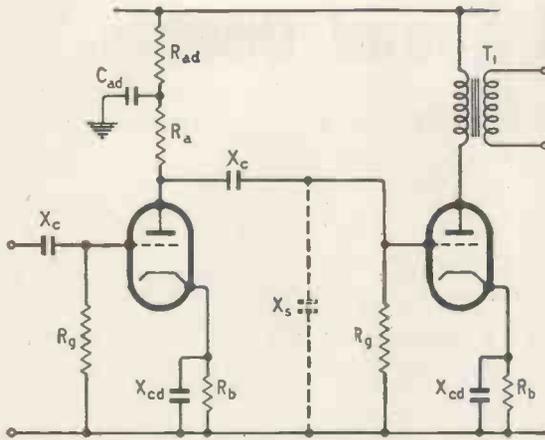


Fig. 3. Elementary amplifier showing sources of phase shift.

$X_c$ and $R_g$	Output voltage leads input voltage at low frequency
$C_{ad}$ " $R_{ad}$	" " lags " " " " "
$R_b$ " $X_{cd}$	" " leads " " " " "
$R_a$ " $X_a$	" " lags " " " " high "
$T_1$ {	" " leads " " " " low "
" {	" " lags " " " " high "

nized as those used as interstage coupling circuits in RC amplifiers (b) being the grid coupling capacitor and resistor and (c) the anode load resistor with the effective shunt capacitance in parallel with it.

Iron cored devices such as input and output transformers introduce phase shifts at low frequencies of the same order as an RC stage, but may introduce more rapid changes of phase in the region between 30 and 100 kc/s where resonance between the leakage reactance and any stray capacitance can (and usually does) occur.

The circuit diagram of a simple amplifier is reproduced in Fig. 3 showing the circuits responsible for phase shift with an indication of the direction in which the phase is shifted. The overall phase shift is approximately the algebraic sum of the phase shifts of the individual circuits. Application of negative feedback reduces phase shift in the same ratio that it reduces other distortions, a typical result for a high-quality amplifier being shown in Fig. 4.

Though phase shift has been discussed in terms of the difference in time between voltage and current maxima it will be appreciated that this is also the phase difference between the input and output voltages in a circuit such as Fig. 2(b), for the output voltage is in phase with the current in the resistor.

The change of phase with frequency appears to be fairly rapid, even with the simple circuits, but basically it is the change in the time of transmission with frequency that introduces waveform distortion. Further investigation

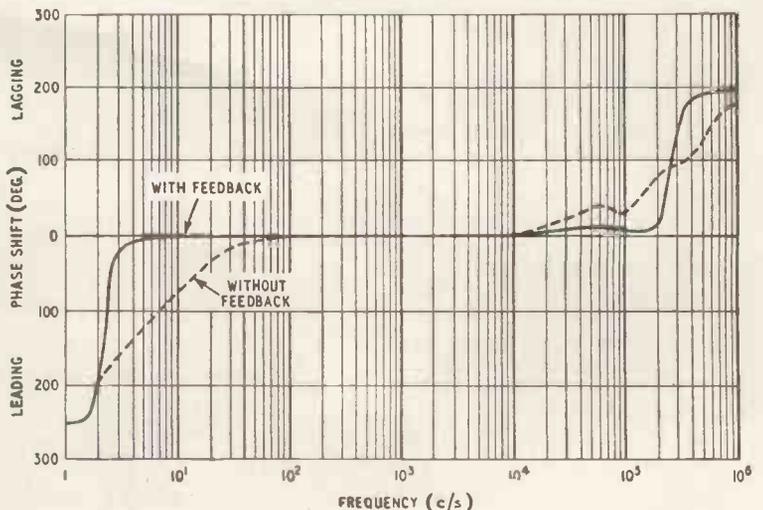
shows that the time of transmission between input and output terminals of a network such as Fig. 2(b) is fairly constant at all frequencies at which the circuit attenuation is low. A time of transmission that does not vary with frequency implies a phase-shift/frequency characteristic in which the phase shift is proportional to frequency and not a phase shift that is constant at all frequencies.†

It takes very little consideration to decide that the waveform of a complex wave composed of many frequencies will be drastically distorted in passing through any device in which the time of transmission varies for each of the component frequencies. An example is illustrated in Fig. 5, the output signal on the right, bearing very little resemblance to the square-wave input signal, though all the distortion shown is the result of phase shift and not the result of any frequency-dependent attenuation.

It will be clear that there is considerable difficulty in designing an amplifier (or any other piece of equipment) in which the phase shifts are reduced to zero at all frequencies. If it is considered that waveform distortion must be avoided there are four possible solutions. The first is merely to avoid phase shift completely, a council of perfection. The second is to avoid phase shift within the audio-frequency band of say, 30 to 10,000 c/s. The third solution is the use of a phase/frequency characteristic in which the phase shift in degrees is linearly proportional to frequency, for if this is done all the frequency components are delayed by the same time interval. It is generally of little consequence if a complex signal takes even several milliseconds to pass through an amplifier, provided that all the components take the same time.

The final solution is separately to determine the maximum amount of phase shift that can be allowed before the result is aurally detectable, and then to ensure that the actual phase shift introduced by the system is below this limit. In an extensive audio network this is the only practical solution. The "just detectable" phase shift is a problem that has been the subject of many investigations, but the most authoritative works known to the writer are due to van der Pol of the Philips Research Laboratory and

Fig. 4. Typical phase-shift characteristics of a high-quality domestic amplifier.



† This aspect is developed by "Cathode Ray," whose contribution this month (p. 188) happens to include a discussion of the basic relationships between phase/frequency distortion and amplitude/frequency distortion.—Editor.



Fig. 5. Effect of phase distortion on a square-wave signal after passing through a reactive network in which there is no variation of attenuation with frequency. Repetition rate, 300 per sec.

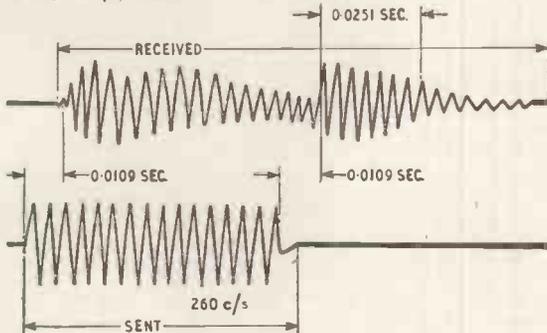


Fig. 6. Distortion of tone pulse due to phase shift.

to Steinberg and Lane of the Bell Telephone Laboratories.

Van der Pol made a limited investigation using a special circuit that allowed him to change the phase of the higher harmonics of a complex wave relative to the fundamental by any amount up to  $360^\circ$ . He noted that any phase shift within this limit introduced no effects detectable when listening to speech.

Steinberg and Lane used an experimental technique that permitted much greater amounts of phase shift to be introduced into the reproducer system. Low-pass or high-pass filters of the normal ladder type introduce appreciable amounts of phase shift near the ends of the transmitted range. Filters of this kind may be added in series to produce any desired amount of shift at any point in the frequency range. The "just detectable" amount of phase shift proved to be so large that it is more convenient and indeed more indicative of the mechanism to express the shift in milliseconds.

To produce effects detectable on speech it was found necessary to shift the frequency components in the 5-8 kc/s band by about 8 milliseconds relative to the 1 kc/s components. Frequency components in the 50-100 c/s region had to be shifted by as much as 70 milliseconds before the effect was detectable. These time differences correspond to a relative phase shift of 64 complete cycles or 23,000 degrees at 8 kc/s and to a shift of 7 complete cycles or 2,520 degrees at 100 c/s.

Delays of this order are recognized as separate hollow ringing echoes, an effect often heard on long telephone lines and somewhat akin to acoustic reverberation.

The electrical effects can be demonstrated by injecting short pulses of tone into the equipment under test. The transmitted and a typical received signal are shown in Fig 6 (based on Fig. 10, p. 503, *B.S.T.J.*, Vol. 9, 1930) for a filter having a time delay of 0.01 seconds, and it will be seen that both head and tail of the transmitted pulse are badly distorted, the pulse being stretched until the received pulse is almost twice as long as the transmitted pulse.

Reference to Fig. 4 will remind the reader that an ordinary amplifier of the type likely to be used by the high-quality enthusiast is more likely to have phase shifts of a few degrees, quite innocuous in comparison with the phase shifts found necessary to produce audible distortion.

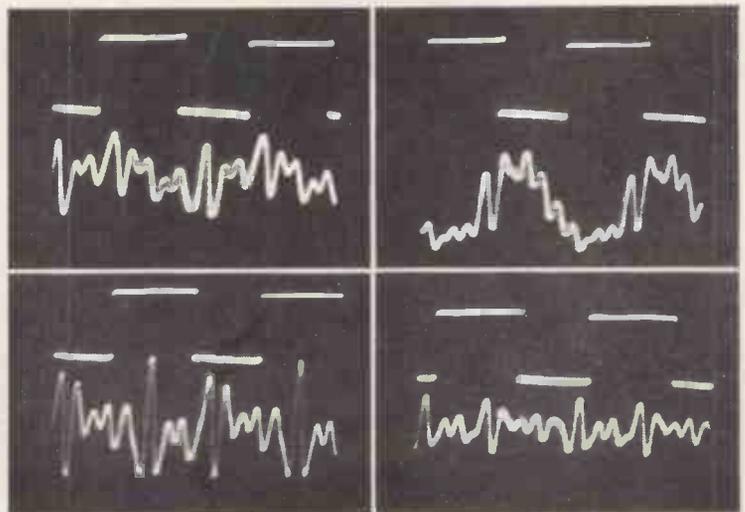
To the best of the writer's knowledge these results remain as authoritative, no subsequent investigation having thrown the slightest suspicion on the results of van der Pol, Lane and Steinberg.

It is commonly stated that though phase shift may not have much effect on the quality of steady tones it does have a much greater effect on the quality of transients. Steinberg did in fact comment upon this point, noting that phase distortion was much more objectionable on speech than on music. However, the minimum detectable phase shifts quoted earlier are the figures obtained from tests on speech. Though transient in nature, speech may not represent the ultimate in this respect so that to gain some personal experience tests were instituted using square waves.

A high-quality reproducer system was set up employing amplifiers capable of passing square waves without perceptible waveform distortion when the output signal at the speaker terminals was viewed on an oscilloscope. Loudspeakers may be the weak link, but those used were representative of the highest quality currently available, several different types having been employed at different times.

The input signal was the square wave shown in Fig. 5, lattice all-pass filters being employed to introduce phase shift without any frequency-dependent attenuation. The result of introducing phase shift

Fig. 7. The lower traces are the acoustic waveforms at points on or near the axis and at distances not more than 3ft from the diaphragm of a loudspeaker to which a square voltage wave has been applied. Repetition rate 900 per sec.



was to convert the waveform of Fig. 5(a) into that of Fig. 5(b) but even this drastic change could not be detected by any member of an experienced listening crew. The equipment has subsequently been used as a demonstration at several lectures, but to date, no listener has ever claimed to be able to detect the difference between the two waves.

This cannot be claimed as an absolutely conclusive test for there are an infinite variety of transient waveforms and it will always be impossible to claim that all have been tested; but taken in conjunction with other results it does suggest that phase shift is certainly not of great importance and may not be of any importance. This point of view has been confirmed in private communication with other workers on the subject.

When the results of laboratory tests appear to contradict common sense it is always worth looking round for confirmation or contradiction from everyday experience. A little consideration of the acoustic conditions in any concert hall will suggest that it is perhaps providential that our sensitivity to phase shift is low.

Sound from any source, original or a reproduction, reaches the listener first by the direct and shortest path and then by successive reflections along paths of increasing length. At listening positions only a few inches apart the acoustic pressure pattern in space varies enormously as different reflection paths of varying length become of predominating importance, and yet the sound quality remains unaltered. This is illustrated by the oscillograms of Fig. 7 indicating the changes in acoustic waveform at points a foot or so apart when a square wave (voltage) is impressed on the loudspeaker terminals. At some points the acoustic pressure waveform approximates that of the electrical signal but at other points there is little resemblance to a square wave. All the check points were on or close to the speaker axis and not more than three feet from the speaker.

Current loudspeaker designs provide another simple indication of the unimportance of phase shift in small amounts. In the sound reproducer field many of the loudspeakers having the highest reputation consist of units radiating the high frequency components either directly from the front of the cone or via a short straight horn, while the low frequency components below perhaps 500 c/s are radiated from the rear of the cone through a long folded horn. The difference in path length traversed by the low and high frequency components may amount to 5-8 feet (5-8 milliseconds, about 360 degrees at 150 c/s) and yet loudspeakers of this type such as the Lowther, Tannoy and Klipschorn have an acknowledged reputation for quality of reproduction.

Quite clearly the evidence suggests that phase shift does not have the importance usually attached to it by the high quality enthusiast. The phase shift introduced by any amplifier of normal design is so low in comparison with the minimum detectable phase shift that it is hardly worth considering. A broadcasting or telephone administration operating an extensive interconnection system that might involve 80-100 amplifiers connected in series would, however, have to pay a little more attention to the phase shift introduced by the individual amplifiers in order to keep the total shift below the minimum detectable figure. Even in this instance the audible effects of phase shift are usually due to shifts introduced by filters or by the line itself near the ends

of the transmitted frequency band and are not due to the amplifiers.

This discussion suggests that the phase shift introduced by a domestic amplifier is of little consequence as an indication of the quality of reproduction and is not really worth quoting. Phase shift is of importance when considering the stability of an amplifier with feedback but this is an entirely different matter.

It is perhaps an indication of the omnipotence of nature that she has developed a hearing system that is insensitive to phase shift.

Thanks are due to Chapman and Hall for permission to use the diagrams taken from the writer's book "High Quality Sound Reproduction" to be published shortly.

## REFERENCES

- "A New Transformation in AC Theory with an Application to the Theory of Audition," Balh van der Pol, *Proc. I.R.E.* Vol. 18, February 1930.  
"Phase Distortion in Telephone Apparatus," C. E. Lane, *B.S.T.J.*, Vol. 9, July 1930.  
"Effects of Phase Distortion on Telephone Quality," J. C. Steinberg, *B.S.T.J.*, Vol. 9, July 1930.  
"Motion Picture Sound Engineering," Chapter 13, (Chapman and Hall).

## BOOKS RECEIVED

**The Services Textbook of Radio: Vol. 3.—Electronics** by J. Thomson, M.A., D.Sc., F.Inst.P., M.I.E.E. Edited by the technical staff of *Wireless World*. One of a series of seven volumes issued jointly by the Admiralty, the War Office and the Air Ministry for the instruction of beginners and as a standard work of reference for technicians in civil life as well as in the Services. Deals primarily with the thermionic valve in all its forms and includes chapters on semi-conductors, photo-electric devices, electron optics and cathode-ray tubes. Pp. 259+ix; Figs. 218. Price 12s 6d. Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.

**Fundamentals of Television Engineering** by Glenn M. Glasford. Comprehensive analysis of television system design problems from the camera tube to the receiver display, in which alternative solutions are considered from both the theoretical and the technically realizable standpoint. Colour and monochrome are dealt with concurrently and circuit analysis makes full use of the transform calculus. Pp. 642+xiv; Figs. 567. Price 71s 6d. McGraw Hill Publishing Company, Ltd., 95, Farringdon Street, London, E.C.4.

**Metal Transfer between Palladium and Silver Contacts at Low Inductances** by J. Riddlestone, B.A. E.R.A. Technical Report U/T133 on the nature and extent of erosion and accretion in contacts breaking currents from 3 to 15A at 6V in circuits with inductance between 0.07 and 96 $\mu$ H. Pp. 21; Figs. 12. Price 12s 10d by post. The Electrical Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

**Electrical Who's Who, 1956-57.** Brief biographies of leading members of the professional and industrial branches of the industry, including telecommunications, together with lists classified under the titles of firms and organizations. Pp. 454. Price 21s. Electrical Review Publications, Ltd., Dorset House, Stamford Street, London, S.E.1.

**British Plastics Year Book, 1956.** Classified guide to products and manufacturers giving addresses of 4,000 firms in 50 countries. Includes buyers' guide to materials and plant, a review of recent plastics patents, a glossary of terms and lists of proprietary names, trade associations, etc. Pp. 740. Price 35s. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1.

# TELEVISION AT U.H.F.

## PROPAGATION PROBLEMS IN BANDS IV AND V

**T**HE success of the future expansion of television broadcasting in this country depends to a marked extent upon the ability to exploit the internationally allocated Bands IV and V, covering the frequency ranges of 470 to 585 and 610 to 960 Mc/s, respectively. Apart from the problems of developing high-power transmitters and sensitive noise-free receivers to operate on these frequencies, it is most important to have a clear and detailed knowledge of the propagation of the radio waves involved. This propagation will determine, on the one hand, the service areas of the transmitters and, on the other, the possibilities of interference from other stations whether engaged in the same or different services.

In a paper\* read before the Television Society in March, Dr. R. L. Smith-Rose reviewed the present state of knowledge of u.h.f. propagation, particularly in so far as the future possibilities of television services in Bands IV and V are concerned. Dr. Smith-Rose and his collaborators, Dr. J. A. Saxton and J. A. Lane, have already published in *Wireless World*† and elsewhere a good deal on this subject and this material was drawn upon for the lecture. Having dealt in general with the theory of u.h.f. propagation over "smooth earth" and over irregular terrain, the lecturer concluded with some practical results with television transmitters operating in the u.h.f. band.

Some experience in this direction has already been obtained in the United States where a number of experimental television stations operating in the u.h.f. band have been set up during the past few years. Early experiments by the Radio Corporation of America have emphasized that it is important that the transmitting aerial system should be as high as possible above the surrounding terrain. A full-scale investigation has therefore been conducted with station KPTV, at Portland, Oregon, where the main populated area to be served is relatively flat and lies in a valley between two mountain ranges. The transmitting aerial at this station was installed on a ridge to one side of the town and at a height of about 1,000ft above it.

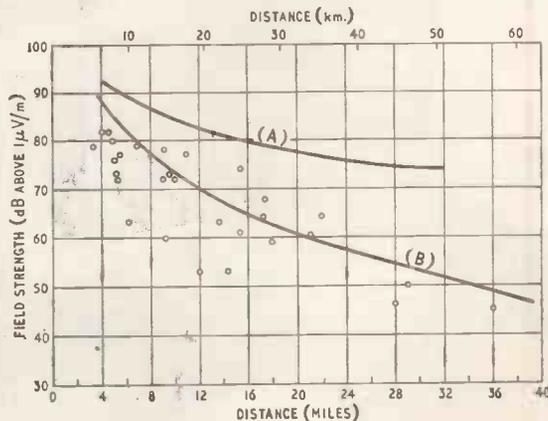
The transmitter operates in the American frequency channel No. 27 (548 to 554 Mc/s). Its output power is one kilowatt fed to a slot aerial installed on top of a 200ft tower. This would give a power gain of 21 in the horizontal plane, but the aerial is mechanically tilted forward about 1 degree towards the populous city area, and it is electrically adjusted to increase the signal radiated in what would otherwise be a "null" in the radiation pattern. The resulting effective radiated power is 16 kW.

Measurements have been made with a mobile receiver of the field strength obtained in four radial directions from this transmitter out to distances of

more than 30 miles. The results calculated on an e.r.p. of 1 kW are reproduced in the diagram on which are drawn curves for the free space radiation (A) and for the median conditions for 50% of locations and 50% of time (B) recommended by the F.C.C. for operation in this frequency channel. It will be seen that the measured values lie reasonably along this median curve although there is a spread among the observed values, particularly at the shorter ranges. Somewhat similar results have been obtained at three other stations at South Bend (Indiana), York (Philadelphia) and Atlantic City (New Jersey) on frequencies which range from 590 to over 700 Mc/s. In all cases, the median curve is followed, but there are conspicuous shadow areas where the field strength may range over  $\pm 10$  dB about this curve.

Field strength contours for the Portland transmitter show a constriction between mountains enclosing the valley, and also the existence of "dead" spots where reception of signals is very difficult indeed; these comprise about 5% of the built-up city and 12% of the whole residential area. However, the transmitter will furnish a good service to 88% of the population in the Portland area, and this could be increased to about 94% by increasing the effective radiated power to between 100 and 200 kW, or about ten times the present value. On this basis it is considered that in such favourable locations the use of u.h.f. for television can compare very well with v.h.f. although it may require ten times as much transmitter power to cover the same area.

Apart from propagation studies, the experience obtained at Portland has provided a good deal of information on the performance of receivers used with the type of aerials to be normally provided for u.h.f. reception. The limit to the reception of good television pictures is set by the noise level of the input circuits of the receiver, this noise being



Measured field strength along four radials from transmitter KPTV at Portland, U.S.A.

\* "Radio Wave Propagation and the Problems of Television Bands IV and V."

† *Wireless World*, May and July 1955.

responsible for what is termed "snow" on the screen of the cathode-ray tube. Actual observations showed that under these conditions a good picture was obtained with a field strength of 2mV/m (66dB above 1 $\mu$ V/m); and this would appear to agree favourably with the target which has been set by the F.C.C. at 1.6mV/m (64 dB above 1 $\mu$ V/m for the class B service). For the first-class or A service, the required signal should be 10 dB greater (74 dB above 1 $\mu$ V/m). It seems likely that in due course these conditions will be met by the use of effective radiated powers well within the limit of 1,000 kW set by the F.C.C.

As a final word of warning, however, Dr. Smith-Rose said there is still much to be learnt about the phenomena of propagation on these higher frequen-

cies. The possibilities of multi-path transmission, in which two or more waves may reach a receiving aerial with resulting complex interference patterns, are likely to add to the difficulties of the so-called "dead" areas of reception. There is also the subject of the effect of varying weather conditions on propagation through the troposphere. In this case, the effects observed are unlikely to be serious at service ranges of 20 to 30 miles; but, as was the case for v.h.f. propagation, a knowledge of these tropospheric effects is essential before plans involving the sharing of frequency channels by stations in different localities are drawn up. These are among the problems requiring further investigation as the development of u.h.f. for television transmission proceeds.

## Manufacturers' Products

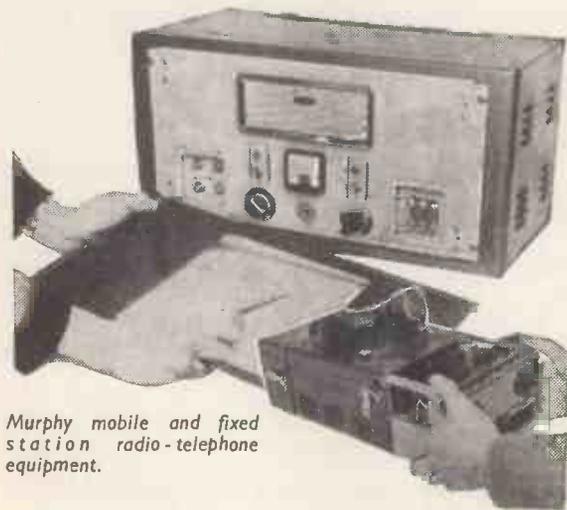
### NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

#### Mobile Radio

THE illustration shows the new mobile radio v.h.f. equipment introduced by Murphy Radio. The unit partly withdrawn from its case is the transmitter-receiver chassis of the mobile set, Type MR800, while the larger self-contained set is the Type MR862 for fixed stations. A separate 6- or 12-volt vibrator-type power unit is used for the mobile set as this allows greater flexibility in installation.

Controls on both sets are reduced to a minimum and on the mobile they comprise only an on-off switch (with receive and stand-by positions), volume control and send-receive switch on the microphone or handset. Transmitter and receiver are crystal controlled and can be set up on any single frequency in one of the three bands 60 to 90 Mc/s, 100 to 133 Mc/s or 133 to 174 Mc/s. The receiver is a double super-heterodyne.

The self-contained fixed station set measures 22in x 11in x 10in and it employs the same r.f. chassis as the mobile set but modified to provide a slightly larger r.f. power output, muting circuits and remote control equipment. It is a.c. operated. The normal controls comprise volume, on-off switch, muting and meter selection



Murphy mobile and fixed station radio-telephone equipment.

switch for monitoring purposes, with the send-receiver switch on the microphone stand (or remote control unit when used). Provision is made for remote control over internal or external G.P.O. lines. In the illustration the front panel surround is removed revealing two sets of subsidiary controls for setting-up and change in frequency. With a suitable transmitting aerial a working range of 15 miles or more is possible.

The makers are Murphy Radio, Ltd., Welwyn Garden City, Herts, and the prices are £85 for the mobile and £150 for the fixed station set.

#### Lightweight Headset

WEIGHING only 7oz, the Type 2566 headsets made by the Industrial Products Division of Amplivox, Ltd., 2, Bentinck Street, London, W.1, are designed to minimize fatigue when worn for long periods. They have in fact been adopted for use in the control towers of airfields under the administration of the Ministry of Transport and Civil Aviation.

Electro-magnetic insert units for the earpieces have acoustically equalized response within  $\pm 3$  dB from 200 c/s to 3,300 c/s. Three types of microphone insert, including a differential noise-cancelling model, are available.



Flexibly mounted Perspex ear discs are a feature of the Amplivox lightweight headphone/microphone sets.

#### U.H.F. Communications Receiver

IN the description of the Eddystone 770U receiver on page 118 in our March issue the bandwidth was given as 15 kc/s whereas this is the kc/s-off-resonance figure at the 3-dB points. The corresponding bandwidth is therefore 30 kc/s.

# LETTERS TO THE EDITOR

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

## Disc Playback Characteristics

THERE have recently appeared an entirely new crop of gramophone recording (playback) characteristic titles:

- (a) R.C.A. "New Orthophonic."
- (b) New A.E.S. (January, 1954).
- (c) R.I.A.A.
- (d) N.A.R.T.B. (June, 1953).
- (e) B.S. 1928:1955.
- (f) C.C.I.R. } Proposed revisions
- (g) I.E.C. } to be confirmed.

All these authorities specify a fine groove characteristic, and they are all identical. Some also specify a coarse groove characteristic and again they are all identical. These two characteristics are now used by nearly all the major manufacturers throughout the world and they may therefore be taken as international standards. All that remains is to standardize the title, preferably in some short form that may be easily fitted around the periphery of a record equalizer selector knob together with the older characteristics.

None of the titles given above is ideal, either because they may not be internationally known or are cumbersome. (Or both; imagine a switch position labelled "British Standard 1928:1955 Fine Groove.") Simplification to "LP" and "78" fails to distinguish between a wide variety of earlier characteristics and does not apparently allow 45-r.p.m. records to be played, not to speak of complications with fine-groove 78-r.p.m. records. Another possible solution is to use the terms "FINE" and "COARSE." The operator of the gramophone will then fall into one of four groups. First, those who know; secondly, those who try to measure the width of the groove with a 12-in rule; thirdly, those who think it refers to the song on the record rather than the groove; and, fourthly, those who do not understand English anyway.

The most logical solution seems to lie in an extension of the Red Triangle, Green Square system (B.S. 1928:1955). This at present may be used on transcription record labels and on pickup heads to indicate fine groove or coarse groove. Used also as an equalizer switch position marking, it forms the basis of a simple unambiguous system, free from language difficulties.

For example, if the record label bears the symbol



(preferably in red), it conveys the following

information:

- (a) The recording characteristic used is that recommended for fine groove records in B.S. 1928:1955 or equivalent.
- (b) The turntable should revolve at 45 r.p.m.
- (c) The pickup head should bear the red triangle symbol (or in the case of turn-over types, be set so that the symbol is visible), i.e., the stylus tip radius should be 0.001 in.
- (d) The equalizer switch should be set to the red triangle position in order to select the correct playback compensation.

Huntingdon.

JOHN D. COLLINSON.

## Single or Double Sideband?

THE decision to open the Crystal Palace Television station on a vestigial sideband basis was taken, states the B.B.C., after consultation with the G.P.O., the Radio Industry, and the Trade. The viewing public was not apparently consulted.

The arguments against such a decision are:—

1. The change makes a large number of receivers obsolete.

2. The channel space saved is jammed in between two channels in a band allocated exclusively to television and is, therefore, unlikely to be used for anything else.

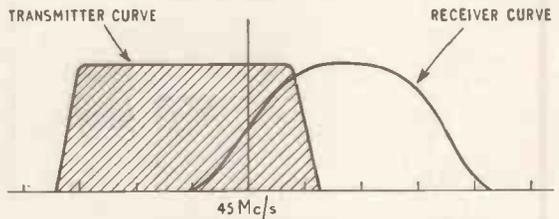
3. Sentimentally there is a case for retaining for as long as possible (and at least until there are no receivers using both sidebands) the superior performance possible with double sideband operation in this special case of the world's first high-definition television service.

4. The change can be made easily at any time in the future.

The modification necessary to the double sideband receiver is not too difficult but the modification to the upper sideband receiver is extremely difficult, involving as it does a complete new tuning set-up over several stages and the inclusion of two or more sound rejection circuits. In the B.B.C. statement to the Press dated March 8th, 1956, these latter receivers are dealt with as follows.

"In a few cases, some modifications to the receiver may be advisable and there may be some slight loss of detail in the picture." This is a masterpiece of understatement.

In the diagram below the shaded area represents the



information sent by a vestigial sideband transmitter. The full line curve shows the reception capability of upper sideband receivers. The area under this receiver curve outside the shaded area represents what is described as the slight loss of detail. If such a "slight loss" occurred in apparatus for the B.B.C. instead of for the public, the B.B.C. would undoubtedly describe the loss of information as serious and unacceptable.

In a classic paper by Sir Noel Ashbridge in 1951\*, on the British Television Service, he says "Consideration has been given to modifying the characteristics of the Alexandra Palace transmitter so that this, too, could radiate only one vision sideband. At the time of consideration the number of receiving sets in use was of the order of 60,000; it was decided that it would be unfair to the owners of these sets to change the characteristics of transmission."

These sentiments are admirable but it would seem that the same situation today has not received the same consideration.

"LAMBDA."

\* Proceedings of the Joint Engineering Conference, 1951, Part II, page 491.

## Ionospheric Scattering at V.H.F.

DR. SAXTON'S article in your January issue is timely—if disappointing. As would be expected from the author, his treatment of the subject is scientific and logical. No one will quarrel with this approach, except perhaps that enough acknowledgment is not given to the great effort put into the study and development of scatter techniques in North America in the last few years.

As you read the article, you get a growing impression

that ionospheric scatter is still largely experimental, and the final section on "Application to Communications" damns the whole subject with such phrases as "unlikely to be satisfactory," or when dealing with telephony—"impracticable transmitter power." It ends with the inference that when an aurora occurs a scatter link becomes "practically impossible"—a generalization which is almost certain to prove untrue.

The Proceedings of the recent Convention of the U.S. Institute of Radio Engineers on scatter give an almost overwhelming volume of information on the subject; in particular an account is given of six circuits in America, Greenland and the Azores which have been operated experimentally using ionospheric scatter over a considerable period. One terminal situated at Sondre Stromfjord, in Greenland (in a region of high aurora activity), appears to have worked Goose Bay satisfactorily over a period of 3½ years. There are, of course, no published figures of the performance of the operational circuits subsequently established, but the fact is that the U.S. Forces have decided to use ionospheric scatter operationally and they will clearly not be satisfied with the very few channels and frequent interruptions that Dr. Saxton expects.

Furthermore, a number of U.S. and Canadian manufacturers and consultants are prepared both to erect ionospheric and tropospheric scatter links or to work out the parameters for the customer who is prepared to do the job himself. They are quick to point out the advantages of such links, such as their reliability and the elimination of frequency changing. In the case of tropospheric scatter very large bandwidths can be handled over short distances.

V.H.F. scatter is not the answer to all communications headaches, and the ionospheric variety has a somewhat limited field of application. However, I do urge that it is time we stopped looking on scatter circuits as a difficult experimental feat; they are already operational, and we in this country are in danger of being left farther and farther behind.

London, W.1.

C. S. CADELL.

### "Precision Photographic Timer"

WE have studied with interest the circuit described by J. G. Thomason in the February issue as we have ourselves used the Miller integrator for timing precisely intervals of the order of 15 minutes. The use of a Miller integrator in this way, in conjunction with a gas-filled triode, is covered by British Patent 613,565.

In practice, it is difficult to realize any advantage from the use of a Miller integrator. Valve ageing and supply voltage variations produce changes in the internal gain and hence in the effective CR product. The most consistent results are obtained when the charging voltage ( $e_m - e_n$ ), is high and reckoned in tens, or preferably hundreds, of volts. Mr. Thomason has shown that, in order to obtain a useful amplification of CR, it is, in practice, necessary to reduce  $e_m$  to a few volts. In consequence small variations in  $e_n$  (due to changes in contact potential between grid and cathode) have a significant effect on the time interval.

For these reasons we prefer to use a cold-cathode trigger tube in the type of circuit shown on page 177 of the April, 1955 issue of *Wireless World*. The economy of this simple circuit more than offsets the higher cost of the relatively large timing capacitor required. Using a 12- $\mu$ F capacitor, long exposure times may be obtained with comparatively low (and hence stable) timing resistors by using a 2.2-megohm variable resistor in series with a number of 2.2-megohm fixed resistors. As each fixed resistor is brought into circuit by a step switch, the exposure time is increased by 15 seconds. This arrangement has the advantage of allowing exposure adjustments by increments smaller than the  $\sqrt{2}$  steps suggested by Mr. Thomason.

We also have used a non-linear resistor such as "Atmite" for exposure compensation, though in a different circuit arrangement. Our experience has been

that its value for this type of work is limited by its high temperature coefficient.

The single-valve circuit referred to above appears preferable on grounds of simplicity, economy, stability, elimination of warming-up period and the wide range of supply voltages over which accurate compensation is provided. This circuit is protected by British Patents 656,275 and 667,296.

Ilford, Limited,  
Watford, Herts.

R. J. HERCOCK.  
D. M. NEALE.

J. G. THOMASON states (your February issue) that the anode should not be started at the full H.T. voltage, or initially there would be no voltage drop across the anode load resistor, no anode current, and therefore no gain. Actually there is no need for an "anode load" at all. If the anode load is disconnected, the capacitor will still commence discharging through the valve as soon as the relay contact A1 is opened, and the rate of discharge will be almost independent of any change in the H.T. voltage during the timing interval. The effective time constant will be:—

$$C(r_a + R(1 + \mu)).$$

Satisfactory operation will depend on whether the amplification factor of an EF37 is sufficient when the anode current is reduced to 1 $\mu$ A. This will have to be determined by experiment unless constant-current curves are available.

Twickenham, Middx.

G. A. ASKEW.

### Future of European Broadcasting

I WAS most interested to read G. H. Russell's article in the January issue on the replanning of the long and medium wavebands.

While his proposals—if they could be put into effect—would undoubtedly improve matters a great deal, I believe that they are open to two serious criticisms:

(1) One of his factors controlling allocations is "population"; surely this ought to be "number of receivers in use."

(2) I do not consider that international reception will be satisfactory, by modern standards, so long as the present 9-kc/s separation is retained. The shifting of local services to v.h.f. should eventually make it possible to use a separation of, say, 15 kc/s, for at least part of the medium wavebands, to be used by one station in each country, transmitting an "international" programme.

Hindhead, Surrey.

G. H. STURGE.

### Non-linearity

IN the January issue of *Wireless Engineer* the Editor refutes statements he has seen to the effect that distortion due to non-linearity cannot be eliminated by opposite non-linearity. I have an uncomfortable feeling that this dunce's cap fits me, for having said (on p. 317 of your July, 1955 issue), "Unlike frequency distortion, the results of non-linearity in one unit of the audio chain cannot be compensated by opposite non-linearity in another." However, it is pretty clear from the *Wireless Engineer* Editorial that compensation of non-linearity is mainly if not entirely of academic interest and is unlikely to be of practical value even within a single unit, such as an amplifier, let alone between one unit and another, such as amplifier and loudspeaker. I doubt whether the Editor could seriously disagree with my statement within the limits of its context. Nevertheless on a point of strict accuracy I readily plead guilty, with acknowledgments to *Wireless Engineer*, and ask that the words "in normal practice" be understood after "cannot."

Bromley.

M. G. SCROGGIE.

Burne-Jones "Super 90" Pickup Arm. The price of this component is £11 11s plus £4 12s 5d tax and not £16 9s as stated on p. 119 of the March issue.

# More Lines for Colour?

By V. J. COOPER,\* B.Sc.(Eng.), A.C.G.I.,  
M.I.E.E., M.Brit.I.R.E.

AN OLD TELEVISION CONTROVERSY BROUGHT UP TO DATE

**T**HE glamour of more lines for our television pictures is once again being widely discussed and from some quarters comes the suggestion that we should adopt a 625-line system for colour television in Bands IV and V. Do we need more lines, and if we have them shall we get better pictures? These are the questions that the viewing public ask and usually expect an affirmative answer; for the number of lines in the picture structure is a property that all can appreciate, and, on first thoughts, the more the lines the better the picture. What is frequently overlooked, in a casual examination of the problem, is the fact that picture quality for a given fixed total information content in the picture is not just a matter of lines. During the past few months the technical press in U.S.A. has made several references to the better pictures we receive in our homes in Britain compared with those received in American homes: yet the Americans have 525 lines and we have only 405.

The difference could be due to a variety of causes, for example, camera control, amplitude linearity response, synchronizing stability, black level stability, apparent resolution, etc. One fact that may be contributory is that the possible horizontal resolution expressed as a fraction of the possible vertical resolution of the 405-line system, using 3 Mc/s bandwidth, is markedly superior to that for the 525-line system using 4 Mc/s bandwidth.

The superiority of the horizontal resolution in our system over that of U.S.A. standards, expressed in round figures on this basis, is about 45 per cent. It would appear that no one has so far published a subjectively derived figure for the optimum ratio of horizontal to vertical resolution, but on the evidence that exists it would seem that in this country we may be nearer the optimum than the Americans.

Let us for a moment consider one of the fundamental requirements in a television picture; the acknowledged requirement that the picture should be wider than it is high—why is this so?

Nature has given us eyes which are laterally spaced. This results in our having the property of vision perspective in the horizontal plane. We therefore appreciate more information that is presented horizontally. By and large, our world spreads around us laterally and the great majority of movement and interest is horizontal. Cinemascope, Vistavision and the other new forms of picture presentation underline this human tendency to enjoy more breadth of vision than height of vision.

It would seem fantastic if cinema screens were made high and narrow instead of wide and shallow. If further proof be needed, the simple experiment of breaking up a line of typescript characters by horizontal lines and a similar line of typescript by vertical lines so that individual letters are mutilated, will demonstrate that as long as horizontal continuity

is preserved the words are much more easily read than when horizontal continuity is destroyed.

The conclusion to be drawn so far, therefore, is that we must preserve horizontal continuity and extend the amount of information horizontally. Fink† suggests that we can usefully extend horizontal information by 50 per cent and this is confirmed in a *Wireless World* article.‡

How do these requirements fit into a television system? The basic factor of television transmission is that the maximum amount of information that can be sent is a function of the bandwidth of the system. In this country, for the 405-line system we use a picture bandwidth of 3 Mc/s; in the U.S.A., for 525 lines, about 4 Mc/s is used, and in Europe, for 625 lines, about 5 Mc/s.

## A Limited Commodity

Bandwidth of transmission is directly related to the number of stations that can be operated in a given band of assigned frequencies. Thus for 3-Mc/s vision band transmissions we can have more channels than the U.S.A. or Europe, or conversely for a given number of channels we need less bandwidth in the radio frequency spectrum.

This is a highly important consideration. R.F. bandwidth available in the foreseeable future is the one commodity in which we are definitely limited. It is, in fact, our capital asset in a bank which for the next 50 years at any rate will not be able to offer overdraft facilities. It is therefore foolish to dissipate this capital asset more rapidly than absolutely necessary. If to-day we use all the available bandwidth, the next generation will find expansion of radio services the more difficult. The conclusion to be drawn, surely, is that the best possible reasons should be forthcoming for any suggestion that bandwidth per channel should be increased. We should, on the other hand, be more concerned with reducing bandwidths used consistent with maintaining a reasonable service.

For a radio service providing entertainment, the use of 3 Mc/s for a vision channel is already outrageous—it occupies over 100 times the bandwidth of the accompanying high-quality sound channel and in terms of value for value the ratio is even greater. This statement is readily acceptable if one conducts the test of (a) looking at television with the sound off, (b) listening to the sound with no vision. The vision information on its own is far less valuable as entertainment than the sound by itself.

We are still a long way from achieving bandwidth reduction without sacrificing picture quality in

\* Marconi's Wireless Telegraph Company.  
† "Principles of Television Engineering," Donald G. Fink, McGraw-Hill Book Company Inc. 1940.  
‡ "Television Standards," *Wireless World*, Oct. 1948, p. 382, col. 1, line 20.

broadcast systems, although the present generation may, by the use of coding, achieve progress in this direction on closed-circuit systems. If we cannot reduce broadcast service bandwidths then at least we should conserve them, and this thought makes the possibility of using more lines far less attractive.

More lines means more bandwidth in transmitters, receivers and link systems and this inevitably means greater cost.

### Consequences of 625 Lines

To achieve a significant improvement in picture quality for, say, large-screen operation we should need to adopt, say, 625 lines, and to preserve the same ratio of horizontal to vertical resolution we should need a bandwidth of over 6 Mc/s. This is considerably beyond the basis of the European C.C.I.R. standards, which have a 5-Mc/s video band. Even 5 Mc/s instead of 3 Mc/s means a serious reduction of channels in a given allocated band of frequencies. In Bands I and III, for example, the U.K. system can use 13 channels while the European system, on 625 lines in the same range of frequencies, can use only 9 channels and each, of course, subject to this lack of horizontal information.

It is frequently argued that the 405-line standards are 20 years old and were the first in the world and are therefore somewhat out of date. Certainly other countries that have followed have progressively standardized on more and more lines.

However, this does not, *ipso facto*, mean that a 405-line system cannot produce all that is required for home entertainment. The quality of pictures we receive is not limited by the standards§ but by the price the public can afford or is prepared to pay.

At a price, it is very debatable whether 625-line C.C.I.R. European standards can give any better pictures than 405-line U.K. standards, despite the increased channel bandwidth and, even without price limitations, doubts still exist.

It is probable that reducing the lines from 625 to 525 within the same 5-Mc/s video bandwidth would improve rather than degrade the picture owing to the closer approach to reasonably balanced resolution, but even then the horizontal information factor would be less than we now have on 405 lines.

If we express the system goodness factors on a basis proposed by Hallows|| related to actual observed resolution capability (i.e. vertical resolution is, say, 0.8 of number of lines¶) we get the following figures:

Europe 625 lines (5 Mc/s): goodness factor 0.8.

U.S.A. 525 lines (4 Mc/s): goodness factor 0.78.

U.K. 405 lines (3 Mc/s): goodness factor 1.14.

There are additional hazards due to multipath reception as the number of lines and bandwidth is increased, and these hazards will be more pronounced as we move into the u.h.f. bands.

For a bandwidth of 3 Mc/s the time of duration of one picture element is approximately 0.14  $\mu$ sec. The reception of signals by alternative paths of different lengths will cause an error in the time of arrival between the two signals. The speed of travel is about 186,000 miles per second, i.e. approximately 327 yards per  $\mu$ sec. Thus a secondary signal received

at high level by reflection from a local re-radiator giving a path difference of 46 yards will produce two received pictures displaced by 0.14  $\mu$ sec, i.e. halving the definition. As bandwidth is increased to permit more lines this effect is more pronounced; for example, for 5 Mc/s video signals the corresponding time for a picture element is 0.1  $\mu$ sec, which is the time delay of a second signal arriving with a path length difference of 33 yards. As the path length difference is reduced the strength of the secondary signal for a given re-radiator will increase and cause a corresponding increase in the visibility of the ghost image. Thus for the European standards there is more chance of ghost images of sufficient strength causing a loss of resolution than for U.K. standards.

The question of more lines would probably not be raised if we made the lines invisible by spot wobble or by shaping the focused spot. If we did this, and removed line visibility as a point of argument, the questions of resolution in vertical and horizontal directions and the optimum relation between these properties would form a more realistic basis for discussion.

When we come to colour television the same arguments apply, but there is a further factor which offers any advantage that might be claimed for more lines. With shadow-mask colour c.r. tubes the line structure is, for all practical purposes, invisible and if colour television using these tubes sets the fashion for "no lines" television then, once again, arguments based purely on lines and line visibility will be pointless.

Economic factors must surely be predominant in deciding standards. In a classic paper on the British television service\*\* Sir Noel Ashbridge sums up the bandwidth and cost problem as follows.

"For all the main operations in television, from production in the studio right through to the receiver in the hands of the viewer, cost must constantly be kept in mind. The television standards adopted in the United Kingdom require only a 3-Mc/s signal bandwidth to produce a satisfactory picture. This restrained bandwidth keeps down technical complications and so reduces cost. It has enabled an economical signal transmission system to be developed and has made possible the design of high-power vision transmitters of relatively high efficiency. More important still, it has enabled the price of the simple domestic receiver to be kept down to a figure which permits wide sales. All parts of the transmission and reception chain would become more technically complex and more expensive with a higher-definition system. Any attempt to transmit a higher-definition signal over a system excessively restricted in bandwidth at any one link of the chain, whether such restriction is in the transmitter, the cable system, the receiver or elsewhere, can result in a received picture considerably inferior to that obtained from a 405-line signal handled throughout by properly designed 405-line equipment (Kirke 1948).

"It follows that a significant improvement in definition could be achieved only by incurring considerable increase in all-round costs. Thus the decision to maintain the 405-line system seems warranted by overall financial considerations as well as by the necessity for economizing in transmission channels."

§ "Editorial Comment," *Wireless World*, Oct. 1948. "Choice of Television Standards," *Wireless World*, July 1950, page 249, second col. "Comparison of Standards."

|| "Television "Goodness Factor,"" R. W. Hallows, *Wireless World*, March 1949, page 87.

¶ "Principles of Television Engineering," Fink. Chapter II, Sec. 7, page 33, line 23.

\*\* "The British Television Service." Sir Noel Ashbridge. Proceedings of Joint Engineering Conference, 1951, Part II, page 491.

# Components Exhibition

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

## RESISTORS

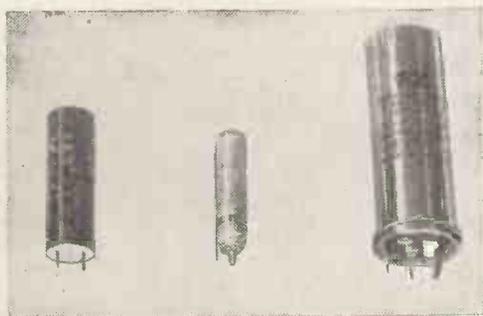
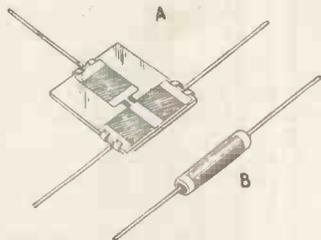
AN interesting development this year is a range of high-precision resistance elements for use in volume controls where reliability is essential and both resistance and linearity tolerances have to be held to closer limits than usual. These are made by Plessey and the resistance element is actually an integral part of the body of the control. This is a high grade phenolic moulding which is extremely hard and has a glass-smooth surface. The resistive part of this element is a carbon composition track and the "binder" consists of the same material as the main moulding. Resistive element and body are moulded in one operation, with contacts moulded in where required. A centre ring for the "take-off" of the wiper contact can be moulded in also. The actual resistance track is about 15 mils thick and almost any resistance grading can be provided. Elements of this kind were shown in single track, twin track, segmental and strip form. The extreme hardness of the element's surface ensures a very long life and exceptional stability.

A new development in the metallized glass resistors made by Painton is to deposit a microscopically thin film of precious metal on to a glass fibre little thicker than a hair and then wind this metallized fibre, like wire, on a ceramic former. Very high resistance values are obtained in a small volume. The resistance range



Section of Plessey high-precision resistive element showing track and moulded-in contacts.

(A) Painton "Metlohm" T-pad metallized-glass resistance network and (B) new metallized glass-fibre resistor.



T.C.C. printed circuit capacitors, showing a 50- $\mu$ F Picapack, 32 + 32 + 16  $\mu$ F, 350 V electrolytic and CPI9ON 0.27  $\mu$ F, 350 V moulded-case type.

The "private" exhibition held in London by the Radio and Electronic Component Manufacturers' Federation from 10th to 12th April is reviewed in these pages. In addition to describing in detail some of the new components and accessories shown, we give in each category a list of exhibitors and their main products. Test and measuring equipment, and also valves, will be in a later issue.

is comparable to that of high-stability carbon types, for example, but the permissible wattage is higher. A 1-watt glass-fibre resistor is about a quarter the size of an equivalent carbon type and about the same as that of a 1½-W wire-wound type. The resistor is protected by a coating of Araldite.

Shown also by Painton were some resistive T pads constructed on the "Metlohm" principle of a precious metal film on a glass plate zig-zag scribed to produce a long resistance track. By having the three elements on a single plate, and produced by the same operation, stability and temperature coefficient are the same for all three.

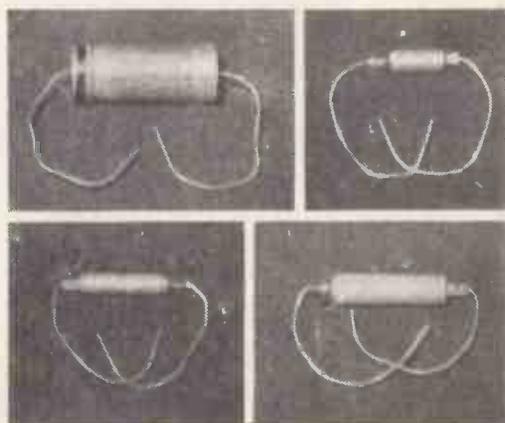
There were numerous minor improvements to the existing ranges of all makes of resistors, but these were mainly of a constructional kind to make the resistors more adaptable to printed circuit applications.

Manufacturers: A.B. Metal Products, British Electric Res., Colvern, Dubilier, Egen, Electronic Comp., Electrothermal, Erg, Eric, Labgear, Morganite, N.S.F., Painton, Plessey, Salford, Walter Instruments, Welwyn, Zenith, W.B.

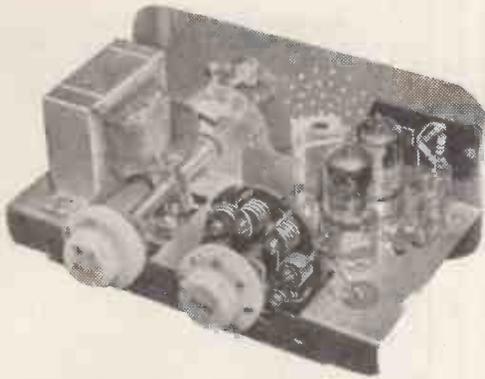
## CAPACITORS

A DEVELOPMENT of more than usual interest is the introduction by Erie of a capacitor having voltage-sensitive characteristics. It provides a controlled change in capacitance with applied d.c. voltages and would appear to have useful applications in f.m. receivers and a.f.c. circuits generally. The dielectric is a thin plate of piezo-electric material with metallized surfaces and while present models have capacitances of the order of

Dubilier new capacitors including "Terecap" (largest) and three miniature electrolytics.







Wolsey Band III convertor with turret coil selector.

details. Improvements in the layout of components have produced small increases of gain and a lower noise level and, perhaps more important, better uniformity between different samples. Oscillator frequency stability is improving, too.

The Band III convertor is even less of a component than the tuner and very few were shown at the exhibition. Wolsey had one, however, in the form of a self-contained unit with a well-finished case, which is unusual in having a Band III turret for the oscillator coils. One switch gives a changeover between bands and the turret provides selection among the Band III channels.

Manufacturers\*: Aerialite (C); Cyldon (T); Long & Hambly (M); James Neill (F); N.S.F. (T); Plessey (D, F, T, Tr.); Thermo-Plastics (M); Whiteley (D, Tr.); Wolsey (C).

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

## SUB-ASSEMBLIES

A VERY simple and flexible system for the construction and manufacture of sub-assemblies was demonstrated this year by Erie. Standard resistors and capacitors are selected and laid out on a tagboard, then wired into the required circuit and immersed in a sealing compound, leaving projecting pins for the connections. Anything between 2 and about 100 components can be assembled in this way, according to the customer's specification, and because there is no tooling involved it is quite easy to make changes to the circuits in the middle of a production run. The design is said to be suitable for automatic assembly methods in the manufacture of electronic equipment.

The general technique of "potting" sub-assemblies in blocks of resin was represented by many examples on the stand of Lion Electronic Developments. A particular unit of some topical interest constructed in this way was a voltage multiplier for supplying a 5-kV polarizing voltage for an electrostatic loudspeaker. Designed by Westinghouse, it contains 5 miniature tubular rectifiers and 6 small ceramic capacitors, and is intended to work from the 700-V a.c. provided by the 350V-0-350V winding of a mains transformer.

Sub-assemblies are very widely used in electronic computers, especially those designed on the "packaging" principle, and at the show this application was represented by a new kind of plug-in unit made by McMurdo. The valve and associated components are built into an inverted-U length of rod which forms both the main support and the handle for plugging in the unit.

A great many sub-assemblies are nowadays mounted on printed circuits, and a representative selection of such circuit plates was to be seen on the T.C.C. stand. This firm was also showing special printed circuits having the conductors flush with the surface of the base material; printed circuits on flexible bases (treated papers, resins,

polythene, etc.), and examples with conductors brought out to one edge for insertion into multi-way sockets or connectors.

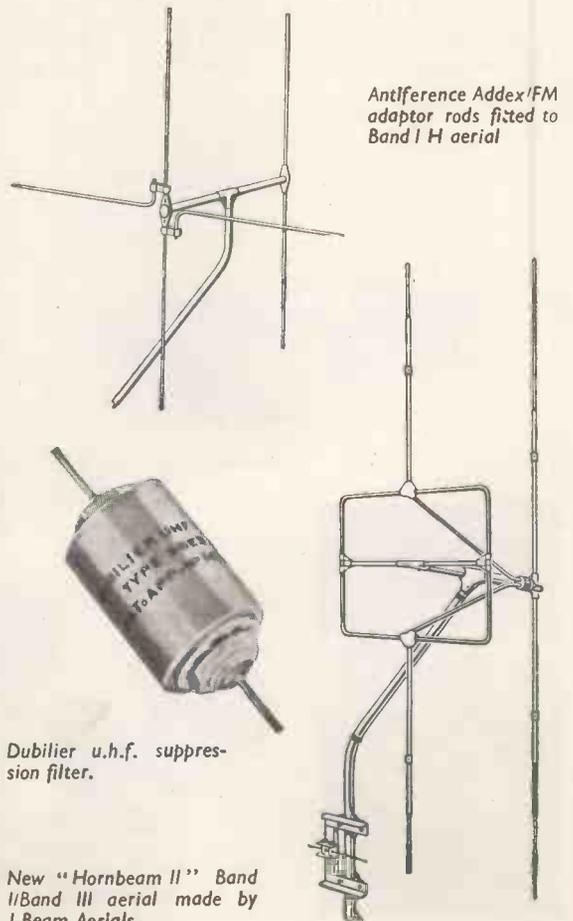
There were, of course, quite a number of coil packs and filter units to be seen. Of particular interest on the Dubilier stand was a u.h.f. suppression filter, covering 200-1300 Mc/s, for insertion in the power supply leads of transmitting equipment. It is a double-T network, using two disc capacitors and a straight-through inductor wire with a ferrite sleeve, and is built into a small cylinder sealed with resin. The attenuation of the unit is in the region of 60db at 1300 Mc/s.

Manufacturers\*: Aerialite (IS); Antiference (IS); Bakelite (PC); Belling and Lee (F, IS); B.I.C. (DN); Bulgin (IS); Cyldon (TD); Dubilier (DN, F); Ediswan (TD); Electro Methods (PC); Erie (IS, CA, PC); Ferranti (DN, F); Hunt (IS, PC); Labgear (BE, F, IS); Lion (DN, CA, F); McMurdo (CA); Morganite (IS); Mullard (F, TD); N.S.F. (TD); Plessey (F, IS, PC, TD); Static Condenser (IS); S.T.C. (BE, IS); Stratton (TD); T.C.C. (DN, IS, PC); Thermo Plastics (F); T.M.C. (IS); Walter (PC); Wego (DN); Westinghouse (RA); Weymouth (DN, F, TD); Wingrove and Rogers (TD).

\*Abbreviations: BE, battery eliminators; CA, component assemblies; DN, delay networks; F, filters; IS, interference suppressors; PC, printed circuits; RA, rectifier assemblies; TD, tuning devices.

## AERIALS

THE television aerials made by J-Beam have always been a little unorthodox in design; for example, the end-connected feeder to the Band I dipole adopted a few years ago; the skeleton-slot beams of last year and now the "Hornbeams" shown this year. The "Hornbeam" is a combined Band I/Band III aerial and, as the illustration shows, consists of a square combined



Antiference Addex/IM adaptor rods fitted to Band I H aerial

Dubilier u.h.f. suppression filter.

New "Hornbeam II" Band I/Band III aerial made by J-Beam Aerials.

with a "V" with two vertical rods joined to the top and bottom sides of the square. Apart from these two rods the sides of the square and the arms of the "V" are all approximately a half-wavelength long at Band III frequencies.

The skeleton square plus "V" section form the Band III system, and this is said to exhibit the unusually broad bandwidth of 170 to 230 Mc/s without the voltage standing-wave ratio exceeding about 1.5 to 1. The Band I section, consisting of the vertical rods and the two vertical sides of the square in parallel, is less broad so the vertical rods are adjustable for tuning to the required Band I channel. A 75-ohm coaxial cable is connected to the apex of the "V" and no cross-over network is required. It can be used either vertically, as shown, or horizontally.

Apart from this novel aerial the main changes appear to be towards consolidating the various designs introduced last year. Ranges have been extended and mechanical features improved where necessary. As an example the add-on elements made by Antiference have now been extended to include an Addex/FM set for use on vertical television aeriels and where the receiver has provision for f.m. reception.

More attention has been given to indoor Band III aeriels, as it appears that within 5 to 10 miles of an I.T.A. station this kind of aerial can quite often be used successfully. Wolsey have a small square aerial for standing on top of the receiver which they call the "HI-Q"; it consists of a full-wave dipole bent into a square with a small loading coil in the top side. Provision is made to plug in the feeder from a Band I aerial, and there is a cross-over network in the base.

A folded dipole bent in the shape of a "V" and mounted on a base, also with a cross-over network incorporated for a Band I aerial connection, was shown by Aerialite. It is known as the "Viking." Aerialite had also a new "Multiway" indoor aerial, mainly, but

not exclusively, for loft mounting, which provides 18 different combinations of Band I, Band III or Band I/Band III aeriels according to the way the rods are inserted in the universal-type centre insulator. Another indoor aerial giving choice of several types, such as Vs, Ts, Ls, etc., was shown by Antiference. This firm has introduced also a simple coaxial cable plug in which the cable is fixed by crimping the sleeve of the plug on to the bared copper braid of the cable. The centre conductor has to be soldered in.

Manufacturers: Aerialite, Antiference, Belling-Lee, B.I. Callender's, Henleys, J-Beam, Labgear, Permanoid, Telcon, Telerection, Wolsey.

## SWITCHES

THERE were no really outstanding developments in the design of switches to be seen this year, but just a series of small improvements. In rotary switches some attention is being given to the better fixing of the stator contacts, which often become loose with continued operation. Walter Instruments, for example, were showing a switch in which the fixed contacts were locked in position by a staple clip. This gives improved security in operation and also prevents the contacts from being loosened by overheating during soldering. A similar improvement was to be seen in a new Plessey rotary switch. Here the contacts are held by a flat wedge type of rivet which not only gives better lateral support but enables them to be mounted on the surface of the wafer instead of in cut-away sections. This makes for a stronger wafer and incidentally allows the conventional rotor to be replaced by a more rigid assembly.

Two other new rotary switches were shown by A.B. Metal Products. The first was a new size, half-way between the ordinary "OAK" type and the miniature "OAK," and was notable for a simpler and cheaper index spring mechanism. The second was intended for switching very small currents in electronic instruments and was equipped with PTFE wafers having an insulation resistance of not less than  $10^{16}$  ohms. This firm also had a wide range of piano-action switches including several miniature types.

Micro-switches with a great variety of actuating mechanisms—plungers, levers, rollers, leaf springs—and actuating pressures were to be seen on both the Pye and Bulgin stands. Normally these switches do not lock into the closed state but Bulgin now have a number of models which do. This firm has also devised a system for ganging micro-switches.

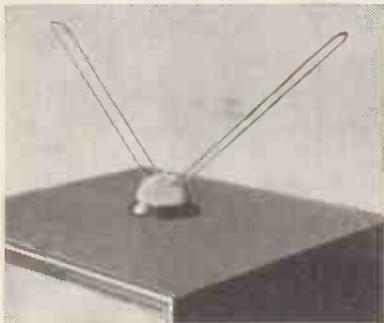
Manufacturers: \* A.B. Metal Products (L, P, PA, R, S); B.E.R.C.O. (R); Bulgin (L, M, P, R); Diamond H (L, R); Electronic Components (P, R); N.S.F. (L, P, R, S); Painton (L, P, R); Plessey (L, P, PA, R, S); Pullin (R); Pye (M); T.M.C. (L, P); Walter (L, P, R, S); Whiteley (P, R, S); Wright and Weaire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

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

## CHASSIS FITTINGS

IN this section probably the most topical trend in design was special fittings for printed circuits. Valveholders

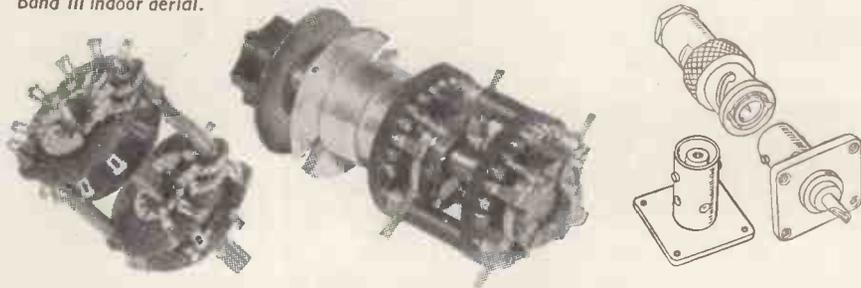
(Continued on page 179)



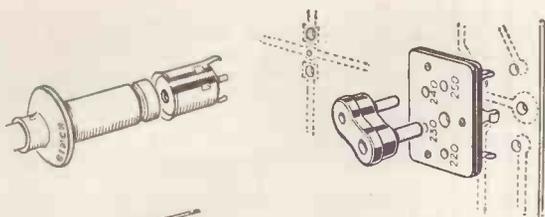
Aerialite "Viking" Band III indoor folded dipole.



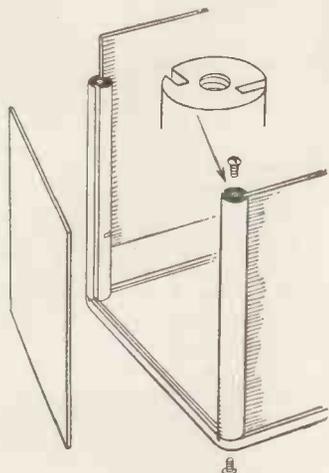
Left: Wolsey "HI-Q" Band III indoor aerial.



Above: Plessey rotary switch of improved construction. Centre: Electronic Components 4-pole 10-way instrument stud switch. Right: Besson and Robinson coaxial connectors with bayonet locking.

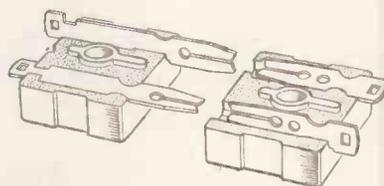
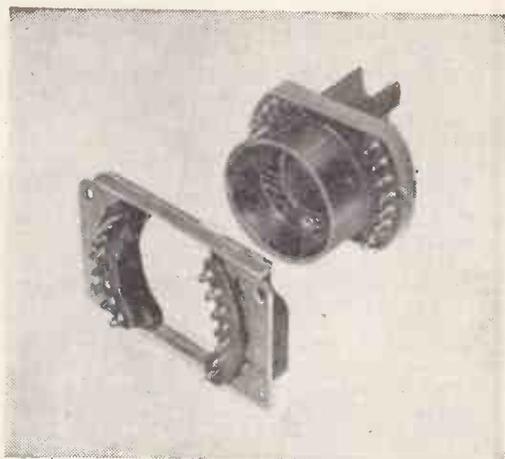
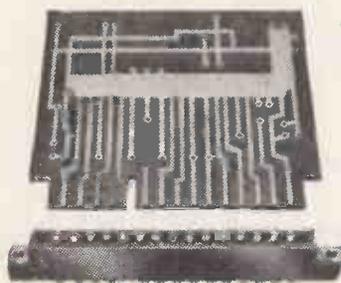


Above: Carr Fastener coaxial socket and mains-voltage selector for printed circuits.



Above: Widney-Dorlec miniature cabinet system. Right: Electro Methods strip connector for printed circuits.

Right: Unusual Ediswan Clix holder for alphabetical indicator tube (16 contacts).



Basic units of the N.S.F. "Varicon" unitized connector system. These can be stacked as required and secured by a central fixing screw through the holes.

for this application are quite common now and also strip connectors for linking the circuits with conventional wiring; usually one side of the connector forms a long socket into which an edge of the printed-circuit plate is pushed. Two of the latest fittings in the printed-circuit category, shown by Carr Fastener, were a coaxial-cable socket and a mains-voltage selector (see sketch at top of page).

Amongst the more conventional fittings, multi-way connectors of miniature construction were shown by several firms, while McMurdo had plugs and sockets moulded in nylon which were notable for their very low insertion force.

A particularly interesting form of construction for connectors could be seen on the N.S.F. stand. It is used in a "unitized" system in which plugs and sockets of any size can be built up from four basic parts, two contacts and two mouldings, and is best explained by the sketch. The contacts are unusual in that they fit into each other with their planes at right angles. The arrangement gives a very effective union between the surfaces and also prevents the plugs from being inserted the wrong way round.

Belling and Lee "Unitors" now have a modified socket giving reduced contact resistance and lower insertion force, and a lever-actuated extractor is a feature of the new design of retainer. This firm was also showing single nylon-insulated square-faced sockets in various colours. Amongst coaxial connectors, Besson and Robinson had some new miniature types in which the two halves are held together by a bayonet locking arrangement (see sketch on page 178).

Valve-circuit supports or turret assemblies (for mounting a valve and a small group of components) were shown in various forms by several firms this year, one using ceramic insulation. Usually they are cylindrical in construction, but Carr Fastener had a new type using straight tagstrips across the central support. Another device built around a valveholder was a mains-voltage

selector (McMurdo). The valveholder formed a socket, while a plug sliding on a central spindle could be rotated and inserted at different angular positions for the different voltages.

Cabinets can hardly be described as chassis fittings, but we must find a corner to mention a new type of "prefabricated" cabinet construction brought out by Widney-Dorlec. As can be seen from the sketch, it consists of a top plate (not shown) and a bottom plate fixed together at the corners by four aluminium rods, into which slots are cut (and also into the plates) for locating the aluminium or steel side panels. The method is only suitable for making up small cabinets and is intended principally for housing miniaturized equipments.

Manufacturers: Aeralite, Antiference, Belling and Lee, Bulgin, Carr Fastener, Colvern, Creators, Ediswan Clix, Egen, Electronic Components, Electrothermal, Hassett and Harper, Hellerman, Igranic, Imhof, Long and Hambly, McMurdo, Micanite, Palnton, Plessey, Power Controls, Ross Courtney, Salter, Simmonds, Spear, Standard Insulator, Stocko, Stratton, Thermo Plastics, Tucker Byelet, Whiteley, Widney-Dorlec, Wimbledon, Wingrove and Rogers, Wireless Telephone Company.

## MATERIALS

ALTHOUGH the field of electrical insulants is nowadays dominated by the synthetic plastics it is interesting to observe that mica—one of the oldest known insulants—still plays an important rôle. By itself it is widely used as a condenser dielectric and for electrode bridges in valve manufacture; in combination with bonding media it finds application in a variety of proprietary sheet, tube and rod materials. A new injection moulding material "Mycalon" has been introduced by Mycalex and T.I.M., Ltd., in which the bonding medium is glass. It has been evolved in conjunction with the Ministry of Supply to meet conditions of high humidity and its initial surface resistivity of  $10^{13}$  ohms per square is recovered within one and a half hours after six humidity

cycles. The power factor is 0.0011 and the permittivity 9.6 at 1 Mc/s.

Fibre glass is much to the fore these days as a reinforcing material for silicone elastomers and other plastics. A coil former was shown by Langley London in silicone-bonded glass fibre in which the thread for locating a spaced-turn single layer winding was formed in the moulding operation. A fabric woven from glass fibre and regularly interspersed with metallic threads forms the basis of a resin-bonded radar reflector which was shown by Thermo-Plastics, Ltd.

Nylon is now firmly established with other plastics used in the production of insulating sleeving and is sought after for any applications requiring enhanced abrasion resistance.

In addition to the thermo-setting adhesive insulating tapes with paper, acetate and glass fibre backing, the Minnesota Mining and Manufacturing Company were showing an extruded PTFE tape designed for bonding by heat.

The substitution of a chlorine atom in polytetrafluoroethylene (PTFE) produces polymonochlorotrifluoroethylene (PCTFE), which exhibits comparable electrical, thermal and mechanical properties and is easier to mould. The Edison Swan Electric Company showed a wide variety of applications for these materials in radio components and as coverings for rollers and the jaws of heat-sealing machines where freedom from sticking is a fundamental requirement.

Cellular polythene, which came to the fore in Band III television aerial cables, is now being applied by B.I.C.C. to a wider range of r.f. cables with improved performance. The use of "Irraydol"—a brand of irradiated polythene—is something of a novelty among the r.f. cables made by Wandleside Cable Works. Although the power factor is slightly lowered, the thermal stability is increased up to 200° C and there is greater resistance to attack by mineral oils.

Among new instrument wires a solder-coated wire for dip-soldered assemblies by Henley's, and a bunched textile-covered wire with self-fluxing enamelled strands by Fine Wires were noted.

Refinements in melting and heat treatment have resulted in magnetic materials (both soft and hard) with enhanced performance characteristics. The Telegraph Construction and Maintenance Company are now producing "Super Mumetal" with initial and maximum

permeabilities of 50,000 and 200,000 compared with 25,000 and 90,000 for the standard alloy. "Special Radiometal" is now available with initial and maximum permeabilities of 4,500 (2,000) and 45,000 (25,000). Another Telcon achievement is the production of Mumetal 0.0007-in foil in widths up to 6in for use in radar pulse transformers and other high-frequency applications.

In the permanent magnet industry a decision has been taken by member firms of the Permanent Magnet Association to proceed with the commercial production of "semi-columnar" magnets in a limited range of sizes and proportions. While not showing the spectacular performance of the experimental "Columax" these "S.C." alloys show a marked improvement over "Alcomax" at an economic price. Much ingenuity is evident in the design of composite magnets with a variety of methods of bonding the soft and hard components. James Neill showed the versatility of the resin-bonding technique and Swift Levick gave examples of a dowelled intercast method of producing composite sintered and cast iron/Alcomax instrument magnets.

Manufacturers: \* Aerialite (C, IS, W); Aero Research (IM); Anglo-American Vulcanised Fibre (CF, IM); Associated Technical Manufacturers (B, C, IM, IS, W); Bakelite (IM); Geo. Bray (CE); B.I. Callenders (C, CO, IS, S, W); British Moulded Plastics (IM); Bullers (CE); Clarke (CF, IM, IS); Connollys (C, IM, W); Cosmocord (CF); Creators (IS); Darwins (M); De La Rue (IM, IS); Duratube and Wire (B, C, CO, IS, W); English Electric (L); Enthoven (S); Fine Wires (W); Guest, Keen and Nettelfolds (B); Helleman (IM, IS); Henley's (C, CO, IM, W); Insulating Components and Materials, Ltd. (IM); Langley London (IM); Linton and Hurst (L); Lion Electronic Developments (IM); London Electric Wire and Smitting (W); Long and Hambley (IM, IS, RP); Magnetic and Electrical Alloys (L, M); Marrison and Catherall (M, L); Mica and Micanite Supplies (IM); Micanite and Insulators (CF, IM, IS); Minnesota Mining (IM); Mullard (DC, M); Multicore (S); Murex (RM, M); Mycalex (IM); James Neill (M); Permanoid (C, IM, IS, W); Plessey (CE, DC, M); Reliance Wire (C, CO, IS, W); Salford (DC, M); Sankey (L); Geo. L. Scott (L); F. D. Sims (C, CO, W); Standard Insulator (RP); S.T.C. (M); Steatite (CE); Suflex (B, CO, IM, IS, W); Swift Levick (M); H. D. Symons (IM, IS); Technical Ceramics (PC); Telcon (C, DC, IM, L, M, RM, W); Telcon Magnetic (L); Telephone Manufacturing Co. (DC); Thermo Plastics (IM); Tufnol (IM); United Insulator (CF, CE, IM); Vactite Wire (RM, W); Wandleside Cable Works (C, CO, W); Whiteley Electrical (CF, M).

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



## WORKED ALL ZONES

C. G. ALLEN, who is the first British amateur (G8IG) to win an international award for having made two-way 'phone contact with amateurs in all the forty zones of the world. This award, which comes from the United States, has been won only once before—by an amateur in Kenya—since it was first introduced some twenty years ago. "Bert" Allen is a director and sales manager of McMichael Radio, Ltd., which he joined in 1923, having previously been a ship's operator.

# British Colour Television

## A GLANCE AT THE PRESENT SITUATION

**T**HIS month a glimpse of the present state of British colour television development was given, in the form of demonstrations, to a study group of the International Radio Consultative Committee on a visit to this country. If these demonstrations helped to clarify the international minds of the C.C.I.R. people, they did very little to sort out the domestic situation as we see it in Britain at the moment. One feels the need for a general stocktaking of the situation.

First of all, then, what of the C.C.I.R. demonstrations themselves? These were arranged by the Post Office and included visits to B.B.C. establishments, to the G.P.O. Research Station and to E.M.I. Research Laboratories. Only one event, however, was thrown open to the Press. This was a demonstration in London by B.R.E.M.A. of various experimental colour receivers built by their member firms and working on N.T.S.C.-type transmissions radiated by the B.B.C. from Alexandra Palace.

The transmitting equipment at Alexandra Palace has already been described in *Wireless World*\* and also the essentials of the N.T.S.C. type of system†. There were 14 experimental colour receivers in operation and seven ordinary monochrome sets for showing the effect of compatible transmissions on existing black-and-white receivers. One of the colour receivers, described elsewhere in this issue, appeared to be in a more advanced state of development than the other equipments but could not be considered as a prototype for mass-produced domestic sets. This and several other of the receivers were built around the 21-inch RCA shadow-mask tri-colour c.r. tube. There were also sets using the earlier 15-inch RCA colour tube and some equipments with rear projection display systems.

In the view of *Wireless World* the pictures on the 21-inch direct-viewing receivers were markedly superior to the others—particularly in colour rendering, brightness and definition. Indeed they were the best colour television pictures we have ever seen. That is not to say, however, that they were perfect. There was quite a wide divergence of colour rendering between different receivers, and in some cases the divergences appeared on the same set. On one screen, for example, the flesh colour of a performer's hands was completely different from that of his face, although neither could be said to be unnatural. On another set, the hue of an actress's lemon-yellow dress fluctuated from greenish-yellow to almost orange in a matter of a few seconds.

Some of the colour receivers were designed for operation on wide-band colour information and some for narrow-band colour information, but one could see no difference between the respective pictures, except occasionally in areas of very small colour detail.

The monochrome receivers, incidentally, gave a very good picture on the compatible colour transmissions and one had to examine the screens very closely in order to see the sub-carrier dot pattern. What was really remarkable, however, was the demonstration of "reverse compatibility"—that is, the colour receivers giving black-and-white pictures from ordinary monochrome transmissions (which the B.B.C. put out after the colour transmissions). It was difficult to believe that the black-and-white pictures were actually being produced by red, green and blue c.r.t. phosphors until one took a magnifying glass to the tube screens and saw the individual phosphor dots fluorescing in their respective colours.

This, then, was the British N.T.S.C. system—and one more experimental transmission to add to the many others that the B.B.C. have been doing in conjunction with B.R.E.M.A. over the past six months or so. But what of the other systems that are supposed to be under

consideration for a possible service in Britain? The three most important ones all work on the principle of transmitting the chrominance information on sub-carriers outside of the normal vision band (unlike the N.T.S.C. system). The first two of these three systems can be considered as being (perhaps) compatible with our present television service in Band I, because although the colour sub-carriers of the stations would overlap the vision bands of stations in adjacent channels, it is thought that the interference between them would not be too serious. (One of these "overlapping" systems uses two colour sub-carriers while the other has a single quadrature-modulated sub-carrier of the N.T.S.C. type.)

The third system under consideration is a wide-band one using two colour sub-carriers outside the normal vision band but not overlapping the adjacent channel. In other words, it requires a wider channel than is at present available in Band I and so would not be compatible with our existing service. It could, however, be used to provide a compatible service in Bands IV or V.

The fact remains, however, that none of these alternatives to the N.T.S.C. system has actually been investigated in a really practical way, and at the moment it seems they are only regarded as an insurance against the possible failure of the N.T.S.C. system. One very simple reason for this is, apparently, that the only suitable transmitting equipment available for tests is at present completely tied up with N.T.S.C.-type transmissions! Whether any such tests will be carried out eventually on the alternative systems remains to be seen, but at the moment, at any rate, the N.T.S.C. system appears to be the firm favourite.

### Cost of Receivers

The choice of a colour system is influenced partly by whether we need compatibility or not,‡ and this in turn depends on a variety of political, social and economic factors. The question of bandwidth and conservation of ether space come into it also, and now there is controversy in progress on the matter of standards—whether we should go to 625 lines for colour or stick to 405 (see page 173). Perhaps one of the most important considerations in the choice of a system, however, is whether it will allow receivers to be mass-produced for the domestic market at reasonable prices.

At least one firm in Britain has worked out in detail the cost of manufacturing receivers for operating on the N.T.S.C. system, and it seems that the price cannot be brought much below £300 for a set. This is much too high to make colour television a practical proposition. It should be said, however, that receivers for the alternative systems would probably cost almost as much, for in all of them a simultaneous colour display system has to be used, and this is what accounts for the biggest proportion of the total cost. Receiver circuitry with some of the alternative systems is likely to cost less than with the N.T.S.C. system because of the simpler demodulation of the chrominance signals, but it is still necessary to have extra equipment of some kind for colour, whatever the system. On this question of receiver cost, then, it seems there is not much to choose between the systems at present under consideration. What is needed is a completely new system which requires simple circuitry and an inexpensive colour display apparatus—something as simple and inexpensive as the old frame-sequential system—but that is unlikely to be found. It is more probable that we shall have to adopt one of the four systems already described and put our trust in future development to reduce the cost of the colour display apparatus and the complications of the circuitry.

\*"Colour Television Tests," *Wireless World*, December, 1955.

†"Transmitting Colour Information," *Wireless World*, August, 1955.

‡"Must We Have Compatibility?" *Wireless World*, December, 1954.

## MODIFICATIONS TO THE

# Sensitive Three-Valve T.R.F. Receiver

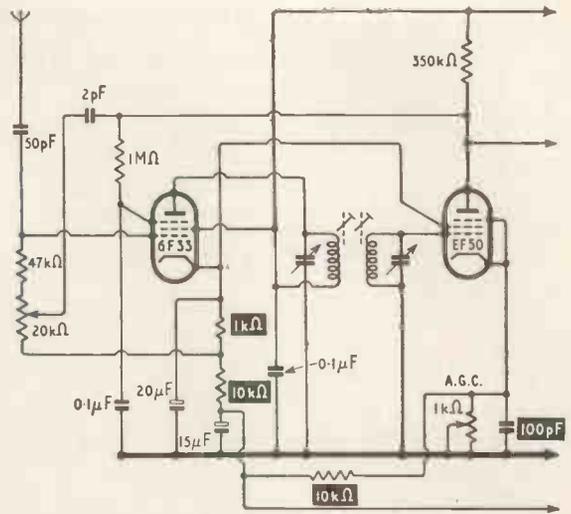
CIRCUIT CHANGES FOR OPTIMUM  
PERFORMANCE WITH 6F33 VALVE

By H. E. STYLES, B.Sc.

IN notes on the above receiver, published in the January (1956) issue of *Wireless World*, it was stated that a 6F33 might be employed as an alternative to an EF50 with a diode connected between suppressor and cathode. It may be desirable to point out that owing to differences between the operating characteristics of 6F33 and EF50 valves a direct substitution is not practicable and an appropriately modified circuit for the r.f. and detector stages is given here. Comparison with Fig. 5 on page 618 of the December, 1955, issue of *Wireless World* will show what modifications are required.

These changes ensure that the 6F33 operates with a cathode potential of about 100 V and a cathode current of about 5 mA. Maximum screen dissipation is thereby limited to 0.8 W specified by the valve maker.

It was found that owing to the somewhat lower gain obtainable from a 6F33, reaction becomes inadequate unless a 100 pF capacitor is shunted across the cathode resistor. Introduction of this capacitor reduces negative feed-back of r.f. potentials to the grid of the detector



The modified circuit discussed in the text.

valve. As a consequence, the latter valve produces a greater amplitude of r.f. at its anode and reaction is thereby enhanced sufficiently to outweigh the reduced gain of the r.f. stage. It is probable also that detection efficiency may be improved by addition of this capacitor.

The 6F33, which can also be obtained under the designation CV239, possesses a much shorter suppressor grid base than the EF50. This is distinctly advantageous in that it enables adequate gain control to be obtained on a strong signal without depressing the anode potential of the detector valve to any marked extent. Detector overloading is thereby completely obviated and a longer aerial can be employed without risk of distortion on local stations.

## CLUB NEWS

**A.W.R.A.R.S.**—Membership of the recently formed Army Wireless Reserve Amateur Radio Society is open to any serving or past member of the Army Wireless Reserve Squadron or any other Royal Signals unit. Details of the Society's activities, which are stated to be entirely non-military, are obtainable from the chairman, A. D. Taylor (G8PG), 37 Pickerill Road, Greasby, Wirral, Cheshire, or the secretary, J. A. Bladon (G3FDU), "Madresfield," Jack Lane, Davenham, Northwich, Cheshire.

**Barnsley.**—At the May 11th meeting of the Barnsley and District Amateur Radio Club, J. Ward (G4JJ), chairman of the club, will speak on transistor developments. Meetings are held on alternate Fridays at 7.0 at the King George Hotel, Peel Street, Barnsley. Sec.: P. Carbutt (G2AFV), 33 Woodstock Road, Barnsley.

**Birmingham.**—C. H. Banks, of C.J.R. Electrical and Electronic Development Limited, will speak on "Industrial Control" at the May 11th meeting of the Slade Radio Society. A fortnight later N. B. Simmonds will deal with rectifier circuits. Meetings are held at 7.45 at the Church House, High Street, Erdington. Sec.: C. N. Smart, 110 Woolmore Road, Erdington, Birmingham 23.

**Bromley.**—At the monthly meeting of the Bromley Radio Club (North West Kent Amateur Radio Society) on May 4th, there will be a discussion on the National Field-Day. Meetings are held at 8.0 at Shortlands Hotel, Station Road, Shortlands, Kent.

**Bury.**—The Bury Radio Society has recently been re-organized and meetings are now being held on the second Tuesday of each month at 8.0 at the George Hotel, Kay Gardens. Information on the club activities is obtainable from John E. Hodgkins (G3EJF), 24 Beryl Avenue, Tottington, near Bury, Lancs.

**Chelmsford.**—The next meeting of the Chelmsford group of the British Amateur Television Club will be held at 7.30 on May 10th in Marconi College, Arbour Lane, Chelmsford. F. H. Townsend, vice president of the club, will speak on "Recent developments in camera tubes." Sec.: D. W. Whele (G3AKJ), 56 Burlington Gardens, Chadwell Heath, Essex.

**Checkheaton.**—"Multi-channel telephony" is the title of the talk to be given by E. G. Smith (G.P.O.) on May 2nd to members of the Spen Valley and District Radio and Television Society. On the 16th G. F. Craven will deal with the interpretation of valve characteristics. A joint meeting of the Spen Valley, Leeds and Bradford societies will be held on May 30th at the Leeds G.P.O.; subject, "Transatlantic Cable". Sec.: N. Pride, 100 Raikes Lane, Birstall, near Leeds.

**Crystal Palace.**—The Crystal Palace and District Radio Club has been formed to widen the scope of the activities of the Norwood and District R.S.G.B. Group. Meetings are held on the third Saturday of each month at 8 in Windermere House, Westow Street, Crystal Palace. Sec.: G. M. C. Stone (G3FZL), 10 Liphook Crescent, Forest Hill, London, S.E.23.

**Edgware.**—The headquarters of the Edgware and District Radio Society (G3ASR) are now at Canons Park Community Centre, Merrion Avenue, Stanmore, where meetings are held each Wednesday at 8. Sec.: E. W. Taylor (G3GRT), 99 Portland Crescent, Stanmore, Middx.

**Portsmouth.**—Meetings of the Portsmouth and District Radio Society, which is affiliated to the Royal Marine Signal Club, are held each Tuesday evening at the British Legion Club, Queens Crescent, Southsea. Sec.: L. B. Rooms (G8BU), 51 Locksway Road, Milton, Portsmouth.

# Experimental Colour Receiver

THE COLOUR KILLER AND THE TRI-COLOUR C.R.T. CIRCUITS

BY H. A. FAIRHURST\*

(Continued from page 118, March issue)

**I**N a colour receiver it is not essential, but very desirable, that the chrominance amplifier should have automatic gain control, for although the receiver is itself controlled, this can do nothing about selective fading which may alter the relative amplitudes of the video and colour information. Therefore some means of obtaining a suitable control voltage must be found.

The colour synchronizing burst immediately suggests itself as the source of such a voltage, for it consists of a fixed amplitude and duration of just the frequency round which the colour information is centred. Very conveniently, too, it has already been gated out of the signal and is ready for use. The colour burst is rectified by a diode in a conventional manner and the resulting negative voltage applied to the grid of the first chrominance amplifier (Fig. 7). A delay diode delays the application of this voltage by a small amount.

The colour killer must now be described (left-hand side of Fig. 7). This is not an essential part of a colour receiver but it is a desirable adjunct, for in its absence a monochrome picture received on the colour receiver could be crawling with the coloured noise called "parc." This effect is due to the inability of the colour demodulators to distinguish between chrominance sub-carrier plus sidebands and luminance information which contains similar frequencies. Such frequencies in the luminance band beat with the reference oscillator and produce coloured streaks of light, or, in the case of the higher frequency blocks of Test Card C, bright rainbow hued bands. The colour killer is therefore a circuit which "kills" the chrominance amplifier in the absence of a colour sub-carrier, i.e., on a monochrome picture, and as a colour sub-carrier is or can be arranged to be always accompanied by the colour burst, the killer can be made to depend on the presence or absence of the burst.

It would seem at first glance, therefore, that the colour killer must be possessed of magical properties, unless it is to consist of a separate amplifier chain and rectifier in parallel with the chrominance amplifier, provided solely to kill the chrominance amplifier in the absence of the burst. Otherwise the colour killer must be able to "know" when the burst is there, and this possibly when the amplifier is already cut off because a monochrome picture has been transmitted just previously. Fortunately circuits exist which perform this task and recourse to the expensive alternative is not necessary.

The colour killer circuit adopted in this receiver (Fig. 7) makes use of the fact that it is possible to observe whether the burst is present or not once a line, notwithstanding the fact that the chrominance

amplifier is cut off during the rest of the line period. A suitably timed positive-going pulse is applied to the grid of the a.g.c.-controlled and colour-killed chrominance amplifier which brings it into a state of conduction. If there is a burst present, this is amplified normally and is rectified to produce the a.g.c. voltage. As well as controlling the gain of the first chrominance valve, this negative voltage also controls the colour killer, which has positive-going gating pulses on its anode and negative-going pulses on its grid derived from the line timebase.

## Colour Saturation Control

In the presence of a burst, and hence the presence of the negative a.g.c. voltage, the colour killer is cut off and the negative-going pulses on its grid have no effect on the anode circuit. However, in the anode circuit are positive-going pulses whose amplitude is adjustable by the potentiometer, and these pulses drive the chrominance amplifier into grid current, thus providing a bias in addition to that of the a.g.c. voltage. As the amount of this additional bias is controllable by the potentiometer, this becomes a very convenient "saturation" control.

Taking the case where no burst is present, the a.g.c. voltage becomes zero, thereby causing the colour killer to conduct. The negative pulses on its grid now produce large positive pulses on the anode which in their turn cut off the first chrominance amplifier by virtue of the grid current that flows. It will be seen, however, that the chrominance amplifier is always switched on during the time interval when the burst occurs; therefore the killer circuit is always able to recognize whether the burst is there or not. A potentiometer allows the setting of the killer bias to the correct working point.

A thing worth noting with this arrangement of switching the amplifier to full gain during the burst

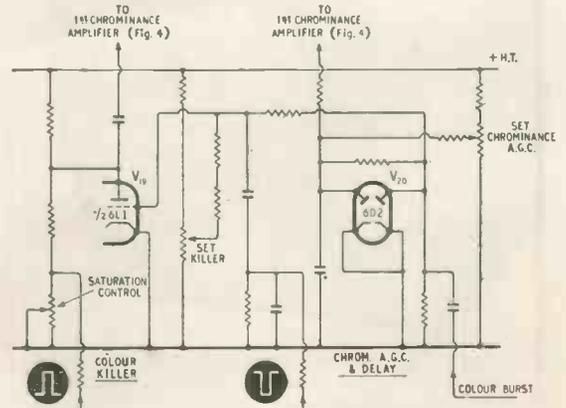
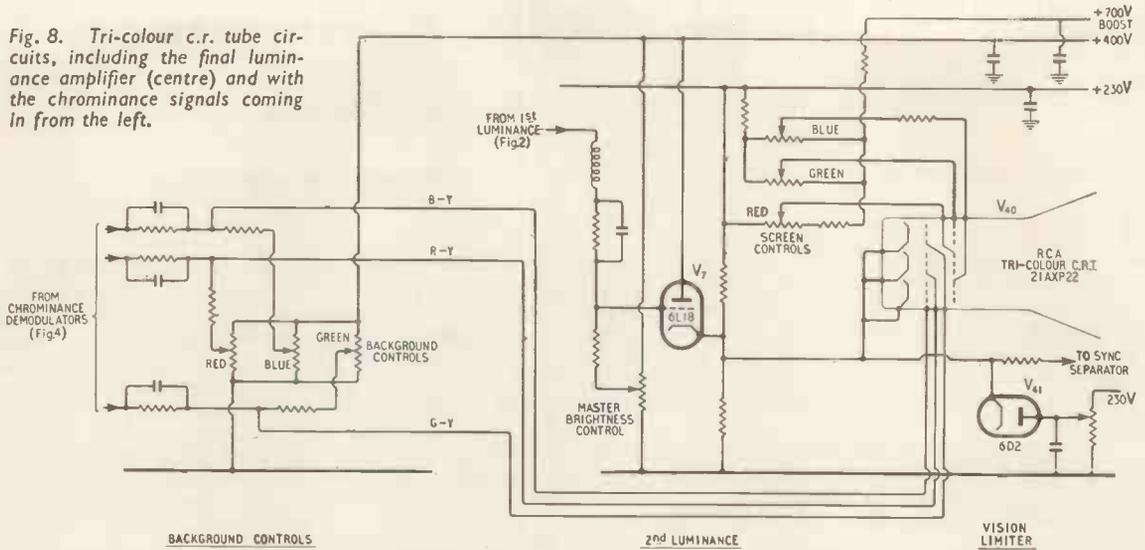


Fig. 7. The colour killer and chrominance a.g.c. stages.

\* Murphy Radio. This article is based on a lecture given by the author to the Television Society. The receiver, among others, was recently demonstrated operating from "live" B.B.C. test transmissions on the occasion of the visit of C.C.I.R. Study Group XI to Britain.

Fig. 8. Tri-colour c.r. tube circuits, including the final luminance amplifier (centre) and with the chrominance signals coming in from the left.



period is that perfect a.g.c. control can be achieved with only one controlled valve, an impossibility with normal circuits.

Before dealing with the timebases and ancillary equipment it will serve a useful purpose to enumerate the requirements of the three-gun shadow-mask c.r. tube. First and foremost there must be means for adjusting the individual electron guns so that their cut-off points fall at the right

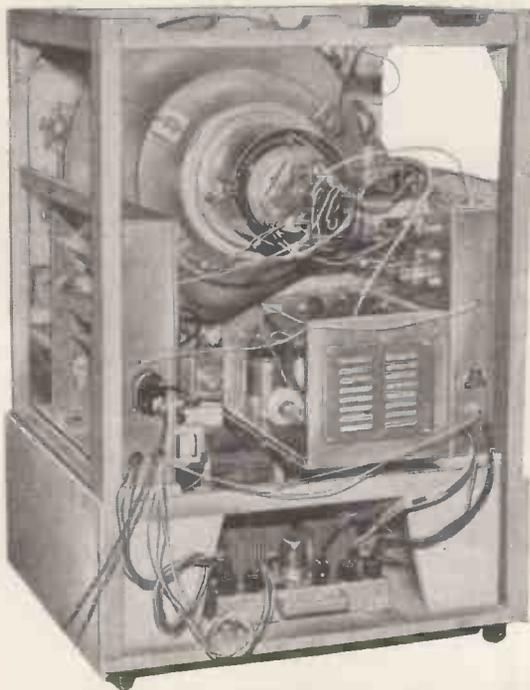
voltage with, at the same time, the right length of grid base. Without this possibility the tube would give the correct colour rendering at one brightness only. Secondly, the three electron beams must be made to strike the shadow mask at substantially the same spot over the whole of the picture area. Thirdly, the scanning generators must be capable of delivering sufficient power to scan the tube—at the elevated e.h.t. which is required to give sufficient brightness and a good enough focus.

Right at the outset of the design, in order to save time, it was decided to use RCA components as far as possible in the scanning and e.h.t. circuits, but it was soon found that the line-scan transformer which was suitable for 525 lines was not equally suitable for the British 405 lines. The work on the display side therefore divided itself into two parts: the design of a line-scan circuit which would scan the tube and produce a stabilized 25-kV e.h.t. supply capable of delivering 1 mA, and the donkey work of adapting the American tube control circuits to suit the particular receiver.

Taking these last-mentioned circuits first and referring to the circuit diagram (Fig. 8) it will be seen that there are three "background" controls which enable the R, G and B guns to be set to the correct level of brightness. These are set in conjunction with the three screen controls which are in effect potentiometers between the boost line and + h.t. These latter provide an adjustment of the grid bases of the individual guns, the cathodes, grids and screens acting as triodes. Once these six controls are set, the picture brightness can be altered by the master brightness control, which is in the cathode-follower circuit.

Included in the circuits which had to be adapted to the present receiver are the vertical and horizontal shifts. If it is not obvious from the outset that a tube containing three separate electron guns requires something more than a shuffle plate if the registration is not to go amiss when shifting the picture, it very soon becomes self evident that such simple devices are of no use.

In fact, the method adopted is that of passing d.c. (Continued on p. 185)



The accessibility obtained by making the sides of the cabinet detachable. The timebase and e.h.t. chassis on the right has its screen removed. The dynamic convergence yoke can be seen on the end of the tube.



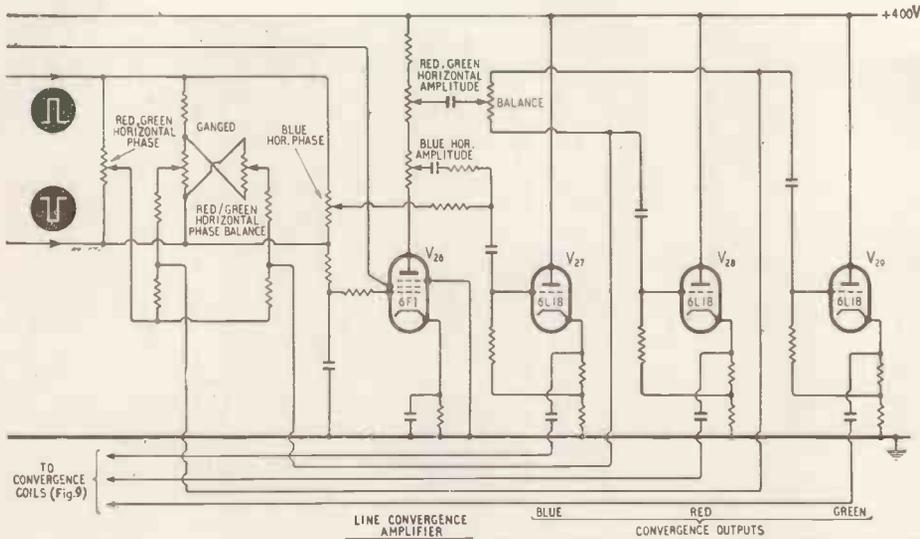


Fig. 11. Line convergence amplifier and output valves.

derived from the frame timebase by suitable R and C circuits (Fig. 9). There naturally have to be three outputs, each controllable both in amplitude and phase. In the case of the horizontal convergence, an attempt was made to carry out this operation with static circuits on the lines suggested in information supplied by RCA, but without a great deal of success. It may be that a reasonable compromise can be reached at 15 kc/s, whereas it cannot at 10 kc/s, or it may be that we had set our standards rather higher, but in the end it was decided to use valves for the job, and the circuit shown in Fig. 11 was the result.

In this circuit, integrated pulses from the line timebase appear in amplified form on its anode. The correct proportions of this amplified sawtooth are fed on to the grids of the three convergence output valves in conjunction with a pulse from the line timebase in such a manner that the resulting waveform drives the correct current through the convergence coils. The output valves are merely cathode followers to obtain the low impedance source that is necessary.

Controls are provided to adjust both the amplitude and phase of the pulse and sawtooth, and in practice these are adjusted until the correct current waveform is produced. The correct current is of course that which gives the best convergence of the three beams over the whole screen, and as the line and frame convergence controls are by no means independent of each other, it will be appreciated that the correct setting-up of the convergence is no mean feat.

Turning now to the timebases themselves, the frame timebase (Fig. 9 shows the output valve) can be dismissed in very few words, its sole departure from normality being the amount of current required to scan the tube. As, however, the sensitivity of the frame coils is relatively high, a normal 5-watt output valve is quite suitable.

The line timebase, however, is some-

what specialized in that it has to provide an e.h.t. supply of 1 mA at 25 kV in addition to scanning the tube. The circuit of the timebase itself is conventional, but it uses an American type valve, a 6CB5, in the output stage (Fig. 10) as being the only one available at the inception of the design capable of doing the job. The economy diode is also an American type — a 6BL4. The line timebase has to supply the necessary gating pulses for the receiver and these are provided by a special winding.

The line timebase is frequency controlled by a conventional a.f.c. loop, and here of course there was a wide choice of circuits available, although somewhat naturally the one chosen was a circuit in common use in our laboratories. The discriminator diode in this circuit has to be fed with equal amounts of positive- and negative-going sync pulses, and these are provided by a phase splitter valve which is half a double triode. The sync separator itself is conventional and needs no further mention. The other half of the phase-splitter double triode is used to remove the line clutter from the differentiated frame sync pulses before passing them on to the frame timebase.

As has been stated, the e.h.t. requirements for the shadow-mask c.r. tube are 25 kV at 1 mA (most of which goes into the shadow-mask itself) and this must be stabilized to ensure good registration at all picture brightnesses. A voltage doubler circuit has been used with a third rectifier as a one-way device to prevent the pulse on the anode of V37 from

The timebase and e.h.t. chassis, showing the complete screening achieved.



appearing on the cathode of V39. Shunted across the output of the supply is a stabilizing triode, a 6BD4A, which has been specially developed for the purpose. Its grid is connected to a tap low down on a potentiometer between the cathode of V39 and earth, and this tap can be varied to control the e.h.t. In action the total current drawn by the c.r. tube and the stabilizer valve is more or less constant, as any change in the loading of the c.r. tube alters the grid voltage of the stabilizer in such a sense that the change of current through it compensates almost exactly.

The shadow mask c.r. tube, being electrostatically focused, needs a source of focusing voltage, and this is provided by a shunt across the "undoubled" e.h.t. rail.

There remains only the h.t. power supply, whose only out-of-the-ordinary feature is the number of milliamps required. The actual equipment contains two large metal half-wave rectifiers in a doubling arrangement, providing a 230-V rail and a 400-V rail, with a total consumption of 600 milliamperes. The 400-V rail is used to feed the timebases, the luminance cathode follower and the chrominance demodulators, while the 230-V rail feeds the receiver section, the screen grid of the frame output valve, and the screen grid of the horizontal convergence amplifier. In series with the common h.t. return is a small resistance which provides a negative source of 10 volts for the frame shift.

A receiver using 40 valves and a 21-in cathode-ray tube is naturally no small object, and when it is considered that the RCA shadow-mask c.r. tube has a metal cone at a potential of 25 kV it will be realized that something special has to be done to ensure the safety of the personnel operating it.

In view, also, of the uses to which the receiver was to be put, it was thought advisable that it should go through an ordinary living-room door, so considerable effort was put into the mechanical design, much more than would be necessary for the normal laboratory experimental receiver. Accessibility, too, was considered most important, and all the setting-up controls have been brought out to the front. The sides of the cabinet are detachable, allowing free access to the undersides of the timebase and receiver chassis, which are mounted vertically on each side of the tube. The power supply chassis is out of the way on the base of the cabinet.

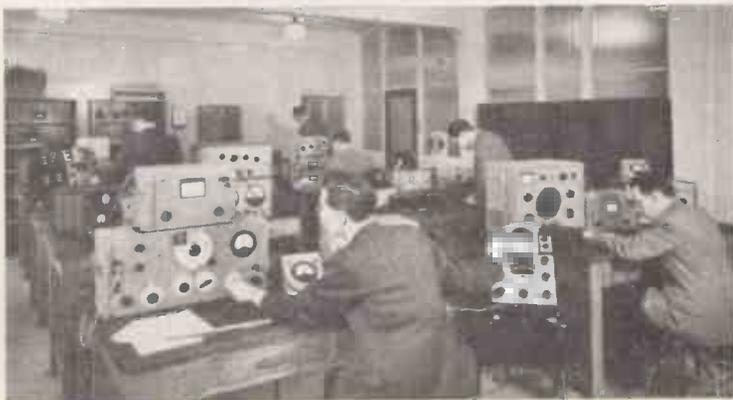
In operation with the cabinet open there are no

exposed live parts other than ordinary h.t. and boost rails, and the boost feeds only the c.r. tube screen controls. The timebase is completely screened and the metal cone of the tube is protected by a polythene shroud, so no particular precautions against shock need be taken other than those normally adopted by engineers in the laboratory. With the cabinet closed, of course, there are no live exposed parts whatsoever, the metal escutcheon round the protective glass being bonded to earth. The protective glass is  $\frac{3}{16}$  in thick and is in itself a sufficient protection against X-rays.

The setting-up and operation of the receiver is not a subject that can be dismissed in a few words, as there are not only the convergence, screen and background adjustments to be made, but also the colour purity to check to ensure that the red, green and blue guns hit centrally the red, green and blue phosphor dots respectively all over the screen. This colour purity is controlled by movable permanent magnets on the neck of the tube. On a yoke round the periphery of the face-plate are adjustable magnets to compensate for stray fields. When it is considered that all these adjustments are more or less inter-dependent, it will be realized that the setting-up of a shadow-mask c.r. tube is more a matter for practical experience rather than a wordy description of the process. The matter will be dismissed, therefore, with the assurance that although the process may take nearly all day the first time it is attempted, skill is rapidly attained until the whole sequence can be gone through in an hour or so. There is also the saving grace that once set the adjustments appear to stay put.

In conclusion the author would like to convey a few messages of thanks to various people. To begin with, and speaking for all television workers, we in Britain certainly owe a debt of gratitude to the members of the N.T.S.C. committee in America, first for developing their extremely elegant system of colour television and secondly for being so forthcoming in the publication of results. Next, thanks are due to RCA for their assistance in supplying information and parts, without which the receiver would have been much longer in the designing, and to the B.B.C. for their immense help at all stages. Last, but not least, a "thank you" to the group of engineers without whose intense efforts the receiver would not have seen the light of day nor this article have been written.

ONE of the laboratories in the post-graduate School of Electronics established by Automatic Telephone and Electric Company and its associates, which include B.I. Callenders and Hivac. The School, which recently held its first open day, is situated within the company's main works at Liverpool and has at present accommodation for 30 students. There are two types of course provided—one lasting 3 months and the other a year. Prospective students are, in the main, selected from the company's staff and are paid whilst studying.



# Distortion—Audible and Visible

Relationship between Amplitude/Frequency and Phase/Frequency Response

By "CATHODE RAY"

A LITTLE quiet entertainment has been afforded by perusal of successive issues of British Standards in which the approved names for various kinds of distortion are set forth. As the older *Wireless World* readers may remember (and the younger ones too, if they have read the volume I have been plugging with a shamelessness rivalling that of the B.B.C. in their interview programmes—"Second Thoughts on Radio Theory"), one of my hobbies is hurling bricks at the promoters of misleading or illogical technical terms. British Standard 204 of 1943 provided a particularly attractive group of targets. One of them was "non-linear distortion," for my rude remarks on which see p. 388 of the book just mentioned. The footnote on its next page records with satisfaction that in BS.2065 of 1954 "non-

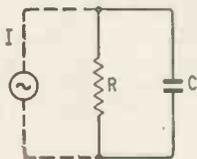


Fig. 1. The voltage set up across a resistance by a given signal current decreases with increasing frequency if there is a capacitance (intentional or otherwise) across it.

linearity distortion" was admitted as an alternative. Now, in BS.661 of 1955, "non-linearity distortion" has been promoted into first place and "non-linear distortion" banished altogether.

This little progression is satisfactory more as a sign that authorities may be open to reason than because of the objectionableness of the term in question, which is no worse than a little loose. A more outstanding target was "attenuation distortion," because it was not only not in general use but was no improvement on the term that was in general use—"frequency distortion," mentioned by BS.204 only to black-list it as "Deprecated." Now, although I myself have used "frequency distortion" I will readily admit that it is wrong. But at least it gives people a chance of guessing the correct meaning, whereas if "attenuation distortion" suggests any meaning at all it is unlikely to be the right one. Evidently the British Standards Institution began to think so too, for in BS.2065 they substituted the precise term "amplitude/frequency distortion," with "frequency distortion" as a permitted alternative. This was evidently too much for some of their advisors, for although in BS.661 "amplitude/frequency distortion" is retained as the recommended term we find "attenuation/frequency distortion" as an alternative and "frequency distortion" deprecated again. There is still some inconsistency, for whereas "phase distortion" is a permitted alternative for "phase/frequency distortion," "amplitude distortion" is a result of non-linearity and is not at all the same thing as "amplitude/frequency distortion." It will be interesting to see what the next edition of BS.204 says!

The reason for this preliminary argument about terms is that I find myself rather stuck by my own fussiness, for this month's subject is to be a comparison between what (to give them their precise names) I must call "amplitude/frequency distortion" and "phase/frequency distortion," and these do seem a bit of a mouthful for repeated use. And, for the reason just explained, although one of them can be abbreviated to "phase distortion" the other must not be "amplitude distortion." So for the purposes of this article I am going to call the things "a/f.d." and "p/f.d."

The terms thus abbreviated are so precise that they hardly need explanation, but it may be as well just to make sure that we all know what we are talking about.

In such things as sound or vision communicating and reproducing equipment, there should be equal treatment of all the wanted frequencies. For instance, if one assumes that full reproduction of sound necessitates 20 to 20,000 c/s, then a graph of overall amplification or transmission against frequency should be perfectly flat between these limits. One would then be able to say that the a/f.d. was nil. If, however, the graph increasingly sloped downwards above, say, 3,000 c/s the a/f.d. would by "high-fidelity" standards be serious. So would a fall-off below 300 c/s.

## Vector Diagrams Again

In general, a/f.d. is caused by inductance and capacitance, because (unlike resistance) their impedance varies directly or inversely with frequency. In an amplifier, for example, the useful frequency band is often limited at the top by capacitance causing a falling impedance in shunt with the signal path, and at the bottom by capacitance causing a rising impedance in series. It was these simple and common effects that we considered in connection with Nyquist negative-feedback diagrams.\* You may, perhaps, remember how those diagrams showed very clearly that long before shunt capacitance is sufficient to cause an appreciable drop in amplification it has a very pronounced effect on phase.

Now, of course, this is not necessarily connected with feedback, and the reason it showed up in Nyquist diagrams is because basically they are vector diagrams. One of the merits of vector diagrams is that they show amplitude changes clearly and phase shifts even more clearly. It happens that the explanation in the December 1955 issue of how a simple Nyquist diagram is formed could be used all over again now for our comparison of a/f.d. and p/f.d. For the sake of any who don't remember, or can't refer to it, here is a summary.

At the upper frequencies the circuit in which a

\*In the December 1955 and January and February 1956 issues.

signal voltage is set up is very often equivalent to that shown in Fig. 1, where a signal current  $I$  flows through a resistance and a capacitance in parallel. The resistance may be that of a coupling resistor in parallel with the resistance of the signal source (a valve, for instance). The capacitance may be due to a capacitor used to suppress frequencies beyond the wanted band, but quite often it is no more than the inevitable stray capacitance of the circuit. The signal voltage is equal to  $I$  multiplied by  $Z$ , the impedance of  $R$  and  $C$  in parallel, and for purposes of comparison  $I$  is assumed to be the same at all frequencies, so the amplitude/frequency characteristic in this case is really the same as a graph of  $Z$  against frequency.

Not only does this particular  $Z$  decrease in magnitude with increasing frequency, but an increasing phase difference develops between the current  $I$  and the voltage. So there are three inter-related quantities—amplitude (or magnitude of  $Z$ , denoted by  $|Z|$ ), phase difference (denoted by  $\phi$ ), and frequency ( $f$ ). A single two-dimensional graph shows only two things at a time, but where sound reproduction is concerned phase difference can be left out of account, because nobody has succeeded in showing that it makes any audible difference—at least, in the sort of situation we are considering now; stereophony is a different matter. So the usual form of graph for the purpose is simply  $|Z|$  (or its equivalent) against  $f$ .

For plotting this graph,  $|Z|$  can be calculated for a number of frequencies from the formula

$$|Z| = \frac{R}{\sqrt{1 + (2\pi fCR)^2}}$$

and the ratio of  $|Z|$  to  $R$  can be expressed either as a fraction or in decibels, as a measure of the a/f.d. But there is a much easier way. At very low frequencies  $(2\pi fCR)^2$  is so small compared with 1 that it can be neglected and so  $|Z|$  is practically equal to  $R$  alone, so this part of the graph is a horizontal line at 1 (or 0 dB). At very high frequencies, 1 is so small compared with  $(2\pi fCR)^2$  that it can be neglected and so  $|Z|$  is practically

Fig. 2. The decrease in voltage in Fig. 1 varies with frequency as shown by the dotted curve. The two straight lines, meeting at the frequency at which the shunting reactance is equal to the resistance, are a good approximation to the curve at frequencies well off that point, at which the loss is 3 dB.

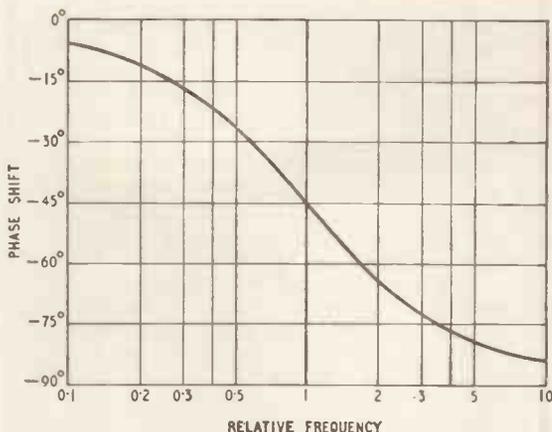
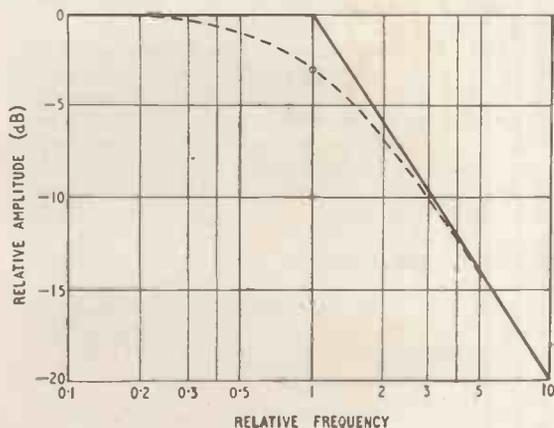


Fig. 3. Phase shift corresponding to amplitude loss shown in Fig. 2.

$1/2\pi fC$ , which is the impedance of  $C$  alone. This is inversely proportional to frequency, so can be represented on the graph by a line that slopes off in such a way as to halve the amplitude for each doubling of the frequency. Halving amplitude is a drop of 6 dB and doubling frequency is a rise of one octave, so the slope of this line is commonly called 6 dB per octave. If a logarithmic frequency scale is used, to match the dB scale which of course is logarithmic, the sloping line is straight, as in Fig. 2. The frequency at which the two straight lines meet is the one at which the impedance of  $C$  is equal to  $R$ ; that is,  $1/2\pi fC = R$ , so  $f = 1/2\pi CR$ . It is what we called the "turning frequency."

### Rapid Plotting

At this particular frequency, neither 1 nor  $(2\pi fCR)^2$  is negligible compared with the other; in fact they are equal. It is here, naturally, that the two-straight-line approximation is furthest from the truth; since  $(2\pi fCR)^2 = 1$ ,  $|Z|/R = 1/\sqrt{2} = 0.707$ , which is -3 on a dB scale. This accurate point can be plotted on the graph, and it gives one a mark for drawing a smooth curve (dotted in Fig. 2) connecting up the two lines.

Note that just as we have "normalized" the amplitude scale by relating  $Z$  to  $R$ , so we have treated the frequency scale, relating all frequencies to the turning frequency. So the Fig. 2 graph holds good for all circuits that can be reduced to Fig. 1; to convert its relative frequency scale to actual frequencies for any particular values of  $C$  and  $R$ , multiply it by  $1/2\pi CR$ .

Precisely the same curve applies when the upper-frequency drop is caused by series inductance instead of shunt capacitance. Because the inductive impedance is  $2\pi fL$  the turning frequency is  $R/2\pi L$ .

The same graph turned around left to right is correct for lower-frequency drop due to series  $C$  or shunt  $L$ , the turning frequencies being calculated in the same way.

It is generally agreed that until a/f.d. amounts to 3 dB it is hardly noticeable, so the effective frequency band of a piece of sound-reproducing equipment is usually reckoned between the upper and lower -3 dB points. If only "single-order"

arrangements like Fig. 1 are responsible, these points are at the two turning frequencies. But in a complete system, of course, there are generally a number of things causing top and bottom cut, and the effective band width is narrower than that for any one of them.

Although the accompanying phase shifts may not matter to the ear, they do matter if negative-feedback is to be used, so it may be necessary to supplement Fig. 2 by a phase/frequency graph. (Just as "amplitude" was to be understood as relative to the amplitude at middle frequencies where there was no a/f.d., so it is for "phase.") The phase angle,  $\phi$ , is the angle whose tangent is the ratio of resistance to shunt reactance, or of series reactance to resistance; so for Fig. 1  $\tan \phi = 2\pi fCR$ . At the turning frequency,  $f = 1/2\pi CR$ , so  $\tan \phi = 1$ , and a table of tangents shows  $\phi$  to be  $45^\circ$ . Strictly speaking it is  $-45^\circ$ , because the phase is lagging. Calculating a few more points to plot, we get Fig. 3.

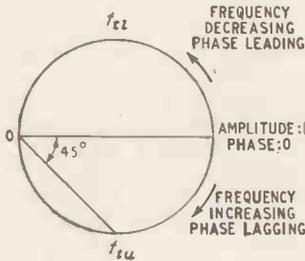


Fig. 4. The circle is the track of the tip of a vector hinged at O, representing signal voltage in a circuit where there is "single-order" cut-off at both high and low frequencies, as the frequency is varied. The vector  $O f_{tu}$  corresponds to the marked point at -3 dB in Fig. 2.

Fig. 5. Waveform (a) is made up of two sine waves of equal amplitude and 3:1 frequency ratio. When the amplification of the higher frequency is reduced relatively to the lower by 7 dB, (b) is the result. The accompanying phase shift further distorts the waveform to (c).

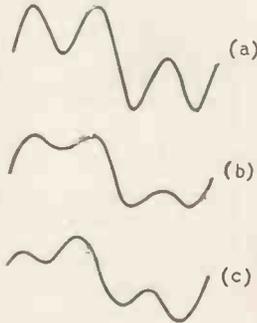
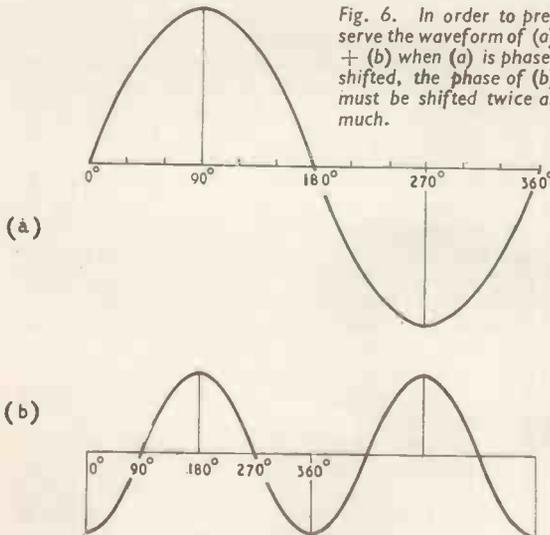


Fig. 6. In order to preserve the waveform of (a) + (b) when (a) is phase-shifted, the phase of (b) must be shifted twice as much.



It serves also for series inductance, but for low-frequency cut the graph must not only be turned left to right but the  $-$  become  $+$ .

These two graphs taken together show that phase starts noticeably sliding down before amplitude (so it is lucky our ears don't detect the phase shift), but for this particular comparison the vector form of graph is neater. Since we have so recently gone fully into this, I'll just show Fig. 4 as a reminder. The only difference between it and those we used in connection with feedback is that because it was negative feedback we were interested in they were upside down. But we still have the familiar circular shape. The "origin" is marked "O," and the horizontal diameter starting from it is the vector representing no distortion. Its length represents the amplitude, taken as 1 for comparison, and the fact that it points at 3 o'clock is the conventional way of showing that its phase angle is zero. The fall-off in amplitude, shown one way in Fig. 2, appears in Fig. 4 as the decreasing length of the vector when its tip moves around the circle towards O, while the phase shift is indicated directly by its change of direction. And we see that the direction changes quite a lot—say  $20^\circ$ —before the shortening is very noticeable even to the eye. By the time it is noticeable to the ear—say  $-3$  dB, at  $f_{tu}$  or  $f_{tl}$  (the upper or lower turning frequencies)—the phase shift amounts to  $45^\circ$ , as we have already seen in Fig. 3.

### Visible Effects

And now, having collected together our tools and reminded ourselves how they are used, we can start on the job.

The first thing to notice, in reviewing a/f.d. and p/f.d., is that neither of them can distort a single-frequency signal. The essence of both kinds of distortion is that they treat different frequencies unequally, and if only one frequency is present there is nothing that can be unequal. So a sinusoidal waveform cannot suffer from a/f.d. or p/f.d.

But if now we put on a very slightly more entertaining programme, say "Cathode Ray's" *Duet in A Flat for Two Audio Signal Generators*, and if at a given moment the soprano generator is playing a note of a frequency specified in Fig. 2 as "3" and the tenor generator is accompanying it on frequency "1," it is clear that there will be distortion, because the relative strengths of the two notes are upset to the extent of 7 dB. If the passage in question were scored for equal intensities from the two instruments\*, the input waveform (assuming zero phase difference at the start) would be as in Fig. 5(a), where one whole cycle is shown. If now the higher tone is reduced by 7 dB the result is Fig. 5(b), which has a markedly different waveform—almost an approximation to a square wave—and distortion can certainly be said to have taken place. But this is not what would be obtained from an actual distorting circuit, for the a/f.d. is inevitably accompanied by p/f.d., with the result shown at (c).

Although (c) looks distinctly different from (b), it would sound just the same. So would waveforms with even more striking visual differences. But for

(Continued on page 191)

\*In "Cathode Ray's" musical works, directions are, of course, given in dB instead of the usual vague terms such as *pp* and *mf*.

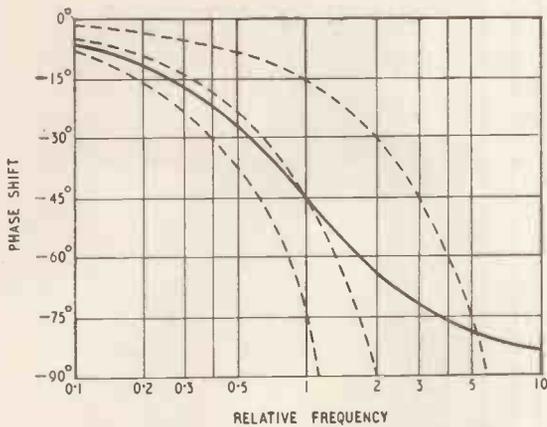


Fig. 7. To the actual phase-shift curve of Fig. 3 are added dotted curves all of which represent zero phase/frequency distortion.

some purposes, notably television, p/f.d. cannot be ignored. So we are going to switch attention from the well-known a/f.d. to the not quite so well-known p/f.d.

Because a/f.d. is shown on an a/f characteristic diagram such as Fig. 2 as departure from the straight and level, one might suppose that the same applied to a p/f diagram and p/f.d. The fact that the sloping p/f curve in Fig. 3 has certainly knocked the shape out of Fig. 5(b) seems to confirm that. And it is obvious that a perfectly flat p/f characteristic at the zero level indicates no p/f distortion; if there were no phase shift of any of the component parts of a waveform, the whole thing would be left where it was. But it is also true that a waveform is not distorted by being shifted as a whole. This matches the fact that altering the amplitude as a whole does not distort—otherwise amplification would by definition be distortion! Any number of no-distortion lines can be drawn on an a/f graph; they can be at any level, so long as they are level, showing that the amplitude is changed equally at every frequency.

### A Catch

In the same way, presumably, horizontal no-distortion lines can be drawn at any level on a p/f graph, showing that the phase is shifted equally at every frequency? But we presume too much. There is a catch hidden in the word "equally." Fig. 6 will show it more clearly than a lot of explanation. Phase is reckoned in fractions of a cycle, usually in 360ths, commonly called degrees. Waveform (b) is twice the frequency of (a), so has twice as many cycles in a given time, and therefore twice as many degrees. If (b) is added to (a) it sharpens its positive half-cycle and blunts its negative half. Now if (a) is phase-shifted 90° to the left its positive peak is brought to the starting point, and to preserve the same shape wave (b) must be moved to the left an equal time interval. But on its phase scale that is 180°. If its phase shift were the same as (a)'s its positive peak would not coincide with (a)'s and the composite waveform would be quite different; in a word, it would be distorted.

If (b) had been three times the frequency of (a), its phase shift would have had to be three times (a)'s.

On a p/f graph, then, the only no-distortion line

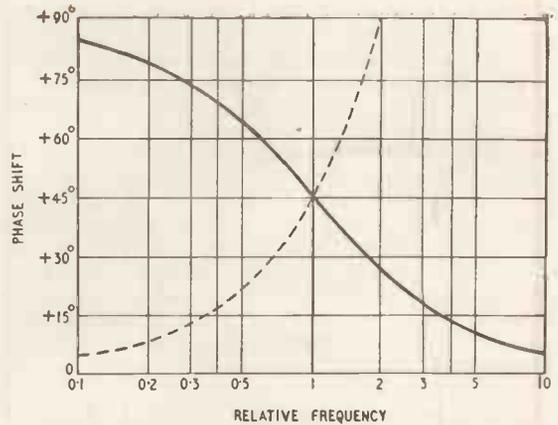


Fig. 8. Whereas the actual phase-lag curve in Fig. 7 causes hardly any phase distortion up to the high-frequency cut-off, the phase-lead down to and beyond low-frequency cut-off falls right across the no distortion lines, one of which is shown here.

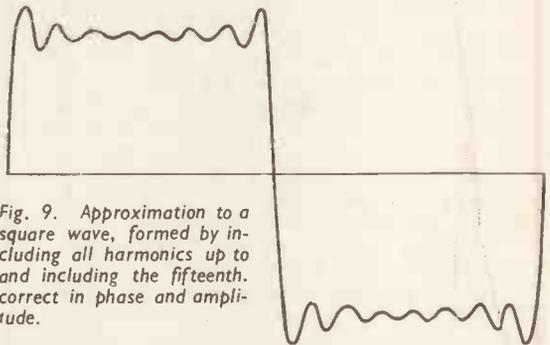


Fig. 9. Approximation to a square wave, formed by including all harmonics up to and including the fifteenth. correct in phase and amplitude.

that is flat is the one at 0°; all the others must indicate phase shifts proportional to frequency. If the shift at the reference frequency (1) is 45° as in Fig. 3, at twice the frequency it must be 90°; at four times, 180°; and so on. Such a curve does in fact follow Fig. 3 fairly closely up to 45° (Fig. 7) although beyond that it goes right off. So although the amount of a/f.d. up to that point, which is usually tolerated, is accompanied by a relatively large amount of phase shift, it is not a large amount of phase distortion. It looks as if p/f.d. is a negligible factor in the distortion of any waveform by a top-cut circuit having a turning frequency no lower than the highest significant frequency in the waveform; practically all the distortion is a/f.d. That does not, of course, mean that the phase shift of the waveform as a whole can always be ignored, but just that it does not appreciably affect the wave shape.

Having previously noted the mirror relationship between top-cut and bottom-cut circuits, one may perhaps suggest that the same kind of principle applies also to bottom-cut circuits. But no! This is where the symmetry breaks down. As Fig. 8 shows, the leading phase-shift curve corresponding to the lagging curve of Fig. 3 could hardly differ more from the dotted line, which is the no-p/f.d. curve passing through the 45° point. We may expect, then, that visible distortion at the low-frequency end of the band will be worse than at the high-frequency end. Whereas at the h.f. end virtually only the a/f.d. has any effect, at the l.f. end there is a/f.d. plus probably even greater p/f.d.

Just how it works out in practice depends, of course, on the original waveform of the signal, because on that depend the frequencies present and their relative amplitudes and phases. Perhaps the most important waveform after the sinusoid is the square wave. Moreover, distortion of it is easy to see. So it should be a good example for comparing the effects of l.f. and h.f. distortion. For some purposes it is essential to keep its front nearly vertical or its top nearly horizontal, or both. It contains odd harmonics only, up to infinity if the squareness is to be perfect. The third harmonic is one-third the amplitude of the fundamental, the fifth one-fifth, and so on, so the absence of the very high ones is not conspicuous. All the harmonics start off in phase, in order to provide the infinitely steep rise and fall.

### Fourier or Oscilloscope

If you are looking for something to while away a very long time (or something to do with your new electronic computer) you can try making up the square-wave recipe just given, adding in harmonics until the result is square enough. Myself, I have never got beyond the fifteenth, and that yields a rather poor apology for a square wave, with a lot of ripples on the supposedly flat top (Fig. 9). One can then (if still in the game) alter the amplitudes and phases in accordance with any desired distorting circuit and note results. Besides being liable to revive the mathematicians' riot that broke out on the appearance last September of "Fourier—Fact or Fiction?" this suggestion will no doubt be rejected as intolerably tedious or expensive—unless the fascination of it gets you.

There are two simpler methods. One is to consider the distorting circuit as a capacitance charging or discharging through a resistance. The other

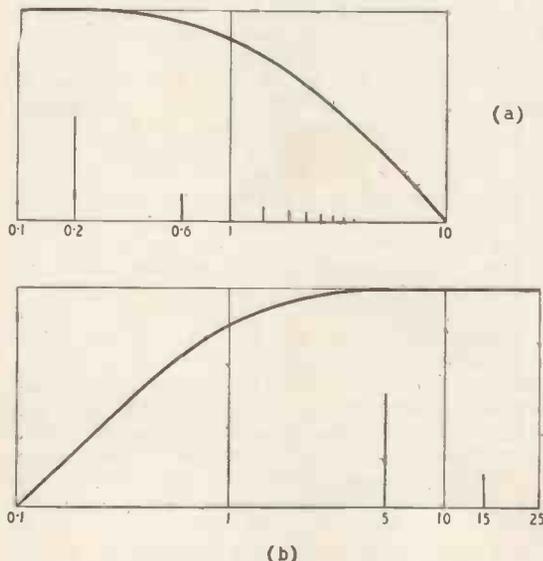


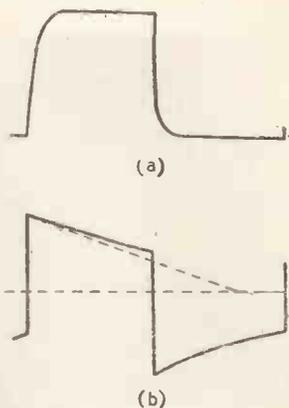
Fig. 10. These two diagrams show the relative amplitudes and frequencies of the first few components of a square wave, in relation to (a) high and (b) low frequency cut-off curves. In (a) the fundamental of the square-wave is one-fifth the cut-off frequency ( $=.1$ ) and in (b) it is five times, giving the same reduction in amplitude.

is to connect a square-wave generator to the appropriate distorting circuit and observe the output on an oscilloscope.

Fig. 10 shows the basis of the first comparison we shall make. In each case the fundamental, represented by the tallest vertical line, is on the safe side of the turning frequency (1 on the scale) by a 5 to 1 margin. The attenuation and phase shift are therefore the same in both, as regards the fundamental. But as regards the whole series of frequencies in the square wave, the odds appear to be heavily against it in the top-cut case (a), because all the harmonics are lower down the curve than the fundamental; in fact, all except the third and fifth are right outside the accepted frequency band, as usually defined. On the other hand, in (b) all the harmonics are on the safe side of the fundamental, and might be expected to be almost free from distortion.

How does it actually work out? Fig. 11 shows what the oscilloscope reveals when tests are made under the conditions just described. Waveform (a) corresponds to Fig. 10(a), and (b) to 10(b). There is no doubt that the l.f. distortion (b), though under apparently much more favourable conditions, is more visible than the h.f. Which was more troublesome in practice would depend on whether the need was for a steep front or a flat top. In (a), the distortion is due mainly to the weakening of the harmonics, which reduces the steepness of the wave-front. As we saw in Fig. 7, there is very little relative phase shift except at frequencies which are barely represented in the output. In (b), on the other hand, a/f. distortion is almost negligible, and the pronounced tilting of the horizontal parts of the square wave is due almost entirely to the phase-shift of the fundamental relative to the harmonics. An approximation to it can be obtained by adding to a true square wave the difference between a sine wave starting at  $0^\circ$  and one starting at  $11.3^\circ$ , both of them having an amplitude  $4/\pi$  times that of the square wave.

Fig. 11. Oscillograms of square waves distorted by the conditions shown in Fig. 10. Although Fig. 10(a) would suggest much worse distortion than (b), the relatively serious effect of phase-shift in (b) proves decisive.



### Square-wave Testing

However fascinating Monsieur Fourier may be, there is no doubt that for square waves the charging capacitor approach is simpler. According to it, the blunting of the wave-front in Fig. 11(a) is caused by the shunt capacitance in Fig. 1 having to charge up before the full voltage can be established across the resistance. The theory of the thing shows that if the rate at which C began to charge were kept up the charging would be completed in CR seconds. Now Fig. 10(a) shows the square-wave frequency  $f_s$  to be 0.2 times the turning frequency  $f_t$ , which we

know is  $1/2\pi CR$ . Therefore,  $CR$  is  $0.2/2\pi f_s$ , or  $0.2/2\pi$  times the duration of one square-wave cycle, or  $0.2/\pi$  or 0.064 times the duration of half a cycle. In other words, if the beginning of the upward rise in Fig. 11(a) were produced until it hit the original perfect flat top, it would do so only about one-sixteenth of the way along it.

The sloping top in Fig. 11(b) is caused by capacitance in series. Ideally, it would not charge at all during half a cycle, but because it is not infinitely great it must charge somewhat. It begins at a rate which, if kept up, would complete the job in  $CR$  seconds. Fig. 10(b) shows that the square-wave frequency  $f_s$  is 5 times the turning frequency,  $1/2\pi CR$ . Therefore,  $CR$  is  $5/2\pi f_s$ , or  $5/2\pi$  or 0.8 times one cycle. So if the starting slope had continued it would have reached the zero line in less than a cycle, as shown dotted in Fig. 11(b).

This, then, is a very sensitive test of low-frequency loss. By adjusting the oscilloscope so that the square waves are very narrow, it is quite easy to detect a sloping top when the turning frequency is as much as 50 times lower than the square-wave frequency used for testing. In fact, by using a single test frequency of, say, 1,500 c/s one can detect turning

frequencies of both 30 c/s and 20,000 c/s, and thereby estimate the effective bandwidth of an audio amplifier. Of course, in complete amplifiers with more than one stage the relationships between  $a/f$  and  $p/f$  characteristics are more complicated (as we saw in the January issue), but nevertheless the square-wave test at a single frequency—or at the most two frequencies—gives one some idea of the bandwidth, and at the same time shows up any resonances, as ripples on the flat top, and enables one to judge their frequency and damping.

Another thing that emerges from our study is that if we want to preserve a flat top to a square wave-form it is certainly not enough to make sure that it is just on the right side of what is usually reckoned as the cut-off frequency. It looks as if, for a 50 c/s square wave, the cut-off frequency ought to be not higher than 0.5 c/s. In other words, the coupling capacitor must be large enough for its reactance to be only about one-hundredth the resistance fed through it—say  $3\mu F$  for  $100k\Omega$ , instead of the  $0.1\mu F$  that would do nicely for sine waves. However, if one doesn't like this, alternative dodges can sometimes be used, such as low-frequency boost circuits. But that is another story.

## V. H. F. at SEA

By CAPT. F. J. WYLIE,\* R.N. (Retd.)

### PROPOSALS FOR MARINE RADIO-TELEPHONE SERVICE

**TOWARDS** the end of last year an international conference was held at Gothenburg, Sweden, to improve marine radio-telephone communication in the Baltic and North Sea. The main work concerned the effective use of the frequency band 1,605 to 3,905 kc/s, which includes the international distress and calling frequency (2,182 kc/s), and an agreement was unanimously adopted by the 13 participating countries. During the conference an informal meeting, attended by all delegates, was held to discuss the use of v.h.f. for the marine mobile services and our contributor, who was an observer for the International Chamber of Shipping, here summarizes the results of the discussions at Gothenburg.

**S**HIPS of any flag may communicate with each other and with the coast stations of other countries without any difficulty using standardized m.f. and h.f. equipment. With v.h.f. radio-telephony, the situation is very different; services like those offered in the other bands do not exist and the majority of the few ships which do carry v.h.f. equipment, do so for communication within their own companies' networks. The thousands of deep-sea ships which are potential beneficiaries of the advantages of short-range radio-telephony are not equipped because no such internationally agreed service is offered in the ports and on the coasts of the world.

For v.h.f. to be an economic proposition for ships, it is necessary to use broad-band equipment, with crystal switching to change the frequency. This means that a single unit of equipment would have to cover a band of about 2 Mc/s or, preferably, 1.5 Mc/s. More complicated equipment may, of course, be built up of units which together cover a much wider band. Further, to achieve intelligible speech between stations, it is necessary to specify with considerable accuracy a number of technical parameters for the equipment. At the present time, as far as international usage is concerned, no frequency band is defined and no technical characteristics have been agreed. Added to these technical barriers is the lack of international collaboration between governments and the other interested parties.

The shipowners' Radio Advisory Service in the U.K. has been endeavouring for some years to stimulate interest in this matter through both national and international channels. Due in considerable measure to these efforts, opportunity was taken by the delegations at the Baltic and North Sea Radio-telephone (2 Mc/s) Conference at Gothenburg to discuss informally the basic requirements of an international maritime v.h.f. service. Without difficulty, informal agreement was reached on frequency bands (156.0-158.025 and 160.525-162.525), the type of modulation (f.m.), channel spacing† and on a tentative frequency plan giving in general terms the channel

\* Radio Advisory Service of the Chamber of Shipping and the Liverpool Steam Ship Owners' Association.

† Initially 100 kc/s, but it is recommended that equipment should be designed for 50-kc/s channel spacing.

Mc/s	Nature of communications
156.1*	Intership, harbour and docking
156.2*	Intership, harbour and docking
156.3†	Intership (First choice)
156.4*	Intership, harbour and docking
156.5*	Intership, harbour and docking
156.6†	Port operations (First choice)
156.7*	Intership, harbour and docking
156.8†	Safety and calling
156.9*; 161.4*	Harbour and docking or public correspondence
157.0*; 161.5*	Harbour and docking or public correspondence
157.1*; 161.6*	Harbour and docking or public correspondence
157.2*; 161.7*	Harbour and docking or public correspondence
157.3; 161.8	Public correspondence (Second choice)
157.4; 161.9	Public correspondence (First choice)

\* Single or double frequency operation.

† Single frequency operation only.

allocations (see Table). It is to be hoped that at the VIIIth Plenary Assembly of the C.C.I.R. in Warsaw this summer, there will be equally little difficulty in settling all the other vital parameters.

If this desirable situation is reached, there will then be known all the essential factors for the design of ships' v.h.f. equipment. It then remains for legislation to be made on the facilities to be provided by v.h.f. Administrations will have to assign frequencies and establish public correspondence services and port authorities will (it is to be hoped) offer pilotage, navigational and other services on v.h.f. in the ports of the world.

Perhaps the most vital point which will still remain to be established, is the number of channels which will be needed to operate the international facilities to be offered. One of the principal factors in the cost of the ship's equipment will be the number of channels it must cover. It will be useless to say that the ship should be prepared to use any of the 30 channels made available in a 1.5 Mc/s wave-band with 50 kc/s spacing, when the maximum number which any port uses may be found to be 10. On the other hand, it will be equally frustrating for the shipowner to provide his ships with 6-channel equipment to find that the average port uses 12 channels.

This rather simple arithmetic is complicated by the fact that the magic number, when it has been found and agreed, will not only describe the best number of channels for a ship's equipment but will also define the number for which all countries will need to assign the same frequencies. The ideal to be aimed at is that a ship of any nationality should be able to close any coast and enter any port and take advantage of any v.h.f. radio-telephone service available, using equipment offered at a reasonable price because it needs to cover only, say, 8 to 12 channels.

The kind of communications in mind are with the pilot vessel, the port radar station, the port traffic authority, the berthing or docking officer and, through public correspondence, perhaps, to owner or agent, fire brigade or police. This is all "ship's business." It is doubtful whether the large volume of passenger radio-telephone traffic could or should be carried on this basic equipment. The peak de-

mands for "ship's business" and passenger calls will synchronize and so must be operated simultaneously in different bands.

It is abundantly clear, first, that the subject of international maritime v.h.f. contains a large number of unsolved problems, most of which will concern at least three of the four main interested parties and, secondly, that the haphazard development from small beginnings, which characterized the growth of the m.f. and h.f. systems, will not be healthy for v.h.f. It is hoped that the Gothenburg informal agreement has set the ball rolling, nationally and internationally, and that by the time the C.C.I.R. has settled the technical parameters, the much needed collaboration between administrations, manufacturers and users will be manifest.

## Professional Recording Methods

IN a lecture to the British Sound Recording Association recently W. S. Barrell, B.Sc., of E.M.I. Recording Studios, outlined the development of professional disc recording during the past 30 years and contrasted the heavy gravity-operated direct-recording machines using wax masters with the relatively portable magnetic recorders with which tape masters are now produced. In his view the facility with which these magnetic tapes can be cut and edited has not proved an unmixed blessing. Modern artists seem to have lost the ability to go through even a 4½-minute session without coughing or rustling—an essential qualification for recording in the days of the wax disc.

Lacquer discs are now used in the first step from tape to the record stamper, and an entirely new disc recorder has replaced the older one, using a single-turn moving-coil cutter, which had given long years of service with wax. The new machine incorporates an automatic variable groove-spacing device, and is push-button operated throughout, including the selection of turntable speed and operation of the run-off groove mechanism.

Mr. Barrell made some interesting comments on studio technique in general and expressed the view that no single microphone had so far proved itself suitable for all types of recording. E.M.I. chose the appropriate instrument for any given recording from a range of different types—all with similar measured characteristics. In his view the old E.M.I. (Blumlein) moving-coil microphone was still the best for recording the piano.

## Ionic Fire Alarm

ONE disadvantage of conventional fire indicators and alarms, which depend on a rise of temperature for their operation, is the time delay before the critical temperature is reached, particularly if the indicating device is some distance from the original seat of the fire.

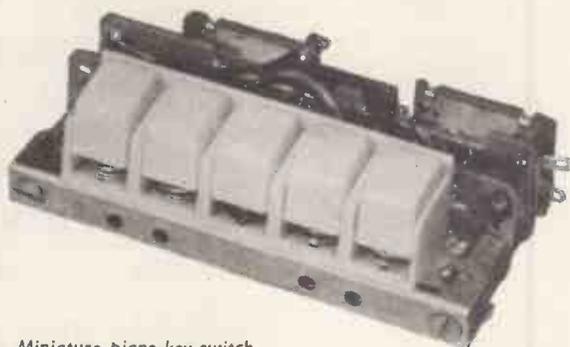
A new method due to E. Meili depends on the reduction by smoke particles and other products of combustion of the current induced in an ionization chamber by a minute radioactive source. To compensate for normal variations due to atmospheric pressure and temperature a second ionization chamber, to which smoke cannot enter, is connected in series with the first to form a potential divider. The change in potential due to smoke is applied to a cold cathode gas discharge triode which operates a relay.

The manufacturers of the system in this country are The Minerva Detector Company, Ltd., Red Lion Street, Richmond, Surrey.

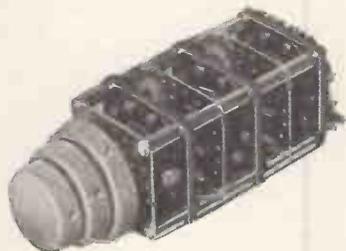
# French Components Show

**T**HE accompanying photographs show a few of the more interesting items displayed at the Parc des Expositions, Paris, where the 19th exhibition of radio components, valves, accessories and measuring instruments was held this year. Organized by the Syndicat des Industries de Pièces Détachées et Accessoires Radioélectriques et Electroniques, the show as a whole was notable for being well laid out and decorated, with plenty of space between the stands, and for the novel feature of having a programme of lectures running during exhibition hours.

It was definitely a French national exhibition—there being practically no foreign products on show—and the accent tended to be on “professional” components and accessories, and things designed to satisfy military specifications. However, there was a noticeable increase in new components for f.m. receivers, for multi-channel television sets and for high-quality sound reproduction equipment. Printed



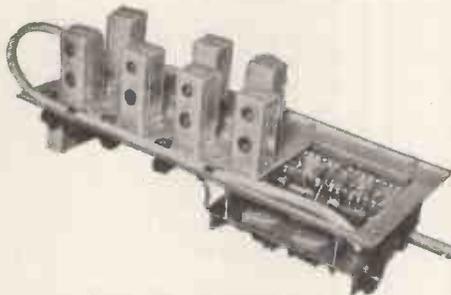
Miniature piano-key switch shown by Op.alix.



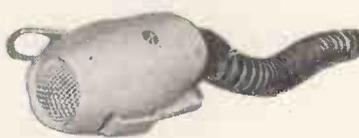
Triple coaxial rotary switch made by Dyna.



Left: Klystron of 4 megawatts output power produced, mainly for use in linear accelerators, by Compagnie Générale de T.S.F. The height of the valve is about 3 feet.



Multi-channel television receiver “front-end” shown by Cicor.



Left: Microphone incorporating a transistor pre-amplifier, shown by Lemonne.



Television focusing and picture-centring assembly with control by flexible cable, made by Aréna.



Left: A miniature gramophone turntable (45 r.p.m.) made by Edentzter. Right: The same equipment in a small portable record player by Clement, using a transistor amplifier (OC70, OC71 and two OC72s) and powered by four 1.5-V torch batteries. The size of the exhibits can be seen from the copy of our French contemporary, *Toute La Radio*, underneath.

Right: An oscilloscope made by Leres. The bandwidth of the Y amplifier is 60 Mc/s.



circuits were very much in evidence and also miniature components for use with transistors. The outstandingly original development work done by the French on velocity-modulation valves for s.h.f. was represented by new types of "Carcinotrons" (backward-wave oscillators) for operation in radar equipment.

The subjects of the lectures (18 in all) gave additional emphasis to the "non-entertainment" tone of

the exhibition—magnetic recording in the field of information; new forms of construction for electronic circuits; magnetic materials (in particular, ferrites); semi-conductor devices and their influence on component design; methods of control in the manufacture of components. The final address, by an official of the industry, gave an account of the work which is being done in France to establish proper specifications for radio components.

## Instructional Films on Waveguides

Colour Animation as an Aid to Teaching

ANYONE who has ever attempted to explain the principles of waveguides will hardly need convincing of the value of animated film as a teaching aid. Without movement, the most skilfully drawn diagrams call for a considerable effort of imagination on the part of the trainee, and the instructor is not always fortunate enough to be able to count on this. The appearance of a set of five films developing the subject clearly and logically from the basic principles of electric and magnetic fields is therefore most welcome. They are 16-mm sound films in colour—practically essential for distinguishing the fields—produced by Science Films, Ltd., for the Royal Air Force, but are available to the other Services and to technical colleges, etc.; inquiries should be addressed to Air Ministry (S.T.4), London, S.W.1.

Each film runs for about 20 minutes, and is intended to be shown at an appropriate point in an extended course of instruction. Because of the heavy cost of animated film in colour, they are highly concentrated and need to be supplemented by a considerable amount of classwork; for the same reason it would be most desirable for trainees to see each one at least twice.

Part I ("Guiding Electromagnetic Waves") starts from the propagation of transverse electromagnetic waves along two-conductor transmission lines, and indicates the desirability, for microwaves, of reducing losses by removing the inner conductor of a coaxial cable, with its solid supports; but propagation of such waves then becomes impossible owing to boundary conditions being wrong.

Part II ("Bouncing Waves") continues the story by showing that the introduction of a longitudinal component of either electric or magnetic field, so that the waves are reflected alternately from top and bottom of the guide, sets up acceptable boundary conditions. The resulting field patterns and their motions are then developed. This is undoubtedly the key film in the series and the one in which animation is most helpful.

Part III ("E and H Waves, Launchers and Slots"). From the  $H_{01}$  rectangular mode in Part II, the other modes are distinguished, and factors governing the choice of waveguide dimensions are explained. Animation again results in a particularly effective treatment of launching probes. Wall currents are considered, and their bearing on radiating and non-radiating slots.

Part IV ("Resonant Cavities, Joints and Stubs"). The production of standing waves by reflection from a closed end of a guide is shown by superimposing animated diagrams, and the length of guide is suc-

cessively reduced until it is no more than a resonant cavity. Next come the techniques necessary for feeding a rotating aerial—choke joint, undesired-mode suppression, etc.—and series and shunt stubs are explained by analogy with transmission lines.

Part V ("Iris and other Matching Devices; Common T and R Systems"). This film falls into three sections: the first, dealing with irises, screws and dielectric rod matching devices, consists largely of pictures of the devices included, with little animation or development from basic principles; the second makes better use of the medium in explaining common T and R systems; and the third is a recapitulation of the four preceding films.

Throughout, particular care is taken to link the theoretical explanations with practical application in radar installations. The tempo of the exposition seems to vary somewhat from section to section, but this—and the impression that fields consist of lines—can no doubt be corrected by the instructor. There are one or two slight inaccuracies in the delineation of the fields. On the whole, though, all concerned in the production of these films are to be congratulated on an excellent job and a valuable addition to teaching facilities.

M. G. S.

### A.R.R.L. Handbook

THE 33rd edition of The Radio Amateur's Handbook now available has been considerably revised and its 26 chapters reflect the most up-to-date techniques in amateur radio communication and frequency measurements. Some of the new equipment has a particular appeal to the beginner, but this is not at the expense of the advanced amateur as space has been made for it by omitting obsolete designs.

The tables of valve and semi-conductor data cover 39 pages and are right up to date. Much of this information is not available elsewhere in such easily assimilated form.

Compiled by the headquarters staff of the American Radio Relay League the handbook contains 608 pages of text, charts and illustrations, plus a 13-page index. It costs 30s (32s by post) in the U.K. and is obtainable from the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1, or from The Modern Book Co., 19-23, Praed Street, Paddington, London, W.C.1.

#### "Magnetic Tape Amplifier"

In Fig. 1, p. 120, of the March issue, the lower end of P3 should be joined to the junction of C14 and R13; on p. 122, col. 2, line 52, R43 should be R38; on p. 123, col. 2, line 10, R4 should be R5 and on p. 124, col. 2, line 27, the series grid resistor and not R9 should be 1 M $\Omega$ .

## APRIL MEETINGS

### LONDON

4th. I.E.E.—“The Crystal Palace television transmitting station” by F. C. McLean, A. N. Thomas and R. A. Rowden; “The Broadcasting House—Crystal Palace television link” by Dr. A. R. A. Rendall and S. H. Padel; and “Band I television transmitter design with particular reference to the transmitters at Crystal Palace” by V. J. Cooper and W. J. Morcom at 6.15 at Savoy Place, W.C.2.

6th. Brit.I.R.E.—Discussion on “The importance of visual aids in the teaching of advanced radio and electronic engineering” opened by R. H. Garner at 6.30 at the School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

6th. Television Society.—“Television transmitter design” by V. J. Cooper (Marconi's) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

9th-14th. I.E.E.—Convention on digital-computer techniques at Savoy Place, W.C.2.

19th. Television Society.—“Recent progress in transistors with reference to television” by J. H. Barry, A. E. Jackets and D. D. Jones (G.E.C. Research) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

20th. B.S.R.A.—“Magnetic tape as a control medium for machine tools and allied equipment” by D. T. N. Williamson at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

23rd. I.E.E.—“Automatic assembly systems for electronic equipment” by G. W. A. Dummer at 5.30 at Savoy Place, W.C.2.

25th. Brit.I.R.E.—“Radio and television interference—its growth and effects” by M. Smith at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

26th. I.E.E.—“Radio astronomy” by Professor A. C. B. Lovell at 5.30 at Savoy Place, W.C.2.

### BIRMINGHAM

23rd. I.E.E.—Annual general meet-

ing of South Midland Radio Group, followed by “F.M. broadcasting and reception” by H. E. Farrow at 6.0 at the James Watt Memorial Institute, Great Charles Street.

### BRISTOL

10th. Television Society.—“Oscilloscopes” by T. S. Whish at 7.30 at the Hawthorns Hotel, Woodland Road.

### GLASGOW

11th. Brit.I.R.E.—“Glasgow University synchrotron: its principles and application” at 7.0 at the University's Department of Natural Philosophy.

### MALVERN

9th. I.E.E.—Informal discussion on technical education to be opened by Dr. K. R. Sturley and C. F. Partridge at 7.30 at the Winter Gardens.

### MANCHESTER

5th. Brit.I.R.E.—“Design of an underwater television camera” by D. R. Coleman and D. Allanson at 6.30 at Reynolds Hall, College of Technology, Sackville Street.

11th. Television Society.—“Cathode-ray tubes for television” by M. D. Dudley (Ferranti) at 7.30 at the College of Technology.

18th. Television Society.—“Some problems of a band-sharing colour television system” by A. V. Lord (B.B.C. Research) at 7.30 at the College of Technology.

### PORTSMOUTH

11th. I.E.E.—Annual general meeting of Southern Centre followed by discussion on “Soldered joints” opened by W. Ford, at 6.30 at the College of Technology Extension, Anglesea Road.

### WEYMOUTH

13th. I.E.E.—“Application of electronics to accountancy” by W. Woods-Hill at 6.30 at the South Dorset Technical College.

## MAY MEETINGS

### LONDON

9th. I.E.E.—“Time sharing as a basis for electronic telephone switching: a switched highways system” by L. R. F. Harris at 5.30 at Savoy Place, W.C.2.

9th. Royal Society of Arts.—“Automation” by the Right Hon. the Earl of Halsbury (National Research Development Corporation) at 2.30 at John Adam Street, W.C.2.

14th. I.E.E.—Discussion on “An elementary presentation of the principles of magnetism and electromagnetic induction, with demonstrations” opened by Professor K. A. Hayes at 6.0 at Savoy Place, W.C.2.

16th. Royal Society of Arts.—“Electronic photography” by Commander C. G. Mayer (R.C.A.) at 2.30 at John Adam Street, W.C.2.

23rd. Brit.I.R.E.—“The measurement of the velocity of ‘light’ by electronic methods” by Dr. K. Froome at 6.30 at the School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

25th. B.S.R.A.—“Description and demonstration of the B.B.C. (Type DRD 5) fine groove reproducing desk”

by H. J. Houlgate, followed by a recital of unusual recordings from the B.B.C. archives presented by T. H. Eckersley at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

### BIRMINGHAM

2nd. Junior Institution of Engineers.—“Electronic control—the new power in industry” by J. A. Sargrove (Automation Consultants and Associates) at 7.0 at the James Watt Memorial Institute, Great Charles Street.

### GLASGOW

2nd. I.E.E.—“The search for and salvage of the Comet aircraft near Elba” by Commander C. G. Forsberg and G. G. MacNeice at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

### STAFFORD

4th. I.E.E.—“Germanium and silicon power rectifiers” by T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell at 7.0 at the Technical College.

### TORQUAY

10th. I.E.E.—“Radio astronomy” by A. B. Thomas at 3.0 at the Electrical Hall.



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# RANDOM RADIATIONS

By "DIALLIST"

## Aerial Adventures

I LEARN from readers writing in response to my request for information on f.m. and television reception that a variety of v.h.f. signals are being received on all kinds of apparently quite unsuitable aerials. Good f.m. reception from Pontop Pike on a channel-5 television aerial is more or less commonplace, and at greater ranges than I'd expected. Reports are reaching me of good signals from the channel-8 Lichfield I.T.A. transmitter received on channel-4 Sutton Coldfield aerials. That's not, perhaps, very surprising. The mid-frequency of channel 4 is 60Mc/s and that of channel 8 is 188Mc/s—very nearly an exact multiple. And though the London I.T.A.'s mid-frequency of 193Mc/s is much further from being an exact multiple of the B.B.C.'s 43.5Mc/s, a good many living in the London area tell me that they receive the Band III programmes quite happily on their Band I aerials. A Brentwood reader has outdone the lot by receiving the sound part of the vertically polarized I.T.A. transmissions on his horizontal Wrotham aerial! As I said, a month or two since, queer things can happen to the

polarization of these waves. Reverting to Band III reception on Band I aerials, it'll be interesting to hear in due course how those using Holme Moss aerials (mid-frequency 50Mc/s) get on with Winter Hill (mid-frequency 193Mc/s). They should manage pretty well at shortish ranges, I think.

## A Crying Need

A PROBLEM that should be tackled firmly—and right speedily—by the radio industry is that of radiation from the line timebases of television receivers. Quite apart from its effects on other TV sets, this radiation is responsible for more than 10 per cent of the cases of interference with ordinary sound reception investigated by G.P.O. engineers. The radiation takes place during the line flyback. No visible interference occurs in one's own set, since the brightness is (or should be) below black level at the time. Nor do neighbouring sets normally affect each other if they are tuned to the same transmitter; the flyback occurs at the same instant in all of them and all are then blacked out. But matters are very different if one viewer is watching a B.B.C. pro-

gramme and a neighbour switches to the I.T.A. station. The flybacks then occur at different times and one far-too-common result is the appearance of a vertical bar on the screen.

## No Half-measures

It's no good trying to find palliatives. So long as strong radiation takes place from the line timebase, interference between TV receivers tuned to different stations is bound to be experienced. Even if the two stations used the same aerial mast and a common master scanning generator, there'd still be trouble. What, for instance, would happen if the B.B.C. station were relaying a distant outside broadcast and by means of "Genlock" had tied its waveform generators to the O.B. apparatus? The evil will have to be tackled at its roots and means found of reducing the radiation to harmless proportions. One thing that surprises me is that I don't recall having seen in any American publication, technical or lay, reference to line timebase radiation interference despite the variety of programmes (I suppose I ought to write "programs"! ) radiated in the big towns. Is one wrong in concluding that American TV set manufacturers have found ways of limiting radiation during the line flyback to something quite innocuous?

## Reduced Handyman Outfit

DURING the years in which I lived at no great distance from London I was able to build up a combined lab-workshop so well found that it contained a useful selection of the instruments and the tools needed for dealing with receiver construction, tests, experiments and repairs, as well as with the domestic jobs that come the way nowadays of anyone who is (or thinks he is) any kind of handyman. And then fate decided that I should cease to be a householder and should be on my rather lonely own as the tenant of part of someone else's house. It was clearly impossible to keep the entire contents of the lab-workshop, for there'd be nowhere to put them or use them. I wonder if, in a similar quandary, you'd have come to the decisions



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that I made. My lathe, drilling machine, oscilloscope and valve-voltmeter have fallen by the way. Good homes, I may mention, have been found for all of them. All that I've kept is a useful selection of small tools and appliances. Among these are two high-quality multi-range measuring instruments, an electric drill with a complete outfit of Morse "twists" from 0 to 60, a drill-plate, assorted pliers, various files, a wire-stripper, box spanners and screwdrivers ranging from the jeweller's to one with a blade  $\frac{3}{16}$  in wide. So far, these have helped to do all the necessary jobs. Can you suggest any omission?

### Modernization

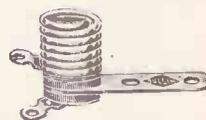
IN my new home I've had all the electric wiring done, or re-done (and some of it badly needed that!) on the ring-main system with the latest kind of 13-ampere outlets for anything that is meant to be plugged into a socket. I'm delighted with the simplicity, the neatness and the safety of the whole installation. Particularly am I pleased with the plugs (3-pin, of course), which contain not only the fuse appropriate for the apparatus to which they're attached—3A, 7A or 13A, as the case may be—but also a small, but quite effective, switch in the phase lead. It breaks all loads up to 13A without any fuss and you can be sure that apparatus left plugged in but switched off is in a perfectly safe condition. Both my sound and TV receivers have their plugs (fused 3A) so connected that the chassis are neutral. When I switch off at the plug or at the set I know that they're electrically inert. They are, in fact, about as safe, whether working or not, as electrical apparatus can be.

### It'll Be Welcome

THOSE who live on or near the East Anglian coast hardly know what it is nowadays to receive a B.B.C. sound programme free from interference. Direct intrusion of foreign stations, ear-splitting heterodynes and the maddening signals from radio beacons all play their horrid parts in ruining reception. Very rarely can one use one's set as a means of entertainment. Many people seldom switch on except to hear some important item of news or to get the sports results. The Norwich (Tacolneston) f.m. station is due on the air in a few months now. And won't it just be welcome!



(TO B.S. 98/E.10)



**Bulgin Pilot Lampholders** to accept Miniature Edison Screw-cap lamps are manufactured to B.S. 98/E.10 specifications and to the usual high Bulgin standards, using the finest available materials. The range is vast and further special types and finishes (such as R.C.S.1000) can be made to quantity orders.



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**M.S.T. HOLDER** with Cadmium-plated clip. Open-"shell" for normal M.E.S. cap lamps. Available with many other brackets and clips.



**MOULDED-BASE Model.** Moisture resisting. Heavily plated. Lamp-pip connection is by sprung-plunger with integral tag.



**ROLLED-SHELL** types. Illustration shows model without bracket, but with rubber grommet for fitting directly to chassis, etc.



**DECORATION LAMPHOLDER.** Insulated shroud of P.V.C., normally supplied black, but available in many other colours to quantity orders.

**BELL-MOUTHED** version of the model above. Normally hung in a run of wiring but may be wedged in  $\frac{1}{16}$  in. diam. hole.

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# UNBIASED

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## When, Whence, Whither, Who?

WE all know when wireless telegraphy was born, but I have been having great difficulty in finding out when, whence, whither and by whom the first message was sent by wireless telephony. It was obviously long after Marconi's pioneer days, as c.w. had to be invented first, and that reminds me, I don't even know the when and who of this.

The birth of radiotelephony was certainly in pre-valvular days. I don't mean before November 16th, 1904, but before the valve came into use as a generator of oscillations. I seem to recollect somebody in the early c.w. days sticking a prodigious number of parallel water-cooled microphones in series with the aerial, the paralleling being necessary so that they could handle the large power without burning out too soon. But apart from this hazy recollection I am as ignorant as old Kaspar was about the battle of Blenheim, and I hope you can do more to satisfy my thirst for knowledge than he could for little Peterkin.

## Art or Science?

THE word "art" has often been used in the editorial columns to describe wireless or electronics and I am sorry to see in the January issue that it has caused distress to one reader who wants the word banned in favour of "science." He says that the true engineer should be able to deduce by scientific reasoning why or why not a circuit is good.

Maybe he can nowadays, but I am quite certain that this was not so in the hit-and-miss days of thirty years ago. It was then a fine art to get a super-regenerative receiver to function satisfactorily and steadily, and those who could do it were few and far between. I met some of them but not one could explain how he did it any more than Rembrandt in his day could explain his skill with the brush.

A super-regenerative receiver of the early twenties was more unpredictable and capricious than a

woman. In fact a well-known psychiatrist of the period, who was also in the front rank of radio experimenters, told me that he had observed that men who could tame a "super-regen." also had a wonderful way with women. That, as you will remember, was an achievement that even excited the obvious envy of Solomon, despite all his wisdom and experience.

Nowadays, of course, the art of "super-regen." control has been developed into a science and anybody can learn how to make one of these formerly intractable receivers eat out of his hand, but the taming of women still remains an art known only to the few like Petruccio. Even this may one day become an exact science.

The truth is that all branches of science start as an art in which only the chosen few, gifted with a strange intuitive genius, are proficient. Eventually knowledge is painfully acquired and becomes available to all who care to study, and so the former art becomes a science. I regard radio as just emerging from the chrysalis state of art, but until it has fully done so it is incorrect to call it by either name.

## Wireless in the Wilds

I WONDER if any of you who live within comfortable range of one of the B.B.C. transmitters and are able to sit back and really enjoy the programmes ever spare a thought for those less fortunately situated in the wilds of Wales or Scotland—or even of England—whose listening is punctuated by fading, distortion and "noises off."

It is for these people that the B.B.C. has embarked on its v.h.f. service and it hopes—somewhat optimistically in my opinion—eventually to give "local station" reception to over 90 per cent of the population by this means. To give equal results to the remaining 10 per cent would need a very great and expensive extension of the v.h.f. service.

For a long time past I have thought that the real solution to the problems of those who find themselves left out in the listening jungle is for communities to erect their own fly-power v.h.f. station which would be linked to the B.B.C. network by a landline rented from the G.P.O. In certain cases—such as in the Western Isles—each transmitter would have its own diesel-powered generating unit.

It would be hopeless to try to erect

and operate such a station on a basis of voluntary subscription, especially in Scotland. The only real solution to the problem would be for the thing to be run by the local council along with other public services at a cost of no more than a few bawbees added to the local rates.

## Robinson Crusoe's Radio

MANY people have told us, in the old desert-island discs programme, what sort of records they would take with them if sentenced to spend a period of solitary confinement on a desert island. Nobody but myself, however, seems to have thought of what sort of wireless set they would



Desert island delights.

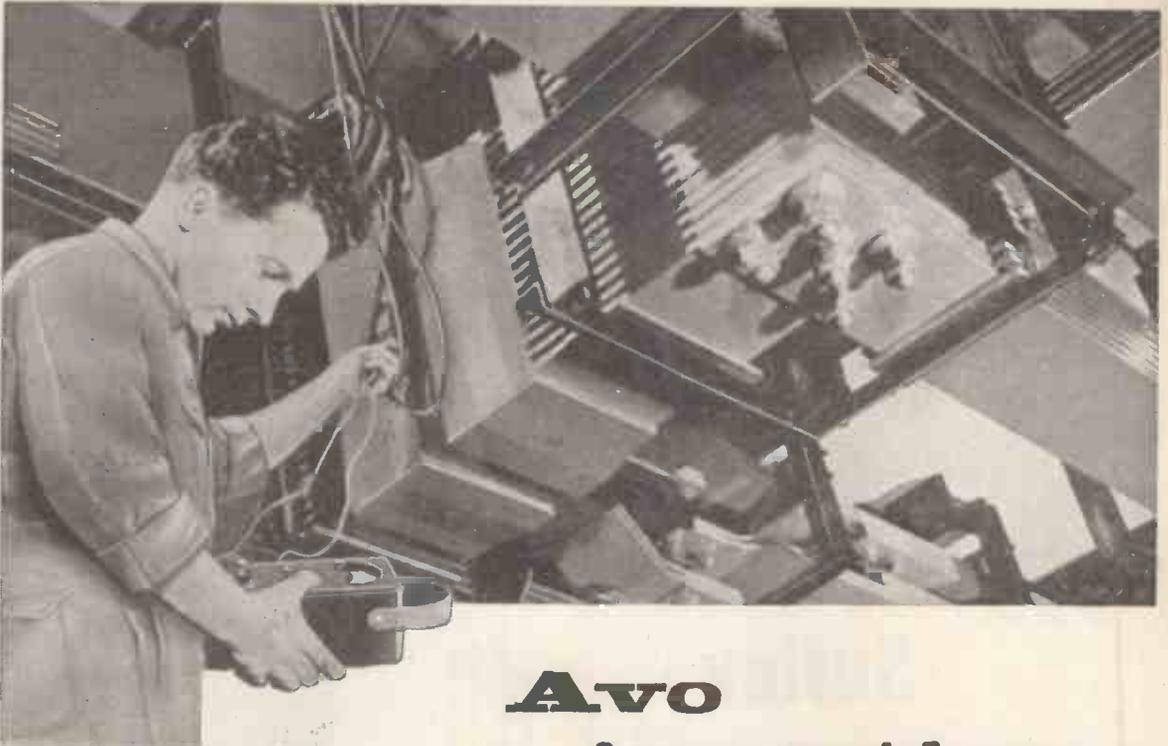
take in similar circumstances. Desert islands are usually situated in remote localities, but a good s.w. receiver would bring in all the music the heart could desire.

The only snag is l.t. and h.t. supply. One could take enough spare valves and components to last a lifetime, but spare dry cells would soon dry up, as desert islands seem to be always in tropical seas. Accumulators and a wind-driven generator wouldn't do as, no matter how carefully tended, the plates of the cells would eventually disintegrate in the course of a life sentence.

I would be chary of trying to store even "inert" dry cells in tropical regions. I think my solution—laugh if you will—would be a large quantity of the old-fashioned wet Leclanché cells which we used to employ for our domestic electric bells in days of yore; in some districts they are still in use. It would be easy to take a large supply of spare zinc rods or even porous pots. But there is one point on which I need the advice of you battery experts. Should I need to take sacks of spare sal-ammoniac, which is ammonium chloride, or could I use sodium chloride, or in other words sea water? The ideal source of power in such circumstances would be solar batteries but as far as I know they are not yet in production.



Both equally intractable.



Photograph by courtesy of British Insulated Callenders' Cables, Ltd.

# Avo in action..

The checking of a busbar installation in a large steel works is an interesting example of the important contribution of the world-famous AvoMeter to the maintenance of electrical power plant. AvoMeters will be found wherever electricity is used in industry.

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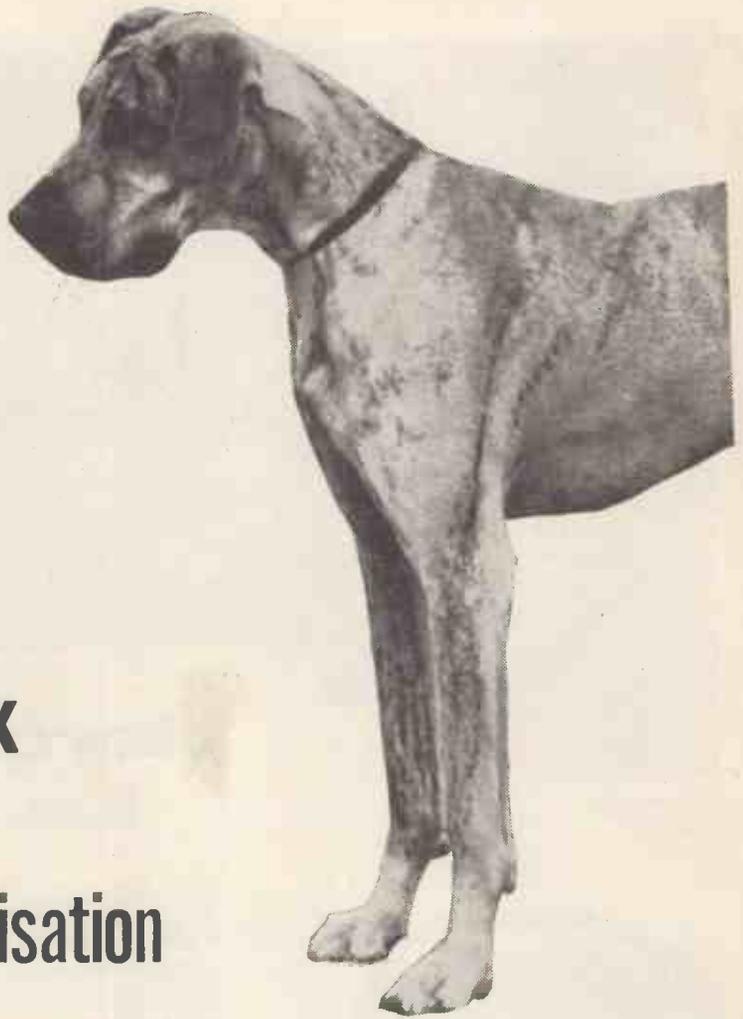


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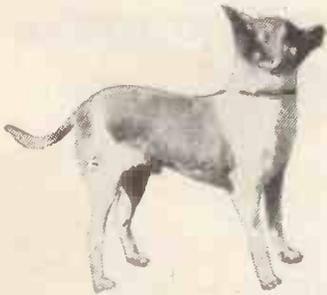
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## V.H.F. POWER TETRODE

*a new addition  
to a popular range*



This new tetrode, the QY3-65, embodies a similar technique and construction to the Mullard range of all-glass transmitting valves which are already well established in communications and industry. It has an anode dissipation of 65 watts and a maximum frequency of 250 Mc/s and is directly interchangeable with the American 4-65A.

Relatively high outputs can be obtained from the QY3-65 at low anode voltages, and its quick heating filament allows power consumption during standby to be reduced to a minimum.

Write for detailed information on this valve, power triodes and other tetrodes made by Mullard.

MAXIMUM OPERATING CONDITIONS (CLASS C AMPLIFIER) AT 50 Mc/s									Maximum frequency at reduced ratings (Mc/s)
Valve	Type	$V_a$ (V)	$V_{g1}$ (V)	$I_a$ (mA)	$I_{g1}$ (mA)	$V_{in}$ (peak) (V)	$P_{load}$ (W)	$\eta$ %	
QY3-65 (CV1905)	TETRODE	3000	-100	115	10	170	224	81	250
TY2-125 (CV1924)	TRIODE	2500	-200	205	40	390	310	76	200
QY3-125 (CV2130)	TETRODE	3000	-150	167	6.5	300	300	75	200
QY4-250 (CV2131)	TETRODE	4000	-225	312	9	374	800	80	120

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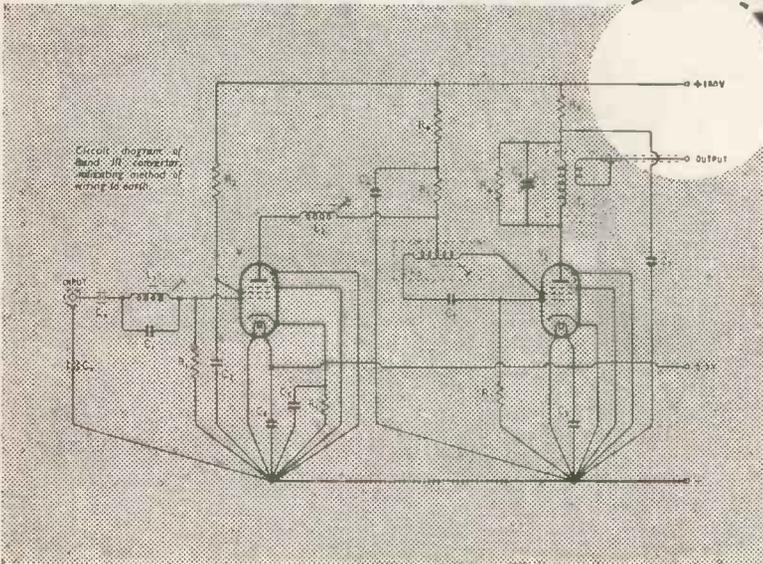
## SenTerCel

### selenium rectifiers

as recommended in the "Wireless World" (May 1954 issue)

From a range of miniature rectifiers designed for domestic Radio and Television receivers, types RM0 and RM1 are recommended for use in T.V. Band III Converters.

It may be convenient to use type DRM1 ; an assembly of two RM1 rectifiers on a spindle and bracket.



Circuit diagram of Band III converter, indicating method of wiring to lamp.



Send for Brochure F/SRT.9

TYPE	RM0	RM1
Maximum ambient temperature	35°C 55°C	35°C 55°C
Maximum output current (mean)	30mA 15mA	60mA 30mA
Maximum input voltage (r.m.s.)	125V	125V
Maximum peak inverse voltage	350V	350V
Max. instantaneous peak current	Unlimited	Unlimited
Weight	0.82 oz.	1 oz.

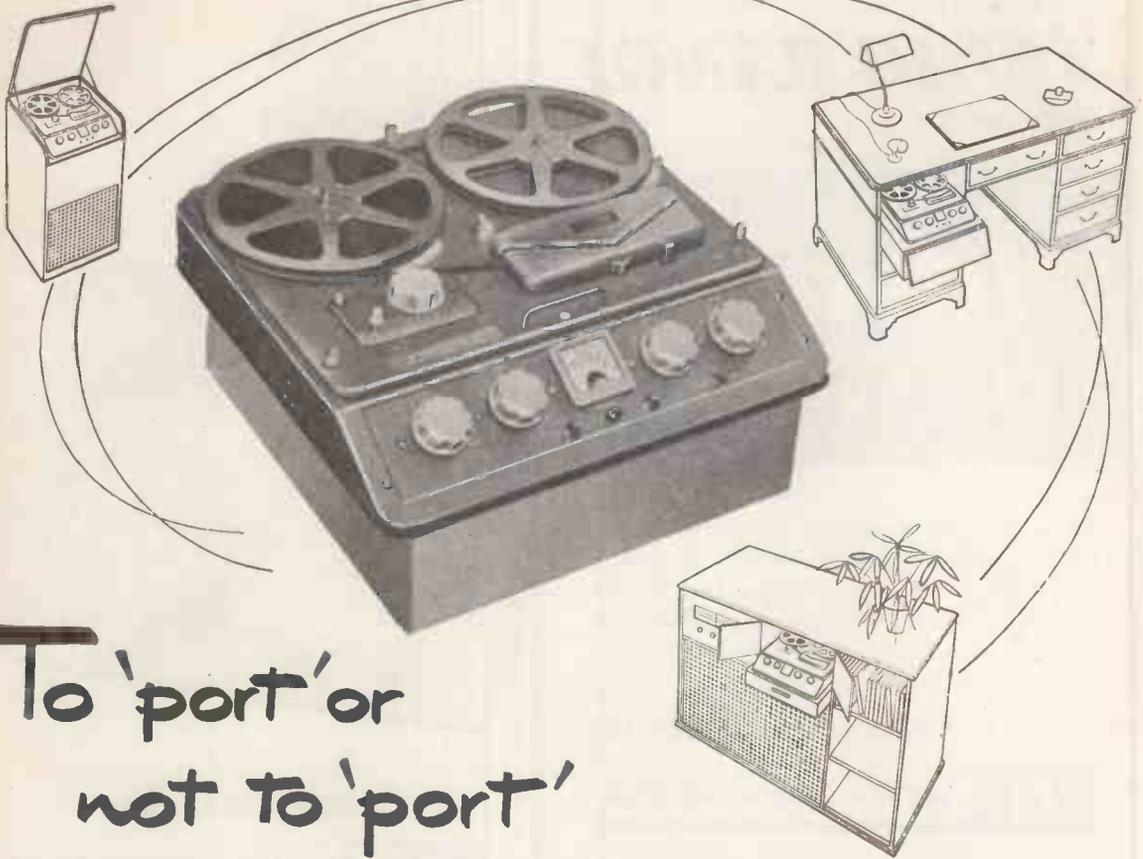


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## To 'port' or not to 'port'

Yes—that is the question! And a very important question, too. For portability in a Tape Recorder isn't always an advantage. It can, indeed, prove a costly handicap if valuable—and irreplaceable—recording opportunities are lost because the instrument is not set up for immediate use.

So, if it is not your intention to carry your Tape Recorder around, we know you'll be interested in the new Ferrograph '66'. Tape Recording is no longer something to amuse (and amaze) your friends. It's a serious business—an opportunity to capture for your future enjoyment the spine-tingling glories of great music. And you'll do it with greater certainty if your Recorder is always ready for instant use.

By the omission of an inbuilt loudspeaker it has been possible—without sacrificing even one of its many valuable features—to design the Ferrograph '66' so that its main baseplate substantially overlaps the high fidelity amplifier beneath it. Thus, it is child's play to fit it into a console, a desk, a bookcase, or, in fact, any suitable piece of furniture of period or contemporary design. All that is necessary is to provide a wood surround with an opening  $15\frac{3}{4}'' \times 16\frac{1}{2}''$  on which it can be mounted. If a single drawer is too shallow, an adjacent pair can be easily converted for the same purpose.

The '66', basically a series 2 Ferrograph in a new form, is a most versatile instrument. By mounting it alongside a turntable and an F.M. tuner, you can have at the turn of a switch recording from the three sources of microphone, radio and pickup with the added advantage of using the Ferrograph hi-fi amplifier separately for disc-playing or radio if desired.

Most attractively finished in gold bronze with cream knobs and accessories, the ensemble will readily harmonise with the most luxurious surroundings and permit tape recording and playing at its best to be always available at the turn of a switch.

Model 66.N  
 $3\frac{3}{4}''$  &  $7\frac{1}{2}''$  p.s.  
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# Ferrograph

## "66"

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Covers from 15-50,000 c/s in three ranges. Accuracy  $\pm (2\% + 1 \text{ c/s})$ . Output (continuously variable) into 600 ohms.  $0.1\text{mW}-1\text{W}$  (0.25-25v)  $\pm 2\text{db}$ , output impedance approximating to 600 ohms over the whole range. Maximum output into 5 ohms is greater than  $\frac{1}{2}\text{W}$ .

LIST PRICE IN U.K. **£35 12s.**

**Type J2** similar to J1 but with output voltage meter.

LIST PRICE IN U.K.

**£45**



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15 c/s to 50,000 c/s



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Wow and Flutter have been reduced to the minimum, being less than 0.2% and less than 0.05% respectively. The unit is equipped for dual voltage ranges of 100 to 130 and 200 to 250 volts, 50 or 60 cycles according to the motor pulley fitted.

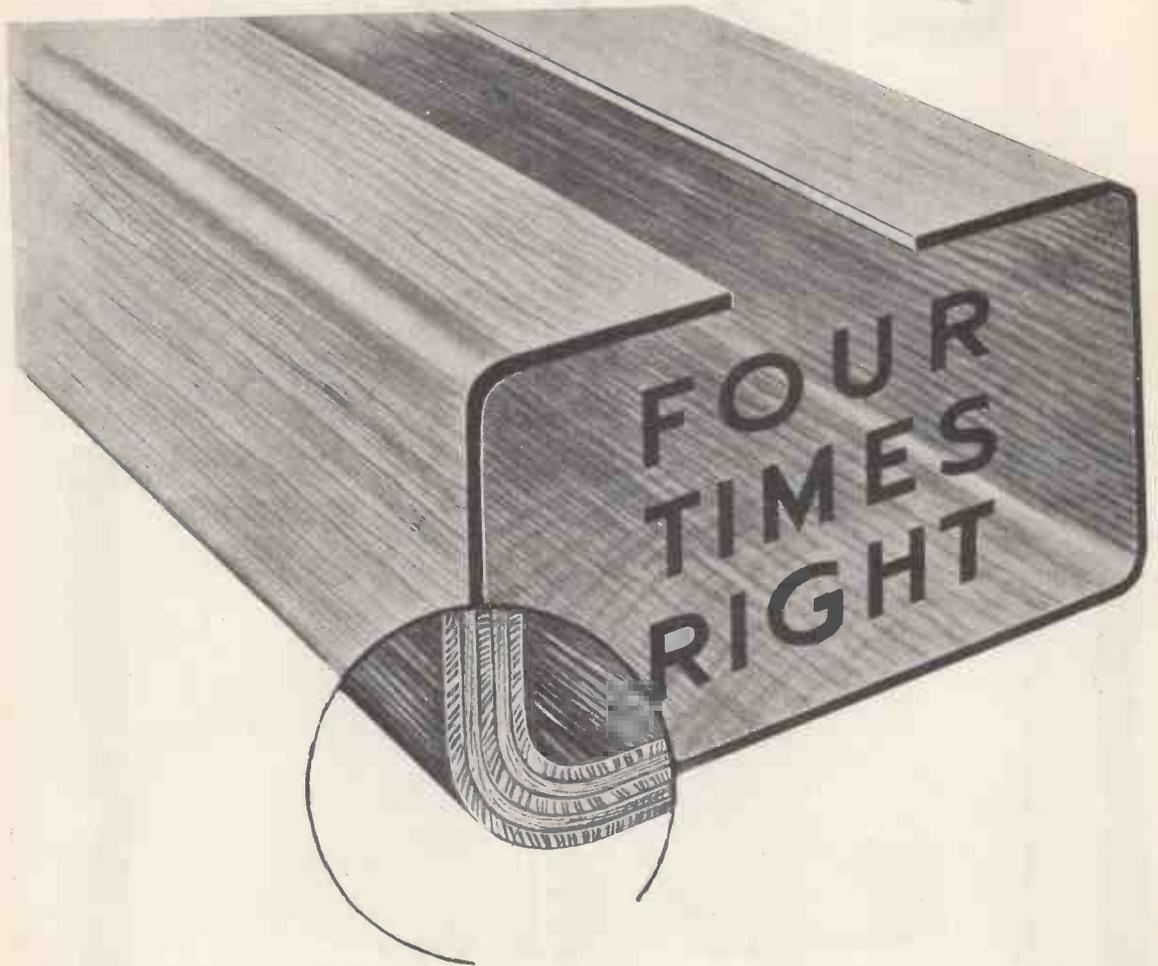
The Model 301 is finished in high quality grey tone enamel, is fully tropicalised and is supplied complete with a plastic stroboscope, a tube of special grease, all fixing screws, washers, template and instruction manual. . . . see your Dealer now.



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The shell is especially well adapted for the Radio and Television industries, and experience indicates that the cost of a cabinet can be easily halved by the use of this shell. Enquiries are invited from cabinet manufacturers.

### **Special Notice**

The SPEARS-LAMINA Shell is manufactured by Matthew Spears and Company Limited, Kirkcaldy, under Mr. James Henderson's Patents. All proper steps will be taken to protect the Patent rights in the case of any apparent infringement.

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Tube Size		Dia.	Len.	Dia.	Len.	Dia.	Len.
D.C. Rating	70° C. Wkg. Test	1/8"	2 3/8"	1 1/8"	2 3/8"	1 1/8"	3 1/8"
2.0 kV.	4.0 kV.	0.05	μF.	0.1	μF.	0.15	μF.
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8.0 kV.	16.0 kV.	0.002	μF.	0.005	μF.	0.0075	μF.
10.0 kV.	20.0 kV.	0.0015	μF.	0.003	μF.	0.005	μF.
12.0 kV.	24.0 kV.	0.001	μF.	0.002	μF.	0.003	μF.
15.0 kV.	30.0 kV.	0.0007	μF.	0.0015	μF.	0.002	μF.
18.0 kV.	36.0 kV.	0.0005	μF.	0.001	μF.	0.0015	μF.
20.0 kV.	40.0 kV.	0.0003	μF.	0.0007	μF.	0.001	μF.
25.0 kV.	50.0 kV.	0.0002	μF.	0.0005	μF.	0.00075	μF.
30.0 kV.	60.0 kV.	—		—		0.0005	μF.

The capacitance value is a nominal maximum for a given tube size and voltage rating, capacitance tolerance ± 20%.

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The principal features of the E·A·R Three-Nine-Five Amplifier based on a circuit developed by Mullard can be summarised as follows:—

1. Very low harmonic (less than 0.05% at 20 watts 400 c/s) and intermodulation distortion (at 40 c/s and 10 kc/s (ratio 4:1)—0.7% at 20 watts).
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6. Adequate power output to allow peak passages to be reproduced without overload.
7. Low output resistance to provide electrical damping for the loudspeaker system.

These claims are amply supported by a technical specification which creates a new standard of performance for commercially produced amplifiers.

### Brief Technical Details—E·A·R Three-Nine-Five Amplifier

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The amplifier has an output stage of two EL34 valves operated under distributed load conditions, giving high power handling capacity with low distortion. The output transformer uses the latest type of grain oriented steel, and has been specially designed to realise the high potentialities and exacting specification of the amplifier. Negative feedback is applied overall, the high value of which, combined with the low inherent output impedance of the output stage, gives at 20 watts output on a 15 ohm load a measured output impedance of 0.8 ohm. This corresponds to a damping factor of approximately 50.

#### CONTROL UNIT

The Control Unit has five controls; input selector, volume, bass and treble, and a filter switch. Two positions only are provided on the input for record playback, the one for I.P. being based on R.I.A.A. and the one for standard on the suggested E.M.I. characteristic. The majority of record manufacturers are recording normally to the R.I.A.A. characteristic and those remaining are sufficiently close to make it possible to compensate for the difference by the judicious use of the wide range tone controls available. The filter switch has three positions: 5 kc/s., 10 kc/s., and 20 kc/s.



E·A·R Six-Ten-P  
23 gns.



The Six-Ten-P shown here features a 10-watt amplifier with very low distortion (less than 0.2% total harmonics), together with a separate control unit enabling all types of pickups to be used, including low sensitivity variable reluctance heads.

The control unit, developed by E·A·R, employs two of the latest low-noise pentodes (EF86) with negative feedback loops. The wide range tone controls are fully adequate to compensate for any variation in acoustic conditions. 23 gns.

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#### SIX-TEN

POWER OUTPUT: 10 watts min.  
14 watts max. (approx.)  
HARMONIC DISTORTION:  
Less than 0.3% at 10 watts 400 c/s.

19 gns.

#### FIVE-TEN

POWER OUTPUT: 10 watts min.  
14 watts max. (approx.)  
HARMONIC DISTORTION:  
Less than 0.3% at 10 watts 400 c/s.

18 gns.

#### SEVEN-FIFTY

POWER OUTPUT: 4 watts.  
Comprises the amplifier section of the famous E·A·R A750 Record Reproducer.

9 gns.

Produced by the makers of E·A·R Gramophones

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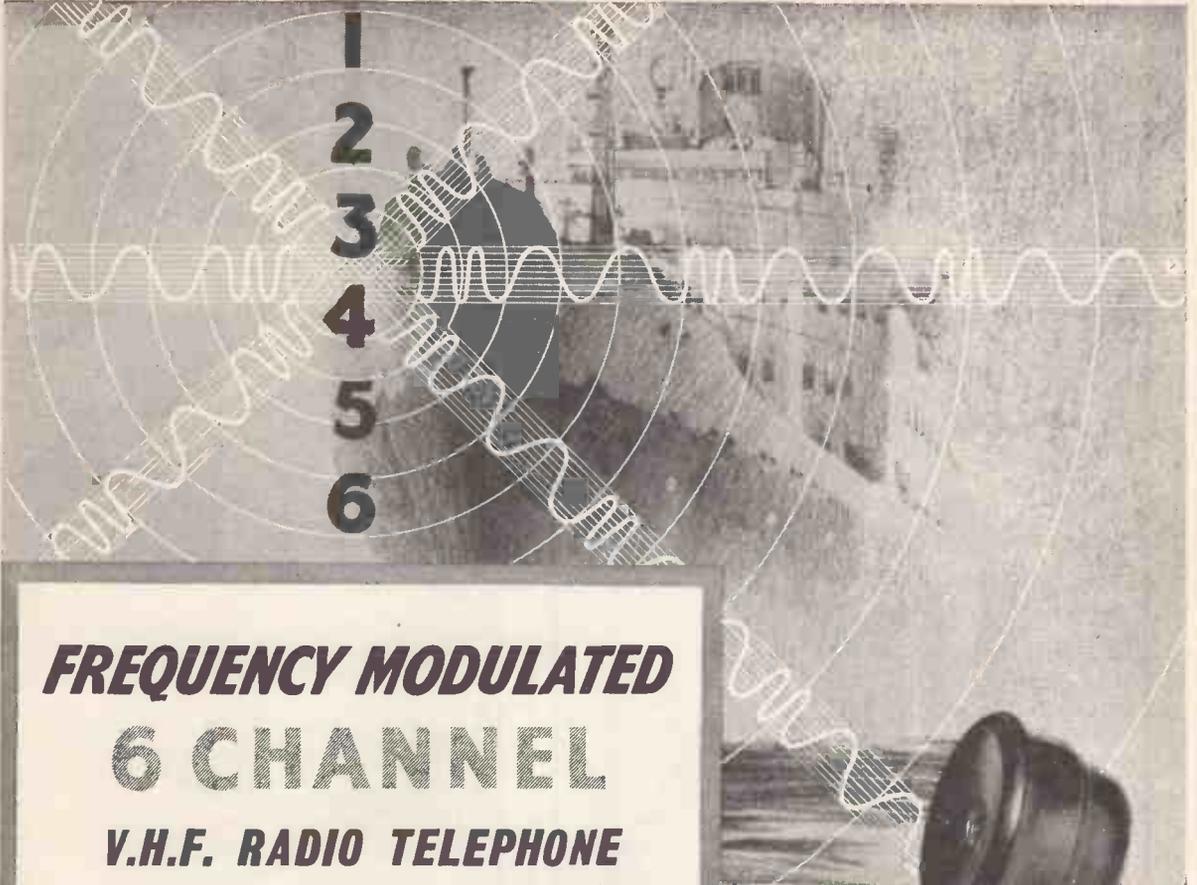
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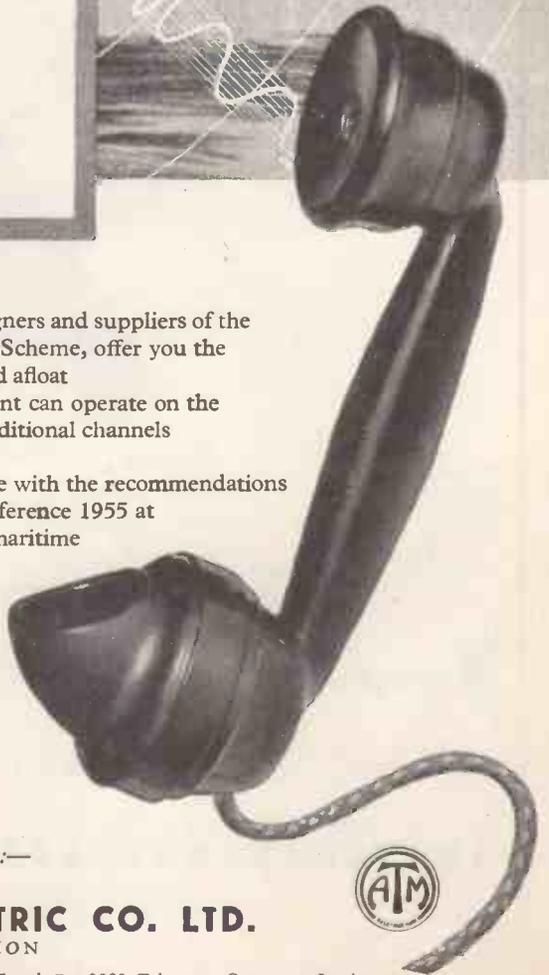
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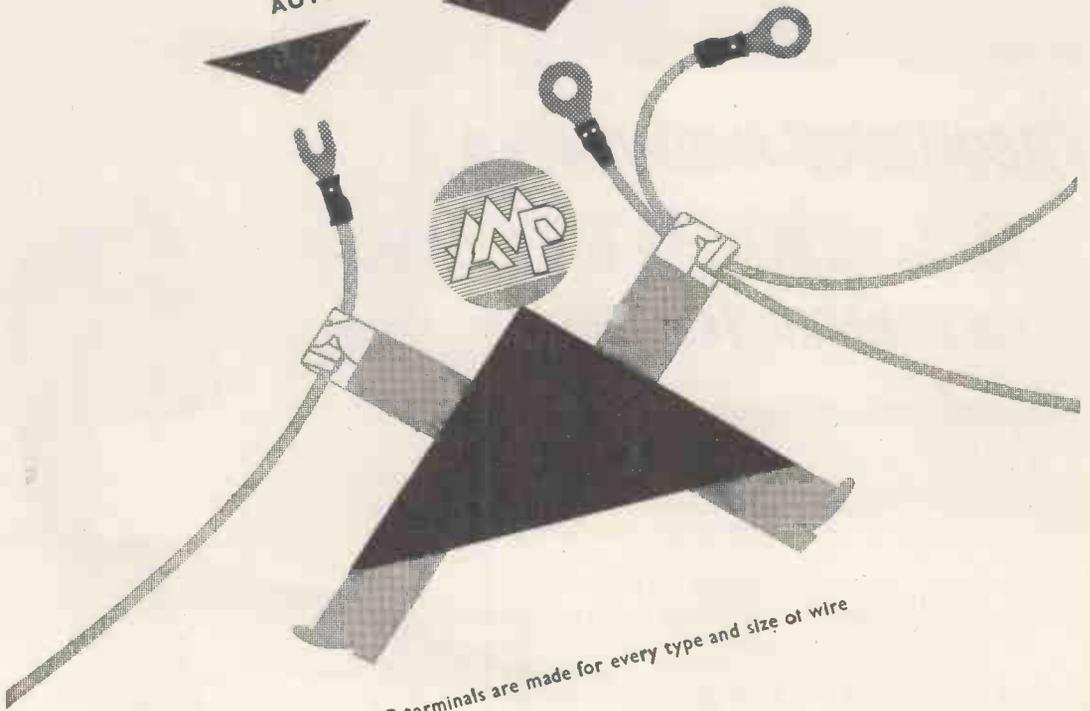
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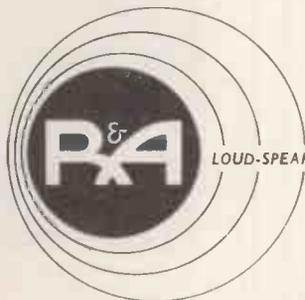
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stampede  
of wild  
elephants ?**



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ENGLAND

# LOCKWOOD



VISION CONTROL DESK  
B.B.C. TELEVISION SERVICE LIME GROVE.

Constructed by **LOCKWOOD** and Designed in  
Conjunction with the B.B.C. Planning & Installation  
Dept.

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THE BRITISH BROADCASTING CORPORATION

AND

## THE LOCKWOOD

*Standard Loudspeaker Cabinet*

ACCEPTED AS A STANDARD FOR HIGH QUALITY REPRODUCTION  
BY BROADCASTING, TELEVISION AND RECORDING STUDIOS

AS RECENTLY DEMONSTRATED AT THE  
**LONDON AUDIO FAIR**

WITH

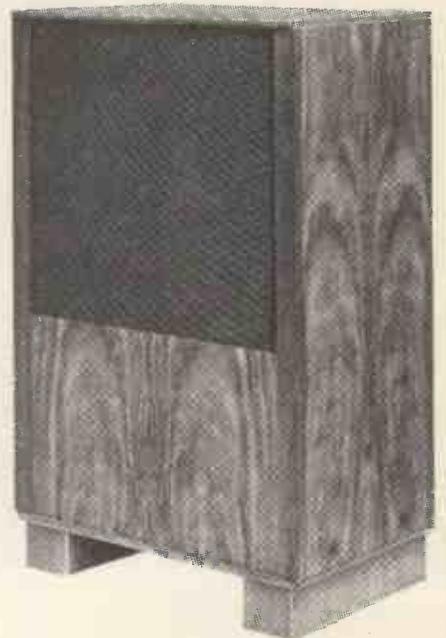
THE **PLESSEY** IONOPHONE

THE PLESSEY CO. LTD. ILFORD, ESSEX

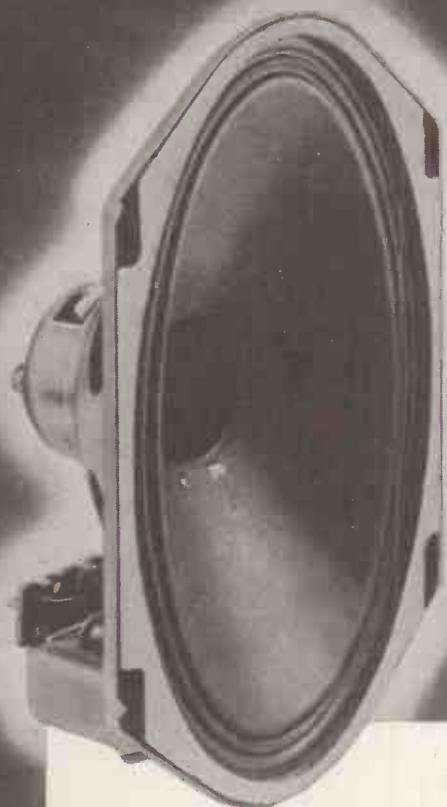
AND

THE **KELLY** RIBBON SPEAKER

THERMIONIC PRODUCTS LTD. SOUTHAMPTON



**LOCKWOOD & CO. (WOODWORKERS) LTD. LOWLANDS ROAD, HARROW, MDX.**



*Announcing*

The first of the Elac  
**“ELMAG”**

*Series of  
 High Fidelity Units*

**9 x 5 Elliptical Speaker  
 Type 59T.**

This unit is designed to give good quality at domestic volumes, it can be operated successfully in conjunction with a normally good receiver.

Where a Power Amplifier of the Mullard 510 or similar type is contemplated 4 units are recommended. Suggestions for cabinet designs are available on application.

Flux Density, 8000 gauss (27,500 Maxwells) Frequency  
 Response 40-12,000 Cps.

**RETAIL PRICE.....38/2 inc. Tax**  
**With Transformer .....49/4 inc. Tax**

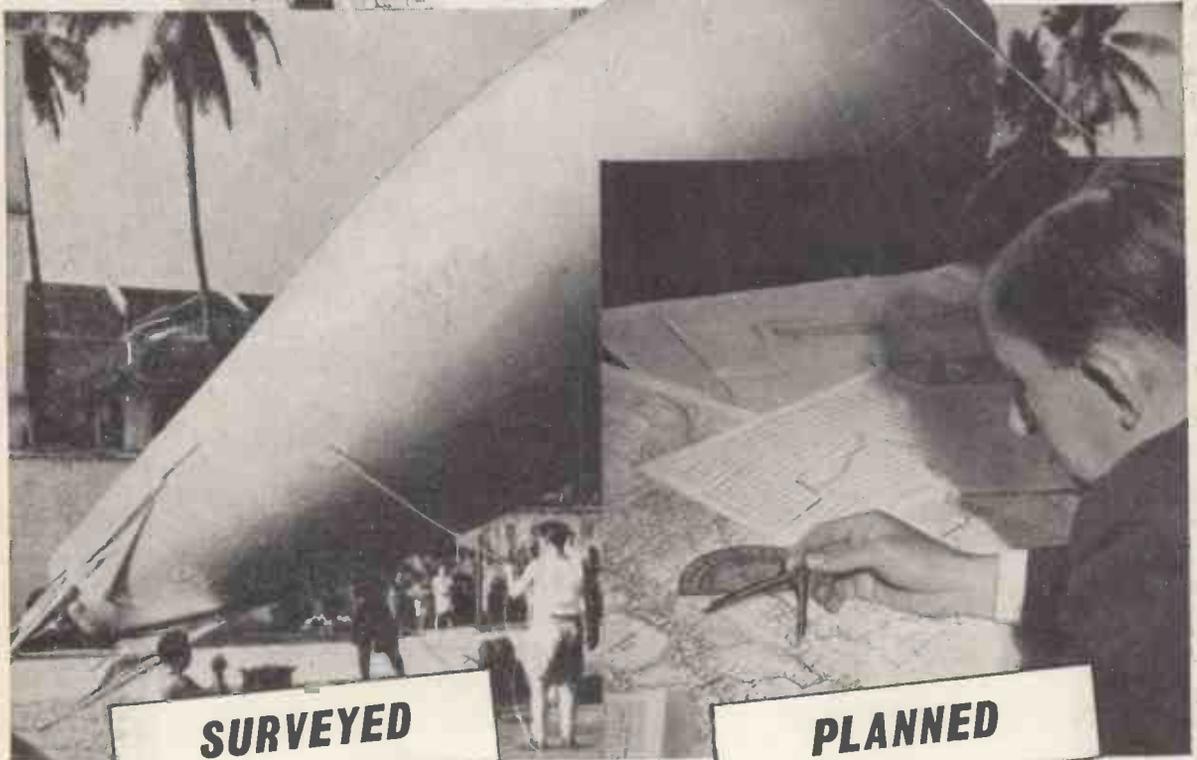


**ELECTRO ACOUSTIC INDUSTRIES LTD**

STAMFORD WORKS. BROAD LANE. TOTTENHAM. N.15 TEL: TOTTENHAM 0505-9



# MARCONI



**SURVEYED**

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## V. H. F. MULTI-CHANNEL SYSTEMS

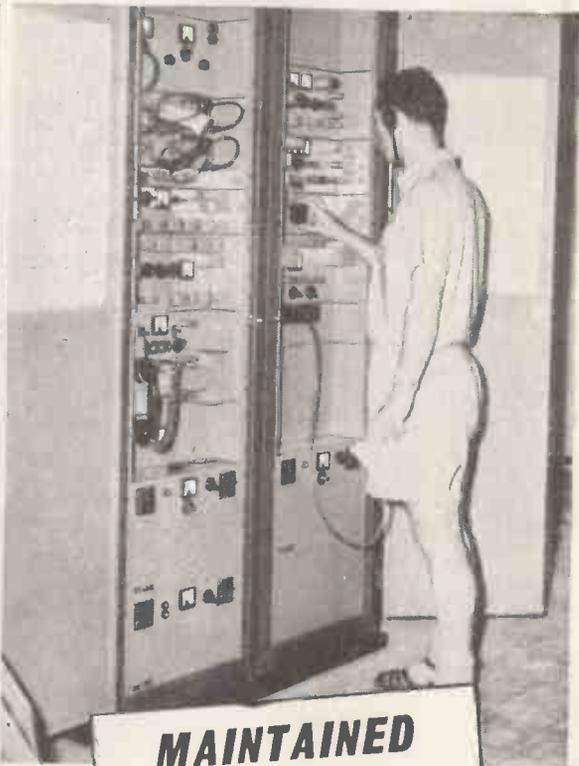
VHF radio-telephony was welcomed in its early days as an economic means of providing communication over terrain where the cost and difficulty of erecting line or cable routes was prohibitive. Today Marconi's have developed multi-channel systems

which, by employing frequency modulation to widen the bands, provide up to 48 telephone channels and are recognised as being preferable to line systems in many instances on grounds of performance as well as installation cost.

# COMPLETE COMMUNICATION SYSTEMS — *all the world over*



**INSTALLED**



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*Over 80 countries now have Marconi-equipped communication systems. Many of these are still giving trouble-free service after more than 20 years in operation.*

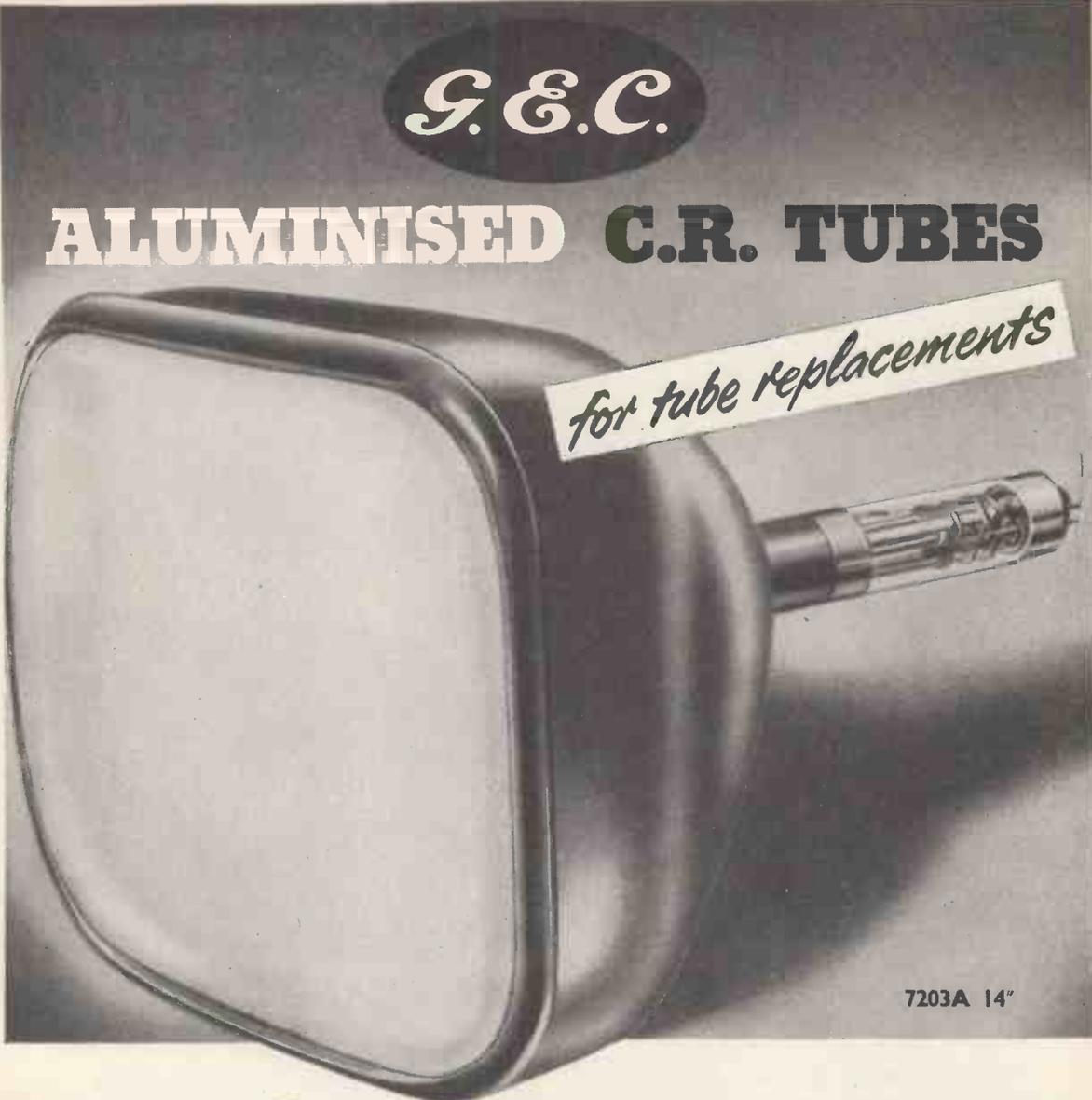


The lifeline of communication  
is in experienced hands

# MARCONI

**Complete Communication Systems**

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX.



**G.E.C.**

## ALUMINISED C.R. TUBES

*for tube replacements*

7203A 14"

The G.E.C. 14 in. Cathode Ray Tube type 7203A has the following attractive features:—

1) Improved tube life and reliability.

2) A narrow beam angle *triode* gun giving:—

- (a) Uniform focus over the entire screen area.
- (b) Small spot size.
- (c) Freedom from astigmatism.

3) A high reflectance aluminium backing to the fluorescent screen giving:—

- (a) 70% increase in picture brightness.
- (b) High contrast daylight viewing.
- (c) Complete elimination of ion burn from both positive and negative ions.

Price £14 . 15 . 0

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# So much depends

Soldering operations are not notably glamorous — but how much depends on the efficiency and economy with which they are carried out! Always the quality and dependability of your own products. Often, in the long run, the difference between profit and loss.

By relying on ENTHOVEN for all your soldering requirements you are banking on the best known name in the industry — a name that represents nearly 150 years experience in non-ferrous metals and a proud record of achievement in research and development.



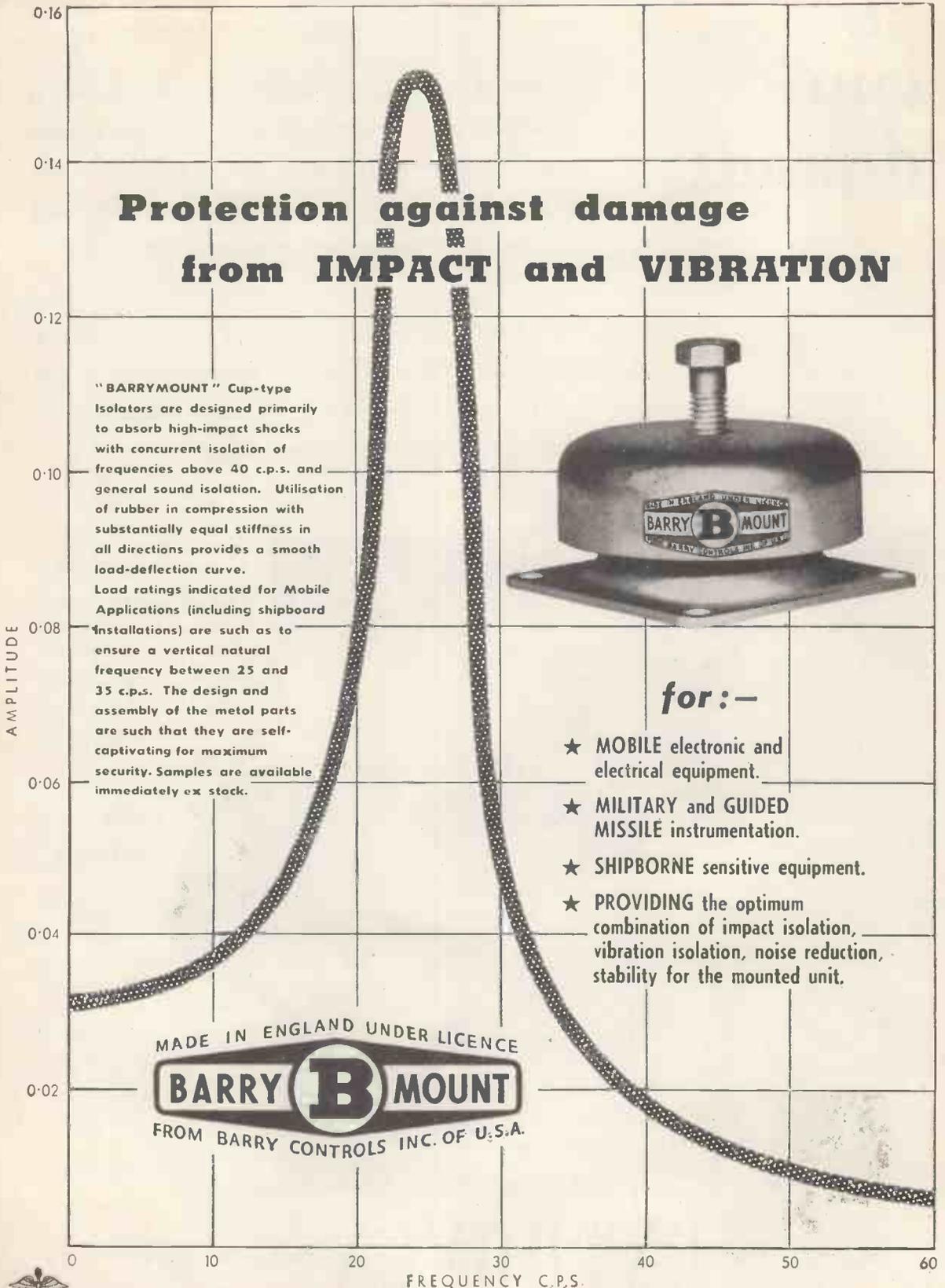
There is an ENTHOVEN SOLDER PRODUCT for every engineering and manufacturing requirement. Please write today for our newly revised Brochure or consult us quite freely on your particular problems.

## \* main contents

Flux Cored Wires.  
"Entocene"  
Solder Paints. Soft Solders in Sticks, Ingots, Sheet, and Wire.  
Soldering Fluxes. Cored and Solid Solder Pre-forms. Tin, Lead, and Solder Powders.  
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Low Melting Point and High Temperature Service Solders.

# ENTHOVEN SOLDER PRODUCTS

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# Protection against damage from IMPACT and VIBRATION

"BARRYMOUNT" Cup-type Isolators are designed primarily to absorb high-impact shocks with concurrent isolation of frequencies above 40 c.p.s. and general sound isolation. Utilisation of rubber in compression with substantially equal stiffness in all directions provides a smooth load-deflection curve. Load ratings indicated for Mobile Applications (including shipboard installations) are such as to ensure a vertical natural frequency between 25 and 35 c.p.s. The design and assembly of the metal parts are such that they are self-captivating for maximum security. Samples are available immediately ex stock.



for:—

- ★ MOBILE electronic and electrical equipment.
- ★ MILITARY and GUIDED MISSILE instrumentation.
- ★ SHIPBORNE sensitive equipment.
- ★ PROVIDING the optimum combination of impact isolation, vibration isolation, noise reduction, stability for the mounted unit.

MADE IN ENGLAND UNDER LICENCE  
**BARRY B MOUNT**  
 FROM BARRY CONTROLS INC. OF U.S.A.



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**CEMENTATION (MUFFELITE) LTD., 39 VICTORIA STREET, LONDON, S.W.1**

# PHYSICAL SOCIETY 1956

Cinema-Television Limited announce the first demonstrations of four new instruments which will be given at the above exhibition.

## HIGH SPEED OSCILLOSCOPE

*Employing a new 5" diameter 'Cintel' tube this oscilloscope is designed for repetitive and single shot pulse examination and has a frequency response extending to 500Mc/s. Sensitivity 50V/inch. Maximum writing speed 50 inches/ $\mu$ sec.*

## DECIMICROSECOND CHRONOMETER

*A high speed chronometer for measuring time in the range 0.125 $\mu$ sec to 1 $\mu$ sec in steps of 0.125 $\mu$ sec. Indication of the measurement is given on seven panel mounted meters in decimal notation.*

## ELECTRONIC PHOTOGRAPHIC PRINTER

*Designed to provide uniform contrast contact prints from variable density negatives without loss of information.*

## SIGNAL TRACER

*A multi-purpose instrument designed on the well known 'Grid Dip' principle.*

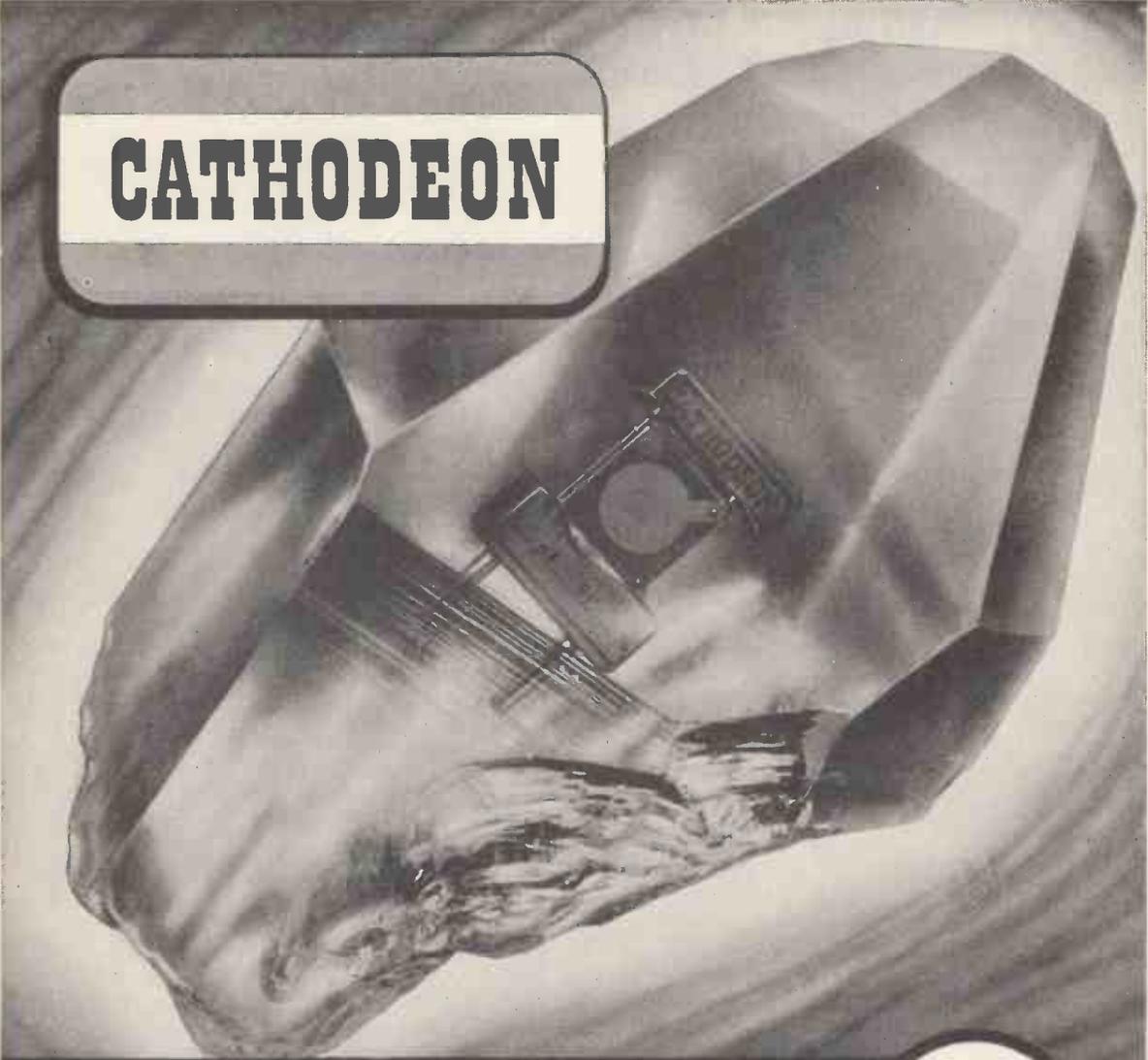
The following will also be demonstrated:

Miniature Multi-channel Recording Equipment.  
Flying-Spot Microscope with Counter.  
Automatic Frequency Monitor 20Mc/s,  
and a range of specialized Cathode Ray Tubes.

**CINEMA TELEVISION LTD**

A COMPANY WITHIN THE RANK ORGANISATION LIMITED

WORSLEY BRIDGE ROAD · LONDON · S.E.26  
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**CATHODEON**

# Quartz Crystals

**FOR  
RELIABLE  
FREQUENCY  
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*Frequency Range, 2,000—20,000 kc/s*

*Our range now includes crystals for close tolerance requirements*

ENQUIRIES ARE INVITED FOR OVERTONES UP TO 60 MC/S.

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Key-in  
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## FLEXIBLE REMOTE CONTROL OUTFITS

Our experience in the industrial field has indicated that there is a definite need for this type of outfit offering facilities for making prototype flexible remote controls as required.

The two gauges of Remote Control flexible shafts in these outfits cover the range of torque loadings required for • volume controls • all types of wave change switches • condensers • all controls likely to be met in electronic, radio and television equipment.

The outfits are reasonably priced and comprise:

- No. 130 (.130 in. dia.) for remote controls up to 4 n. length.....£7. 0.0
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(For use without flexible casing)



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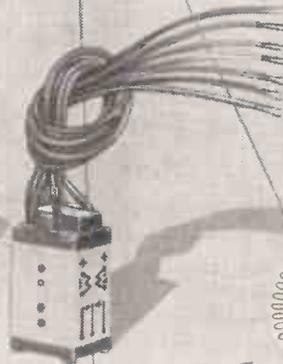
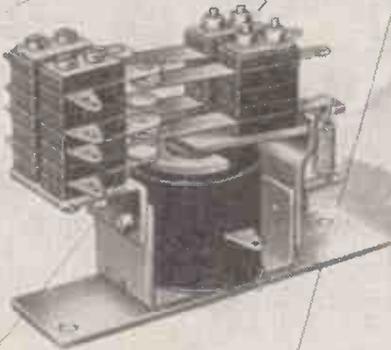
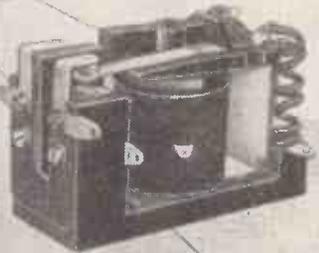
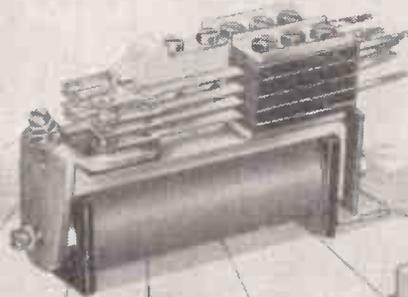
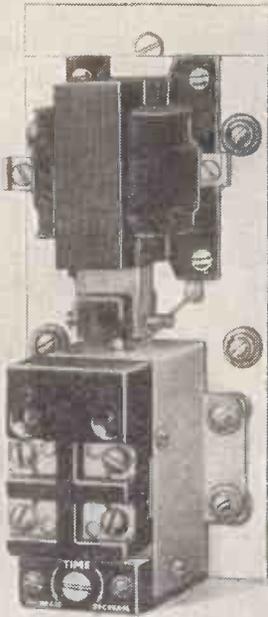
The S. S. White Company will be pleased to advise which Outfit is most suitable for specific applications.

A detailed Parts List is available upon request.

# Precision Relays

*An extensive range  
of standard types  
always available  
for prompt delivery*

**SPECIAL TYPES  
DESIGNED TO SUIT  
YOUR NEEDS**



*—THE WORLD-RENOWNED SPECIALIST DESIGNERS  
AND MANUFACTURERS OF ALL TYPES OF RELAYS*

***Now FREE to all!***

**THE E-M TECHNICAL ADVISORY SERVICE**

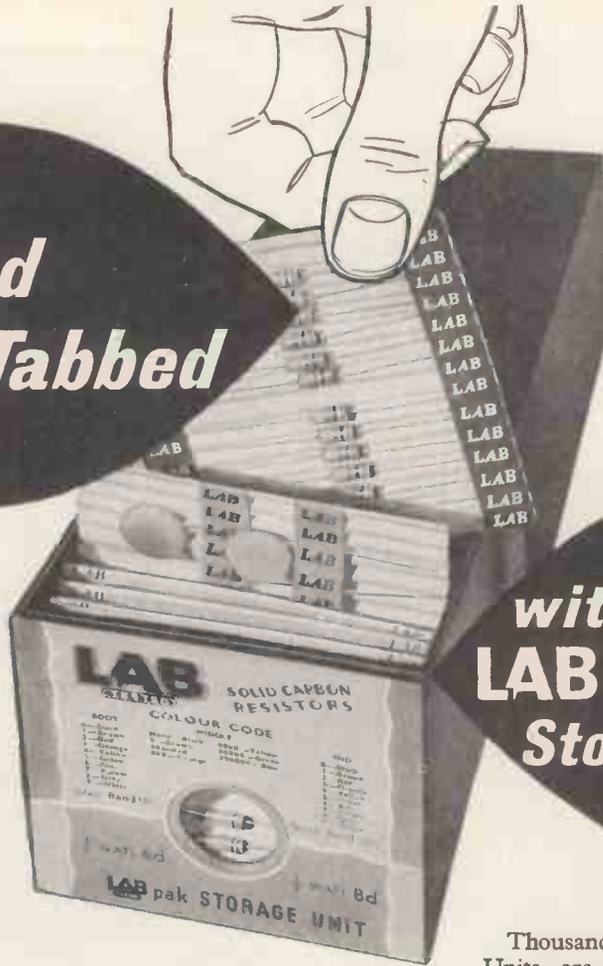
Regardless of whether your relay problem is simple or complex, the fact remains that the only reliable solution is that which entirely eliminates risk.

We therefore respectfully invite you to avail yourself of the wide resources of technical knowledge and practical experience possessed by the specialist technicians of our Relay Division.

**Full technical data  
and illustrated leaflets  
promptly forwarded  
on request!**

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**with  
LAB Continuous  
Storage Units**

REF.	WATTS	MAX. VOLTS	OHMS	MIN. ORDER FOR FREE UNIT	UNIT STORAGE CAPACITY
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**RESISTORS**

T	½	250	10 to 10M	240	720
R	1	500	10 to 10M	180	500

Tolerances available ±20% 10% 5%

**HIGH STABILITY RESISTORS**

HS3	½	750	1 to 500M	93	500
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Tolerances available ±5% 2% 1%

**WIREWOUND RESISTORS**

LM	5 & 10	—	5 to 100K	72	300
LP	5 & 10	—	5 to 100K	72	300

**CERAMICAPS**

CER	Tubular	500	3 to 470pf	141	500
HK	Tubular	500	470 to 5000pf	141	500
HKD	Disc	500	470 to 5000pf	141	500

Tolerances available ±2% 10%

Thousands of LAB Continuous Storage Units are daily solving the problem of control and storage of the great range of resistors. Compact, and capable of storing up to 720 separate resistors, LABpak make selection positive, simple and speedy. Now that Ceramicaps, Histabs and Wirewound resistors have been added to the carded range the usefulness of LABpak storage units is enhanced.

FREE with any purchase of the LABpak range, these units are the complete answer to the storage problems of small production units, laboratories, etc.

**MAKE UP YOUR ORDER TODAY — DELIVERY EX-STOCK**

All LABpak resistors are carded in ohmic value, rating and tolerance, colour indexed and tabbed for easy selection.

The LAB Continuous Storage Units are available from your normal source of supply, but more detailed information and literature can be obtained from

**THE RADIO RESISTOR COMPANY LIMITED**

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from every  
point of view

"Frequentite" is the most suitable insulating material for all high frequency applications. Seventeen years ago we introduced the first British-made low-loss ceramic, and consultation with us before finalising the design of new components is a wise precaution.

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S.P.77

**for the  
most uniform  
response**

Of all the different bases that are used for magnetic recording tapes, none can match the precise uniformity of cast cellulose acetate. 'Scotch Boy 111', with its cellulose acetate base, offers recordists the most exact uniformity of response that any tape can provide. 'Scotch Boy 111' is the best of all tapes for high-precision recording, whether of voice, instrument, or mechanical sound.

For laboratory experiments that require the utmost uniformity of response 'Scotch Boy 111' is the natural choice: at 1000 c/s its

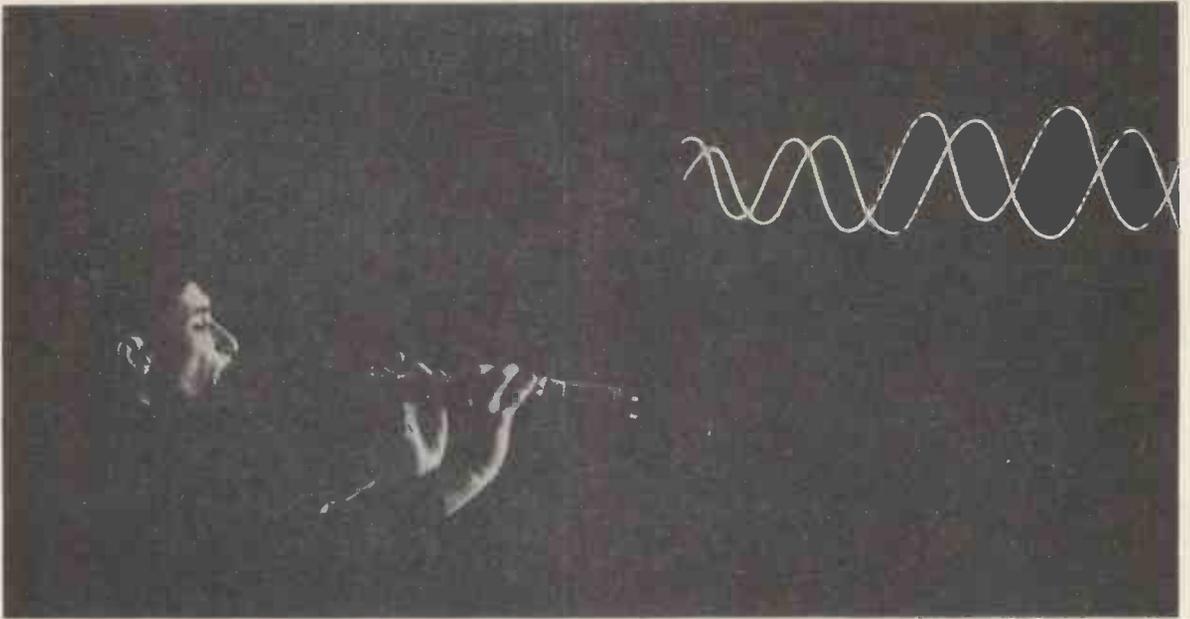


Photo and oscillograph of Cy Laurie playing a characteristically agile embroidery of a phrase from "King of the Zulus".

output variation within each reel is less than  $\pm \frac{1}{4}$  db., and the variation from reel to reel is less than  $\frac{1}{2}$  db. 'Scotch Boy 111' is used by the services for experiments that involve the precise measurement of mechanical and other sounds, and by sound technicians and expert recordists all over the world.

'Scotch Boy 111' is supplied in 1200-ft. lengths on easily-threaded, 7" plastic spools, and also in 600-ft. and 2400-ft. lengths. All these lengths are free from splices.



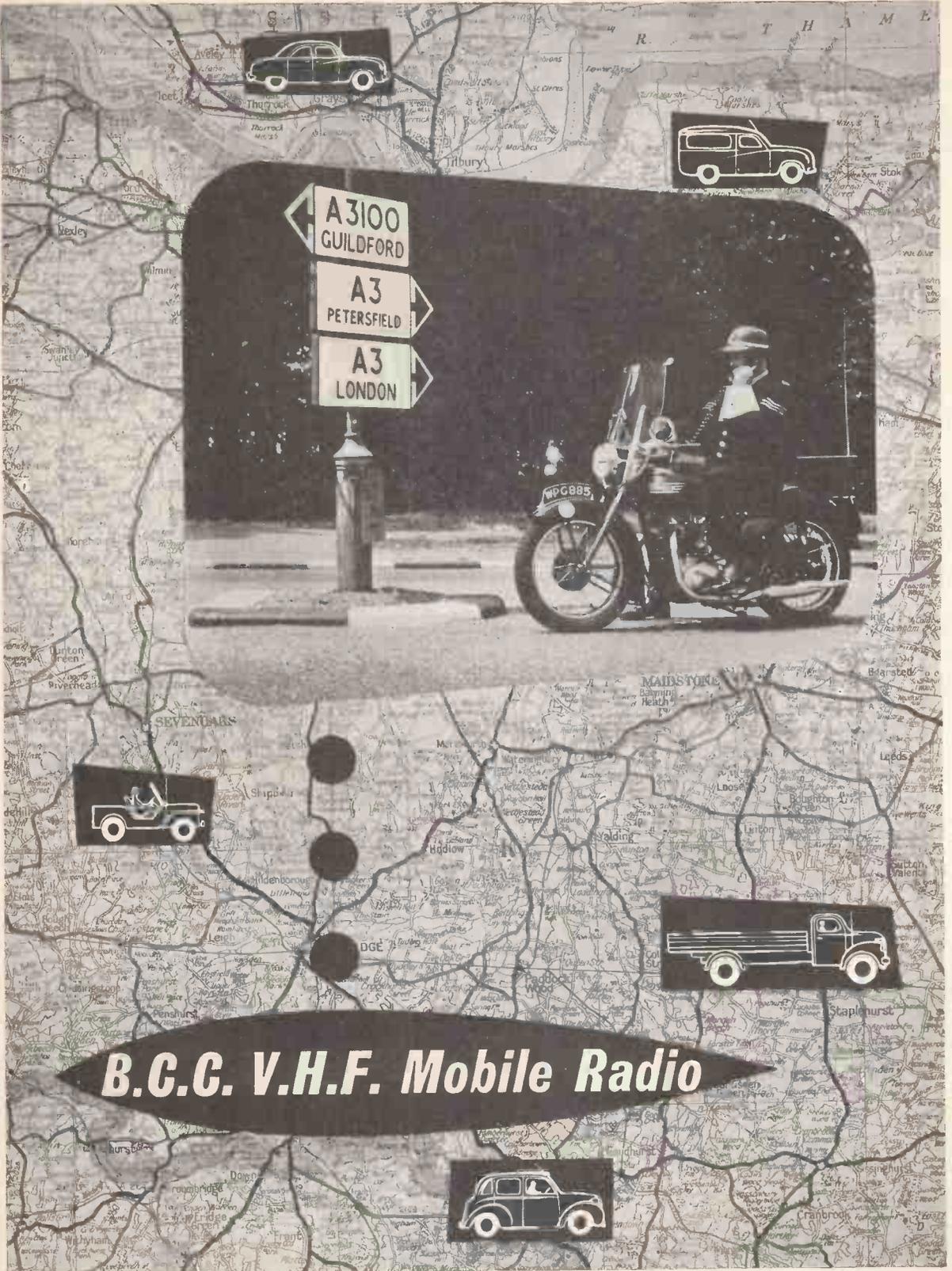
Record on 'Scotch Boy 111'

-the tape with the cellulose acetate base

**'SCOTCH BOY'**  
Regd. Trade Mark

**MAGNETIC RECORDING TAPE**

ANOTHER  PRODUCT



**B.C.C. V.H.F. Mobile Radio**

**BRITISH COMMUNICATIONS CORPORATION LIMITED**

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## INSTRUMENTS

### X-BAND MICROWAVE WATTMETER — TYPE U.181

A feed-through torque vane wattmeter for absolute measurement of power in the wavelength range 3.05 to 3.45 cms. It will measure power in the range 1 to 100W or the equivalent mean of pulsed power. Accuracy between 100 and 10 watts is  $\pm 2\%$  falling to  $\pm 10\%$  at 1 watt. VSWR better than 0.9.

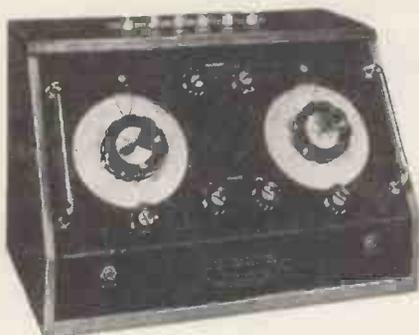
Price £275 net ex works



### R.F. BRIDGE — TYPE B.601 15 Kc/s TO 5 Mc/s

A highly accurate transformer ratio arm bridge for the measurement of capacitance, resistance and inductance within the range 0.01 pF to 0.02  $\mu$ F, 10  $\Omega$  to 10 M  $\Omega$  and 0.5  $\mu$ H to 50 mH. It can be used to measure complex impedances, balanced or unbalanced, or between any pair of terminals in delta formation.

Price £125 net ex works.



### VIDEO OSCILLATOR — TYPE 0.22B

A portable instrument covering the range 10 Kc/s to 10 Mc/s with an output of +10 db to -50 db on 1 volt p. to p. amplitude stabilised to 0.5 db over its full frequency range. It includes a 50 cps. square wave output and facilities for direct reading of the modulus of the load impedance.

Price: Portable £165 net ex works  
Rack mounted £158 net ex works.

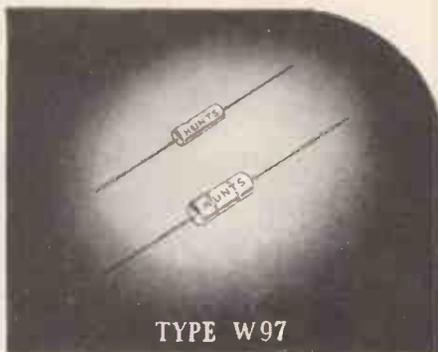


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THE WAYNE KERR LABORATORIES LTD · NEW MALDEN · SURREY · MALDEN 2202

# REVOLUTIONARY

*in design—  
and performance!*



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

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

**TEMPERATURE RANGE: -100°C to +100°C**

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

### CAPACITOR UNIT

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

### CASING

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

### INSULATION OF CASING

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

### TERMINATIONS

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

### INDUCTANCE

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

### INSULATION RESISTANCE

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

### POWER FACTOR

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

### CAPACITANCE TOLERANCE

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

**W97 IS A 'MUST'**

for the

**MAKERS OF ELECTRONIC EQUIPMENT**

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

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

### TYPE W97 STANDARD RANGE

LIST NO.	CAP µF.	DIMENSIONS (inches)	
		L.	D.
200 volts D.C.			
BM7	0.002	0.610	0.135
BM8	0.004	0.610	0.135
BM11	0.004	0.500	0.180
BM9	0.005	0.610	0.135
BM12	0.005	0.500	0.180
BM13	0.01	0.500	0.180
BM14	0.02	0.610	0.180
BM15	0.03	0.610	0.260
BM16	0.04	0.610	0.260

LIST NO.	CAP µF.	DIMENSIONS (inches)	
		L.	D.
400 volts D.C.			
BM4	0.0004	0.610	0.135
BM5	0.0005	0.610	0.135
BM6	0.001	0.610	0.135
BM18	0.002	0.500	0.180
BM19	0.003	0.500	0.180
BM20	0.005	0.610	0.180
BM21	0.01	0.610	0.260

LIST NO.	CAP µF.	DIMENSIONS (inches)	
		L.	D.
600 volts D.C.			
BM25	50 pF.	0.500	0.180
BM1	0.0001	0.610	0.135
BM26	0.0001	0.500	0.180
BM2	0.0002	0.610	0.135
BM27	0.0002	0.500	0.180
BM28	0.00022	0.500	0.180
BM29	0.00025	0.500	0.180
BM3	0.0003	0.610	0.135
BM30	0.0003	0.500	0.180
BM36	0.0004	0.500	0.180
BM31	0.0005	0.500	0.180
BM32	0.001	0.500	0.180
BM33	0.002	0.610	0.260
BM34	0.003	0.610	0.260
BM35	0.004	0.610	0.260

LIST NO.	CAP µF.	DIMENSIONS (inches)	
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600 volts D.C.			
BM25	50 pF.	0.500	0.180
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BM26	0.0001	0.500	0.180
BM2	0.0002	0.610	0.135
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BM36	0.0004	0.500	0.180
BM31	0.0005	0.500	0.180
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BM36	0.0004	0.500	0.180
BM31	0.0005	0.500	0.180
BM32	0.001	0.500	0.180
BM33	0.002	0.610	0.260
BM34	0.003	0.610	0.260
BM35	0.004	0.610	0.260

LIST NO.	CAP µF.	DIMENSIONS (inches)	
		L.	D.
600 volts D.C.			
BM25	50 pF.	0.500	0.180
BM1	0.0001	0.610	0.135
BM26	0.0001	0.500	0.180
BM2	0.0002	0.610	0.135
BM27	0.0002	0.500	0.180
BM28	0.00022	0.500	0.180
BM29	0.00025	0.500	0.180
BM3	0.0003	0.610	0.135
BM30	0.0003	0.500	0.180
BM36	0.0004	0.500	0.180
BM31	0.0005	0.500	0.180
BM32	0.001	0.500	0.180
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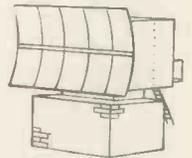
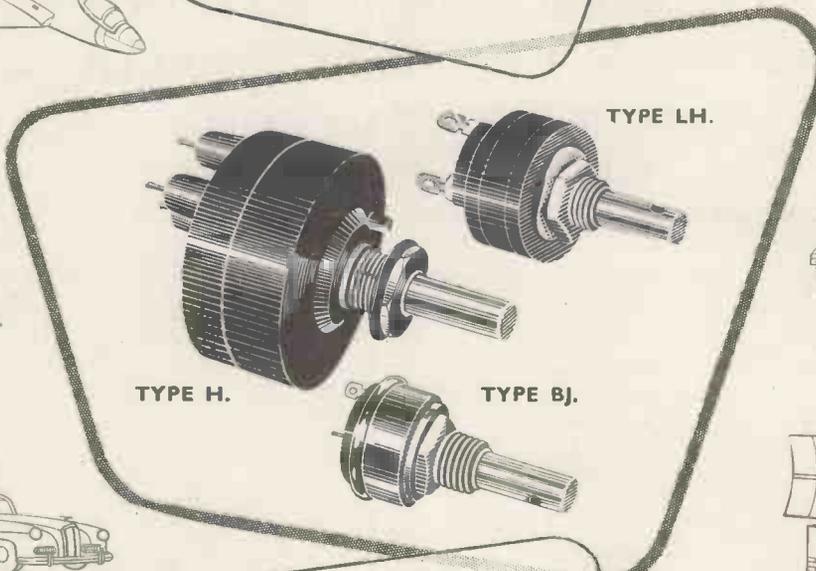
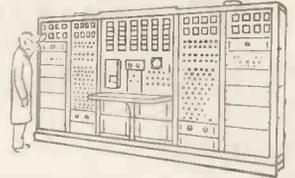
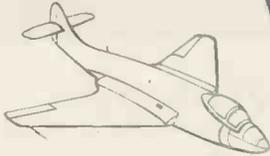
LIST NO.	CAP µF.	DIMENSIONS (inches)	
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BM1	0.0001	0.610	0.135
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BM29	0.00025	0.500	0.180
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BM29	0.00025	0.500	0.180
BM3	0.0003	0.610	0.135
BM30	0.0003	0.500	0.180
BM36	0.0004	0.500	0.18

# MORGANITE CARBON POTENTIOMETERS

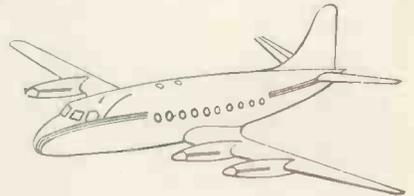
for the Services and all professional equipment applications



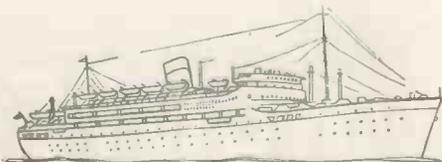
**TYPE H.** 1½ watts — sealed. The most reliable potentiometer for Services and special requirements. Approved to RCL 122.

**TYPE LH.** ¼ watt — sealed. For special applications. Approved to RCL 122. Can be supplied with or without locating peg ring.

**TYPE BJ.** 1/10 watt — sealed. Ideal for all miniature applications — used on airborne radar and wherever size and weight are important factors.



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

We are now specialising in the supply of units for making up high-fidelity Radio and Record-reproducing Equipment for use in the Home, small Halls, Schools and Gramophone Societies and single items for replacing in existing equipments and radiograms.

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**STUDIO AND DECCA "SYMPHONY" AMPLIFIERS.** As above but with built-in pre-stages to precisely match these pickups 2 gns. extra.

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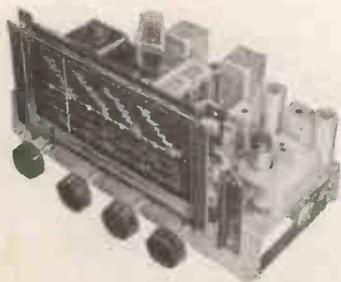
**No. 1 "SYMPHONY" T.R.F. TUNER** £7/15/-.

**No. 2 "SYMPHONY" SUPERHET TUNER** £12/2/-.

**No. 2 SUPERHET TUNER WITH VARIABLE SELECTIVITY,** £14/15/-.

**No. 1 "SYMPHONY" FM TUNER.** High grade instrument with extremely silent background £15.8.0. Power Pack £3.7.6.

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**BURNE-JONES (B.J.) PICKUP ARM.** Revolutionary new type to eliminate tracking errors, takes 3-pin heads such as Decca XMS and new type ACOS HGP55 hi-fi heads directly. Price £3/3/-.

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If any reader should have his mind set on a high-priced amplifier of another make and would like to save money if possible, we should like to make the following clear-cut offer: If he buys one of our "Symphony" Model Amplifiers (Standard, Decca or Studio version) and is not entirely satisfied with it he may return it for full credit against any other amplifier or tuner on the market. It should be emphasised at this stage that as Retailers we can supply any Amplifier, Radio Tuner, etc. advertised.

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### Station T.V. Tuner

These coils have been specially wound for use in the "View Master" T.C.C. Printed Circuit Commercial Television Converter, as described in the January, February and March 1956 Issues of "Practical Television." The packet contains Coils, Iron Dust Slugs, Screening Can and Screws.

PRICE 30/-

Switch, Fine Tuner, Coil Mounting Plates and Tag Panel for the 3 Station Tuner. PRICE 27/-

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Stop Press: "MAXI-Q" F.M. TUNER UNIT assembled and valved at £9/19/6 inc. Power Pack at £3.

"OSRAM" F.M. TUNER completely assembled and valved at £30/16/- inc.

**MULLARD AMPLIFIERS PRICE AND DETAIL REVISION**  
Due to recent introductions and modifications we are standardising on one chassis for the "5-10" "5-10A" and "5-10B" which includes the front control holes and an additional valvoholder hole, thus the alternative valvoholder hole can be used as required and the front control holes either used or not. The internal screen is provided as a long type but there are additional holes to enable the constructor to shorten the screen and assemble for the "B" version.

"5-10" Front Panel, Gold finished with control markings 6/6

Common Chassis, Base Plate and Screen for the "5-10," "5-10A" and "5-10B" 19/6

Type "A" Pre-Amplifier Chassis and Front Panel (unprinted in 16 swg Aluminium) 8/6

Type "B" Pre-Amplifier Chassis and Front Panel (unprinted in 16 swg Aluminium) 12/6

Complete metalwork for use with the T.C.C. Printed Circuit... 10/-

Mullard F.M. Tuner Chassis, completely punched 12/6

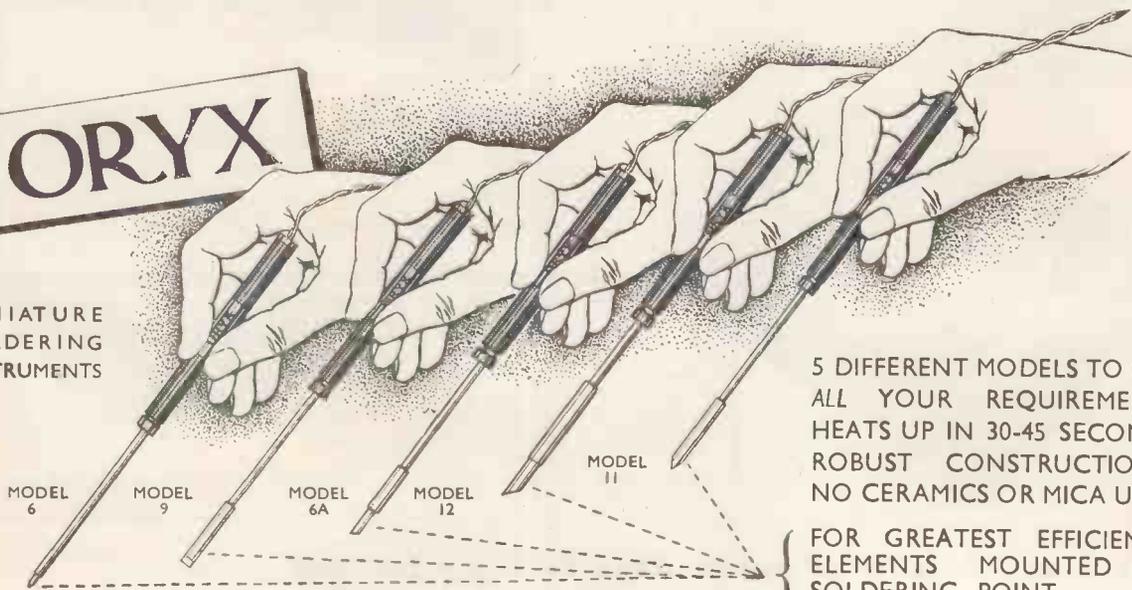
Base Plate for above 4/-

NOTE: Transformer holes in all chassis are not drilled due to the various types obtainable.

The chassis for the Mullard 3 Watt and 20 Watt Amplifiers are executed under our special home constructor chassis service only. Material is in either 16 swg Bright Aluminium or Matt Black 19 swg Steel at 1d. per square inch—plus 3d. per bend—plus 2d. per round hole—plus 2/- per shaped hole—plus 1/- postage.



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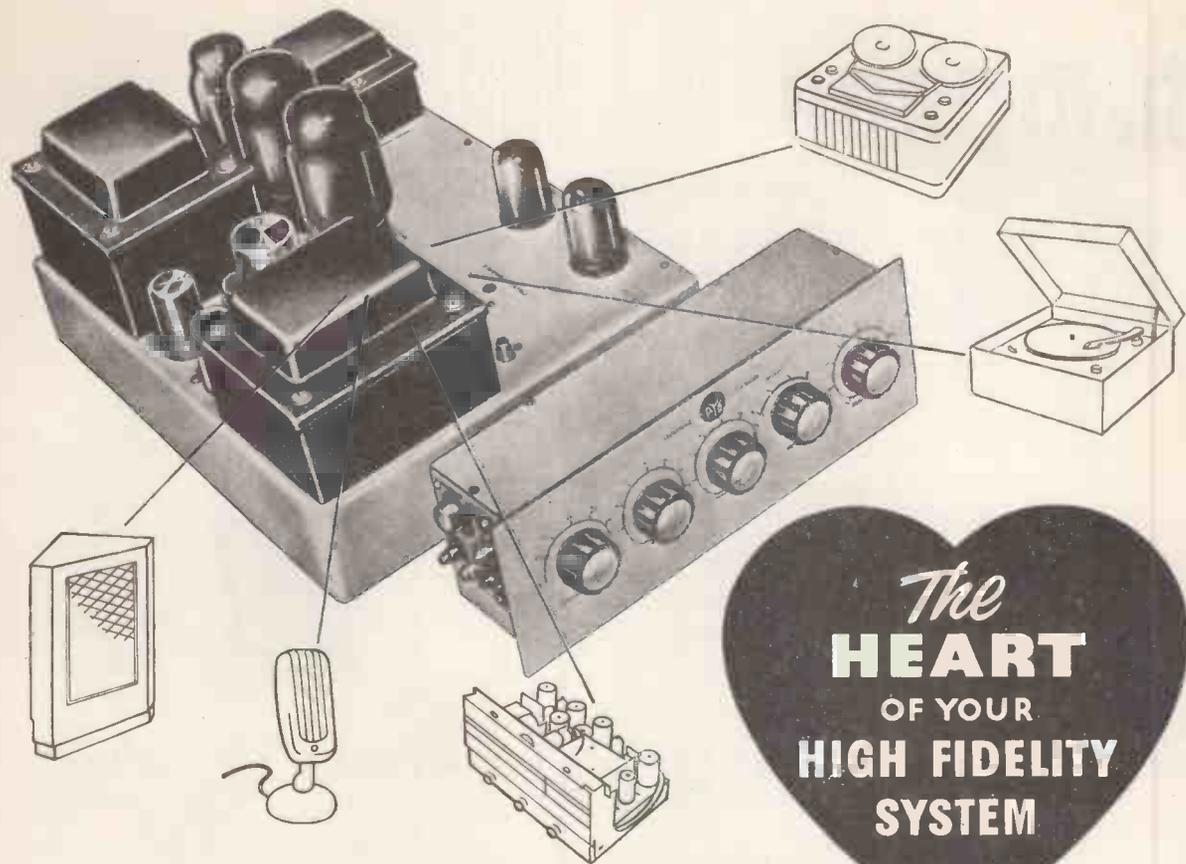
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11*	10 watts	6 only	5/32" (4 mm)	0.5 oz.	6"	35/-	7/6
9	8.3 watts	6, 12 & 24	5/32" (4 mm)	0.25 oz.	6"	25/-	1/8
6A	6 watts	6 only	3/32" (2.4 mm)	0.25 oz.	6"	25/-	1/8
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\* Model 11—Special High Temperature Model.



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- ★ PLUG-IN PICKUP COMPENSATORS

PRICE  
**40 GNS**  
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**Provost POWER AMPLIFIER . . . . HF25**  
**Proctor REMOTE CONTROL UNIT HF25A**

POWER AMPLIFIER	REMOTE CONTROL UNIT
<p>26 db. negative feedback and an output from 2-160,000 c.p.s.</p> <ul style="list-style-type: none"> <li>● A combination of negative and positive feedback raises the damping factor of the amplifier to infinity, thereby ensuring full control of loud-speaker speech coil movement.</li> <li>● Output transformer specially designed to meet exacting specification of amplifier</li> <li>● Amplifier can be controlled from distances up to 20 ft (6m). Cathode follower output from remote control unit minimises cable losses.</li> </ul>	<p>Smooth, highly flexible controls and facilities for record player, tape recorder, microphone and radio tuner inputs</p> <ul style="list-style-type: none"> <li>● 5 types of plug-in compensators available to match all known types of pick-up</li> <li>● Four switched inputs and a choice of four record replay characteristics for U.S. COL. L.P., R.I.A.A. or EUR. L.P., U.S. 78, or EUR 78</li> <li>● Continuously variable lift and cut controls for bass and treble with clearly marked level positions</li> <li>● Treble filter control gives three sharp cut-off frequencies and an unrestricted response position.</li> </ul>

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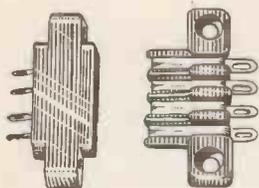
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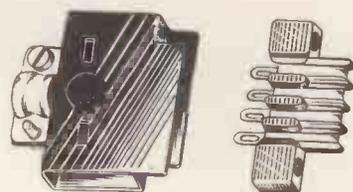
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- Voltage rating                      750 Volts working

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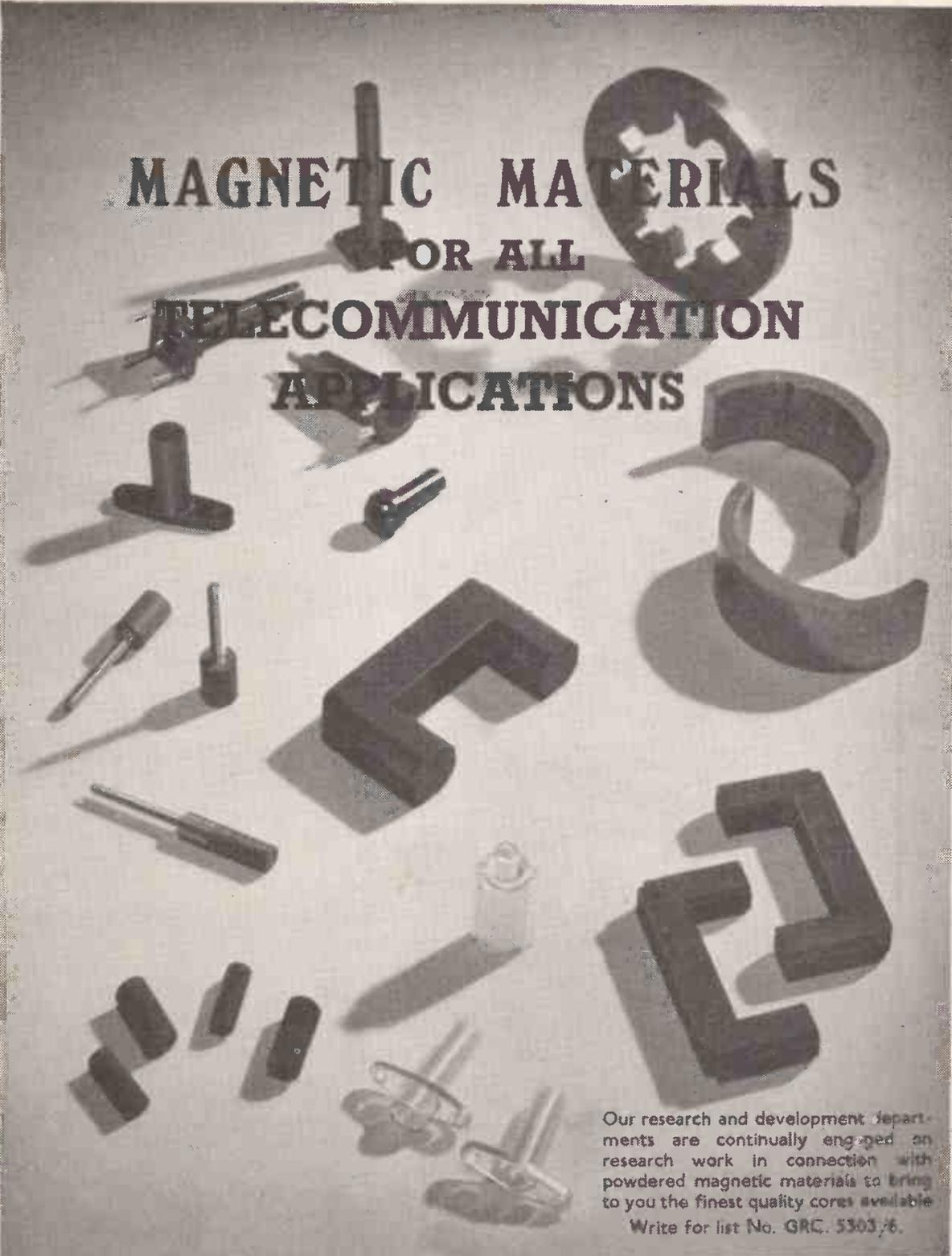
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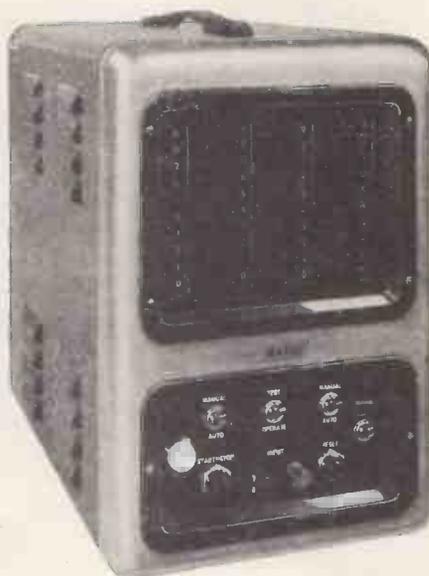
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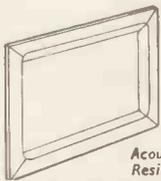
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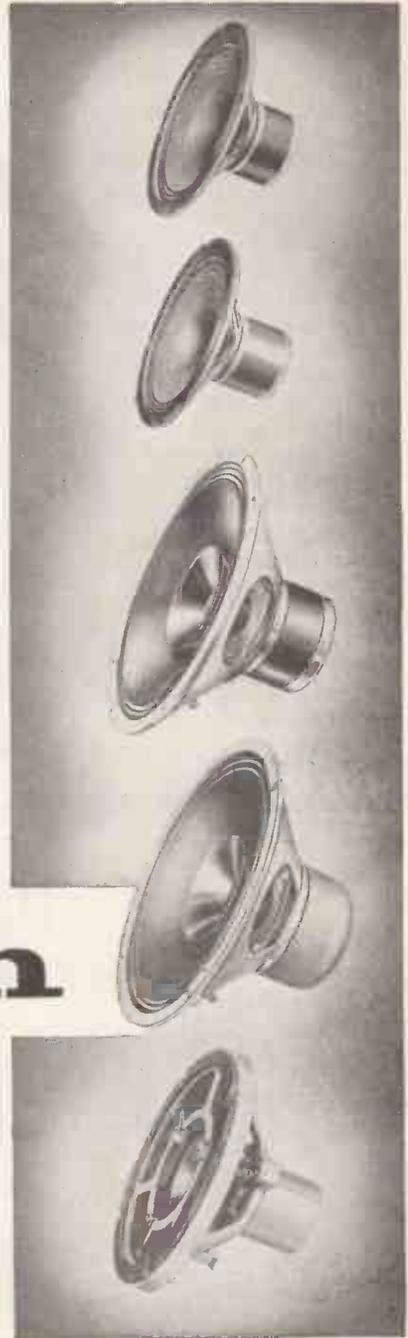
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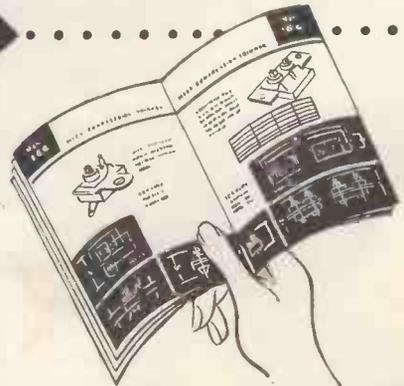
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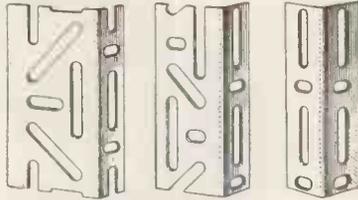
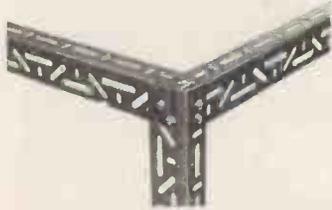
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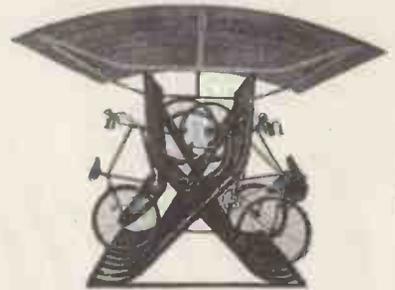
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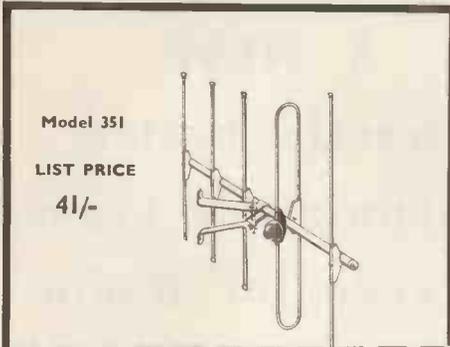
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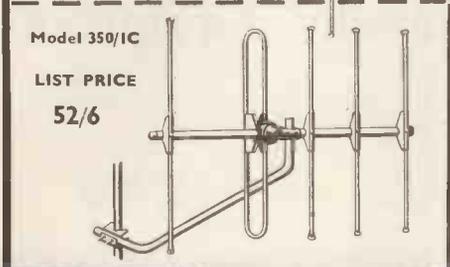
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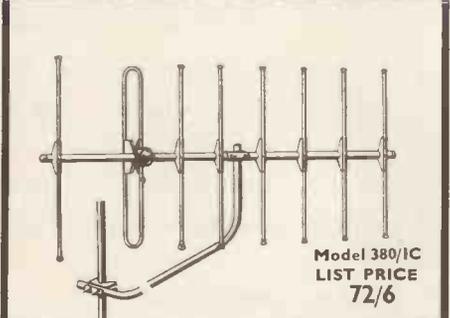
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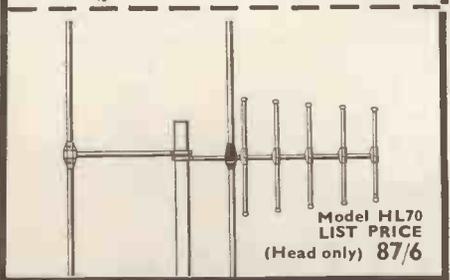
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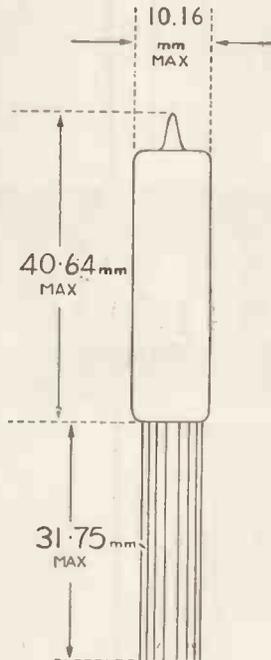
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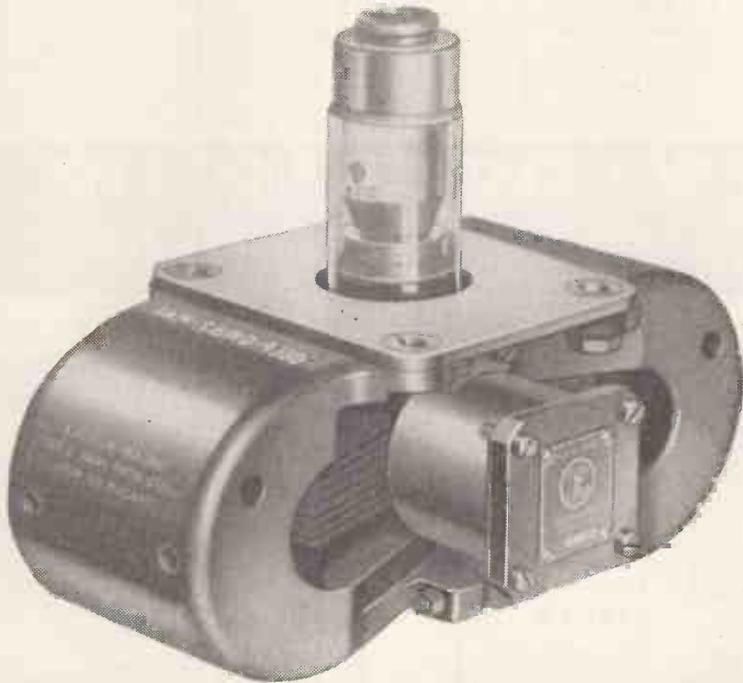
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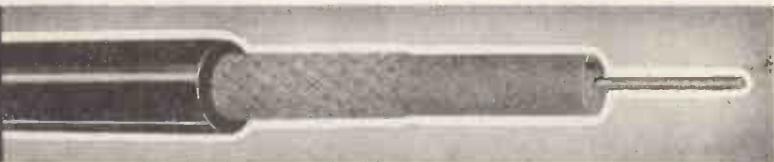
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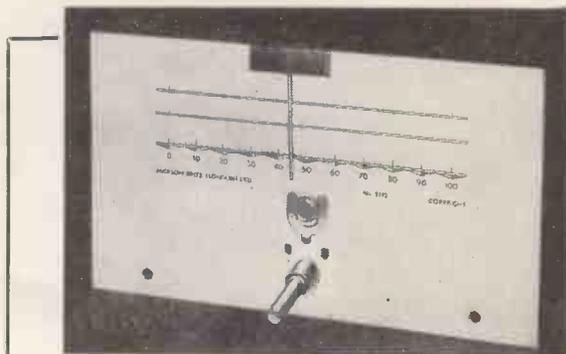
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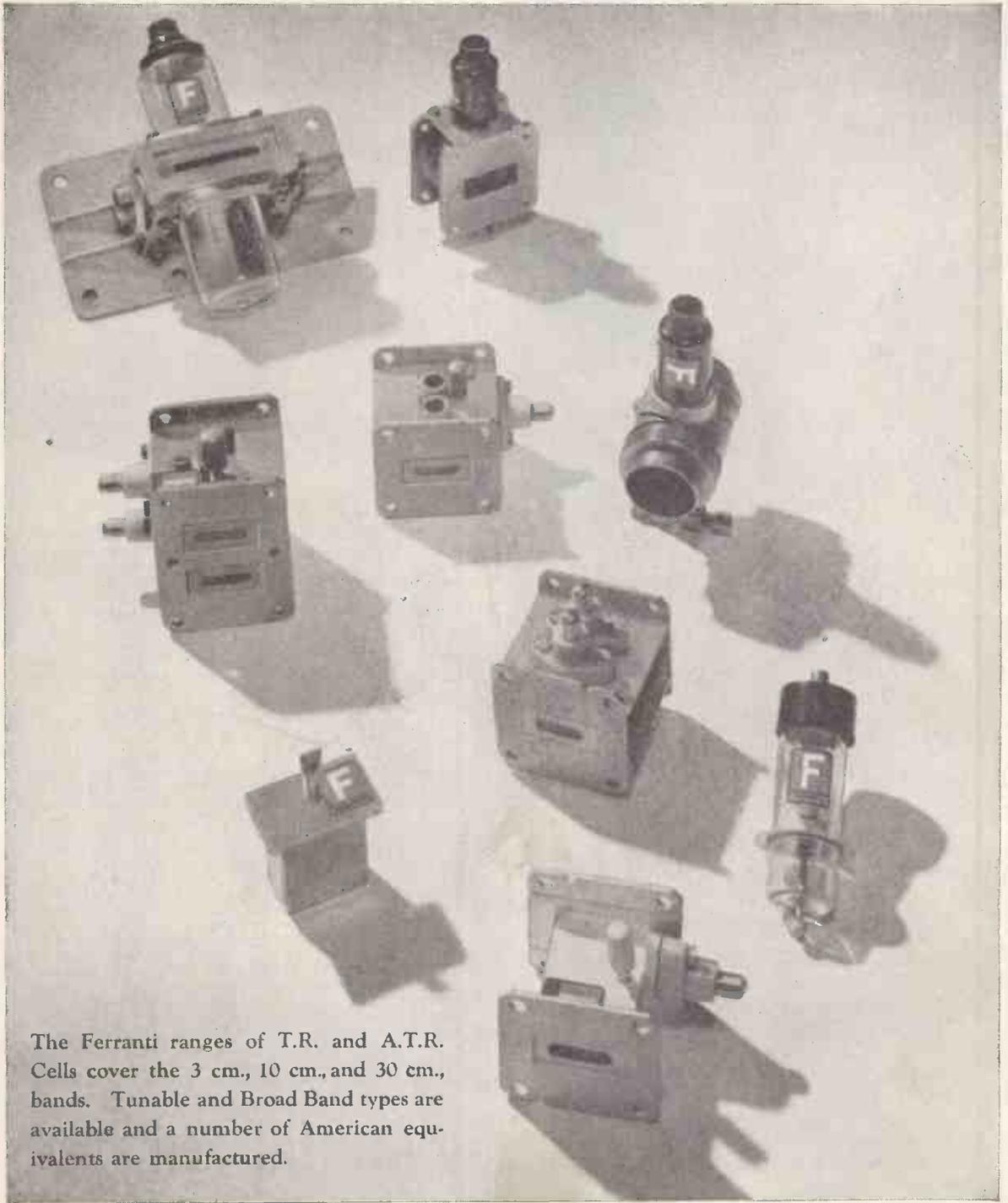
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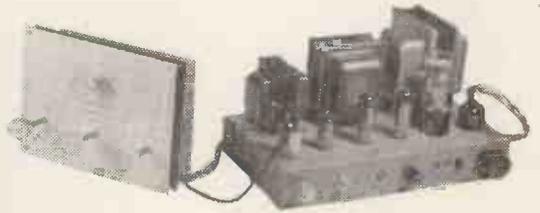
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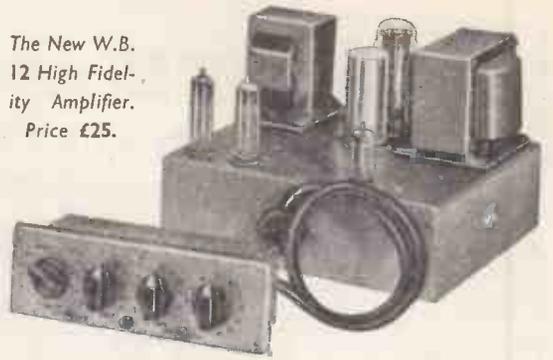
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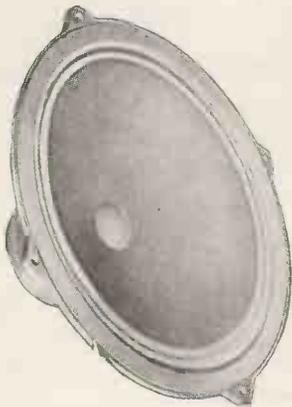


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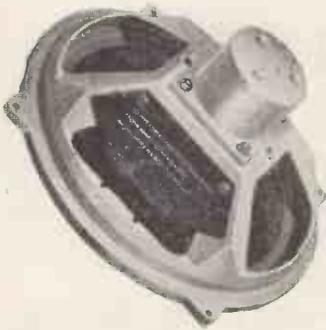


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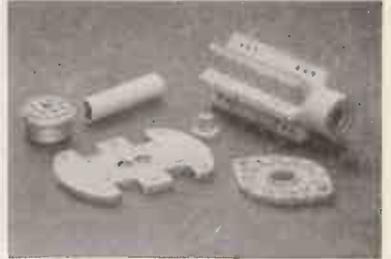
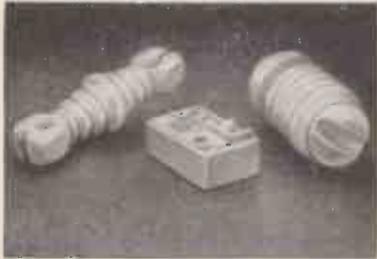
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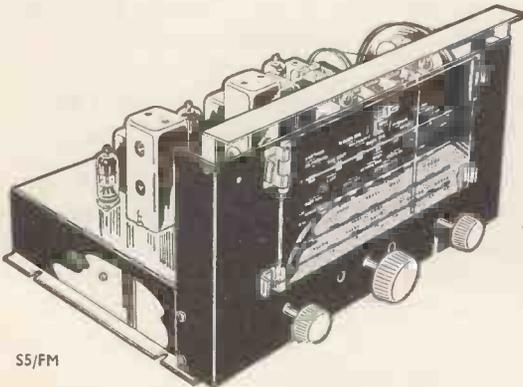
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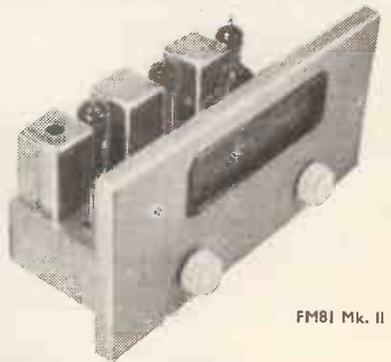
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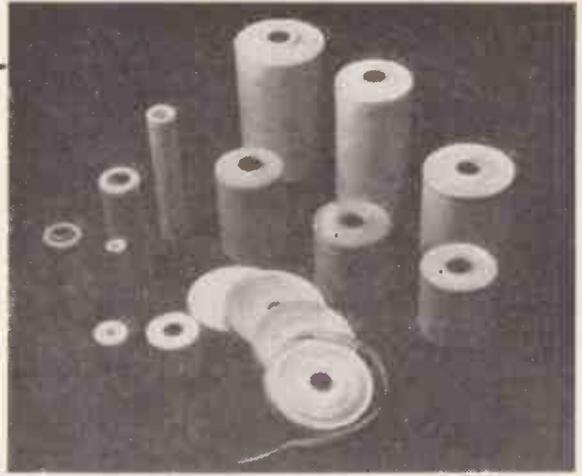
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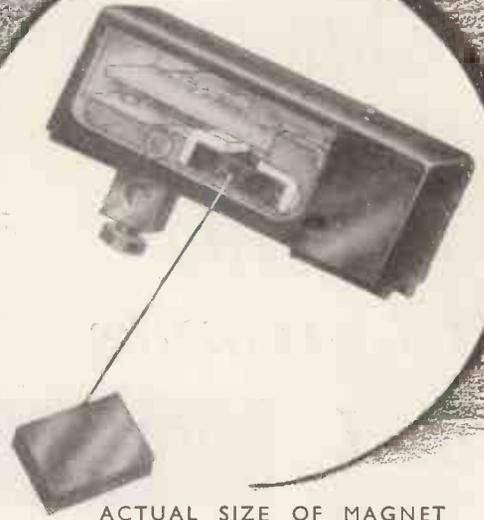
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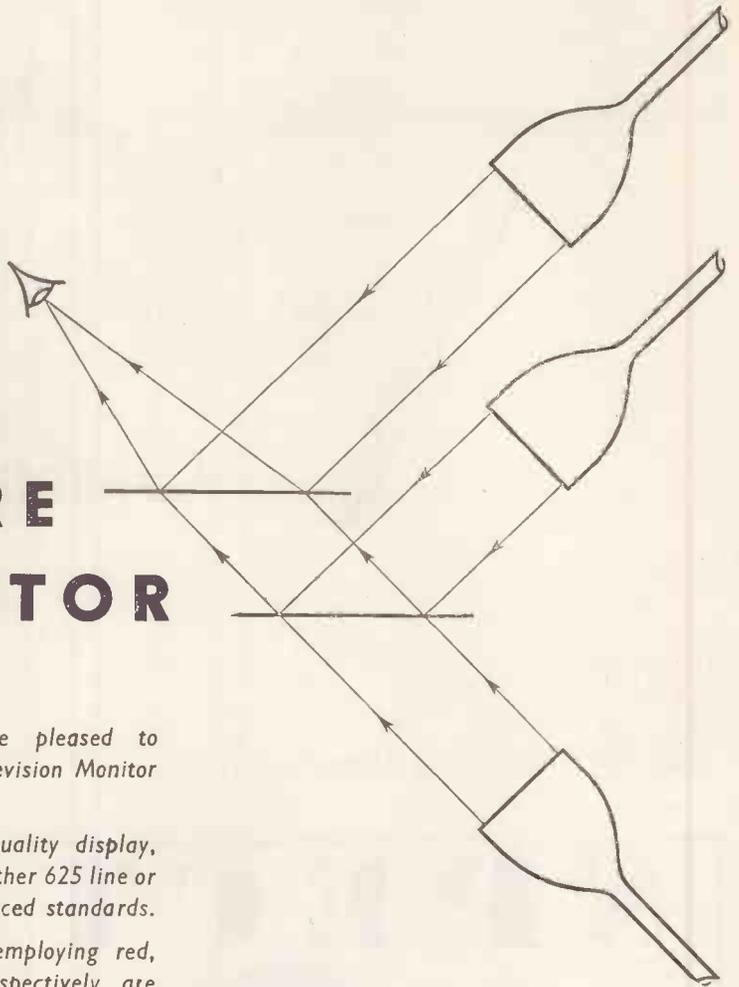


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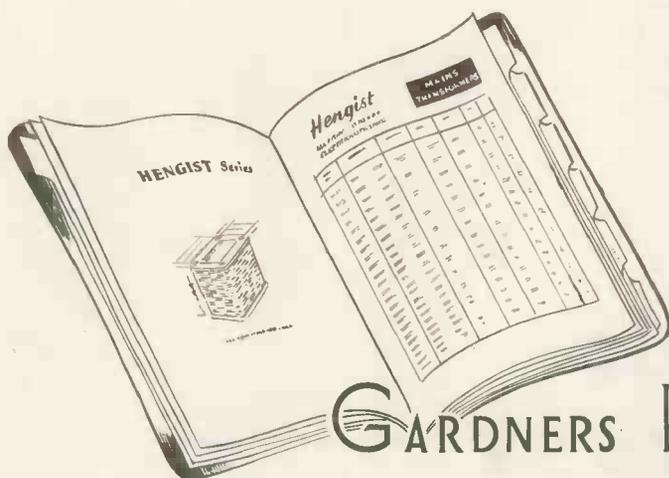
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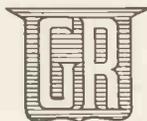
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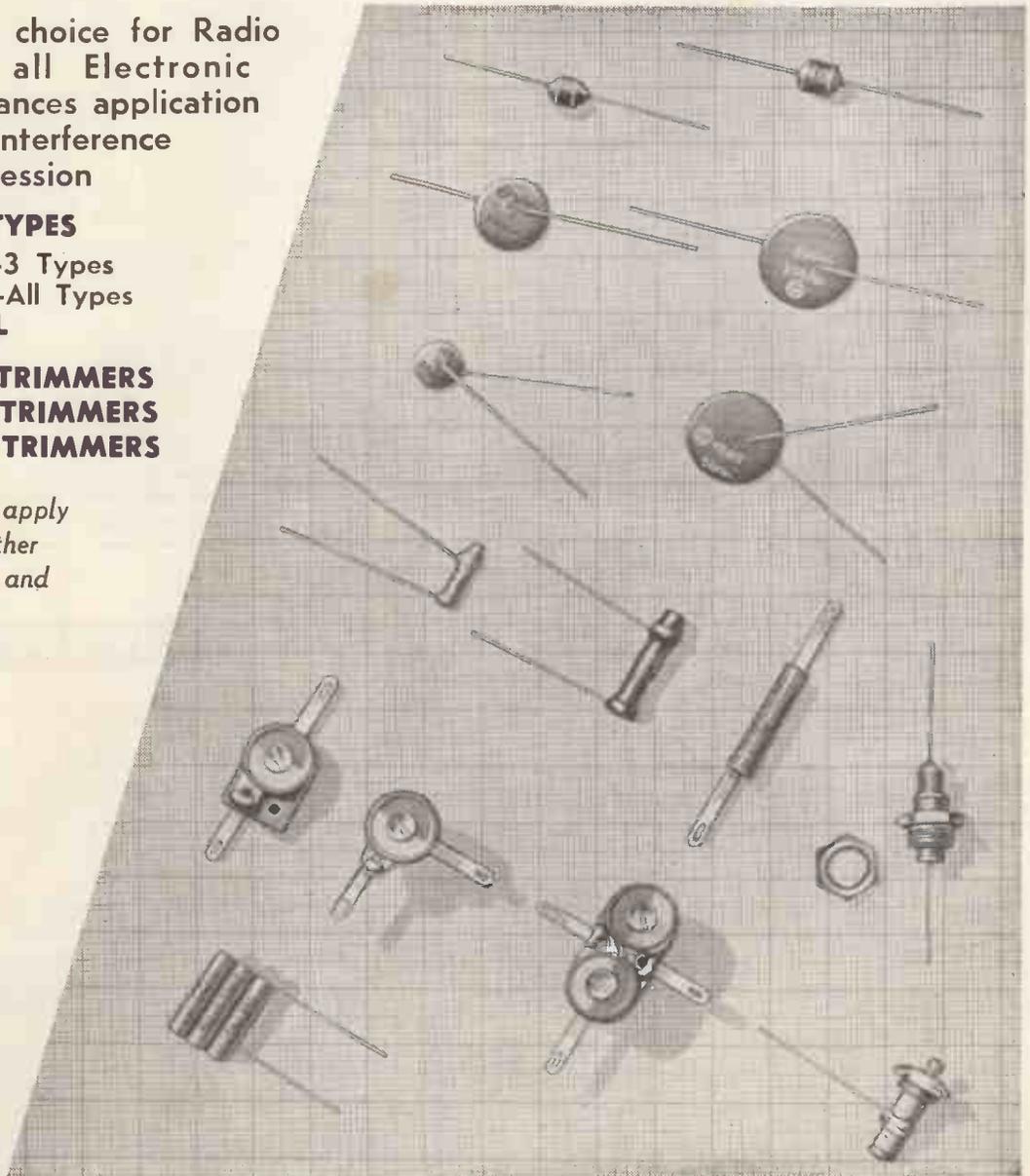
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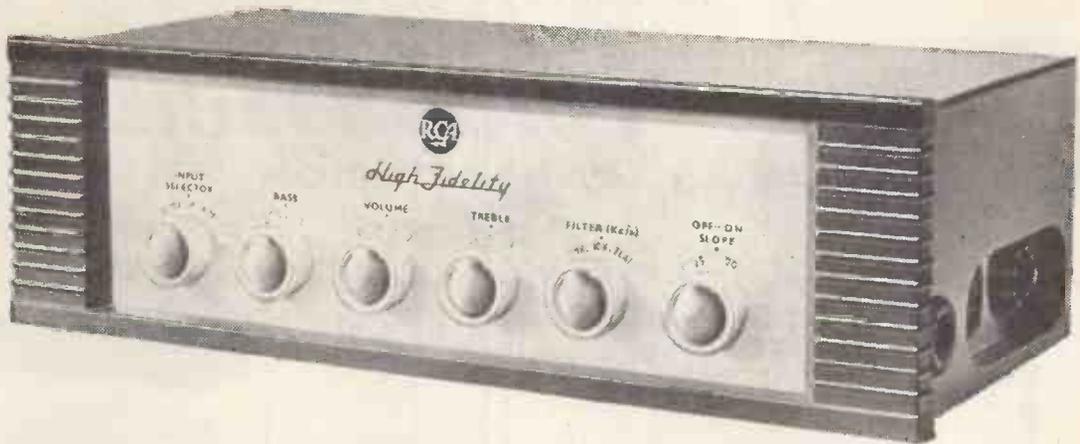
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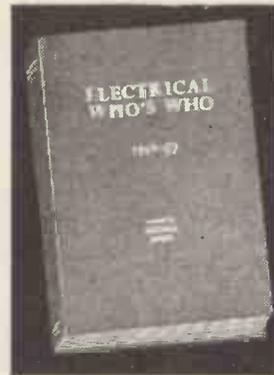
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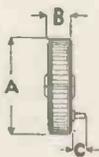
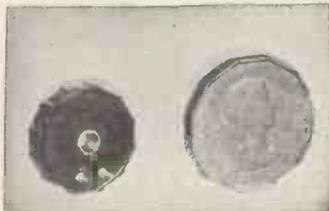
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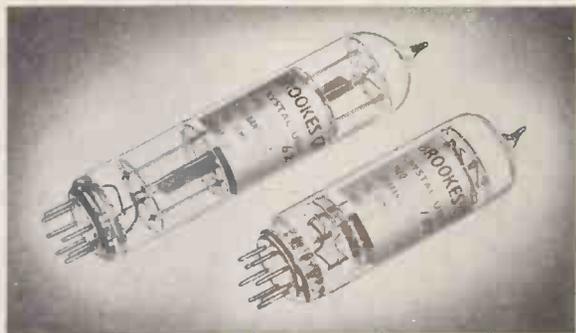
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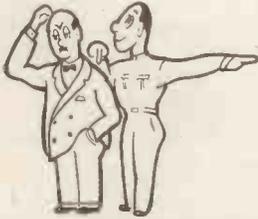
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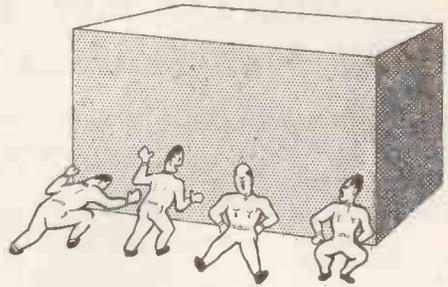
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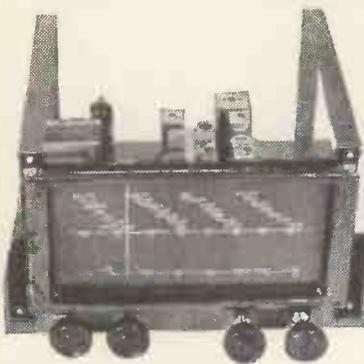
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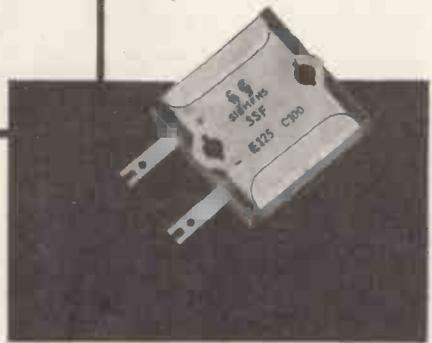
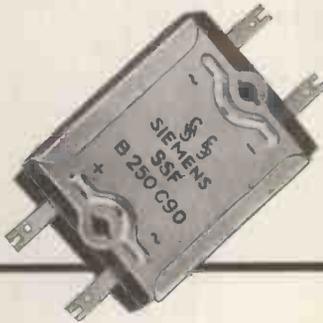
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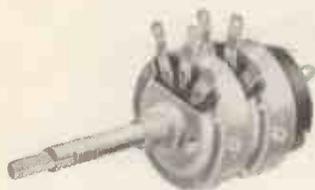
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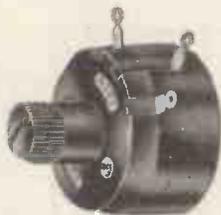
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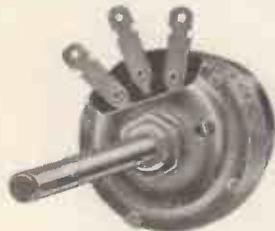
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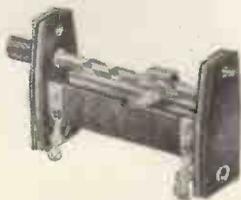
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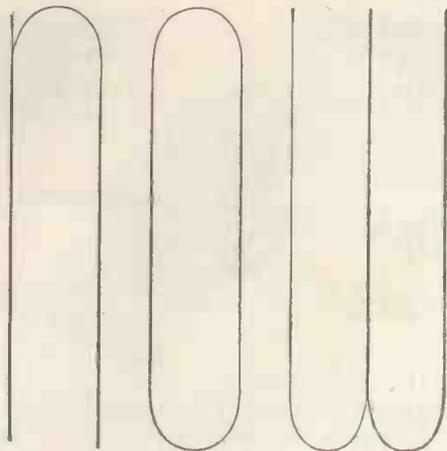
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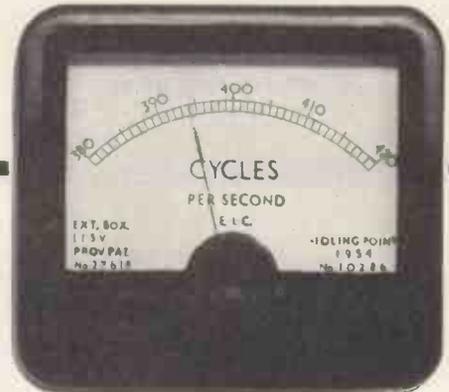
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This modern valve, the Ediswan ESA.1500, is a directly heated, forced air cooled, thoriated filament triode primarily intended for operation as an Oscillator in R.F. heating equipment. It may also be used as an R.F. or A.F. power amplifier.



**RATING**

Filament Voltage (volts)	$V_f$	8
Filament Current (amps)	$I_f$	26
Maximum Anode Voltage (volts)	$V_a(\text{max})$	5,500
Maximum Usable Filament Emission (amps)	$F_{em}$	6
Maximum Anode Dissipation (kW)	$W_a$	2.5
Mutual Conductance (mA/V)	$g_m$	* 7.5
Amplification Factor	$\mu$	* 24
Anode Impedance (ohms)	$r_a$	* 3,200
Maximum Operating Frequency at full rating (Mc/s)		40
R.F. Power Output (kW)		6

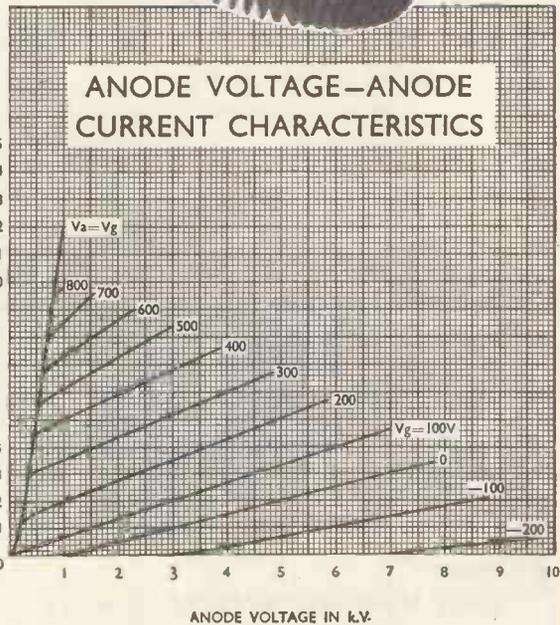
\* Taken at  $V_a = 5,000\text{v}$ ;  $I_a = 400\text{ mA}$ .

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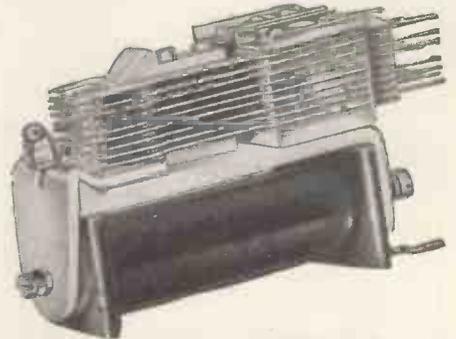
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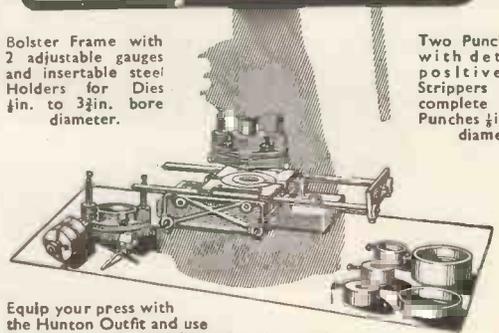
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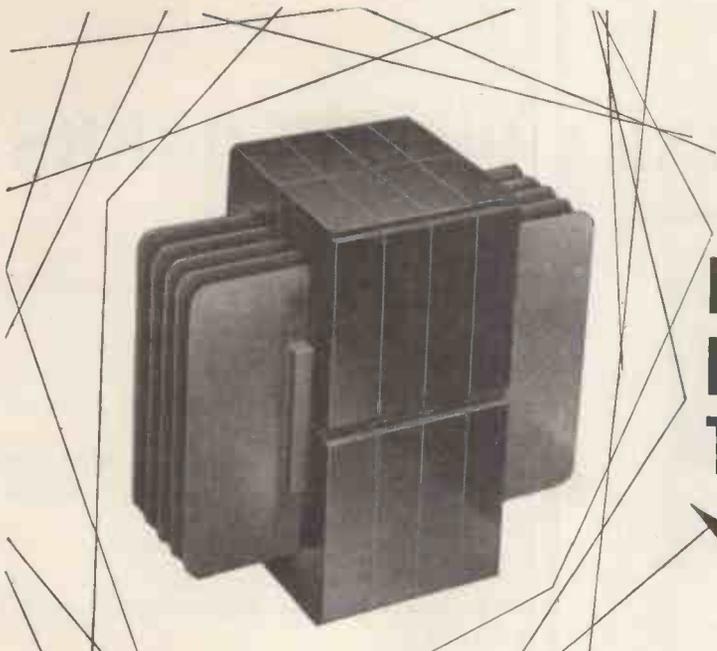
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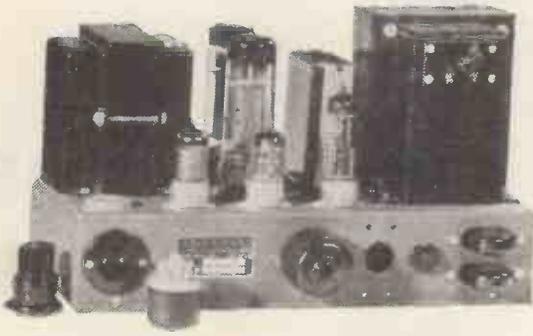


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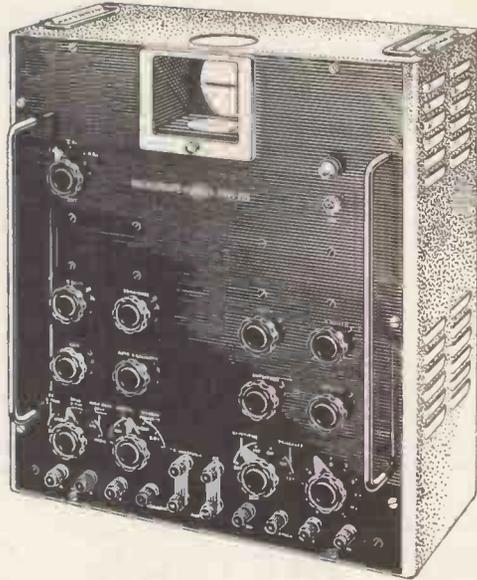
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- A deflection of 1 cm. ensures rigid synchronisation over the whole frequency range.
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THE OSCILLOSCOPE TYPE 723 utilises a vertical cathode ray tube with a 4-inch flat screen, which is viewed through a surface aluminised-mirror. This form of construction has considerable advantages. The instrument which is only 8in. deep, may be forward rack mounted on a 19in. rack, but when employed for bench use it takes up less room than a conventional oscilloscope. The screen is observable at a reasonable height from the bench without tilting, and an effective light shield is obtained without a projecting hood. The large front panel makes possible a clear and convenient layout of controls, and an Oscilloscope Camera Type 758 may be mounted permanently on the top of the instrument without interfering in any way with normal viewing.

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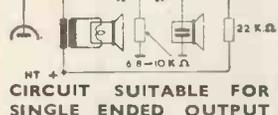
**GOLD PLATED DIAPHRAGM.** With a gold sputtered polythene diaphragm for purity of tone these electrostatic loudspeakers, recently introduced into this country by TSL, are designed to reproduce the very high frequencies in the sound spectrum and to operate between 7 and 20 kc/s where the ordinary dynamic loudspeaker sounds flat and lifeless when reproducing certain symphonic passages. To obtain life-like high quality reproduction and reception, just add one or more high fidelity TSL electrostatic speakers to your receiver, radiogram, television or AM/FM receiver.

**THREE MODELS AVAILABLE.** To meet differing conditions and types of amplifiers TSL market three models of their electrostatic "tweeters."

Type LSH 75. For single ended output and small push-pull amplifiers. Type LSH 518. A high output wide-angled model for medium power amplifiers. Type LSH 100. A high power diffused model for all classes of amplifier.

**INSTALLATION.** TSL electrostatic loudspeakers must be operated from a high impedance source, i.e., from the primary of the existing output transformer. They are not suitable for connection at speech coil impedance.

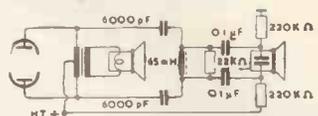
**FITTING A TSL ELECTROSTATIC SPEAKER** to any ordinary receiver is simple—it merely entails the addition of resistors and capacitors.



**CIRCUIT SUITABLE FOR SINGLE ENDED OUTPUT**

To fit an LSH 75 the best method is to suspend the unit centrally in front of the cone of the existing speaker. When two or more electro-

static units are to be added they should be mounted as near to the dynamic loudspeaker as possible. Leads from the equipment to the electrostatic "tweeters", should be kept to the minimum length.



**SYMMETRICAL NETWORK FOR PUSH-PULL**

**CIRCUITS.** The circuits illustrated are but two of the many ways in which electrostatic units may be added to existing receivers and amplifiers. Circuit values are the same for each model. Resistor and capacitor, or choke and capacitor values, have been chosen to provide necessary filter constants to prevent frequencies of the middle and lower registers reaching the electrostatic units.

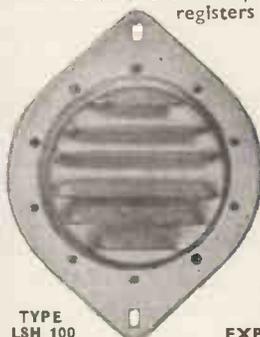
- Type LSH 75 ..... 12/6d.,
- Type LSH 518 ..... 17/6d.,
- Type LSH 100 ..... 21/-.

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Full instructional data supplied with each model.

The frequency response of each model is identical and is as follows:—

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8 kc/s " =	+ 13dB
10 kc/s " =	+ 15dB
12 kc/s " =	+ 18dB
14 kc/s " =	+ 18dB
16 kc/s " =	+ 18dB
18 kc/s " =	+ 13dB
20 kc/s " =	+ 10dB



**TYPE LSH 100**

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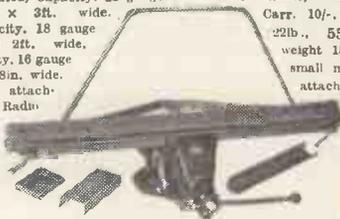
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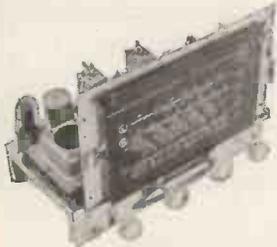
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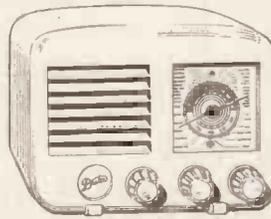
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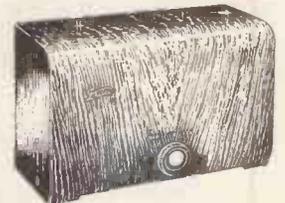
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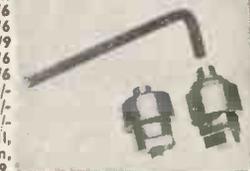
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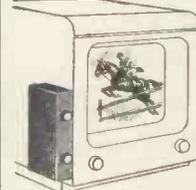
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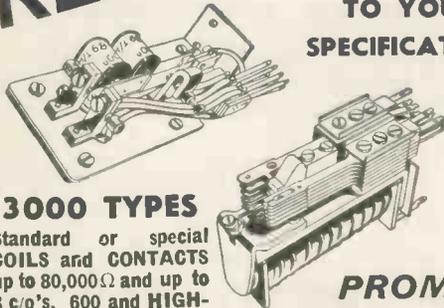
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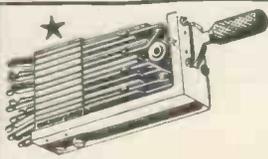
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NOW AVAILABLE WITH EITHER  
4 OHMS OR 15 OHMS SPECIAL COIL

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#### Specification

Power Handling Capacity	15 Watts Peak AC
Flux Density	14,000 Gauss
Speech Coil Impedance	4 or 15 ohms (Please state requirements on order)
Fundamental Resonance	27 c/s
Frequency Range	25 c/s—18 Kc/s
Overall Diameter	12.1/8in.
Overall Depth	6 1/2 in.
Nett weight	7 lbs. 8 ozs.
Packed weight	9 lbs. 9 ozs.
Chassis	Die cast non-magnetic alloy

List Price - £10 10 0

## H. A. HARTLEY CO. LTD.

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We offer you the ideal microphone for audience and artistes:

#### the almost invisible Studio Microphone MD 3 ST.

The pencil thin rod with the almost invisible halfpenny-size microphone.

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- Satisfies the most exacting acoustical requirements;
- Wide frequency range;
- Impedances 50 and 200 ohms;
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- No extra stand required.

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If the microphone is to be connected to a high ohm amplifier-input we recommend Miniature Transformer TM 212, which, although very small (lin. by 1/2 in.) has proved to be a high grade input transformer. It is effectively screened against external magnetic fields. Frequency range up to 20,000 cps. It is easily mounted because of its practical central fastening attachment.

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0A2	1LN5	2T/450E	5BP4	6AS7G	8F7E	6SF5	7E5	12J7GT	25Z6GT	82DDT	280A
0A3	1N3	2T/400A	5BP7	6A7A	8F8G	6SF7	7E6	12K7GT	26J	83TH	282A/B
0A50	1N5G	2X2	5C/100A	6A7T	8F8GT	8SG7	7E7	12K8	27	83VP	284
0A58	1N5GT	2X2A	5C/450A	6AU6	8F11	8S7	7F7	12K8G	27S	83ME	270A
0A180	1N21B	3A4	5CP1	6AU8	8F12	8S7GT	7G7	12K8GT	28D7	83SPT	274A
0A180	1N23	3A5	5CP7	6AV6	8F13	8S7	7H7	12Q7GT	30	84ME	279A
0A180	1N34(A)	3A8	5DB1	6AX4GT	8F18	8S7GT	7K7	12SA7	30C1	84SPT	271A
0B2	1N35	3A/110A	5D/100	8F4G	8F33	8S7GT	7N7	12SA7GT	30L1	85ME	282A
0B3	1N38(A)	3A/107A	5FP7	8B5	8G8G	8S7GT	7Q7	12SC7	31	86KU	288
0C3	1N39	3A/141A	5GP1	8B7	8G8G	8S7GT	7R7	12SF7	32	87PT	300B
0C601	1N43	3A/142A	5JP4	8B8	8E8	8S7GT	7S7	12SG7	32E	87A	304B
0C602	1N45	3A/144A	5LP1	8B8	8E8G	8S7GT	7T7	12SH7	33	87	304H
0D3	1N48	3AP1	5L35	8B8G	8E8GT	8S7GT	7W7	12SH7	33A/100A	87	304TH
0E2	1N48	3B4	5M4GY	8B8G	8E8	8S7GT	7Y4	12S7GT	34	75	304TL
0G3	1N51	3B7	5T4	8BA6	8E8	8S7	7Z4	12SK7	34E	76	307A
0Z4	1N52	3B2A	5U4G	8BA7	8J5	8S7	8A1	12SK7GT	35A5	77	310
0Z4A	1N54	3B2B	5V4G	8BD7	8J5G	8S7	8A8	12SK7GT	35C5	78	310A
0Z4G	1N55(A)	3B2S	5W4	8BE8	8J5GT	8T7G	8D2	12SN7GT	35L6GT	79	310B
1A3	1N60	3B/151A	5W4G	8BE7	8J6	8T8	8D3	12SQ7	35T	80	311
1A5G	1N64	3BP1	5W4GT	8B8G	8J7	8T8GT	8D5	12SQ7GT	35W4	80/S	311A
1A5GT	1N65	3B4	5X4G	8BE8	8J7G	8U5G/6G5	8D6	12SR7	35Z4GT	81	311B
1A7G	1N69	3C23	5Y3G	8B95	8J7GT	8U7G	8D6	12S7	35Z5GT	82	313C
1A7GT	1N72	3C24	5Y3GT	8B16	8J8G	8U7G	8D6	12X3	36	83	318
1AB8	1P1	3C45	5Y4	8BK7	8K8G	8U8	8D2	12Y4	36	83V	323A
1AC6	1P5GT	3C/150E	5Y4G	8BL7	8K8GT	8V4	8D8	13D1	36A	84/6Z4	327A
1AD4	1P10	3C/351A	5Z3	8BM5	8K7	8V6	8E7	13D2	37	85	328A
1AE4	1P11	3C/351A	5Z4	8BQ5	8K7G	8V6G	8N7	13D3	38	85A1	328A
1AH5	1Q5GT	3CP1	5Z4G	8BQ6GT	8K7GT	8V6GT	8U8	13PA	38E	85A2	332PEN
1AJ4	1R4	3D2	5Z4GT	8BQ7A	8K8	8V6GT	8E8	13SPA	39/44	86(T)	337A
1B3GT	1R5	3D/100A	6A3	8BR7	8K8G	8W2	8E8	13VPA	40	86V	354V
1B24	1S4	3DP1	6A8	8B7	8K8GT	8W4GT	8E8	14A7	40SUA	89AG	357A
1B28	1S5	3E2B	6A8	8B7G	8L5G	8W7G	8E8	14B6	41	89C	358A
1B27	1T2	3E2P	6A8	8B7GT	8L6	8X3	8E8	14E7	41E	89CV	368A(WE)
1C1	1T4	3EP1	6A8G	8B8	8L6G	8X4	8E8	14H7	41MHL	95	371B
1C2	1T5GT	3FP7	6A8GT	8BX6	8L6GA	8X5	8E8	14K7	41MP	100TH	380A
1C3	1U4	3H/150J	6A8T	8BX7	8L7GT	8X6G	8E8	14R7	41MPT	117L7GT	388A
1C5G	1U5	3LF4	6A85	8C1	8L7	8X6GT	8E8	14S7	41MTL	117N7GT	383A
1C5GT	1X2A	3Q4	6A87	8C5	8L7G	8X8	8E8	14S7	41MXP	117Z3	394A
1CP1	2A3	3Q5GT	6A8S	8C5G	8L3A	8Y6G	8E8	14A2	41MXP	117Z8GT	417A(WL)
1D5	2A4G	3Q5GT	6AC7	8C5GT	8LD3	8Y7G	8E8	15A6	41STH	119A	450TL
1D6	2A5	3S4	6AD8G	8C6	8M1	8Z4	8E8	15D1	42	121P	451PT
1D8GT	2A6	3V/490A	6AD7G	8C6G	8M6G	8Z5	8E8	12A8GT	42E	121V	451PT
1D13	2A7	3V4	6AD8	8C10	8M7	8Z5G	8E8	12A8GT	43	121V	451PT
1E4	2B7	4/100BU	6AE8	8C21	8M5	7A2	8E8	12A8H	43MPT	150B2	610XP
1E7G	2C21	4B31	6AF6G	8C28	8M7	7A3	8E8	12A8S	43MPT	155PT	705A
1E7GT	2C22	4C27	6AF7G	8C28G	8M7G	7A4	8E8	12A8S	43U	205F	707A/B
1F1	2C36(A)	4C28	6AG5	8C29	8M7GT	7A5	8E8	12A8S	45	210DDT	708A
1F2	2C34	4C34	6AG6	8C16	8M7GT	7A6	8E8	12A8S	45 Spec.	210HF	709A
1F3	2C40	4D1	6AG7	8C16	8P7G	7A7	8E8	12A8S	46	210HL	713A
1F5G	2D4A	4E1	6AH6	8C6K	8P8	7A8	8E8	12A8S	47	210LF	714AY
1FD1	2D21	4E27	6AJ5	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1FD9	2E22	4J3	6AJ7	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1G4GT	2G30	4THA	6AJ8	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1G5G	2G21	4TPB	6AK5	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1G5GT	2J21A	4XP	6AK6	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1G6GT	2J28	5AP1	6AK7	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1H5G	2J31	5A/102A	6AK8	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1H5GT	2J32	5A/102B	6AL5	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1H9G	2J34	5A8	6AM5	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1J5G	2J38	5A2A	6AM6	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1K5G	2J39	4B4G	6AN7	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1K7G	2J48	5B/100A	6AQ4	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1L4	2J54	5B/250	6AQ5	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1LA4	2K25	5B/254M	6AQ8	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1LA3	2N63	5B/502A	6AR5	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1LC8	2N64	5B/700A	6AS5	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A
1LD5	2T/270K	5BP1	6AS8	8C6K8	8P9	7A7	8E8	12A8S	47	210M	715A

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808	1867	ACT9	CV100	DH147	ECC35	GDTAB	LD410	PD220A	RL18	UF85	VT94
809	1881	ACT17	CV101	DH149	ECC40	GEX00	LL2	PEN20A	RL37	UF89	VT96
810	1960	AH2E1	CV103	DH150	ECC81	GEX34	LL4	PENB4	RM1	UL41	VT98
811	2050	AL2	CV111	DH151	ECC82	GEX35	LN152	PEN25	RM1A	UL84	VT99A
812	2051	AL4	CV115	DK32	ECC83	GEX45/1	LP2	PEN38C	RM2	UM35	VT99
814	2103	AP4	CV117	DK33	ECC84	GEX54/3	LP4	PEN46	RM3	UQ80	VT100B
815	2151	APR4B	CV118	DK40	ECC85	GEX54/4	LP6	PEN220A	RM4	UU5	VT107
816	3220K	APP40	CV119	DK91	ECC91	GEX54/5	LP25	PEN383	RX233A	UU8	VT103
826	3851	APP4G	CV135	DK92	ECC1	GEX55	L55	PL21	RY235	UU9	VT114
828	4082A	AR7	CV132	DK93	ECC82	GEX55/1	LS6A	PL21	S22AF	UY1	VT501
829	4019A	AR10	CV174	DL33	ECH3	GEX86	LS850	PL82	S25A/B	UY41	VT510
829A	4019B	AR11	CV179	DL35	ECH21	GL1	LSD3	PL83	S25	UY85	VT510
829B	4020A	AR12	CV188	DL41	ECH22	GT1B	LSD7	PM2	S27A	UY1N	VT29
830B	4021A	AR13	CV191	DL43	ECH35	GT1C	LZ319	PM2DX	S28A	V30	VT33
832	4022AR	AR300(A)	CV193	DL66	ECH42	G100	M125H	PM4DX	S130	V226	VT39(A)
832A	4033L	AR4101	CV210	DL70	ECH8J	GU21	M183	PM12M	S130P	V248A	VT72
833A	4033A	AR20	CV222	DL71	ECH81	G050	MH4	PM22A	S130P	V248A	VT72
834	4045A	ARDA	CV239	DL92	ECL80	GZ30	MH41	PM202	SD61	V814	VT113
835	4046A	ARP3	CV240	DL93	ECL30	GZ31	MH4105	POVT25	SG250	V1120	VT120
836	4049D	ARP4	CV309	DL94	EF8	GZ32	MHL4	PP2	S1M2	V1906	VT120A
837	4052A	ARP9	CV304	DL85	EF9	GZ33	MHLD6	PP3	SP2	VI907	VT133(A)
840	4080A	AR10	CV380	DL86	EF26	GZ41	MK74	PP5	SP4	VI924	VT134
841	4081A	ARP13	CV987	DL101	EF36	H2	ML4	PP35	SP4	VI934	VT134
843	4082A	ARP34	CV980	DL651	EF37	H30	ML6	PP225	SP2	VI956	VT138
845	4064B	ARP38	CV988	DL510	EF37A	H63	MPT42	P535/IE	SP41	VCR85	VT3027
850	4069A	AR56	CV1254	DM70	EF39	H210	MR10	PT5	SP42	VCR97	VX8010
852	4074A	AS65023	CV1479	DM71	EF40	HBC90	MSAB	PT15	SP61	VCR139A	VX7006
852A	4078A	AR1100	CV1480	DM72	EF41	H91	MSP4	PT45	SP210	VCR140	VX7058
861	4079A	AT4	CV1481	DM74	EF42	H21	MSP41	PK25	ST11	VCR140A	VY8
862	4094A	AT15	CV1487	DRM1B	EF50	HD24	MS/Pen/B	PF80	ST11	VCR140A	VY8
863	4205E	AT40	CV1488	DRM2B	EF54	HF93	MS/Pen/B	PF81	STV70/20	VCR511B	VY81
864	4212D	ATP4	CV1489	DW2	EF73	HF94	MT9F	PF82	STV280/50	VCR516	W31
865	4212E	ATP7	CV1490	DW3	EF80	HF200	MT9L	PF83	STV280/50	VCR516A	W61
866A	4222B	ATP10	DA30	DT90	EF85	HK54	MT544	QV175	U750	VCR517A	W63
866JR	4222A	ATP75	CV1583	DT90	EF85	HK54	MU12/14	PZ30	SU2150A	VCR517B	W63
869B	4242A	ATS25	CV1596	E235	EF98	HK90	MV8/Pen	QA2400	T110	VCR517A	W77
872A	4280A	ATS70	CV1856	E4448	EF99	HL2	N14	QA2401	TB1/80	VCR517C	W81
874	4284A	ATS250	CV1873	EL148	EF91	HL4	N15	QA2403	TD2A	VCR517E	W142
875A	4270A	AU5	CV6008	EL155	EF92	HL23	N16	QA2404	TH4B	VCR518	W149
876	4274A	AR7	EA900	EL150	EF92	HL41	N17	QA2405	TP22	VCR518A	W149
878A	4282A	AZ1	CY2	EL191	EF94	HL80	N18	QA2407	TT4	VCR526	W150
879	4278A	AZ11	CY31	EL192	EF95	HL92	N19	QA2408	TT10	VCR528	W272
884	4282B	AZ21	CY32	EL223	EF904	HPE	N77	QK26	TT11	VCR529	W2329
885	4300A	AZ31	D1	EL228	EH90	HP21	N78	QP21	TT15	VCR530	WD30
902	4304CA	AZ41	D4	EL231	EHT1	HP210	N151	QG70/70	TT16	VCR530	WD30
929A	4304CB	EL15	D15	EL248	EJ22	HP4101	N152	SG40	TRR31	VCU "C"	WD142
929B	4304C	B30	D41	EL254	EK90	HP4101C	N153	QS70/20	TV03-10	VCU "N"	WD709
931A	4310A	B36	D42	EL265	EL2	HP4106	N154	QS75/20	TV05-12	VCU "P"	WE3A
954	4313C	B65	D63	EL266	EL286	HR2V	N709	QS75/40	TV1-50	VGT121	WL417A
955	4323A	B152	D77	EL271	EL22	HR210	NC7	QS75/80	T220	VGT128	X14
956	4328A	B228	D152	EL273	EL32	H21	NC9	QS83/3	TZ40	VI132	X17
957	4328D	B309	DA09	EL320	EL33	HY2A	NC10	QS95/10	VMF4G	V138	X18
958A	4337A	B119	DA30	EL323	EL35	HY90	NC11	QS108/40	U12	VP4	X21
959	4357A	B329	DA41	EL336	EL37	HY615	NC13	QS150/15	U14	VP4A	X22
991	4378	B719	DA60	EL342	EL41	IW2	NC18	QS150/40	U15	VP6	X24
1003	4062	BL63	DA90	EL359	EL42	IW3	NC19	QS150/45	U17	VP12D	X31
1201	4690	BM313	DA100	EL368	EL51	IW4	NC16	QV04/7	U18	VP21	X41
1203A	5651	BT45	DA332	EL379	EL83	KD21	NGT1	QV05-25	U19	VP23	X56
1221	5657	CLB6	DAF91	EL380	EL84	KD24	NGT5	QY2/100	U20	VP41	X61
1223	5672	C1C	DAF98	EL415	EL90	KD25	NS2	R1	U22	VP74	X61M
1225	5676	C5B	DC51	EL417	EL91	KR1	NS5	R2	U23	VR2	X63
1229	5678	C9A	DC98	EL436	EL903	KR3	NT2	R3	U31	VR21	X64
1230	5687	CL44	DC90	EL474	EL474	KR6/3	NT37	R3/16	U33	VR2	X66
1267	5725	CK502	DD4	EL489	EM34	KR2	NT40	R10	U37	VK53	X65
1273	5750	DD6	DD6	EL494	EM35	KT2	NT57T	R12	U41	VR54	X71M
1274	5783	CK549	DD41	EL496	EM80	KTRC	NT63A	R16	U43	VR57	X77
1282	5823	CK721	DDA1	EL516	EN91	KT24	NT86	R17	U52	VR59	X78
1291	6080	CK723	DDL4	EA50	EQ80	KT30	NT98B	R18	U78	VR85	X79
1294	6397	CK1005	DDR3	EA786	ESU300	KT31	NT100	R19	U81	VR85A	X143
1298A	7193A	CK1009	DDR7	EABC90	EY51	KT32	NU2	KC3	U82	VR66	X150
1381HQ	7475	DDR25	EAAC91	EY96	EY96	KT33(G)	NU4	REL21	U82	VR75/30	X150
1803	8011	CL33	DEQ1	EAFA2	EY91	KT41	NU5	REL36	U143	VR75/30	X150
1811	8012(A)	CMG25	DET3	EB34	EZ4	KT42	OM1	RG1	U147	VR80/30	XG1
1812	8013(A)	CS4B	DET5	EB41	EZ35	KT44	OM4	RG1-125	U151	VR81A	YP
1814	8016	CV3	DET9	EB91	EZ40	KT61	OM5	RG3-250	U154	VR102	Y63
1816	8019	CV5	DET10	EB33	EZ41	KT62	OM5A/B	RG6	U319	VR105/30	Z14
1819	8020	CV8	DET12	EBC33	EZ80	KT83	OM6	RG6	U600	VR135	Z19
1820	8022	CV12	DET16	EB041	EZ90	KT63	OM9	RK20(A)	U769	VR150/30	Z21
1822	8025	CV15	DET18	EBC80	FC2	KT61	OM10	RK25	U825	VR24	Z21M
1824	8025A	CV43	DET19	EBC90	FC2	KTW61	OSrlims	RK26	UABC90	VR34	Z22
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1826	9001	CV52	DET25	EB22	FG7A	KTW63	P4	RK30	UBF41	VS110A	Z82
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1842	9005	CV83	DF96	EBL1	FX215	KTZ73	PF25	RK35	UC92	VT46	Z142
1848	9008	CV64	DF81	EBL21	EY51	L2	P1	RK37	UCHE1	VT48	Z142
1849	AC/PEN	CV67	DF904	EY52	G6	L4	PABC80	RK48A	UCR42	VT46A	Z150
1850	AC/P	CV73	DH30	EC54	G8A	L21	PCC84	RK57	UCR81	VT58A	Z729
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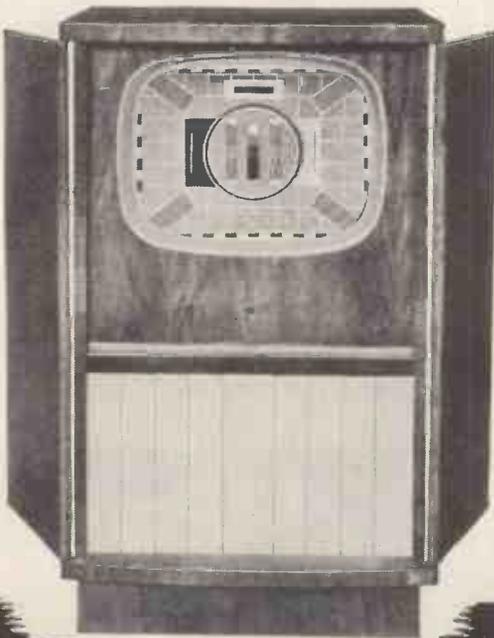
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**COMMUNICATION RECEIVER  
P.C.R.2**

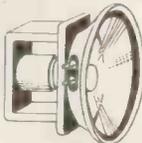
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These NEW PREMIER designs



**3 BAND SUPERHET  
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Latest type Superhet circuit using 4 valves and metal rectifier for operation on 200/250 v. A.C. mains, waveband coverage short, medium and long. The attractive cabinet to house the Receiver is 12in. long, 6½in. high, 5½in. deep, can be supplied in either Walnut or Ivory Bakelite or wood. Instruction book 1/- post free, includes full constructional details and list of priced components.



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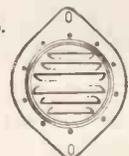
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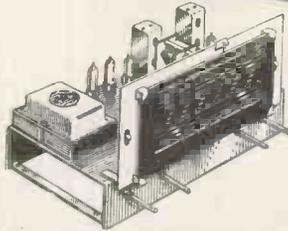


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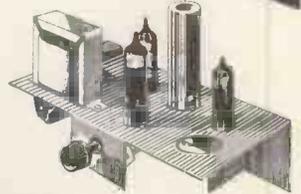
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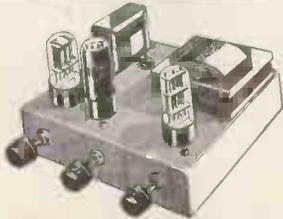


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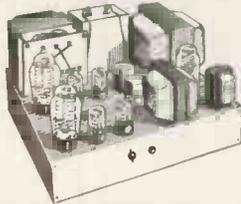


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ELECTRONICS, RADIO, TELEVISION

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APRIL 1956

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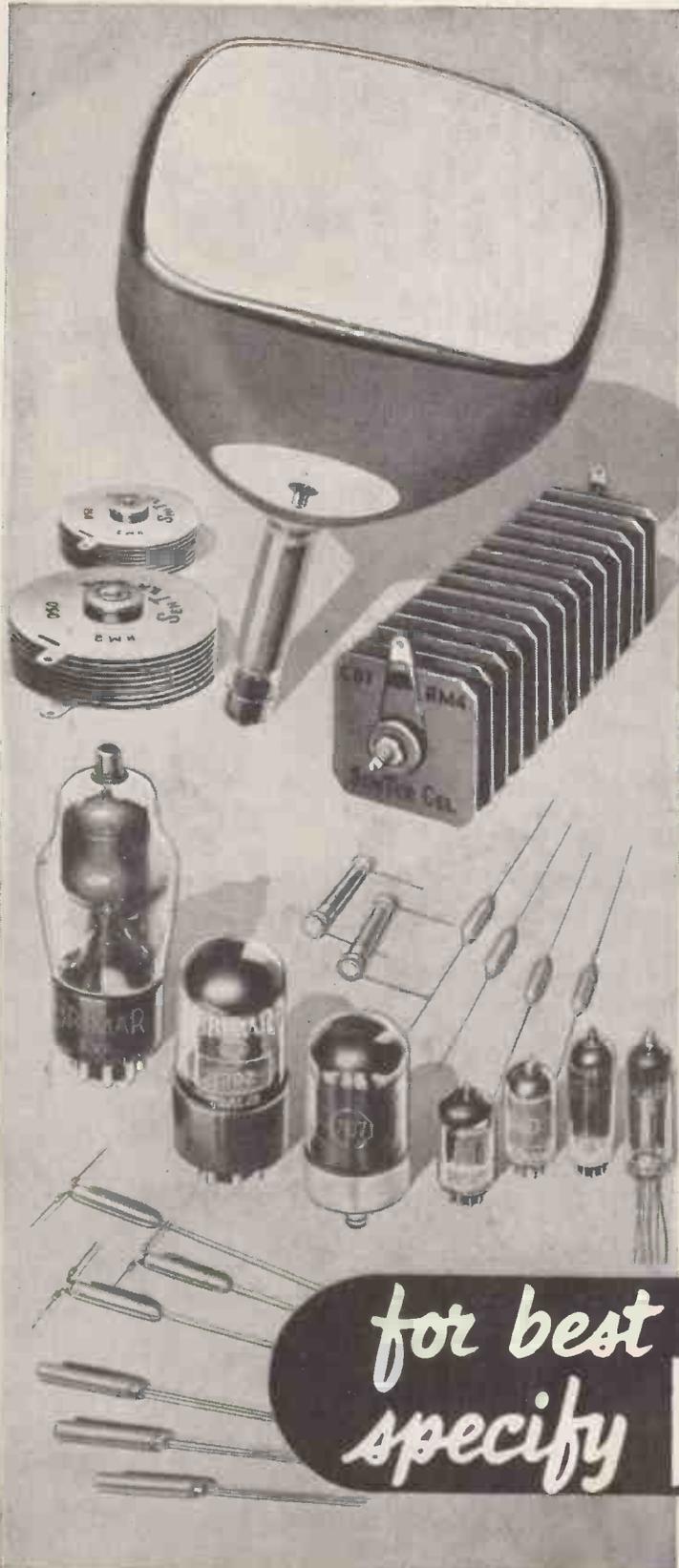
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Components

•  
METAL RECTIFIERS

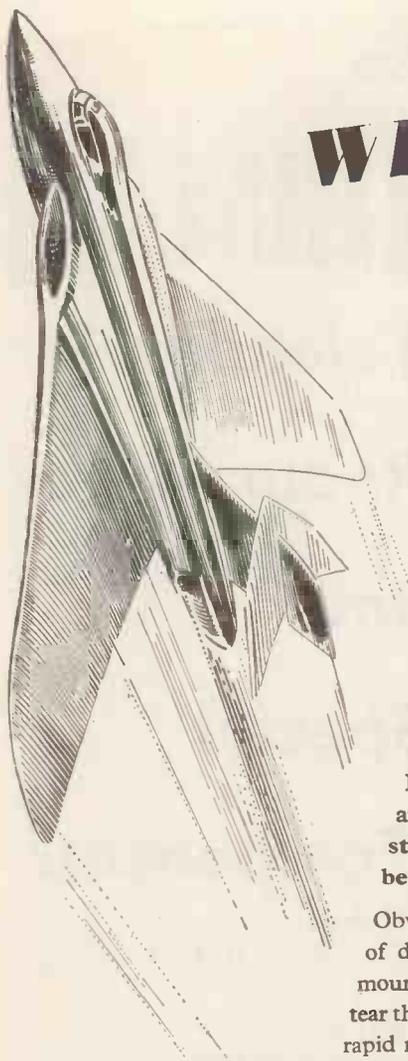
•  
BRIMISTOR  
CURRENT SURGE  
RESISTORS

•  
GERMANIUM DIODES

•  
TRANSISTORS

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*specify* **BRIMAR**

# What's all this about Hi-g?



"g" is the symbol for acceleration which, to the technical, is defined as the differential of velocity with respect to time. More simply this means the rate of change of speed.

When "g" is too great, damage will be done. A locomotive leaves the rails when it takes a curve too fast. At only 6 "g", a pilot blacks out when he pulls out of a dive; at 20 "g", which is very much more than any plane can possibly encounter, the plane would disintegrate.

The stylus tip of a pick-up is subjected to the same acceleration but to an infinitely greater extent. The undulations of a record groove cause the stylus to vibrate as much as 10,000 times per second or more. It moves to one side of the groove, stops, moves to the other, stops again and so on throughout the record. The accelerations acting upon the stylus tip are measured in "g" and with modern recordings may be well over 1000 "g".

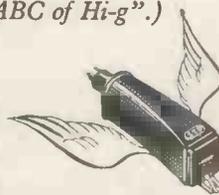
Obviously a light freely suspended stylus will follow rapid changes of direction in record grooves more easily than a heavy, stiffly mounted one. On a heavily recorded record a "stiff" pick-up will tear through record grooves or even jump right out of them. Result; rapid record and stylus wear and poor reproduction.

Correct tracking of modern electrical recordings with their great musical and dynamic range calls for pick-ups specially designed to cope with very high "g". They are available, after much patient research and development, under the name "Hi-g". ACOS "Hi-g" pick-ups perform perfectly at any multiple of "g" they are called upon to meet, representing a truly revolutionary advance in pick-up design. If you want your valuable records to reproduce as well as the makers intended—and to go on doing so for a long time—use an "ACOS Hi-g" pick-up.

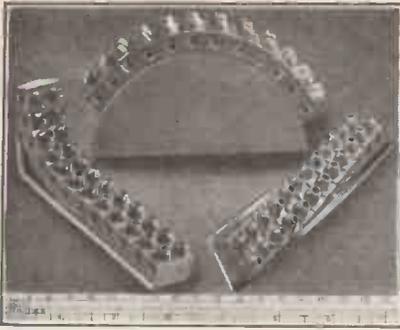
(Write for a free copy of the new Cosmocord booklet "The ABC of Hi-g".)



... always well ahead



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



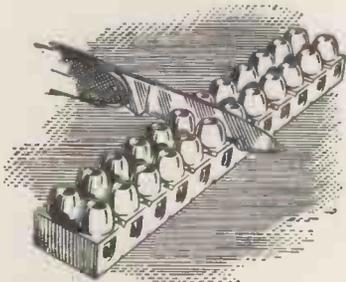
# "BELLING-LEE" FLEXIBLE TERMINAL BLOCK

U.K. Patent 680406

This unique component was designed to provide great flexibility in both planes, thus enabling it to be secured to curves or irregular surfaces. It is moulded in P.V.C., which securely grips the terminal screws so that they cannot fall out even if totally unscrewed from their inserts and the block mounted upside down.

The block is mechanically shock-proof and can easily be sub-divided with an ordinary knife into smaller groups of terminals. Fixing holes provided for each pair of terminals.

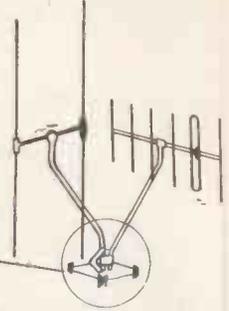
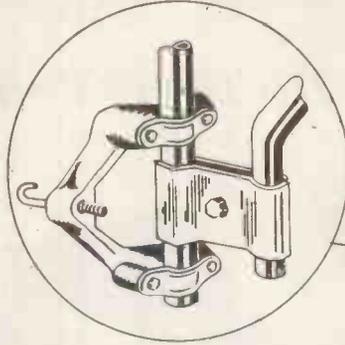
L.744 is a 12-way strip, rated at 5amp., but may be used at the designer's discretion up to 10 amp., or up to 2 kV. peak working voltage between terminals or between terminals or chassis. Overall size, 5in. x .750in. x .625in. high. Hole centres spaced .425in. L.1325 is a new larger version, rated at 15 amp., and conforms with safety requirements B.S.A.15, at 500 v. (r.m.s.).



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

Telephone: Enfield 3322 · Telegrams: Radiobel, Enfield

## "BELLING-LEE" NOTES



### The Last Straw.

Now that I.T.V. is beginning to influence the skyline in many parts of the country, some alarming sights can be seen. In one town, midway between London and Birmingham, there is a nine-element band III array on a 12-foot mast clamped precariously on top of a "Multirod" with handcuff clamps. Now the "Multirod" is designed to stand up to gusts of 80 m.p.h. It is alleged to have withstood 125 m.p.h. But if a gale hits this combined erection the whole lot will come down. It doesn't stand a chance.

"Belling-Lee" design their aerials to be stronger than most, as every dealer in exposed locations knows. But economics prohibit any firm manufacturing aerials so strong that additional arrays may be added without careful thought to wind resistances.

Unless combined aerials or independently mounted band I and band III aerials are being used we recommend the L.903/BS and L.904/BS (illustrated above) for their durability and sensitivity. The illustration shows in detail the original bracket and the special adaptor clamp. In this way none of the original bolts need be disturbed, seizing up troubles do not exist, and the band III array may be orientated as required.

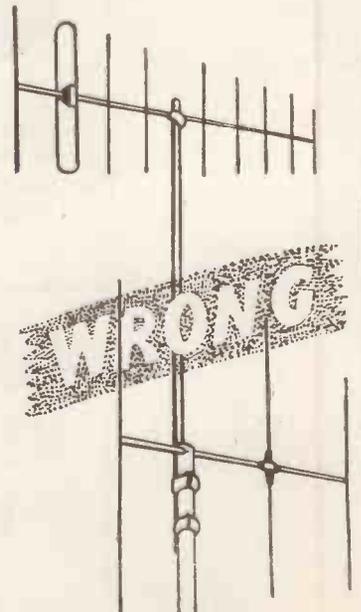
When a band III aerial is required to be attached to a vertical mast, the 3, 6 and 9-element adaptors are available with stacking clamps for fixing on the band I mast, below the array.

### The Fact of the Matter.

Every now and again some local body decides to have a blitz on T.V. aerials and committees

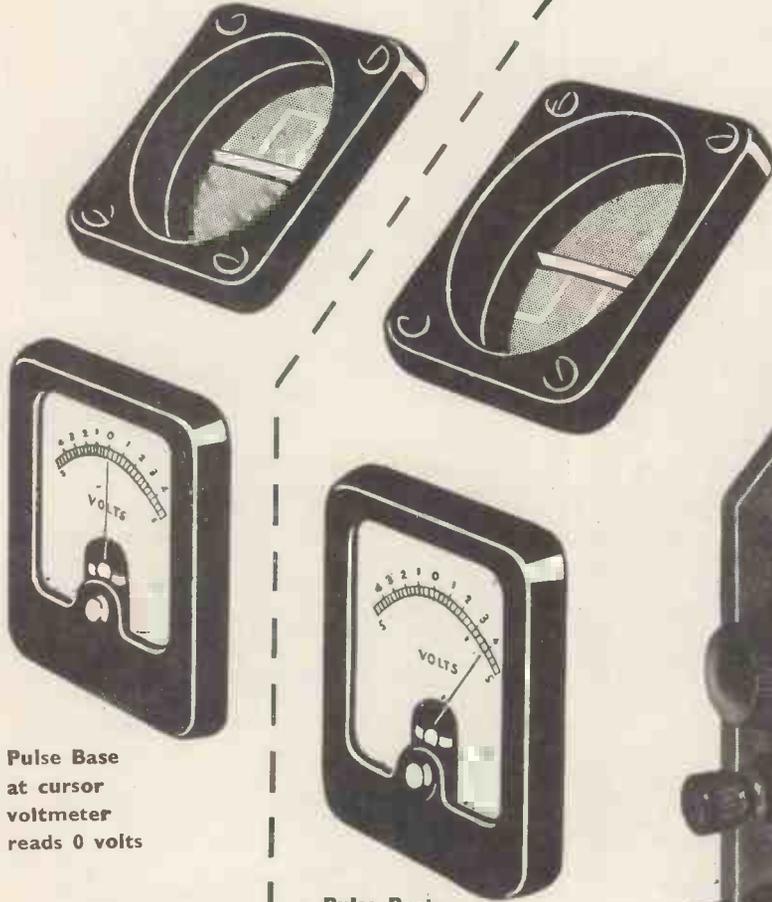
sit and discuss matters quite beyond their knowledge. Recently we heard of a case where only "Multirod" aerials were permissible so that four flat dwellers may share the one high gain aerial rather than have four "H" type aerials on the roof. It is incidental that the district is one where many of the viewers require a "Multirod" in any case, if a tolerable picture is required.

Now where an aerial is being shared, it is necessary to "pad" off the "subscribers" with a star network that has an inevitable loss of 6 dB per point, i.e., the loss with all the viewers switched on, is in the region of 24 dB. The difference in gain between an "H" aerial and a "Multirod" is about 6 dB. only. No comment.



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Written 5th March, 1956

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. . . measure what you see*



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at cursor  
voltmeter  
reads 0 volts**

**Pulse Peak  
at cursor  
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*Extension of Training Schemes for Electronic application*

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*In step with wide expansion of Electric & Musical Industries Ltd. into the development of electronic and automation equipments for industry, E.M.I. Institutes the training organisation in the Group has considerably extended its plans for the future.*

*The 4-year Scholarship scheme introduced several years back to encourage suitable candidates to take up careers in Electronics has proved most successful and a similar scheme is now introduced for the first time for the 3-year Telecommunications Course.*

*In addition to the courses listed below, E.M.I. Institutes are arranging special courses for the E.M.I. Group and the customers of the Group. Present activities and future plans include courses for Digital and Analogue Computers, Process Control and Automation.*

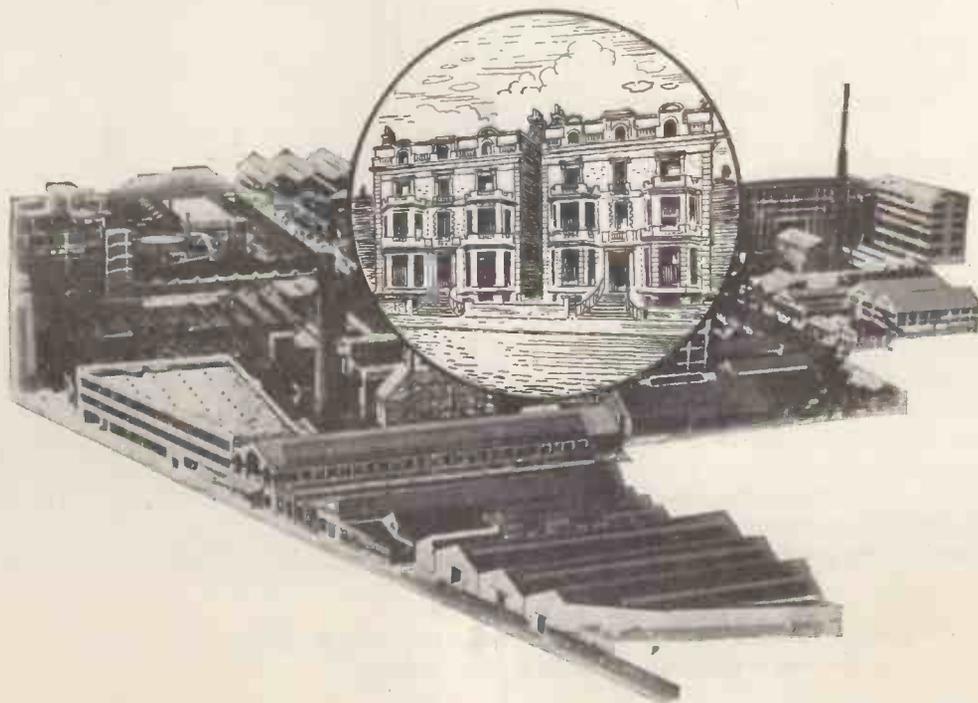
*Full-time courses open to the general public are as follows:—*

**4-YEAR COURSE: Electronic Engineering**—intended for good Science sixth-formers who are capable of training into future team leaders in scientific applications. Final qualifications are B.Sc. and City and Guilds' Full Technological Certificate in Telecommunications Engineering. This course is recognised

by the Institution of Electrical Engineers. At least 18 E.M.I. Scholarships are offered for the 1956 course which commences on October 2nd.

**3-YEAR COURSE: Telecommunications**—Entrance standard G.C.E. Ordinary level or equivalent. This course trains Assistant Development Engineers to City and Guilds' Full Technological Certificate level. Opportunities for practical attachments to E.M.I. Laboratories and Workshops are provided. Details of special Scholarship scheme available for next course, commencing September 11th.

**1-YEAR COURSE:** Full-time day course in the Principles and Practice of Radio and Television. Mainly designed for the training of Radio and Television Servicing Engineers. Next course, commencing May 22nd, is already fully booked. Enrolments for following course, commencing September 11th, now being accepted.



# Caslite

## Iron Dust Cores

by **Plessey**

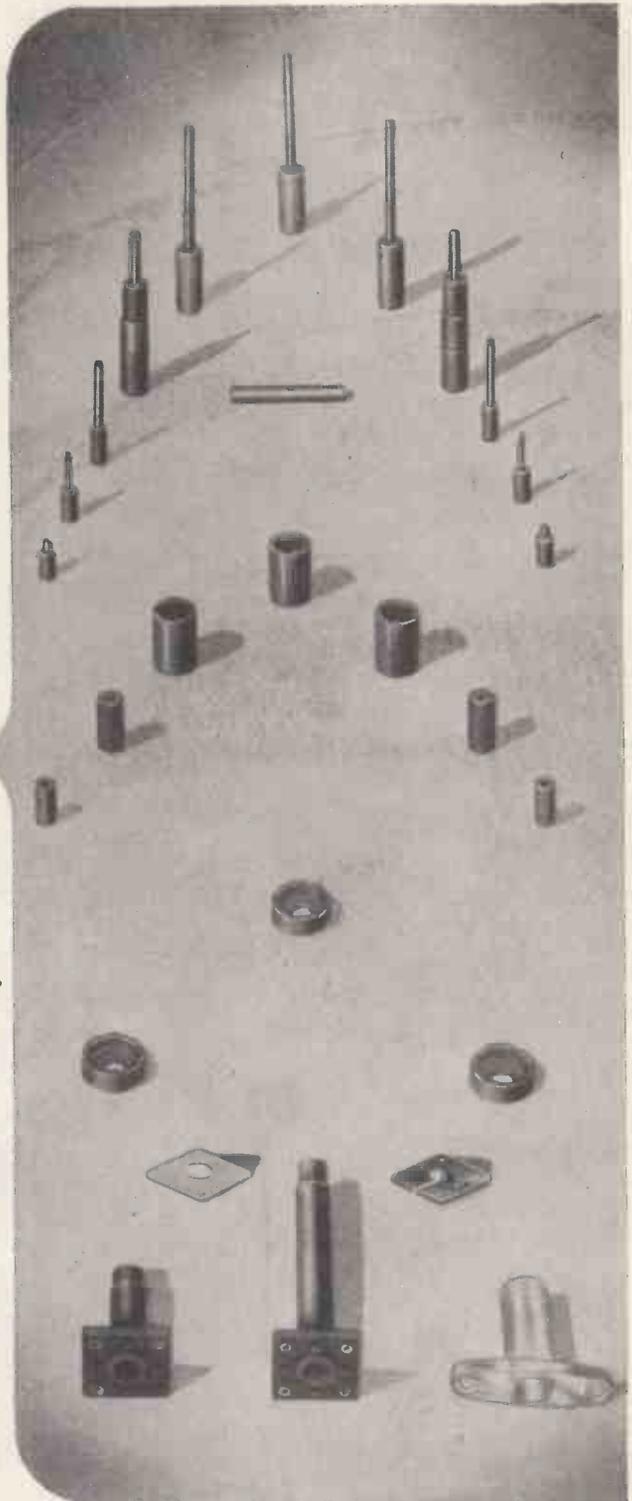
### ***Bigger Standard Range . . .***

Under the registered name CASLITE, The Plessey Company presents a range of superior iron dust cores of the types in constant demand by the radio industry. New manufacturing techniques developed at the Towcester factory have resulted not only in the establishment of a better product within the various material gradings but also in more economic production. In consequence, prices are keenly competitive.

Where cores outside the standard range are required, the Company is always willing to advise on design and to produce iron dust cores to suit special needs.

### ***Better Product . . .***

Due almost entirely to their own continuity of effort to improve the performance of iron dust cores, The Plessey Company now hold an unchallenged position in the breadth and quality of their standard range of cores, both for use at normal I.F. and broadcast frequencies and again for the more recent exploitation of the V.H.F. region and television. In the latter context, the Company is able to announce the introduction of several materials possessing greatly improved qualities for use in these fields. These are the Grade 22 and Grade 23 powders, mechanically suitable for use in conventional constructions and available at economic prices.



Manufacturers are invited to write for Plessey Publication No. 650/2 which contains comprehensive details of these products.

'Caslite' Iron Dust Cores are produced by

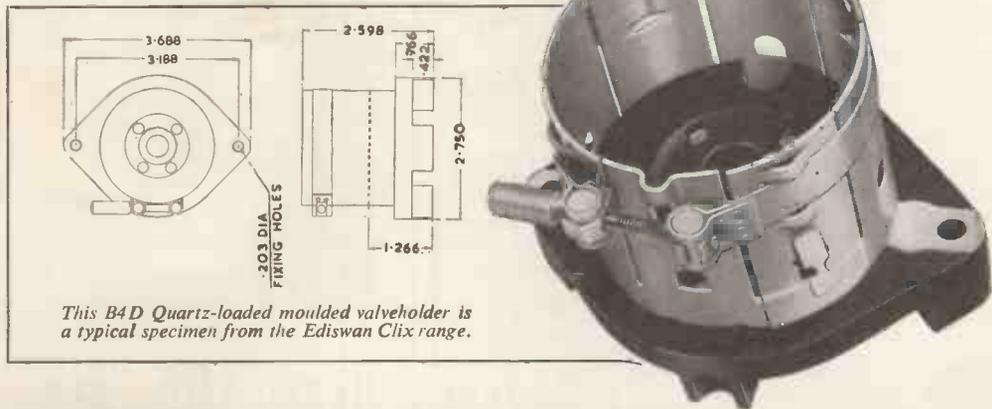
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*This B4D Quartz-loaded moulded valveholder is a typical specimen from the Ediswan Clix range.*

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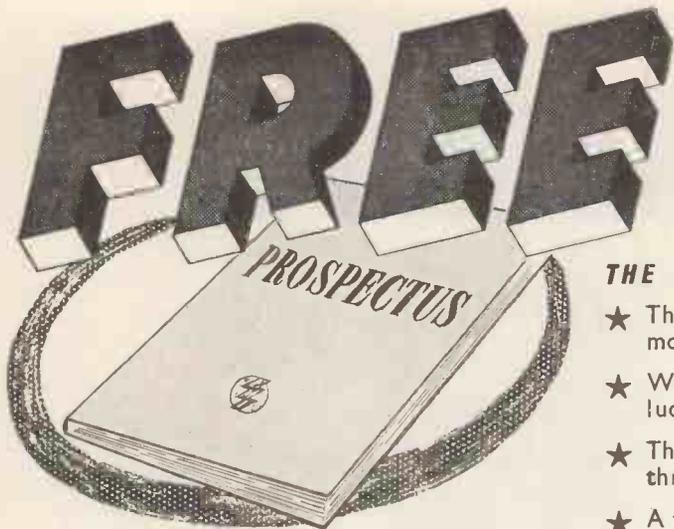
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Designed for laboratory use, this new oscillograph provides a Y amplifier with a very useful frequency characteristic extending from d.c. to 6 Mc/s. The display is presented on a new post deflection accelerator tube at an amplitude of not less than 6 cm over the stated frequency band. The maximum sensitivity of the channel is 0.25 V/cm and calibration is effected by means of the accurate test voltage provided. The time base of the instrument can be switched to fire repetitively from a trigger pulse of either sign derived from the Y amplifier signal or externally. A special refinement, of interest to the Television Engineer, is the provision for triggering from the Frame or Line sync. pulse in a 1 volt D.A.P. (positive) composite video signal. Five calibrated time base ranges are provided giving spot velocities from 30 cm/sec to 1.5 cm/microsec. An X amplifier with a maximum sensitivity of 0.5 V/cm and bandwidth 20 c/s—250 kc/s (—50%) is included and allows time base expansion, continuously variable, of up to five times. Time measurement is by calibrated shift control. The instrument operates from 100—130 or 200—250 volt mains supplies.

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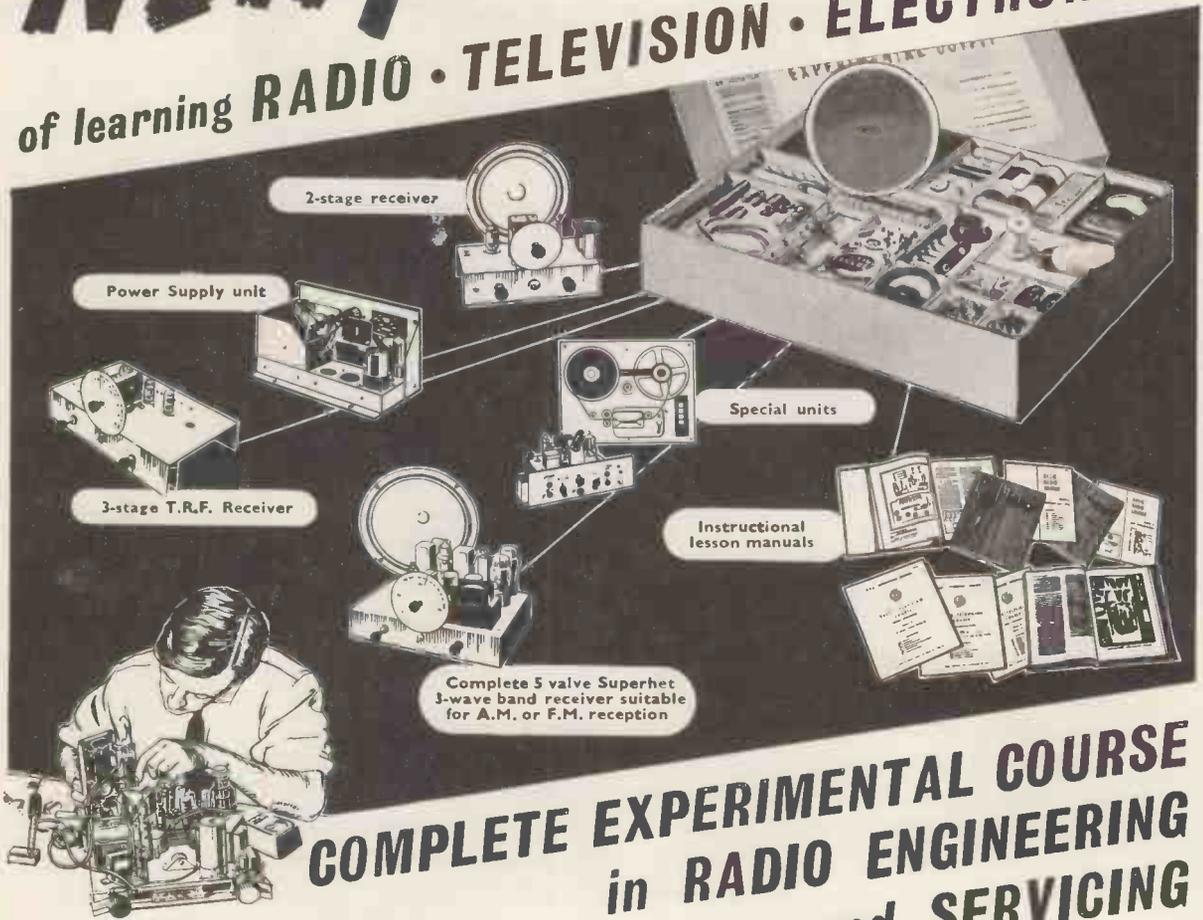
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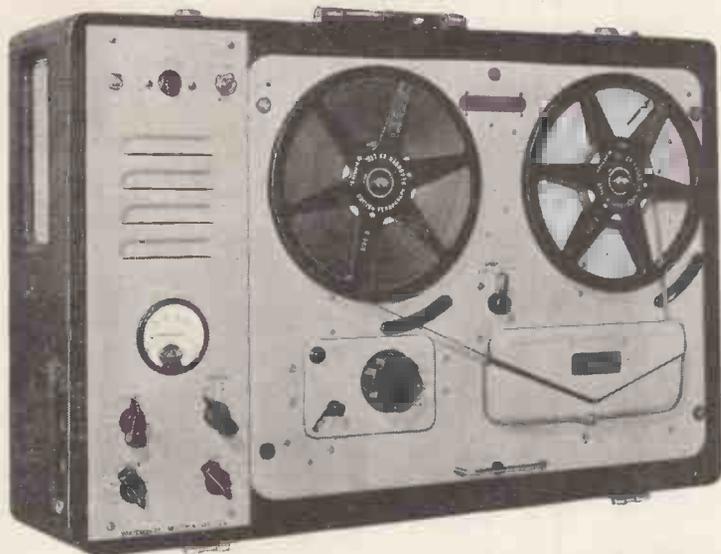
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IC.68A

# VORTEXION TAPE RECORDER



The amplifier, speaker and case, with detachable lid, measures 8½ in. x 22½ in. x 15¼ in. and weighs 30 lb.

**PRICE, complete with WEARITE TAPE DECK ... .. £84 0 0**

★ The total hum and noise at 7½ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

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

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

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

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

**POWER SUPPLY UNIT** to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE £18 0 0.**

## FOUR CHANNEL ELECTRONIC MIXER

is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording.

It is recommended by a number of tape recorder manufacturers for this purpose.

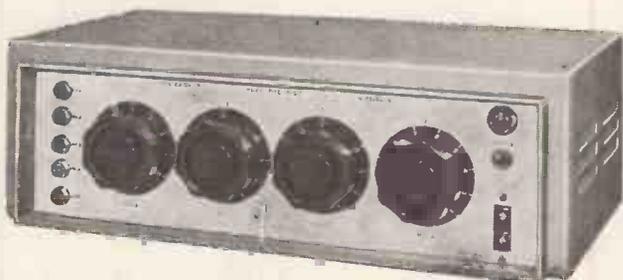
Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced.

The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.

The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.

An internal screened power pack and selenium rectifier feed the five low noise non-microphonic valves.

Used in many hundreds of large public address installations and recording studios throughout the world.



**PRICE £36 15 0**

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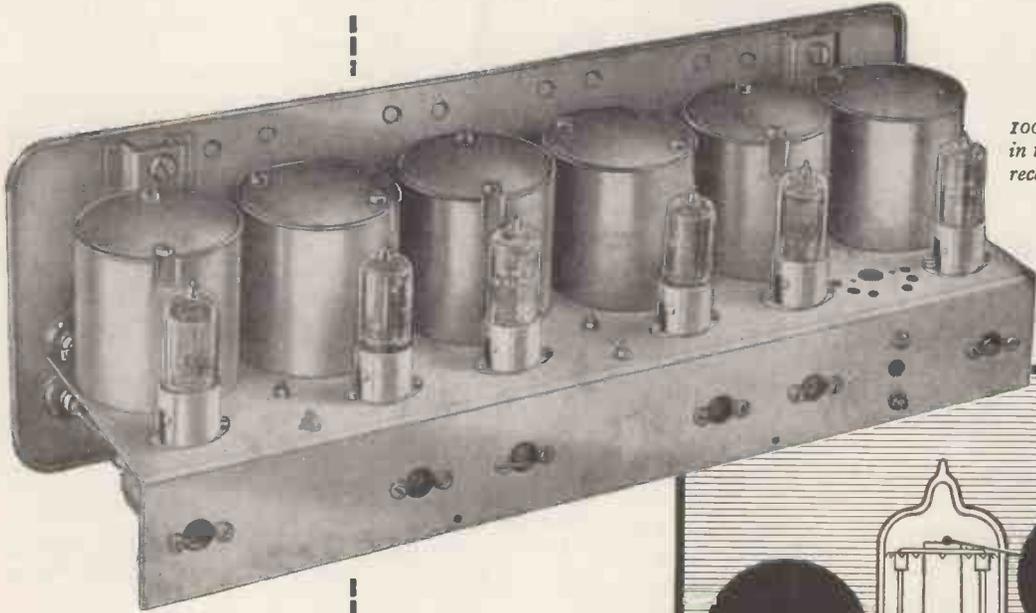
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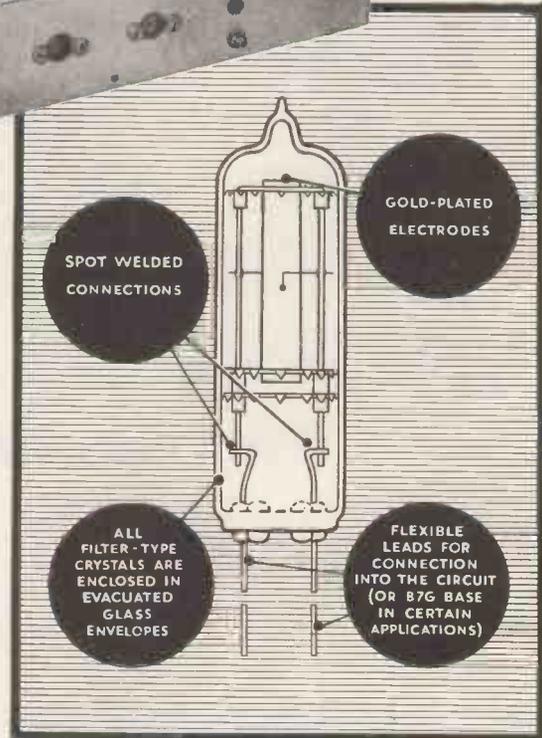
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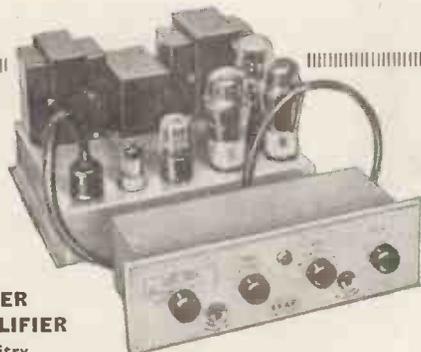
With this clear lead on low-distortion amplifiers we were able to build up an export market much greater than the domestic one, and the increased volume of manufacture resulted in lower prices, which, in turn, brought real high fidelity amplifiers within the reach of the music-lover at home.

We have devoted 21 years entirely to the development and manufacture of audio products and we are proud of our position as the leaders in this field. We are also proud of the fact that the "Point One" amplifiers supplied to our first customers are still giving them results which, even now, cannot be surpassed. Our research and development departments are ever active, our pre-amplifiers have been redesigned for use with the latest input devices, and we have made great progress in the war on prices. From long experience, by the employment of new techniques and by extreme attention to design details during development work on the pre-production models, we enable our labour force to achieve a high output per man-hour. The labour costs thus saved offset the increased costs incurred for high-grade materials, components and finishes, and this together with quantity production (made possible only by a world-wide market) explains how quality products may be sold at reasonable prices.

To our old customers we give our thanks for their support and recommendation—the basis on which our Company has grown. Those who are seeking to obtain the highest quality of gramophone and radio reproduction would be wise to hear and inspect LEAK products which, with their tradition of excellence, represent the best that can be obtained; used by the B.B.C. and overseas broadcasting companies and recording studios throughout the world.



HIGH FIDELITY  
EQUIPMENT



### POWER AMPLIFIER

#### 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:  $\pm 1$  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.

The products we manufacture are:

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Dynamic (Moving-Coil) Pickups

F.M. Tuner Units

and later in 1956 a loudspeaker system incorporating a balanced push-pull electrostatic treble loudspeaker unit.

★ Write for leaflet W ★

## LEAK TL/10 AMPLIFIER & 'POINT ONE' PRE-AMPLIFIER

27 gns. complete

### '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 amplifiers.

#### ★ 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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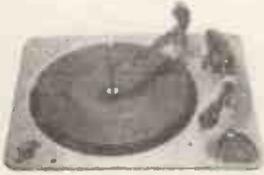
Reprints of "The Gramophone" article (May, 1955), by H. J. Leak, summarising his work and findings on Electrostatic and Dynamic Loudspeakers, are available on request, free of charge.

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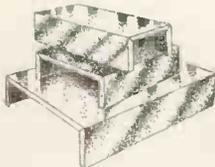
**F.M. TUNER**

This tuner is based upon the very successful circuit in the booklet published by Data Publications. We have made up models at all branches and will be glad to demonstrate. Cost of all parts including valves, prepared metal chassis, wound coils and stove enamelled case, slow motion drive, pointer, tuning knob, in fact everything needed to make the complete unit, is 26/12/6. Data is included free with the parts or is available separately price 2/-.



**SERVICE DATA**

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makes are included: Aerodyne, Alba, Bush, Cosor, Ekco, Ever-Ready, Ferguson, Ferranti, G. E. C., H. M. V., Kolster-Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price 2/- for the complete folder. Our Folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers, "all dry," etc., which have been imported into this country. Names include Spartan, Emmerson, Admiral, Crossley, R. C. A., Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is 1/- Post free.



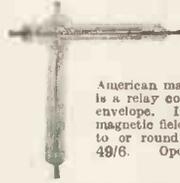
**BLANK CHASSIS**  
18 S.W.G. Aluminium

7x3 1/2 x 2	3/9	14x10x3	7/9
9 1/2 x 4 1/2 x 2 1/2	5/-	16x10x3	8/3
10x8x2 1/2	5/6	16x12x3	8/8
10x5 1/2 x 2 1/2	5/-	19 1/2 x 9 x 2 1/2	8/3
12x9x2 1/2	7/-	20x10x3	10/-
14x9x2 1/2	7/6		

**DASHPOT DELAYED CONTACTOR**

American make type No. R.01D. This has adjustment to delay opening and closing, and has secondary contacts suitable for heavy currents operating coil; 110 v., 50 cycles. Price 37/6.

**VACUUM RELAY**



American made type No. C.61610, this is a relay completely sealed in a glass envelope. It will close in a strong magnetic field or by a coil placed close to or round one of its arms. Price 49/6. Operating coils 25/- each.



**MULLARD AMPLIFIER "510"**

A High Quality Amplifier designed by Mullard engineers. Robust high fidelity with a power output exceeding 10 watts and a harmonic distortion less than 4% at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 20,000 C.P.S.—three controls are provided and the whole unit is very suitable for use with the Coltaro Studio and most other good pick-ups. The price of the unit completely made up and ready to work is 215/10/-, plus 10/- carriage and insurance. Alternatively, if you wish to make up the unit yourself we shall be glad to supply the components separately. Send for the Mullard amplifier shopping list.

**BAND III CONVERTER**

**ADDITA—Many hundreds in use**

Any television receiver, whether superhet or straight A.C. or A.C./D.C., home constructed or factory built, which at present will receive B.B.C. will also receive I.T.A., if this converter is added. No modifications at all are necessary to the receiver. Simply plug in the aerial leads and connect to A.C. mains. The converter is in a neat metal case with provision for fixing to the side or the back of the set. Price 28/10/-, or H.P. terms available on request if required.

**BUILD YOUR OWN CONVERTER**

You can save at least £2 on the above if you build the converter yourself. Price of all components including stove enamelled case and even transfer for the front is 23/10/- or 24/10/- if mains components also required. Data is included free with the parts or available separately price 2/6.

**BAND III FILTERS**

To eliminate patterning and other interferences. Two models—one high-pass cuts out frequencies above 45 mc/c, the other low-pass cuts out frequencies below. Price 27/6 each, postage 2/6.

**RECORD PLAYER FOR 24/10/-**



**3-SPEED INDUCTION MOTOR**

3-speed motor with metal turntable and rubber mat. Latest rim drive with speed selection by knob at the side.

**HI-FI PICK-UP**

Using famous Cosmocord Hi-G turnover crystal. Separate sapphire for each speed. Neat bakelite case with simple adjuster for weight compensation.

**SPECIAL SNIP OFFER THIS MONTH**

The two units for 24/10/-, or 30/- deposit and four payments of 13/-, post and insurance, 5/-. Or fitted upon base, as illustrated, 25/10/-, plus 7/6 post and insurance.

**LIGHTING SNIP**

New perfect fluorescent tubes by famous maker—5 feet 80 watt standard B.C. fitting, 9/6; 4 feet 40 watt standard two-pin fitting, 8/6. Post and insurance and carriage 1/- per tube. Minimum quantity despatched 1 doz.

**CABINETS FOR ALL**

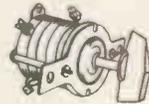
**WE CARRY A VERY VARIED STOCK PLEASE CALL**



The one illustrated is the "Empress." It is undoubtedly a beautiful piece of furniture. It is elegantly veneered externally in figured walnut, internally in white sycamore. The radio section is raised to convenient level but is not drilled or cut. The lower deck acts as the motor board, again is uncut, it measures 16x14 and has a clearance of 5in. from the lid. There is a compartment for the storage of recordings. Overall dimensions of this essentially modern cabinet are 3ft. wide, 2ft. 8in. high and 1ft. 4 1/2in. deep. Price 214/14/- carriage and insurance 20/-.

**TOWARDS AUTOMATION**

Rotary switch—Ministry Ref. No. AP57579, this is a motor driven switch, the driving motor being a synchronous type for working on 110 volts 50 cycles. The two switches have 20 positions each and are enclosed by a Perspex fronted lid. Separately operated relays providing interlocks. Price 24/17/6 each.



**30 AMP ROTARY SWITCHES**

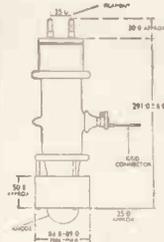
A very robust switch, made by one of our most famous firms. Will give lifetime of service. Price complete with pointer knob. 4 pole change over, 10/-, 6 pole change over, 17/6. D.P. on/off 15 amp., 4/6.

**HIGH WATTAGE LAMPS**

All G.E.S. Base

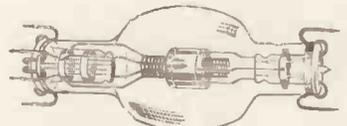
1,000 watt, 230 v., 7/6. 1,500 watt, 230 v., 9/6. 400 watt (fluorescent), 17/6.

**SPECIAL PURPOSE VALVES**



Triode Type CV 1098 this is a high-power air-cooled triode. Specification of which is as follows: Filament voltage 8.2 v., filament current 35 amps., anode dissipation 750 watts.

This valve is very suitable for R.F. heating at high frequencies and two of these in push-pull under Class C conditions would have an output of approximately 2 kilowatts. Brand new, still in original shockproof packing, price 25 each. Carriage and insurance 10/-.



**TETRODE TYPE VT31**

This is a high-powered air-cooled tetrode. Specification of which is as follows:—Heater volts 11.25, heater current 8 amp., maximum anode voltage 5 kV., anode dissipation 250 watts, size approximately 1 1/2in. long and 3/4in. across the bulb.

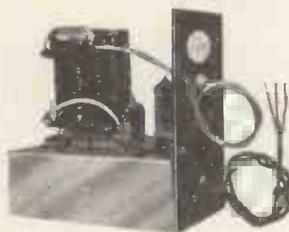
Limited quantity only at 22 each, still in original packing. Carriage and ins. 10/-.

**THIS IS ON OFFER AT APPROX. HALF COST TO MAKE**



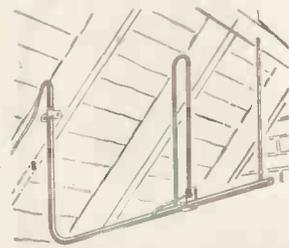
An impressive costly looking cabinet originally designed for T.V. but simple modification makes the cabinet suitable for radiogram, amplifier, tape recorder, or reflex speaker—size 23in. wide, 22in. deep and 37in. high. Limited quantity at £8/15/- each, carriage 12/6.

**E.H.T. GENERATOR**



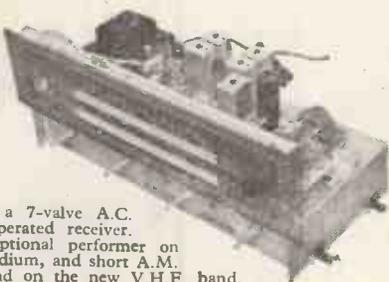
This is a made-up unit, power consumption 6.3 volt 8 amp. filament and approx. 59 mA H.T. Contains three 6V4 valves. Output from 6 kV to 9 kV rectified with normal H.T. rail input but somewhat higher outputs can be obtained with higher H.T. supply. Dimensions are 6½ x 4½ x 7in. Price 89/6, post, packing, etc., 3/1.

**BAND III AERIALS**



- This is a ½ wave-length 3 element array. Of all alloy construction, the aerial is completely assembled and ready for instant mounting in loft, bedroom cupboard, window frame, etc. Price 12/6 plus 2/-.
- 3 element array with swan-neck mast with "U" bolt clamp for fitting to existing masts from ½in. to 2in. dia. .... 41/6
- 3 element array with cranked mast and wall mounting bracket ..... 42/6
- 3 element array with cranked mast and chimney lashing equipment ..... 65/-
- 5 element array with swan-neck mast and "U" bolt clamp for fitting existing mast from ½in. to 2in. dia. .... 52/6
- 6 element array with cranked mast and chimney lashing equipment ..... 67/-
- 8 element array with swan-neck mast and "U" bolt clamp for fitting to ½in. to 2in. dia. mast.... 89/-

**AM/FM RADIOGRAM CHASSIS**



This is a 7-valve A.C. mains operated receiver. An exceptional performer on long, medium, and short A.M. bands and on the new V.H.F. band. It is an ideal unit for a quality radiogram. Special features include magic eye tuning indicator, extra long scale and pointer travel—latest circuitry employing full A.V.C. feedback, etc., etc. Undoubtedly one of the finest AM/FM chassis available today. Chassis size 17½in. x 6½in. x 7½in. Price £23/17/6, carriage, packing, and insurance 20/- extra.

**THE ARGONAUT**

The Argonaut, a very efficient medium wave and V.H.F. A.C. operated receiver described in the March and April issues of "Radio Constructor," all parts are available and total cost is only £14/10/- which includes drilled metal chassis, nine valves—one of which is a magic eye tuner of the latest type, every resistor and condenser, and even nuts and bolts, etc., needed to completely build the receiver. A cabinet will be available later in the year. The speaker not included in the above is available if required. All parts available separately, send for shopping list.



**THIS MONTH'S SNIP**

14in. T.V. cabinet of the latest styling made for one of our most famous firms—beautifully veneered and polished—limited quantity—19/6 each. Carriage and packing 3/6 extra.

**The "ESTRONIC" BAND III CONVERTER**

To-day's best value in Band III converters suitable for your T.V. or money refunded. Complete ready to operate, 59/6 non mains or 85/- mains, post and insurance, 3/6.

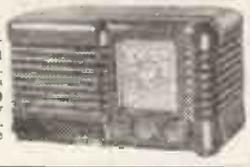


**HALF-PRICE OFFER BEETHOVEN CHASSIS**

Extremely well built on chassis size approx. 9½ x 7½ x 8½, using only first-class components, fully aligned and tested, 110-240 volt A.C. mains operation. Three wave bands covering medium and two shorts. Complete with five valves, frequency changer, double diode triode, pentode output and full wave rectifier. Special cash-with-order price this month, £5/19/6, carriage and insurance 7/6. Polished Cabinet 49/6.

**NEW CIRCUIT**

OCCASIONAL 56—we have evolved a new T.R.F. circuit and have had really good results, equal in fact to many superhets. You really should try this circuit. All parts including valves (6X7, 6X7, 6F6, and 6X5) and Bakelite case with back cost only £5/10/-, plus 2/6 post and insurance. Data included with the parts is also available separately price 2/-.



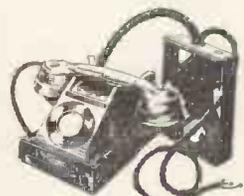
PLEASE INCLUDE POSTAGE WHEN ORDERING

**RII55 YOURS FOR £3 and 12 monthly payments of 11/6**



The RII55 is considered to be one of the finest communication receivers available to-day. Its frequency range is 75 kc/s. to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F. so obviously a robust receiver which will give years of service. Completely overhauled and guaranteed in perfect working order. Price £8/19/6, or £3 deposit, balance by 12 monthly payments of 11/6. Carriage and Transit case 15/- extra. Mains Power Pack, with built-in speaker, £5/10/-, or in polished cabinet, £6/15/-.

**OFFICE TELEPHONES**



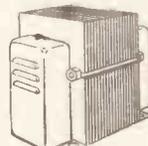
New G.P.O. telephone sets with internal bell and push button switch easily connected together to form office Intercom. Price £2/10/- each. Post, etc., 2/6.

**TRANSFORMER SNIP**

11/6

Post 2/-

Fully shrouded—standard 200-250 v. primary 280-0. 280 at 80 mA., 6.3 v. at 3 amp., 5 v. at 2 amp.



**FINE TUNERS**



Ceramic trimmers all with ½in. spindles of fair length. 5, 10, 15, 30, P.F. all 2/3 each or 24/- per dozen.

**CIRCUIT DETAILS**

Diagrams and other information extracted from official manuals. All 1/6 per copy. 12 for 15/-.

American Service	R.109
Sheets	78 receiver
A.1134	'76 receiver
BC.348	R28/ARC5
BC.312	RII16/A
R.103A	RA-1B
B.C.342	AR88D
RA-1B	AN/JA-P1
R-208	78
R-1155	78
R-1124A	R.T.18
R-1132A/R-1481	CAY-46-AAM:
R-1147	RADAR
R-1224A	A.S.B.-3
R-1082	Indicator 62A
R-1355	Indicator A.S.B.3
B.C.1206-A/B	Indicator 62
B-455-A (or -B)	Indicator 6K
B-454-A (or -B)	R.F. unit 24
B-453-A (or -B)	R.F. unit 26
Transmitter T1164/	R.F. unit 25
B.D.J.N.	R.F. unit 27
Fifty-eight walkie-talkie	Wireless set No. 19
Frequency meter	Embedded valves
B.C.221	

**ELECTRONIC PRECISION EQUIPMENT LTD.**

249 Kilburn High Road, Kilburn.  
Phone: MA1 4921  
Half-day Thursday

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Phone: RUISLIP 5780  
Half-day Wednesday

152-153 Fleet St., E.C.4.  
Phone: FLEET 2833  
Half-day Saturday

29 Stroud Green Road, Finsbury Park, N.4.  
Phone: ARCHWAY 1049  
Half-day Thursday.

Post orders should be addressed to E.P.E. LTD., M.O. Dept. 2, 123, TERMINUS ROAD, EASTBOURNE. All enquiries to Eastbourne address and please enclose S.A.E., terms are cash with order.

## BUILD THE JASON "ARGONAUT" M.W./F.M. TUNER

FOLLOWING THE SUCCESS OF OUR F.M. TUNER KIT, WE NOW INTRODUCE THIS SUPER-SENSITIVE MW/FM TUNER. THE SWITCHING AND WIRING ARE SIMPLE, BUT PERFORMANCE HAS NOT BEEN SACRIFICED. THERE IS SPACE ON THE CHASSIS FOR POWER PACK AND OUTPUT STAGE. THE BUILDING INSTRUCTIONS ARE APPEARING IN MARCH AND APRIL 'RADIO CONSTRUCTOR' AND WILL BE AVAILABLE AS A REPRINT.



DIAL ASSEMBLY, WITH CHASSIS FLYWHEEL TUNING, JACKSON BROS 4 GANG CONDENSER, GLASS SCALE CALIBRATED, WITH STATION NAMES ON BOTH BANDS £3-18-0

ALL COILS INCLUDING RATIO DETECTOR, MW COILS AND TWIN IF'S ..... £8-11-9

AVAILABLE FROM OUR USUAL STOCKISTS INCLUDING CLYNE RADIO, HOME RADIO OF MITCHAM, SMITH'S EDGWARE ROAD ETC. APPROX. TOTAL COST TO BUILD ..... £16-0-0

### THE JASON MOTOR & ELECTRONIC Co.

328 Cricklewood Lane

LONDON N.W.2 — Telephone SPE. 7050

## When you buy a tape recorder

*your choice will be governed by  
two factors —*

### PRICE AND SPECIFICATION

*The best tape recorder won't be cheap —  
but it will be good value for money.*

The Grundig 'Specialist' TK.820/3-D is the best value for your money. Its presentation, its versatility, its performance, its push-button track changeover, makes it the only possible choice for so many people. Provided the machine has the facilities, appearance and ease of control you demand, it remains to check whether or not its specification will stand up to your requirements.

*Here is the complete technical specification of the TK.820/3-D. Read it critically—and write to us if there is anything else you would like to know.*

**GRUNDIG**

Makers of the finest tape recorders in the world.

**GRUNDIG (Great Britain) LTD., Dept. WW,**  
Grundig House, 39/41 New Oxford St., London, W.C.1  
Telephone: COvent Garden 2995

(Electronics Division, Gas Purification & Chemical Co. Ltd.)

### GRUNDIG 'SPECIALIST'

Mains voltage: suitable for A.C. only, 105–115, 190–210, 210–230, 230–250 volts, 50 cycles. Power Consumption: approximately 90 watts maximum. Mains Fuses: 2 amps (for 105–115 volts), 1 amp (for 190–250 volts). H.T. fuses: 500 mA Surge Resisting, 120 mA Surge Resisting. Valve line-up: EF 86, ECC 81, EL 84, EL 42, EM 71 + 2 metal rectifiers. Mains tapping panel and fuses instantaneously available. Two tape speeds — 3½ ins/sec and 7½ ins/sec: speed change instantaneous by electrical means — heavy duty dual speed split phase induction motor: recording time (with 1,200 feet recording tape) 2 × 30 minutes at 7½ ins/sec — 2 × 60 minutes at 3½ ins/sec: half track recording, track change without spool reversal: track changeover by press button approximately 2 seconds. Trackbutton remains down to indicate which track was played last: frequency range 50–9,000 cycles at 3½ ins/sec, 40–14,000 at 7½ ins/sec: noise is down at least 40 dBs and wow and flutter less than 0.3% at 7½ ins/sec, less than 0.5% at 3½ ins/sec.

Automatic stop foil at end of spools: fast forward and fast rewind time approximately two minutes per full spool. Illuminated precision place indicator: recording level meter by 'magic eye', tone control for treble or bass emphasis.

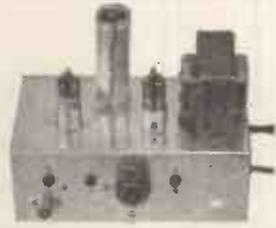
Loudspeakers: elliptical high-flux permanent magnet moving coil + two 2½ inch tweeters. Special four-position speaker control. Connections for low impedance extension speaker and high impedance external amplifier remote controls, earphones. Microphone, diode and radio input sockets.

Overall dimensions: 17 inches × 17½ inches × 9½ inches. Weight approximately 48 lb.

Retail Price 98 gns.



**BAND 3 T.V. CONVERTOR 188/196 Mc/s**  
 ("W. World," May 1954).



Kit of parts complete to build this most successful unit comprising drilled chassis 7 x 4 x 2 1/2 in., valves, wound coils, res., cond., etc., slightly modified version using 8D3 or Z 77 instead of EF 80 valves, £2/5/- post free. Send for blue print and wiring diagram. 1/6 post free. Power Pack Components, including mains trans. and met. rect., 30/- extra. Provision has been allowed on chassis for Band 1-Band 3 switchine. Kit of switch parts 7/6.

**RADIO - GRAM CHASSIS 5 VALVE SUPERHET, LATEST B.V.A. MIDGET SERIES VALVES**

3 WAVEBANDS:—L.W. 800m-2000m, M.W. 200m-550m, S.W. 16m-50m Chassis size 13 1/2 in. x 5 1/2 in. x 2 1/2 in. Attractive Glass Dial 10 in. x 4 1/2 in. edge lit by 2 pilot lamps. Horizontal or Vertical Station Names and 4 control knobs, walnut or ivory to choice. 4 position W/C switch, L.M.S. and Gram. P.U. sockets. Modern circuitry, all coils adjustable dust cored and only quality components used throughout. Delayed A.V.C. and met. feed-back. A.C. mains 200/250 v. Double wound trans. isolates chassis from mains. Aligned and calibrated ready for use.

**BRAND NEW & GUARANTEED £9.15.0 Carr. and ins. 4/6**  
 3-ohm speakers suitable for this chassis available 8" 19/6, 10" 25/-.

This chassis is a genuine bargain and delivery is reasonably good.

**BEST EVER VALUE IN RECORD PLAYERS**

Latest B.S.R. Model. 3 speed Autochanger Mixer Unit. Famous Magidiso 7 in., 10 in. x 12 in. record selector. Modern cream styling. Dust Xial cartridge stylus for high fidelity reproduction. As used by leading Radiogram Manufacturers. Complete with full instructions and template.

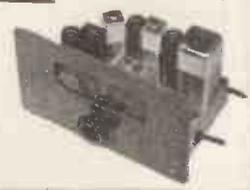
**OUR BARGAIN PRICE £8.19.6 Carr., Ins., 4/6**

**ELECTROLYTICS** Leading Makes New Stock

TUBULAR	CAN TYPES	80 ohm CABLE	CO-AXIAL
25/25 v. 50/12v. 1/9	8+8/450 v. .... 4/6	SPECIAL.—Semi-air spaced polythene. standard 3/16 in. diam. Stranded core. Feeder losses out 50%. 9d. yd.	
50/50 v. 4/500 v. 2/-	8+18/450 v. .... 5/-	COAX PLUGS .....	1/2
100/25 v. .... 2/8	18+18/275 v. .... 4/6	SOCKETS .....	1/3
8/500 v. .... 2/8	18+18/450 v. .... 5/6	COUPLERS .....	1/3
8+8/500 v. .... 4/6	18+18/450 v. .... 6/-	OUTLET BOXES .....	4/6
8+18/450 v. .... 5/-	32+32/350 v. .... 4/6	BALANCED TWIN FEEDER per yd. (80 ohms) 6d.	
18/450 v. .... 3/6	32+32/450 v. .... 6/6	TWIN SCREENED FEEDER per yd. (80 ohms) 1/-.	
18+18/450 v. .... 5/6	60+250 v. .... 6/6	50 OHM COAX CABLE 3d. per yd. 3/16 in. dia.	
32/350 v. .... 4/-	60+100/350 v. 11/6		
32/500 v. .... 5/-	60+250/275 v. 12/6		
32+32/350 v. .... 5/6	100+200/275 v. 12/6		

CONDENSERS.—Mica, Silver, Mica. All pref. values, 3 pl. to 680 pl. 6d. each, ditto ceramics 9d. each. Tubulars, 450 v., 500 v., 1000 v., 2000 v., 5000 v., 10000 v., 20000 v., 50000 v., 100000 v., 200000 v., 500000 v., 1000000 v. Hunts and T.C.G. 0005, 001, 005, 01, 02 and 1 350 v., 9d. .05, 1 500 v. Hunts. 1/-, .25 Hunts. 1/6. .5 Hunts. 1/9.

**JASON F.M. TUNER UNIT 87-105 mc/s**



Kit of parts to build this modern and highly successful unit complete with drilled chassis and J.B. dial, wound coils and screening cans, 4BVA miniature valves, and all necessary quality components, etc., for only £6/10/- post free. Superior dial calibrated met.s., edge lit by 2 pilot lamps, 12/6 extra. Power Pack components kit including double wound mains transformer £2/5/- extra. Tested and approved by "Radio Constructor," etc. Illustrated handbook with full details 2/- post free.

**RESISTORS**  
 Carbon type. Pref. values 10 ohms-10 megohms. 20% Tol. 1/2 w. 3d.; 1 w. 5d.; 1 w. 6d.; 2 w. 9d.  
 10% Tol. 1 w. 9d.; 5% Tol. 1/2 w. 1/-; 1% Hi-Stab. 1 w. 2/-

**WIRE WOUND TYPES**  
 Wire ends. Silicone coated. 25 ohms-10,000 ohms, 5 w. 1/3; 10 w. 1/6; 15 w. 2/-; 15,000 ohms-53,000 ohms, 5 w. 1/9; 10 w. 2/3.

**S.T.C. RECTIFIERS**  
 K3/25 2 kV., 4/3; K3/40 3.2 kV., 6/-; K3/46 3.6 kV., 6/6; K3/50 4 kV., 7/3; K3/100 8 kV., 12/6; K3/160 14 kV.; K3/1- RM1 125 v. 60 mA., 4/-; RM2 125 v. 100 mA., 4/9; RM3 125 v. 120 mA., 5/9; RM4 250 v. 275 mA., 16/-; HT59 250 v. 200 mA., 26/6.

**PRE-SET W/W POTS**  
 T.V. knurled slotted knob type. 25 ohms to 30,000 ohms 3/-; 50,000 ohms. 4/-; 60,000 ohms to 2 Megohms (carbon) 3/-.

**VOLUME CONTROLS**  
 1 in. semi Midget Type. Loaz spindles. All values 10,000 ohms to 2 Megohms. Less sw., 3/-; S.P. sw., 4/-; D.P. sw., 4/9 All individually boxed. Quar. 12 months.

**ALUMINIUM CHASSIS**  
 18 g. Plain undrilled. Folded 4 sides riveted corners, lattice fixing holes Depth 2 1/2 in., 7 in. x 4 in., 4/6; 9 in. x 6 in., 5/9; 11 in. x 7 in., 6/9; 13 in. x 9 in., 8/6; 14 in. x 11 in. 10/6. etc.

**T.R.S. RADIO COMPONENT SPECIALISTS**  
 70 BRIGSTOCK RD., THORNTON HEATH, SURREY

Phone: THO 2188. Hours 9 am-6 pm., 1 pm. Wed. Open all day Saturday. BY THORNTON HEATH STATION. BUSES 130A, 133, 159 166, 190

**L.R.S.**  
 Estd. 1925

**EASY TERMS**

**LEAK QUALITY EQUIPMENT**  
 for the Connoisseur

If you want the Finest Quality Reproduction together with Workmanship of the Highest Order your choice must be LEAK.

AS USED BY BROADCASTING CORPORATIONS THROUGHOUT THE WORLD.

LEAK "TL/10" AND "POINT ONE" PRE-AMPLIFIER. Cash Price £28/7/-, or sent for £4/10/- Deposit and 18 monthly payments of 30/-, carr. and crate free.

**LEAK DYNAMIC PICK-UP**  
 Complete with two detachable diamond heads and transformer. Cash Price £21/19/9 or sent for £4 Deposit and 10 monthly payments of 40/-. Post and packing paid.

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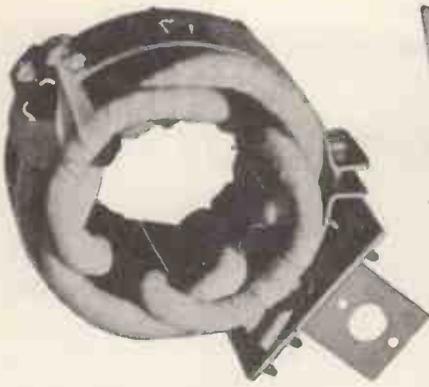
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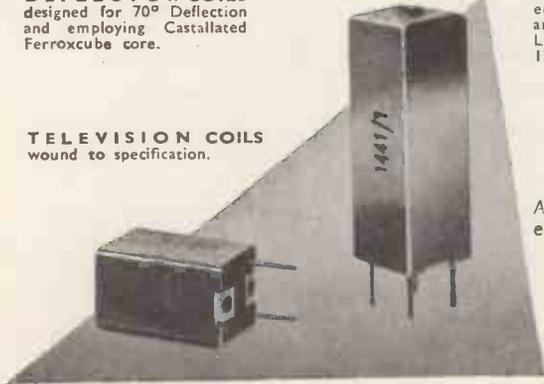
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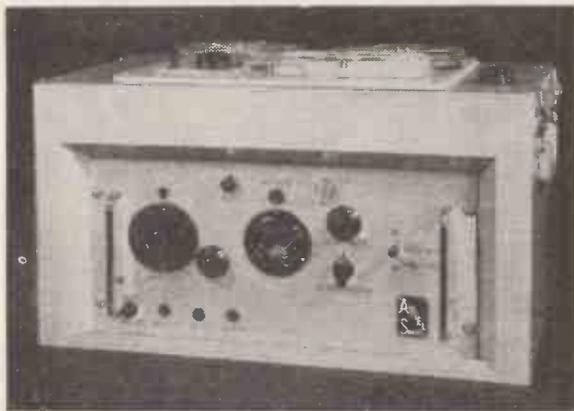


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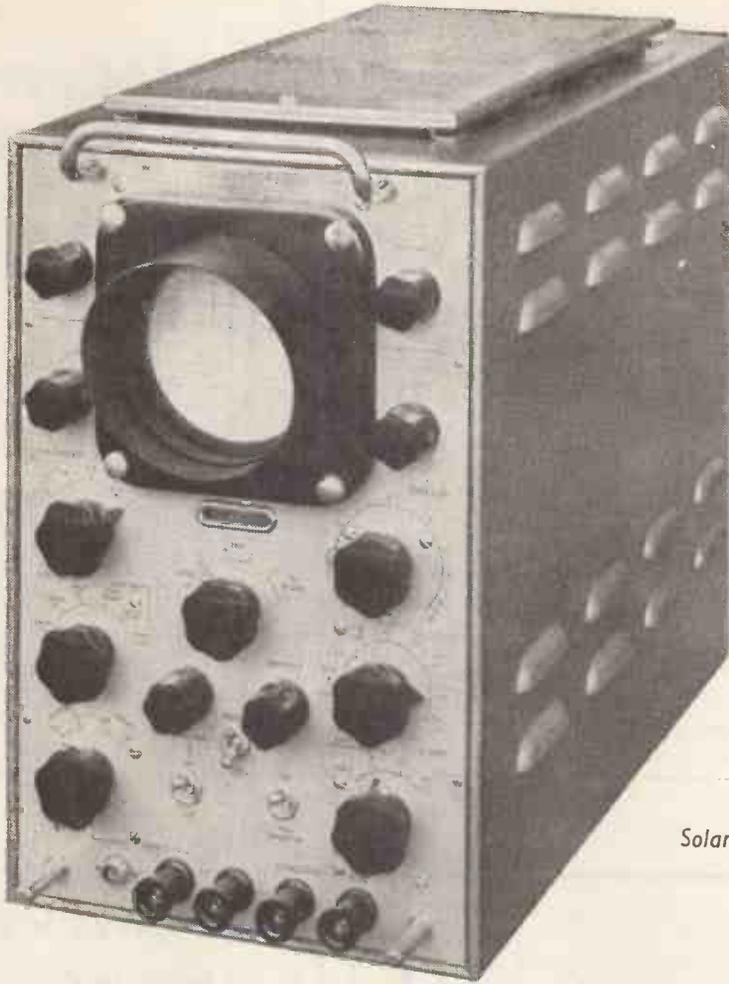
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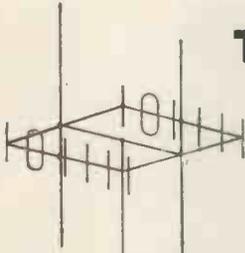
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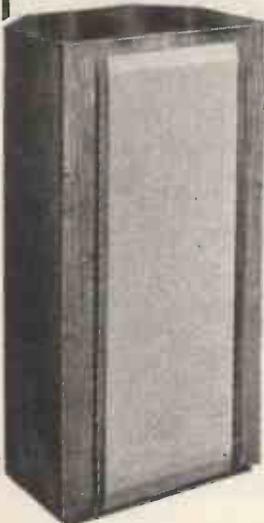


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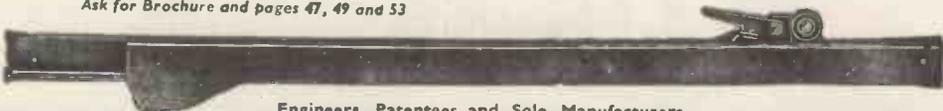
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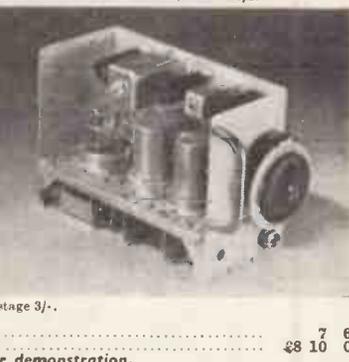
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130 Types: 5675 Kc/s to 8550 Kc/s (Channel 270/389). (In steps of 25 Kc/s.) 80 Types: 6706, 667 Kc/s to 8340 Kc/s. (Channel 0779). (In steps of 33,333 Kc/s). BRAND NEW AND GUARANTEED. 10/- each. Complete sets of 80 and 120 Crystals available.

**62A INDICATOR UNIT**

Containing VCR97 with Mu-Metal Screen 21 valves: 12-EF50, 4-8P61, 3-EA50, 2-EB34. Plus Pots, Switches, H.V. Cond., Resistors, Muirhead 8/M Dial, Double Deck Chassis and Crystal. BRAND NEW ORIGINAL CASES, 67/6. Carr. 7/6.

**TYPE FT241A [54th Harmonic.**

2-Pin 4in. Spacing.  
21.1 Mc/s, 22.9 Mc/s, 26.0 Mc/s  
21.2 Mc/s, 22.9 Mc/s, 26.1 Mc/s  
21.4 Mc/s, 23.2 Mc/s, 26.4 Mc/s  
21.5 Mc/s, 23.4 Mc/s, 27.0 Mc/s  
22.0 Mc/s, 24.4 Mc/s.  
BRAND NEW AND GUARANTEED. 7/6 each.  
Complete Sets of 80 Crystals Channel Q/79 available.  
200 Kc/s., 10/- each.  
CRYSTAL HOLDERS, 1/3 each.  
10% Discount on all orders of 25.

**INDICATOR UNIT TYPE 182A**

Unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-Metal screen, 3 EF50, 48P61, and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Offered BRAND NEW (new relay) at 67/6. Plus 7/6 carr. "Radio-Constructor" scope circuit included.

**THE "TELETRON" BAND III CONVERTER**

This converter which is built around two valves type EF80 (Z719) is for use with T.R.F. or Superhet Band I Television receivers. Complete set of Teletron coils only, with practical and theoretical wiring diagram 15/- post free. Chassis measuring 7in. x 3in. x 1 1/2 in., ready drilled to specification, 3/9 plus 9d. packing and post. Alternatively construction details only with separate individually priced parts list, 6d. post paid. The complete kit as specified, including all the above valves, etc., down to the last nut and bolt, can be supplied at 45/6 only, plus 2/- packing and post. Built up and tested 68/6. Power Pack Kit 22/6 extra.

**PYE 45 Mc/s. STRIP TYPE 3583 UNITS**

Size 15in. x 8in. x 2in. Complete with 45 Mc/s. Pye Strip, 12 valves, 10 EF50, EB34 and EA50, volume controls, and hosts of Resistors and Condensers. New condition. Modification data supplied.  
Price 69/6. Carriage paid.

**RCA 931A PHOTO-ELECTRIC CELL AND MULTIPLIER**

For facsimile transmission, flying spot telecine transmission and research involving low light-levels. 6-stage multiplier. Brand new and guaranteed, only £21/10/- Special 11-pin base 2/-, Data sheets included. Equivalent to Mazda 27M1 and 27M2.

**PHOTO-ELECTRIC CELLS.**  
Brand New and Boxed. 4 Pin U.X. base  
Baird 6818 - U.S.A. 71A - 868, 17/6 each.

**CRYSTAL MICROPHONE INSERTS**

Ideal for Tape Recording, Gramophone Amplifier, etc. Very sensitive Guaranteed and Tested, 5/- (ex-units) or 6/6 Brand new and boxed.



*Acknowledged for Perfection*

*Stern's "fidelity"  
Tape Recorder*

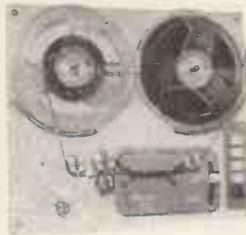
**SUPPLIED ASSEMBLED and  
READY FOR USE for £43/-/-**



**GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS)** (Plus £1/10/- carriage and insurance. £1 is refunded when packing case is returned to us.) H.P. terms. Deposit £21/10/0 and 12 monthly payments of £1/19/11. The items illustrated and described form the complete equipment.

THIS RECORDER IS AVAILABLE TO MAIL ORDER CUSTOMERS. SEND S.A.E. FOR ILLUSTRATED AND DESCRIPTIVE LEAFLET.

- Will play the new pre-recorded tapes.
- Provides 2 hours playing time at 3½ in. or 1 hour at 7½ in. per second.
- Will take all standard reels up to 1,200 ft.
- Extension speaker sockets are provided.
- Has dual input channels for "mixing".

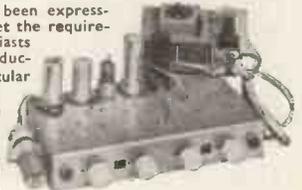


**THE NEW TRUVOX MODEL TR7U TAPE DECK**

THE NEW TRUVOX MODEL TR7U TAPE DECK. 3 Shaded-Pole motors. Drop-in Tape Loading. Push Button Control. Separate Push Button Brake. Fast forward and fast reverse. Silent drive eliminating Wow and Flutter. Half Track working and 2 speeds, 3½ in. and 7½ in. per sec. Positive Azimuth Adjustment. Overall size only 14½ x 12½ in.

**MODEL T.R.I./F. QUALITY AMPLIFIER**

This amplifier has been expressly designed to meet the requirements of enthusiasts for fidelity reproduction, and in particular to CORRECTLY operate the above TRUVOX DECK. It is supplied complete with a matched Elliptical 3 ohm P.M. Speaker, it incorporates an efficient Tone Control arrangement and has a Magic Eye Level Indicator (Operative on Record). A Co-axial Socket is also incorporated for MONITORING on Record. This can also be used to feed an external amplifier. The Amplifier can also be used for high quality reproduction of gramophone records direct from a gram unit.



ACOS CRYSTAL MICROPHONE MODEL MIC.33.1  
1,200 ft. REEL OF SCOTCHBOY MAGNETIC RECORDING TAPE.

**PORTABLE ATTACHE CASE**

This, as may be judged from the illustration above, is a neat, compact and attractively finished case, being covered with maroon rexine and having an ivory coloured speaker escutcheon. It contains concealed pockets to accommodate the Microphone, Mains Lead and a spare 1,200ft. reel of tape.

**HOME CONSTRUCTORS!!  
BUILD IT FOR £40/-/-  
IT ONLY NEEDS CONNECTING UP**

H.P. Terms are shown below.

The actual assembly of the Tape Recorder is extremely simple and only involves a few connections. The Truvox Tape Deck and the Quality Amplifier are supplied tested and ready for use, and all that is required to complete the Recorder is to connect the two together (a connection chart is supplied for this purpose) and secure them by the screws provided into the Attache Case.

**PRICE SUMMARY**

WE WILL SUPPLY ALL FIVE UNITS LISTED ABOVE, i.e. THE COMPLETE BUT UNASSEMBLED RECORDER FOR £40. H.P. Terms: Deposit £10 and 12 monthly payments of £2/15/- or in two parts as follows:—

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK MODEL TRIF AMPLIFIER WITH SPEAKER, 1,200ft. REEL OF TAPE .....	£33 10 0	£16 15 0	£1 11 1
(b) ATTACHE CASE AS ILLUSTRATED .....	£6 10 0	—	—
ACOS CRYSTAL MICROPHONE .....	—	—	—

See note below re packing charge

**NOTE:** Please send 30/- to cover cost of packing, carriage and insurance. We will refund £1 if the packing case is returned to us intact.

**EACH UNIT IS AVAILABLE SEPARATELY AS FOLLOWS:**

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK .....	£23 2 0	£11 11 0	£1 1 5
(b) AMPLIFIER MODEL TRIF WITH SPEAKER .....	£14 14 0	£7 7 0	9 months at 18/6
(c) PORTABLE ATTACHE CASE .....	£5 0 0	—	—
(d) ACOS CRYSTAL MIKE "33" .....	£2 10 0	—	—
(e) REEL OF TAPE 1,200ft. ....	£1 15 0	—	—

Please include £1 when ordering (a) or (c) for packing charge, this whole amount will be refunded if case is returned to us intact.

**STERN RADIO LTD.**

109 & 115 FLEET ST., LONDON, E.C.4

Phone: CENTral 5812-3-4



# FOR VALVES—GUARANTEED NEW AND BOXED

024	6/-	6F6M	8/6	9003	8/6	EB41	8/-	PL83	13/-
1A3	6/-	6F11	13/-	9004	8/6	EB41	11/-	PP225	5/-
1A5GT	6/6	6F13	13/6	9006	6/-	EBF80	11/6	PY80	10/-
1A7	11/6	6F15	13/6	954	2/-	ECC31	8/6	PY81	10/6
1CSGT	8/9	6G6G	4/-	955	4/9	ECC84	12/6	PY82	10/6
1HSGT	10/6	6H6	3/6	956	3/6	ECCH35	13/6	QP21	7/6
1NSGT	10/6	6J5/GT	5/-	10C2	12/6	ECCH81	13/6	SP22	6/-
1L4	6/6	6J5M	6/6	10F1	12/6	ECL80	10/6	U22	8/-
1LD5	6/9	6J6	7/6	10F9	12/6	EFL22	8/6	U329	13/6
1R5	8/-	6J7G	6/6	10P13	11/6	EL2	12/6	U403	9/-
1SS	7/6	6K6GT	6/6	12A6	6/9	EL41	11/6	U404	9/-
1T4	7/6	6K7G/GT	9/-	12AH7	6/9	EL84	12/6	UB41	8/-
1U5	8/-	6L7M	7/6	12J5	6/6	EM34	11/6	UB41	8/-
2X2	4/-	6K7	6/9	12A7U	9/6	EM80	12/6	UBC41	11/-
3A4	7/-	6K8G	8/9	12BA6	10/-	EY51	13/6	UCH42	11/-
3Q4	9/6	6K8GT	9/6	12BE6	10/-	EZ40	10/6	UF41	11/6
3Q5	10/-	6L1	13/6	12C8	8/-	EZ41	11/-	UY41	10/6
3D6	5/6	6L6G	9/-	12H6	5/-	EZ80	12/6	VR21	3/-
3S4	8/6	6L7M	7/6	12J5	6/6	E1148	2/-	VR53	6/6
3V4	8/6	6N7	7/-	12J7	9/6	EY91	7/-	VR54	2/-
4D1	3/-	6Q7G/GT	9/-	12K7	9/6	FV41/500	10/-	VR55	7/6
4J4G	8/6	6S4GT	8/-	12K7	9/6	GZ32	12/6	VR56	6/6
5Y3GT	8/6	6S7G	7/6	12SC7	7/6	H2	5/6	VR57	8/-
5Z3	8/6	6SH7	6/-	12SG7	7/6	HL23DD	7/6	VR92	2/-
5Z4G	8/9	6S7GT	8/-	12SH7	5/6	HP211C	6/9	VR105/30	7/6
6A7	10/6	6SK7	5/6	12SJ7	8/6	HP135	8/6	VR116	4/-
6ABG/GT	10/6	6SL7	8/-	12SK7	6/6	K72	5/-	VR119	4/-
6AC7	6/6	6SN7	8/-	12SQ7	8/6	K733C	10/6	VR136	7/-
6AG5	6/6	6SQ7	9/3	12SR7	7/6	K766	10/6	VR137	5/6
6AK5	6/6	6SS7	8/-	20D1	10/6	KTW61	7/9	VR150/30	8/-
6AL5	7/-	6U4GT	15/-	20L1	12/6	KTW63	8/6	VR23	8/-
6AM5	5/-	6U5G	8/6	25L6GT	8/6	KTZ41	6/-	V570	2/-
6AM6	7/6	6U7G	9/-	25U4GT	10/-	LP220	6/9	VT52	8/-
6AQ5	9/-	6V6G/GT	9/-	25Y5G	11/6	M5J	5/6	VT501	6/-
6AT6	8/9	6X4	8/-	25Z4G	9/-	MS/PEN	5/-	VU39	8/9
6B4	5/-	6X5GT	7/9	25Z6GT	8/6	N78	12/6	VU64	9/-
6B8	4/-	7B6	9/6	35L6GT	9/-	N79	12/-	VU111	8/6
6BA6	8/-	7B7	9/6	35W4	10/-	P41	9/-	VU120A	3/-
6BE6	8/-	7C5	8/6	35Z4GT	9/-	P215	5/-	W77	8/6
6BW6	9/-	7C6	9/-	50L6GT	9/-	PEN25	8/-	W61	8/-
6C4	7/-	7H7	8/-	AC/P	6/9	PEN46	8/6	X65	10/-
6CSGT	7/6	7Q7	8/-	AC/PEN	6/6	PEN220A	4/-	X66	11/6
6C6	6/6	7R7	8/-	ATP4	6/6	PCF84	13/6	Y63	9/-
6C9	10/-	757	9/-	AZ1	10/6	PCF80	12/6	IS50(A)	6/6
6D3	7/6	7Y4	8/6	DH73M	10/-	PCF82	12/6	12SC7	2/6
6D6	7/3	75	10/6	EABC80	13/6	PCL83	12/6	AZ31	10/6
6F6G	7/6	77	8/6	EAC91	10/-	PL81	13/6	5R4GY	9/6
				EAF42	12/6	PL82	11/6		

### MAINS DROPPING RESISTANCES

725 ohms Erie tap at 600 ohms	each	1/6
650 ohms taps at 375 ohms, 500 ohms, 5 ohms, 30 ohms	2/6	
770 ohms Mains Dropper for Midget Radios with a tap at 125 ohms, size 3in. long x 1/2in. dia.	1/3	
Dagole Mains Dropper .3A, cement coated with 2 sliders	3/9	
.2 amp. as above, 1,200 ohms	3/9	
Green Vitreous Mains Dropper, 1,328 ohms, 2 taps	1/3	
Zenith Mains Dropper, 910 ohms	2/-	

### STC RECTIFIERS

RM 1	3/10	RM 3	5/-
RM 2	4/3	RM 4	16/-

### SMALL SUB-CHASSIS

With 2 valveholders for 954, 955 type of valves ... 5/-

### PENCIL RECTIFIERS

K 3/25	5/8	K 3/50	8/8
K 3/40	7/6	K 3/60	9/8
K 3/45	8/2	K 3/100	14/8

### HEATER TRANSFORMERS Primary 230 v.

Available :

2 volt 1/2 amp.	4/6
4 volt 1.5 amp.	5/-
5 volt 2 amp.	10/-
6.3 volt 1 1/2 amp.	6/-
2 volt 3 amp.	7/9
4 volt 3 amp.	10/-
6.3 volt 1/2 amp.	5/-
6.3 volt 3 amp.	9/-
12 volt .75 amp.	5/-

### CRT ISOLATION TRANSFORMERS Type NR9

Ratio 1-1.25 giving a 25% boost on secondary. Particularly suitable for High Definition Receivers. Four types available to cover most tube heaters.

NR 9A 2 volt; NR 9B, 4 volt; NR 9C, 6.3 volt; NR 9D, 10.8 volt; NR 9E, 13.3 volt.

With Tag Panel and Solder Tags. 10/6 each.

### Type NR12

Mains input : 220/240 volts. Multi output : 0-2-4-6.3-7.3-10 and 13 volts.

Input has two taps which increase output volts by 25% and 50% respectively.

This transformer is suitable for most Cathode Ray Tubes in Medium Definition Receivers.

The MOST versatile Low Capacity C.R. Transformer with Universal Output.

With Tag Panel and Solder Tags, 21/- each.

### Type NR14

A most useful transformer for use with 2 volt Tubes with falling emission. Input : 230/240 volts.

Output : 2-2 1/2-2 1/2-3 volts at 20 amps.

With Tag Panel and Solder Tags, 17/6 each.

### SPECIAL PURCHASE!

G.E.C. Cabinet Loudspeakers. Cat. No. BC1955, 8in. P.M. Moving Coil Loudspeaker Unit, 2 1/4 ohms, with Volume Control. Price 60/- each.

### PHIFCO ALL-IN-ONE RADIO METER

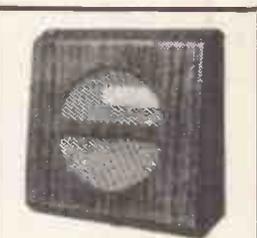
Tests L.T. 0-6 v. A.C./D.C., H.T. 0-240 v., A.C./D.C., MJA 0-30. Black Bakelite Case. Internal Battery for Circuit Testing. Price 32/6 each.

### VARIABLE CONDENSERS

3 gang .0005 mfd.	5/9
2 gang .0005 mfd.	5/9
2 gang .0005 mfd. with feet and trimmers	7/6
2 gang Midget with dust cover .00035 mfd. with trimmers	8/6
2 gang Midget .0005 mfd.	7/6

### T.S.L. FERRO-MAGNETIC AERIAL ROD

A length of Ferrite rod with full instructions for winding Medium or Medium and Long Wave internal aerials. 6/- each.



### LOUDSPEAKER CABINETS

This attractive walnut finished cabinet is available for 6in. or 8in. speaker units. Metal speaker fret, complete with back and rubber feet.

6in. type : Measures 8in. x 8in. x 4in. at base. Price 16/6 each.  
8in. type : Measures 10in. x 10in. x 5in. at base. Price 20/6 each.  
5in. type : Measures 6in. x 4in. x 7 1/2in. 16/6

### LOUDSPEAKER UNITS, ETC.

5in. Types by Elac., Lectrona, Celestion, etc.	17/6
6in. Types by Goodmans, Rola, R. & A.	18/6
8in. Types by Goodmans, Plessey, R. & A.	19/6
10in. Types by R. & A. Celestion, etc.	25/6
6in. Wafer Speaker by Truvox, suitable for Car Radio, etc.	20/-
12in. Plessey Lightweight	35/-
Elliptical Speakers, Goodmans 4in. x 7 in.	19/6
All above are P.M. Speakers, Standard 2-4 v. Speech Coil.	

### TELEVISION TABLE

Size of top, 19in. x 19in. Height, 18in. Rounded legs which unscrew for transit. 40/- each, carriage 3/-.

### CONNECTOR LEADS

Red single lead with wander plug and socket. 4d. each.

### YAXLEY TYPE SWITCHES

1 Pole, 4-Way	1/6
2 Pole, change-over	1/3
3 Pole, 3 Bank, 3-Way	1/6
4 Pole, 2-Way	1/9
2 Pole, 3-Way with Black Knob	1/6
5-Way, 2 Pole, 3 Bank	2/-

### VOLUME CONTROLS, ETC.

Miniature Volume Controls, double pole switch, 2 Meg. r. ... 4/6  
Standard Controls, single pole switch, 2 Meg. r. and 1/2 Meg. r. ... 3/6

### VALVEHOLDERS

B7G, B9A, B9G, etc., Moulded Types	9d.
B7G with Screening Cans	1/6
Ceramic international Octal	1/-
Duodecal Paxolin	9d.

### CABLES, ETC.

Twin Flat Transparent Mains Flex 14/0076	3d.
Screened Cable Singles	6d.
Twin	7d.
Push Back Wire, 14 Strands	2d.
Semi Air Spaced Co-axial Cable Solid 1/0022	7d.
Stranded 7/0076	8d.

### ★ ★ ★ ★ ★



- ★ Easy to Build.
- ★ Valves 6J7, 6K7, 6V6GT plus metal rectifier.
- ★ Walnut cabinet.

Full instructions, point to point wiring diagram. Circuit diagram, and full shopping list 1/-. All components may be purchased separately.

## Build this Excellent Kit for Yourself!

ALPHA 3 VALVE T.R.F. KIT

£5 . 10 . 0

# ALPHA

RADIO SUPPLY CO.



5/6 VINCES CHAMBERS  
VICTORIA SQUARE  
LEEDS 1.

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 2/3.

MAIL ORDER ONLY

WHEN ORDERING PLEASE QUOTE "DEPT. W.W."

# CLYNE RADIO LTD.



18, TOTTENHAM COURT ROAD, LONDON, W.1.

MUSEUM 5929/0095.

(50 yards only from Tottenham Court Road Tube!)

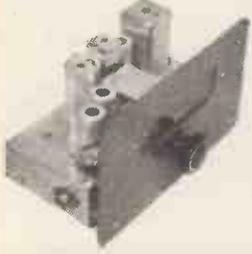
All post orders please to:—24-26, HAMPSTEAD RD., LONDON, N.W.1

EUSTON 5533/4/5

**TELETRON BAND III CONVERTOR!** Still available, this very popular convertor kit as illustrated and fully described in previous issues of the "W.W." For use with most T.E.F. or Superhet Band I T.V. Receivers. Construction details only, with separate individually priced parts list (6d. post free. Kit complete as specified 48/6, plus 2/- p. and p.  
**Mk. II Fringe area version kit complete** 59/6, plus 2/- p. and p. Power pack kit for either of above 25/-  
 We carry comprehensive stocks of all Band III Convertors by leading manufacturers. Also aerials, cross-over boxes, air-spaced/low-loss co-axial cable at 10d. per yard. Let us have your enquiries. Any branded convertor supplied on H.P. terms!

## THE JASON F.M. TUNER

Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in mc/s., and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 8in. x 5in., chassis 7in. x 4 1/2in. x 1 1/2in. Complete standard kit 28/15/- plus 2/6 p. and p. Fringe area kit 27/15/- plus p. and p.



## THE T.S.L. F.M. TUNER!

We can now supply this FM/VHF adaptor either in kit form, or fully assembled, wired and tested. Our price for the ready-built unit which incorporates its own power supply, is 213/15/- only tax paid, plus 5/- P. & P. or H.P. terms. Or the kit complete as specified 210/19/6 plus 3/6 P. & P. The booklet "F.M. TUNER CONSTRUCTION" (32 pages) with full technical data and point-to-point wiring diagrams, together with our separately priced parts list, is available at 2/6 post free.



**THE GRADIENT F.M. TUNER FM74.** We are still able to offer our latest F.M. TUNER as illustrated and described in our previous advertisements. Illustrated comprehensive instruction booklet with individually priced component list 1/6 post free. Or, the kit complete right down to the last nut and bolt 28/19/6 plus 2/6 P. & P.

**THE T.S.L. AM/FM CHASSIS!** Exceptional value. Covers L.M. and S.W. plus F.M.I. 8-valve push-pull output. Ferrite rod aerial. Valve line-up: ECC85, ECH81, EF89, EABC80, EC82, two 6BW6s plus 5y3. Large full-vision dial, size 14 1/2 x 6in. Chassis size, overall: 15 x 7 1/2 x 8in. high. Tax paid 26 guineas, plus 5/- packing and carriage. A supplementary extra is magic eye EM34, 26 guineas, plus 5/- packing and carriage. A supplementary extra is magic eye EM34, 26 guineas, plus 5/- packing and carriage. A supplementary extra is magic eye EM34, 26 guineas, plus 5/- packing and carriage. H.P. terms available. Demonstrations at 18 Tottenham Court Road!

**THE DULCI F.M. TUNER.** Incorporates own power supply, suitable for use with any amplifier. Valve line-up: ECC85, two EF89, EABC80, 6A4, and EM80 Indicator! Overall size: 9 x 6 x 5 1/2in. high. Pre-Budget price 216/16/- plus 8/- P. & P. Illustrated leaflet available, also H.P. terms.

**SPECIAL OFFER!** Champion Model 835 FM/VHF Adaptor! Designed for the instant conversion of A.C. radiograms, table A.M. receivers and Hi-Fi audio amplifiers, to enable owners through their existing equipment to obtain the best results from the new F.M. transmissions. Two connections only. One to the A.C. mains supply, the other to the pick-up socket. Valve line-up: EF89, two EF80s, EB91, and EZ80. In attractive red and cream bakelite cabinet. Illustrated leaflet available on request. Price whilst stocks last only 213/19/6 tax paid, plus 3/6 P. & P. H.P. terms available.

**DENCO F.M. TUNER.** This highly successful kit is still available at inclusive price of 26/7/6 plus 2/6 P. & P. This kit includes all components and the five valves required for the extra I.F. Stage for fringe area reception. If required, "Denco" dial and drive assembly is available for the above at 9/- extra. Full constructional details 1/6 post free.

**F.M. POWER PACK KIT.** We can now supply complete kit for power pack suitable for the above F.M. tuners or any other similar type. Price for the complete kit is 37/6 only, or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X4 and built on chassis size only 6 x 4 x 1 1/2in. Optional extra for power pack. Bulgin Octal Plug 2/3.

### COMPETITIVE!! BAND III. TWO NEW CONVERTORS!

Type "EB," with self-contained power pack and change-over switch for Band 1/3.

Valve line-up: 2 EF80.  
 Size 4in. x 4 1/2in. x 3 1/2in.  
 Separate contrast control for Band 1/3 very simply fitted INSIDE cabinet.  
 200 / 250 volts A.C. only. Price 26/7/6. P.&P. 2/6



Type "M.L.," for running from existing power supplies or separate power pack, available with Series Heaters. Valve line-up: PCC 64 and PCF 80. Size: 4 x 2 1/2 x 4 1/2in. Fitted with external fine tuning control for Band 3 and Band 1/3 change-over switch. Separate contrast control for Band 3. Power requirements: H.T. 150/250 v. at 30 mA., L.T. 15/16 v. 3 amp. (Series Heaters). Unit simply fitted inside cabinet. Complete with handsome escutcheon. Price 24/12/6. P. & P. 2/6. Full instructions supplied with each unit. Please specify whether required for London or Birmingham.



### THE FAMOUS UNIVERTER—COMPARE THE PRICE!

Handsome walnut cabinet. Suitable all areas. Contains own power supply. Simply connect to aerial. Four-valve circuit. Complete with all instructions 26/19/6 plus 3/6 P. & P.

## A.M./F.M.!

### INTRODUCING DULCI RADIO/RADIOGRAM CHASSIS TYPE H4!



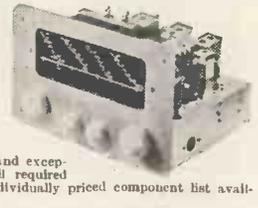
Incorporating the normal Long, Medium and Short wave bands, plus V.H.F. (Frequency Modulated) 87-101 mc/s. Latest miniature B.V.A. valves ECC85, ECH81, EF89, EABC80, EL84, EZ80, EM80. High Q inductances used throughout—Ferrite rods, for Medium and Long Waves Overall dimensions: Length 12in., Depth 1 1/2in. x 5 1/2in. including knobs and including knobs, 9 1/2in. Height 7 1/2in. Dial, which is multi-coloured on black background, has indicators for tone control and

Wavebands, measures Eye tuning, any P.M. speaker of 3 or 15 ohms may be used. Output 4 watts. Price is 227/16/- carriage charge 5/-. Illustrated leaflet available on request.

## AM/FM KIT! FIRST AGAIN!

Introducing the JASON AM/FM KIT for medium waves and F.M.!

By the time this advertisement appears we hope to have full details available. As illustrated this is a very high quality chassis incorporating 8 of the latest miniature valves, plus DM70 magic eye. Kits will be available for chassis complete with output stage at 215/5/-. Also less output stage but with own built-in power pack at 213/19/6 only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Individually priced component list available on request. Both plus 3/6 P. & P.



### SPECIAL PURCHASE! MANUFACTURER'S SURPLUS

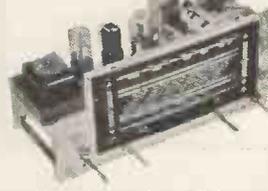
Owing to favourable purchase, we can offer strictly limited quantity of these handsome chassis. AQ/DC 200/250 v. for Medium and Long Waves, plus gram position. Incorporates own frame aerial. Valve line-up: U107, N108, DH107, W107 and X109. Overall chassis size 12 x 5 1/2 x 7 1/2in. high. Attractive bronze dial with orange and cream lettering. Dial size 11 x 4 1/2in. Scale length 7 1/2in. Logging scale provided. Price 27/19/6 only tax paid, plus 3/6 P. & P. H.P. terms. 24 deposit plus four monthly payments of 22/-.



### THE B.C. GRAM REPLACEMENT CHASSIS KIT

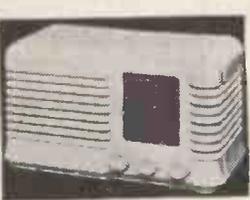
To meet the very great demand for this type of receiver, we have produced this unit! For Long, Medium and Short Waves. Valve line-up: 6K8 Frequency changer, 6K7, I.F. Amplifier, 6Q7 1st Audio Detector and A.V.C. 6V8 Output, 6X5 Full-wave rectifier.

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: 13 1/2 x 5 1/2 x 2 1/2in. Dial size: 10 x 4 1/2in. Assembly is simplified by the use of a 3-waveband coil pack, and pre-aligned 465 Kc/s. I.F. transformers—high-grade drop-through half-shrouded Mains Transformer, with voltage adjuster panel. This chassis can easily be assembled in one evening. Illustrated pamphlet, with full assembly instructions, practical and theoretical wiring diagrams and itemised price list 1/6 post free. The main items for this receiver can be supplied separately, as under. Drilled chassis, complete with valve-holders, A/E panel, P/U panel, tuning, condenser and ready-assembled dial and drive 39/6. 3-waveband coil pack with gram position 39/6 tax paid. Pair of 465 Kc/s. I.F. Transformers 9/6 pair. Half shrouded drop-through Mains Transformer 22/6. The total cost of ALL items purchased separately is nearly £10 but we shall be pleased to supply all the required components right down to the last nut and bolt at a special inclusive price of 28/8/- plus 2/6 packing and postage. A set of four small brown and cream engraved knobs to suit is available at 1/2 each knob. This chassis is a professional job in every respect and can be seen and heard at our premises. This chassis can also be supplied, ready assembled in very limited quantities at 29/19/6 plus 5/- carriage and packing.



Please add postage under £1, or Cash with order. C.O.D charge extra—open 9 a.m. to 6 p.m. Monday to Friday. Sorry but we close at 1 p.m. on Saturday.

**THE "ECONOMY FOUR" T.R.F. KIT.** A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up 6K7, 6J7 and 6V6. Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of Ivory or brown Bakelite, or wooden walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/6 post free. This is allowed if kit is purchased later. Please, 2/6 packing and carriage for complete kit.



**THE "SUPERIOR" FOUR KIT.** Our new four-valve receiver. A.C. mains, 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6S07, 6 X50T and 6 V60T. Chassis ready drilled. Cabinet size, 10 1/2in. x 10in. wide. Maximum depth at base 3in. tapering to 3 1/2in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6 post free. Our price for complete kit, £6/9/6! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wave-change switch, dial, pointer, drum pulleys, drive splines, drive spring and knobs, at 45/-, plus 2/6 packing and carriage. N.B.—Our kits are even supplied with sufficient solder for the job.

N.B. All our T.R.F. Kit circuits now include specially wound Denco "Maxi-Q" coils on polystyrene formers, improved performance! Price remains the same.

**SURPLUS BARGAINS**

METERS				
F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 2 1/2in.	M.C.	R.P.	50/-
50 microamp	D.C. 3 1/2in.	M.C.	F.R. (Tropicalised)	85/-
50 microamp	D.C. 5in.	M.C.	Rectangular	120/-
50 microamp	D.C. 4in.	M.C.	Rectangular	110/-
50 microamp	D.C. 3 1/2in.	M.C.	F.R.	35/-
100 microamp	D.C. 2 1/2in.	M.C.	F.R.	85/-
200 microamp	D.C. 2in.	M.C.	F.R. (Tropicalised)	30/-
500 microamp	D.C. 2in.	M.C.	F.R.	18/6
1 mA.	D.C. 2in.	M.C.	F.R.	17/6
1 mA.	D.C. 2in.	M.C.	F. Sq. (1934 manufacture by Elbit)	25/-
1 mA.	D.C. 2 1/2in.	M.C.	Desk Type	30/-
5 mA.	D.C. 2in.	M.C.	F. Sq.	10/-
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
500 mA.	D.C. 2 1/2in.	M.C.	F. Sq.	10/6
1 amp.	D.C. 2in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2 1/2in.	M.C.	F. Sq.	10/-
20-0-20 amp.	D.C. 2in.	M.C.	F. Sq.	7/6
120-0-120 amp.	D.C. 2in.	M.C.	F. Sq. (shunt required)	15/-
150 amp.	A.C. 4in.	M.I.	R.P.	45/-
1 amp.	R.F. 2 1/2in.	Thermo	R.P.	7/6
3 amp.	D.C. 2in.	Thermo	F. Sq.	6/6
6 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
6 amp.	R.F. 2 1/2in.	M.C.	Thermo F.R.	7/6
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
25 amp.	D.C. 2 1/2in.	M.I.	F.R.	6/6
30 amp.	D.C. 2 1/2in.	M.I.	F.R.	12/6
15 volt	D.C. 2 1/2in.	M.I.	F. Sq.	12/-
20 volt (5 mA.)	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2 1/2in.	M.C.	F.R.	17/6
300 volt	A.C. 2 1/2in.	M.C.	F.R.	35/-
300 volt	A.C. 3 1/2in.	M.I.	F.R.	30/-

SPECIAL. U.S. 0-1 mA. 2 1/2in. taken from equipment but perfect, 22/6 each. R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.

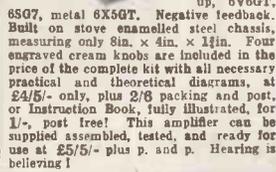
METER RECTIFIERS, 1 mA. by G.E.C., at 8/6, also 5 mA. by G.E.C., at 8/6.

**COMMUNICATION RECEIVER PCR 2**  
3-wave band, 13-50, 100-570, 900-2,000 metres. Valve line-up 6V6, EB33, X61 and 3-EF.39. Illuminated calibrated dial, flywheel tuning, aerial trimmer. In black crackle case size 17 1/2in. x 10in. x 8in. Output socket for 3 ohm speaker, or headphones. Absolutely brand new in original cartons, manufactured for Govt. by F.Y.E. LTD.  
Price £7/10/- only, plus p. and p. 10/-.  
With each set we supply full conversion details for A.C. mains. All required components for conversion available at 32/6 post paid. Limited quantity.  
We can now supply already converted ready for A.C. Mains at £10/5/-, plus carriage. H.P. available.



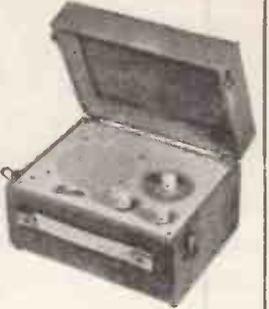
**THE R.C. 3/4 WATT AMPLIFIER KIT.**

Just released! Compare the advantages! Treble bass, AND middle control! For crystal or magnetic pick up! A.C. Mains, 200/250 v. Valve line-up, 6V6GT, 6S07, metal 6X50T. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. x 4in. x 1 1/2in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams, at £4/5/- only, plus 2/6 packing and post, or Instruction Book, fully illustrated, for 1/-, post free! This amplifier can be supplied assembled, tested, and ready for use at £5/5/- plus p. and p. Hearing is believing!



**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 superb—cream dial—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, add to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attaché-case type cabinet: measuring only 9in. x 7in. x 5 1/2in. Weight less batteries 4 1/2lb., with batteries 6 1/2lb. This set really has everything. Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 6in. speaker. Valve line-up 3V4, 1B5, 1B5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of £7/7/- plus 2/6 p. and p. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at 9/3. Also LT. 1.5 v. A.D. 35 at 1/4.



**RAMBLER MAINS UNIT!** At last we are able to offer our special mains unit kit for using our snuggly all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits snugly into battery compartment, can be supplied at 47/8, plus 1/6 packing and postage. Price includes all required components, and full assembly instructions. N.B.—This unit is completely self-contained in a metal box measuring 7in. x 2 1/2in. x 1 1/2in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 v. L.T.

**B.S.R. MONARCH.** The very latest cream 3-speed mixer Auto-changer. Complete with turn-over crystal pick-up. Complete in original manufacturer's cartons, fully guaranteed. Price only £7/19/6. Buy now! Quantity at this price strictly limited.

**TABLEGRAM CABINETS.** Manufacturer's Surplus! Handsome dark walnut finish. Size 16 1/2in. x 13 1/2in. x 1 1/2in. high. Motor board already cut for latest type B.S.R. Monarch Auto-changer. Provision at side for amplification components. Price 79/6 plus 5/6 p. & p. £84/6. Offered for 7in. x 4in. elliptical speaker for which we can supply last night's ROLA at 31/6.



**PORTABLE AMPLIFIER.** To meet a universal demand, we have produced a quality amplifier, primarily for use with the Cabinet Illustrated above, but ideally suitable for any portable record-playing equipment. Comprising EL84 (output), EABC80 (Triple Diode Triode) and metal rectifier (2 of 3R2). For A.C. mains, including separate treble and bass controls. Chassis measurements 6in. x 5in. Front plate 6in. x 4 1/2in. high. Price 92/6 plus 2/6 p. & p. Engraved knobs to suit in white or brown at 1/2 each.



**HIGH FIDELITY!!** Introducing the new Lorenz LP312-2 12in. diaphragm triple unit speaker. Consisting of a 12in. wide range speaker, utilising the very latest super high flux magnet alloys, combined with two T.S.L. Lorenz LFE 65 permanent magnet moving coil electro-magnetic high frequency treble units. These latter are coaxially placed on a steel bracket in the centre of the front of the main speaker so that they do not project beyond the front of the speaker mounting baffle. These two treble units are offset at a specially calculated angle to effectively give 360° spherical response. Base unit 15 ohms, treble units each 5 1/2 ohms. Frequency range 15-22,500 cycles level response. Power rating 25 watts average, peak power rating 40 watts. Cross-over frequency for the treble units 2,000 cycles. Finished in grey and blue vitreous anti-corrosion stove enamel. Price complete £14/19/6, plus 3/6 p. and p. H.P. Terms available. The above described treble speakers are available separately and are without doubt the most sensitive and efficient treble reproducers to date. Price 28/6, plus 11/- P. Tax, plus 2/6 p. and p.

**VALVES**  
We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list but the following is a selection only of brand new imported valve types, fully guaranteed. Purchase Tax Paid.

EABC80	10/-	DAP96	10/6	PY80	10/6
EAF42	10/-	DF96	10/6	PY81	10/-
EB41	7/6	DK92	10/6	PY82	9/6
EB91	7/6	DK96	10/6	PY83	11/6
EB41	10/-	DL96	10/6	UB41	10/6
EBF80	11/6	or 39/6	per set	UCH42	11/6
ECC81	9/-	of four.		UF41	10/6
ECC82	9/-	DM70	9/-	UL41	10/6
ECC83	9/-	EL41	10/6	UY41	9/-
ECC84	15/-	EL84	11/6	8A45	8/6
ECC85	10/-	EM80	9/-	6AT6	8/6
ECC82	15/-	EY61	12/6	6AU6	9/6
ECH42	11/6	EZ40	8/6	6BA6	8/6
ECH81	11/6	EZ80	8/6	6BE6	9/6
ECL80	11/6	PCF80	15/6	6BW6	8/6
EP41	10/6	PCP82	12/6	6X4	7/6
EP80	10/6	PC84	12/6	35W4	7/6
EP85	10/6	PL81	13/6	50B5	10/-
EP86	12/6	PL82	10/6	50C5	10/-
EP89	10/-	PL83	11/6		

In addition we naturally have all usual surplus types available such as 6V6GT, etc. All in our valve price list!

**BRAND NEW G.R. TUBES—**By leading manufacturer, 12 in. equivalent to MW 31/74 £11/19/6- 14KPA4. Tinted. Latest type 14in. rectangular 6.3 v. heater. 12-14 Kv. In original sealed cartons. Limited quantity only at £13/19/6. Ditto 17in. type 17ASP4. price £18/19/6. All H.P. available. Plus 15/- packing, carriage and insurance.

**TRANSISTORS! MULLARD TYPE OC71.** Available ex stock at new list price of 30/- each, post free.



**Another Cabinet Bargain!** Special purchase of walnut veneered trolley-type cabinets, originally intended for use in projection T.V. Easily recognised as being of leading High Quality manufacturer's stock, heavy dark solid walnut. Can be easily adapted to house tape recorder, amplifier, radiogram, etc. etc. Measurements external 24 1/2 x 16in. x 29in. The whole is mounted on castors. Unrepeatable bargain at £5/19/6, plus 10/- packing and carriage. We have a large selection of all type cabinets. A stamp will bring list.

**LF. STRIP.** Ex-Govt. Brand new condition, for 9.72 mc/s., but easily converted if necessary. Band width 180 kc/s. Less valves. Price 15/- only. Limited supply.

**POWER PACK.** By leading manufacturer. Input 200/250 v. Output 350-0-350 280 mA., 6.3 v. 8 a., 6.3 v. 2 a., 4 v. 7 a., 5 v. 2 a. Fully smoothed. Incorporates valve rectifier GZ32. Chassis measuring 13in. x 7in. x 3 1/2in. Wt. 22lb. See only at £4/19/6, plus 3/6 p. and p.

**CLYNE RADIO LTD.**  
18, Tottenham Court Road, London, W.1.

# LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

## WIDE ANGLE 14-INCH CONVERSION PARCEL

Convert to big 14-inch picture! Parcel contains brand new 14in. rectangular C.R. tube (famous make), 6.3 heater, 10-14 Kv. E.H.T. aluminiumed, 1 Ferroxcube line output trans. with width and linearity controls, Ferroxcube scanning coils, frame output trans., Ferroxcube focus magnet, duodecal base, 14in. mask, suggested circuit diagram.

**LASKY'S PRICE, £18.5.0**  
complete parcel,  
Carr. and insur., 25/-. All parts and C.R.T. available separately.

## METER BARGAINS

2½in. moving coil. Brand new microammeters F.S.D. 0-750 microamps., 15 ohms resist., 21/0-1.5 amps., 12/6. 0-200 v., A.C., rect. incorporated, 12/6.  
**DOZENS OF OTHER TYPES.**

## 5-CHANNEL BAND 1 TV PRE-AMPLIFIERS

Famous make, brand new and unused. Contains 1 6AM6 valve. Size 5x2x2in. List 45/-.  
**LASKY'S PRICE 21/-**  
Post 2/6.

## PROJECTION TV UNITS

(Mullard). Consisting of optical unit and E.H.T. unit, complete with valves and C.B. tube. Limited quantity. Full details on request.

**LASKY'S PRICE £21**  
Carr. 21/-.

## FEW ONLY

21in. C.R. TUBES  
**£24**

## COMPLETE 5-VALVE RADIO CHASSIS

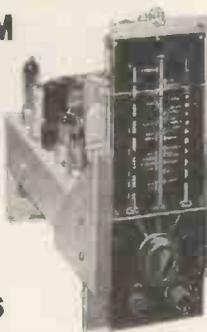
Brand new and unused. A.C./D.C. 200/250 volts. I.F. 465 kc/s. A.V.C., 4 watts output, 3-station pre-set, frame aerial, fully aligned, chassis 10x5½in., max. height 5½in. Completely wired and ready for use, with the addition of a speaker and output transformer. Two controls, volume and station switch. Valves used: 10C1, 10F9 or UF41, 10LD11, 10P14, U404 or UY41.  
**REDUCED PRICE, less valves, 52/6**  
Post 3/6.

## HI-FI EQUIPMENT

Large stocks of leading makes of Hi-Fi Amplifiers, Speakers, etc.

## 6-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES

Famous Maker's Surplus. Brand new, 6-valve, 3-wave Superhet, 13-50 m., 200-550 m., 1,000-2,000 m. Brand new Mullard valves: ECH42, EF41, L63, EB41, 6V6, g.t., EZ40, and finest quality components. Gram. switch, 465 Kc/s. I.F., tone control, 3-colour dial. Overall size: 13½x5, height 12½in. Aperture required for dial and controls 11x3½in. Complete with valves, output trans., knobs, etc.  
**LASKY'S PRICE £10.19.6**  
Carr. & Pkg. 7/6 extra.



## 5-VALVE RADIOGRAM CHASSIS

Latest type miniature valves. A.C. mains, 3-wave superhet. Large full vision dial, 11½in. x 4½in. Overall dimensions 14x6½x7in. Valve line-up, 12AN8, 6BA6, 6AT6, 6BW6, 6X4.  
**LASKY'S PRICE, complete with valves, £9.19.6**  
Carr. 7/6.  
**TABLE CABINET** for above, complete with 6½in. P.M. speaker, 49/9.

## 3-SPD. MIXER AUTO-CHANGERS

ALL BRAND NEW AND UNUSED, IN MAKERS' CARTONS



**GARRARD RC.110.** As illustrated. Complete with t.o. crystal pick-up. Cabinet space required 14x12½x4in. above, and 2½in. below motor board. Cream and brown enamel finish. Complete with instruction book. Limited quantity only. List, £14/13/-.  
**LASKY'S PRICE £8.19.6**  
Carr. 6/-.

**CABINETS AVAILABLE.** Prices on request.

**GARRARD RC.80.** Full length arm with two Decca XMS heads. Limited quantity only. List £20/15/0.  
**LASKY'S PRICE 15 Gns.**  
Carr. 5/-.  
Also available with GC.2 t.o. crystal head at same price.

**B.S.R. MONARCH.** Latest model, with HGP.37 t.o. crystal pick-up. Cream finish.  
**LASKY'S PRICE £7.19.6**  
Carr. 3/6.

**COLLARO RC.54.** With Studio 0 Turnover crystal pick-up. **£9.19.6**

## SINGLE RECORD PLAYERS

Complete with pick-up.

**COLLARO 3/554..... £8 18 4**  
**B.S.R. Model TU.8..... £4 17 3**  
**GARRARD "T" (XMS heads) £12 12 0**  
Carr. 3/6.

## HI-FI ELECTROSTATIC

### SPEAKERS ('TWEETERS')

For high fidelity sound reproduction. Easily fitted to any radio, TV or amplifier. Full data and diagram supplied.

**LSH100.** 7-18 kc/s., 20 db, inherent cap. 1,100 p.f. For outputs up to 20 watts. Size 5x4x½in. 21/-.

**LSH518.** As above, for outputs of 10-12 watts (wide angle sound distribution). Size 7x2x½in. 17/6.

**LSH75.** Inherent cap 800 p.f. For outputs up to 6 watts. Size 3x3x½in. 12/6.  
All post free.

## ACOS TURNOVER CRYSTAL CARTRIDGES

HI/G type HGP.37, as used in latest radiograms. L.P. and standard. Complete with styl. **22/-**  
Post 1/-.

Also, another well-known make at **18/6**  
Post 1/-.

## DECCA PICK-UPS

3-sp. with t.o. crystal head HI/G, and rest. Brown plastic.

**42/6**  
Post 2/6.

## PORTABLE GRAM AMPLIFIER



Uses 3 latest miniature valves, U78, N78, DH77. Volume, bass and treble controls; extension L.S. socket and internal L.S. switch. Indicator lamp mounted on wood baffle.

overall size 14x4½in. with speaker centralised. All top quality new components. For A.C. mains, 200-250 v. Ideal for portable record players, input will match Monarch, RC54, BC9/554, etc. Price, complete with 3 new Osram valves, 7x4in. Goodmans elliptical speaker, metal speaker grille, mains lead, and knobs.

**£5.9.6**

Post & Pkg. 5/-.

## 12-CHANNEL TV TUNER

Famous make. Covers Bands I and III. Complete with valves EF80 and EOC81. Ceramic valve holders, finest quality components. Switch and fine tuning. I.F. output 20-25 Mc/s. Freq. coverage 50-87 Mc/s. and 176-215 Mc/s. Full details and circuit diagram supplied.  
**Post 3/6. KNOB, 2/9 extra. 89/6**

## TELETRON BAND III CONVERTERS

**Mk. I.** Complete Kit to build this converter, drilled chassis, condensers, resistances, coils, 2-E880 valves, etc., with circuit diagram and instructions **48/6**  
Post 1/6.  
Drilled chassis only, 3/9.

**Mk. II.** Uses latest type valves, Cascode R.F. amp. and triode pentode F.C. FCC84 and PCF80, etc. The **17/6**  
COIL SET.

**COMPLETE KIT,** including drilled chassis, valves and diagram, **59/6**  
Post 1/6.  
Circuit diagram only, 3d.

**TELETRON CONVERTER COIL SET.** For use with TEF and 8bet Band I TV sets. Uses two ZT19. Circuit diagram, alignments, full details supplied. **15/-**  
Post 1/6.

## MAKERS' SURPLUS TV COMPONENT BARGAINS

WIDE ANGLE 38 mm.

Line E.H.T. trans., Ferroxcube core, 9-16 kv. 25/-

Scanning Coils, low imp., line and frame 25/-

Ferroxcube cored Scanning Coils and Line Output Trans., 10-15 kv., EY31 winding. Line trans. incorporates width and linearity control. Complete with circuit diagram, the pair 50/-

Frame Output Transformer 10/6

Scanning Coils, low imp., line and frame 17/6

Frame or line blocking osc. trans. 4/6

Focus Magnets Ferroxcube 19/6

P.M. Focus Magnets, iron cored. 19/6

Duoomag Focallisers 22/6

300 mA. Smoothing Chokes 15/-

Electromagnetic Focus Coil with combined scan coils. 25/-

STANDARD 35 mm.

Line Output Trans., no E.H.T. 12/6

Line Output Trans., 6-9 kv. E.H.T. and 6.3 v. winding Ferroxcube 19/6

Iditto, by Igranite 14/6

Frame or line blocking Osc. Trans. 4/6

Frame Output Transformer 7/6

Focus Magnets, without Vernier 12/6

With Vernier 17/6

Focus Coils, electromagnetic 12/6

200 mA. Smoothing Chokes 10/6

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

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**BAND III CONVERTERS**

2 valves and metal rectifiers, metal case. Contains power pack for 200-250 v. A.C. List £8/10/-  
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In original wood transit cases.  
 Brand New £11 19 6  
 Second-hand Grade I £9 19 6  
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 Carr. 12/6.  
 Power Pack and Output Stage with 6½in. Speaker .. £5 5 0

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6.3 v. 1.5 amp. .... 5 11  
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**3-WATT AC/DC MIDGET AMPLIFIER**

Push pull, very high gain. 4 valves: two UL41 (p.p.) UCH42, UAF42. Input voltage 100/100 A.C./D.C. Easily converted to 230 v. Ideal for record players, tape recorders, baby alarms, etc. Supplied fully assembled with valves, circuit diagram and details. **50/-**  
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No. 1. Contains everything to build a 4-valve, 3-wave superhet for 200-250 A.C. mains. Wood or plastic Cabinet as preferred. Can be built for **£7.19.6**

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**INSTRUCTION BOOKS** for above, 1/- each, post free. All components available separately.

**FAMOUS AMPLIFIERS BUILT ON T.C.C. PRINTED CIRCUITS**

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The **MULLARD 510**. Price, according to transformers used, from 15 gns. The Book, 3/6, post free.

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5in., 18/6; 6½in., 19/6; 6½in. with trans., 22/6; 8in., 25/-; 10in., 26/6; 12in., 29/6. 7 x 4in. elliptical, 19/6.

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Very latest circuit covering L., M. and S. wavebands as well as F.M. 8-valve p.p. output. Ferromagnetic aerial, p.u. sockets, ext. speaker sockets and provision for electrostatic Tweeter. Magic eye tuning indicator. For A.C. mains 200-250 v. Valve line up: ECC85, ECH81, EF89, EABC80, ECC82, two 6BW6 (p.p.) 5Y3 rect. Incorporates latest Gorler F.M. components including front end UT3+0. Large full vision dial, size 14½ x 6in. Overall dim. of complete chassis, 15 x 7½ x 8in. high.



**LASKY'S PRICE 26 GNS.** Carr 6/6.



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Incorporates its own power supply and provides complete F.M. coverage. Operates with most radio receivers and any make of Amplifier. Valve line up: EABC80, ECC85, two EF89, 6X4 (Rect.), EM80 Indicator. Incorporates GORLER Inductance Tuning Heart, and magic eye tuning indicator. Dial 10½ x 6in. Overall size 9 x 6 x 5½in. high.

Complete Carr. & Pkg. 7/6 **16 GNS.**

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Coils, each ..... 3 11  
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**20,000 VALVES**

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**JASON F.M. TUNER**

Special parcel containing data book, chassis, front end, dial, drive, tuning condenser, full set of coils, I.F.'s, ratio detector, etc. Post 2/6 **68/9**  
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**THE NEW JASON 'ARGONALIT' AM/FM TUNER-RECEIVER**

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**COMPLETE KIT £15.5** with output stage Carr. 3/6.

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Uses 6AM6, 12AH8, EB91, and two 6BA6. Complete parcel **£6.7.6**  
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**LATEST BRENELL TAPE EQUIPMENT**

The **DECK**. 3-speed, 3 motors, record and **18 GNS.** play back.

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Kraft base, length 1,200ft., Cyldon metal spool. **12/11**  
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All makes of Tape stocked including the new thin long playing tape. Scotch Boy, E.M.I., Grundig, Puretone Ferrograph, Basf, Agfa, Gevaert. All types of spools.

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A high-grade unit complete with power supplies. Incorporates the latest Gorler F.M. components including the permeability tuned front end. Freq. coverage 86-103 Mc/s. Two controls. Valve line up: ECC85, two 6BJ6, 6AL5, EZ80. Chassis **£14.18** only. Post 3/6

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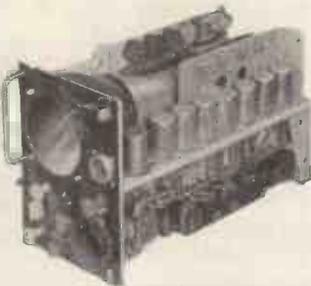
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Ideal for conversion to oscilloscopes, T.V. units, etc. Containing V.C.R.97, 12 VR.91 (EF.50), 2 VR.54 (EB.34), 3 VR.92 (EA.50), 4 CV.118. (SP.61) Slow-motion dial, 13 Pots and scores of useful components. Size: 8½in. x 11½in. x 18in. In wooden packing case. £3, carriage 7/6.



**MINIATURE I.F. STRIPS.** Size 10½in. x 10½in. x 3in., frequency 9.72 Mc/s, 2 EF.92's and 1 EF.91. I.F. amps. EB91, DET/AGC EF.91, AGC. Amp. and EF.91 limiter. Circuit supplied. Price less valves, 8/- each, post paid.

**ADMIRALTY RESPONDER UNIT: Type W.4790.** This receiver tunes from 160-182 meg. Valve line up: VR.136 RF., VR.92 Mixer, VR.137 Osc., VR.65s in 5 I.F. stages. VR.92 Det. output. Modification details available to tune over approx. 80-100 meg. Price 12/6 each fully valved. Post and Pkg. 7/6.

**BENDIX I.F. Transformers, 1.63 Mc/s,** complete in cans, set of two, new and boxed, size 2 x 1½ x 3½in., 5/-, p.p. 1/6.

**BENDIX potted Audio Output Transformer,** complete with integral smoothing choke. Ratings 4½ watt, 9,000 ohm primary, 600 and 4,000 ohm. secondary. Size 4 x 1½ x 2in. New and boxed, 4/6, p.p. 1/6.

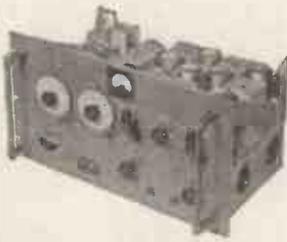
### 2 METRE RECEIVER Type R1392

Air Tested

15 Valve Superhet

Frequency 95-150 Mc/s  
(2 to 3 metres)

Valve line up: 1st and 2nd R.F. Amp. VR.136 (EF.54), 1st Local Oscillator VR.65 (SP.61), 2 Oscillator Multipliers VR.136 (EF.54), 3 I.F. Amp. VR.53 (EF.39), A.G.C. 6Q7, Output 6J5, Muting VR.92 (EA.50), Noise Limiter VR.92 (EA.50), B.F.O. 6J7, Mixer VR.136 (EF.54), De Mod. 6Q7.



Slow motion tuning, normally crystal controlled, or tunable over 95-150 Mc/s. Power supply required: 240-250 volts at 80 mA., 6.3 volts, at 4 amps.

Size 19in. x 10in. x 10in. Standard Rack Mounting. £6/19/6. Complete with valves and circuit diagram, checked and Air Tested. Packing and postage 17/6, 10/- returnable on packing case.

Power Pack Type 234 for use with R1392, £4/10/-, pkg. and post 7/6.

### TRANSMITTER Type T1131-L

Frequency 100 to 156 Mc/s. Output 50 W. Crystal controlled. 200-240 v., 50 c.p.s. Power supply. Housed in 6ft. standard on 19in. rack. In new condition complete with valves.

Send for full details.

### EDDYSTONE RECEIVERS B34

with coils £8/10/-, plus carriage. (Send for details).

### BC-610 TUNING UNITS

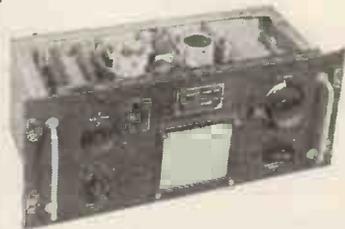
TU49-3 to 4 Mc/s. TU50-4 to 5 Mc/s., 12/6 post paid.

### AMERICAN CLOCKWORK INTERVALOMETER

72-hour jewelled compensated movement. Contacts make every 15 seconds. Can be easily converted to give variable time delay. Panel mounting 3in. x 3½in. Brand new, 12/6, plus 1/6 p.p.

### TUNING UNITS Type T.U.5B

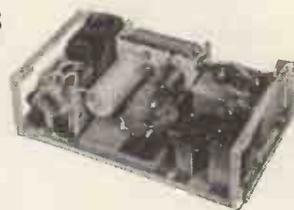
This well-known Tuning Unit has a frequency of 1500-3000 kc/s with 2% accuracy. Micrometer Dial that provides 2,500 divisions over 180° rotation of the tuning shaft which gives plenty of mechanical band spread from 3.5 Mc/s through 28 Mc/s. In addition the unit has a High C Tank Circuit with temperature compensating coil. The above Tuning unit from the BC-375 Transmitter needs only a few additional small parts to convert into a stable Temperature-Compensated VFO which may be used to replace the Crystal in Crystal Controlled Transmitters. Conversion Details and Circuit Diagrams supplied FREE with unit. Price 15/- each, plus 4/- packing and postage.



### POWER UNIT Type 173

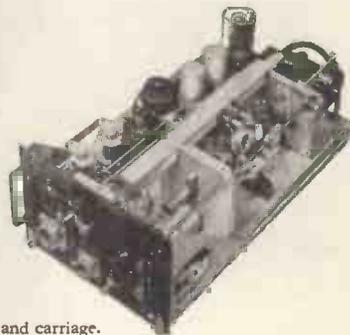
12 or 24 Volt D.C. Input, 120 v. 60 mA. output. Containing Vibrator Transformer, 12 volt Vibrator, two 120 volt Selenium Rectifiers, Chokes and Condensers. Size 10½in. x 6in. x 3in.

Price 12/6 post paid.



### A.P.Q.9 RADAR JAMMING UNIT

Containing 913A Photo Multiplier Cell, complete with resistance network and lightproof box. Wide band amplifier (2) 6AC7 and 6AG7, driving a pair of parallel 807s which Grid modulate a pair of 8012s in push pull. Lecher lines, these cooled by blower motor. Cathode loaded by Co-axial stubs which simultaneously quillotine tune anode and grid lines with a counter mechanism. Output is matched to aerial by a matching stub. Suitable for use in centimetric bands. Brand new. Price £5, plus 10/- packing and carriage.



### A SELECTION OF

### EX-GOVERNMENT SURPLUS VALVES

	Each		Each		Each
6SQ7	6/-	6AL5	7/-	VR.54	2/-
6G6G	5/-	6H6.G	2/-	VR.55	6/-
6L7M	6/-	6H6.M	3/-	VR.56	5/-
6F7G	6/-	6C4	4/6	VR.65	3/6
6SG7M	6/-	6C5	5/-	VR.91	5/-
6SK7	5/6	6C8	6/-	VT.52	4/6
6B7	3/-	OD3	3/-	VT.501	4/6
37	.....	1A3	4/6	CV.18	4/-
6D6G	5/-	1A5	4/6	CV.6	2/-
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6K6.GT	5/6	809	7/-	CV.73	5/6
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6J6	5/-				

### MICRO SWITCH

Universal type (make or break on depression) 5A, 250 v., housed in strong aluminium casting. 2½in. x 1½in. x 1in., with roller on operating lever. Price 3/- p.p.

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# PROOPS BROS. LTD. —

# The Walk-around Shop

## RECEIVER TYPE BC.733

Frequency 100 Mc/s. approx. Four crystal tuned frequencies. 6.9 Mc/s. I.F.s easily altered to 10 Mc/s. Suitable for conversion to F.M. Containing four crystals, two full-wave instrument Rectifier bridges, 90 and 150 cycle tone filter units. Valve line-up: (3) 717A. Low noise mushroom pentodes. (2) 12SG7; (1) 12AH7; (3) 12SR7; 12A6 output. Price £5. Carriage and Packing 7/6.



## ABSORPTION WAVEMETER

Easily converted to 2 metres or 70 cm. in copper-plated metal case 3½ x 4½ x 5½ in. with dial calibrated 0-100 and 80V Neon Tube. Coverage approx. 190-210 Mc/s. New. 6/6 each, post paid.

## FL-8 RADIO FILTER UNITS

Size 2½ x 2½ x 3 in 10/- plus 1/6 p.p.



## R.F. UNITS

R.F.24 20-30 Mc/s. Switched Tuning, Valved. 9/6 each.

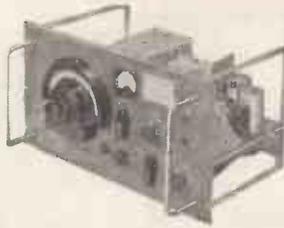
R.F.25 40-50 Mc/s. Switched Tuning, Valved. 9/6 each.

R.F.26 50-65 Mc/s. Variable Tuning, Valved (new). 25/- each.

Packing and postage 2/- each.

## RECEIVER TYPE R 1132

Frequency 108-126 Mc/s. 11-valve Superhet.



Valve line-up: R.F. Amplifier VR.65 (SP.61); Frequency changer VR.65 (SP.61); Local Oscillator VR.66 (P.61); Stabilizer VS.70 (7455).

3 x I.F. Amplifiers VR.53 (EF.39); B.F.O. VR.53 (EF.39); Detector VR.54 (EB.34); A.F. Amplifier VR.57 (EK.32); Output VR.67 (6J5).

Switchable A.G.C. and A.V.C. Variable B.F.O.

Circuit diagrams with units. Easily converted to cover

Wrotham Band. No alterations to wiring required. Conversion Slugs and instructions, supplied free. Size 19 x 10 x 10 in. Standard Rack Mounting.

PRICE £3/7/6. Packing and carriage 15/-, 10/- returnable on Packing Case.

## 2-3mA MEASUREMENT METER

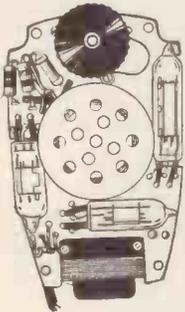
2-3 mA movements in metal case measuring 4½ in. high, 3½ in. wide and 5 in. deep. 7/6 plus 2/- p.p.



## INSULATION TAPE

Perfect condition. ½ in. wide, 25 yd. reels, foiled, in tins, 1/3 each, p.p. 8d.

## Make a miniature POCKET RADIO



Incorporating high "Q" technique using the New Ferrite rod. Made possible by simple conversion of an ex-Govt. Hearing Aid.

**Technical Details.** A Germanium Diode Detector circuit followed by the existing 3-valve Amplifier, giving adequate amplification throughout the medium wave band.

This conversion can be carried out in approximately 30 minutes.

**SEE and HEAR this Miniature POCKET RADIO demonstrated.**

**THE COMPLETE KIT OF PARTS** includes a Type OL10 Hearing Aid (with Crystal microphone) in perfect working order with miniature earphone and moulded ear insert attached: ferrite rod, germanium diode, components, circuit diagram and full instructions. Price £2/6/- (less batteries) post paid. **ALL COMPONENTS SOLD SEPARATELY.**

Deaf Aid Unit with earpiece.....	£1 15 0
Plastic Ear Mould.....	2 0 0
Ferrite Rod.....	5 0 0
Conversion Components.....	4 0 0
Batteries 1.5 v. L.T. (Type D. 18)	8 0 0
30 v. H.T. (Type B.119)	4 3 0

**NOTE:** As the crystal microphone is not used in the Pocket Radio, it can, if desired, be used as a general microphone and it does not require a matching transformer.



## THROAT MICROPHONES TYPE TS30



U.S. manufacture. Complete with elastic strap. Lead terminating at plug PL291. New and boxed. 2/3 post paid. Sockets available at 6d. each.

## MICROPHONES

E.M., with switch. Boxed, new, 1/6 p.p.

## AR 88 RECEIVER

Slow-motion drive mechanism. New and boxed. 10/6 each, plus 1/6 p.p.



## WATERPROOF PLUGS AND SOCKETS

3-pin 5 amp., non-reversible. Suitable for caravan and trailers, etc. 1/3 per pair, post paid.



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Size 2½ x 3 x 2½ in. 10/6 each. 1/6 p.p.

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All for A.C. MAINS 200-250 v., 50 c/s. Guaranteed 12 months.

## ASSEMBLED CHARGER

6 v. or 12 v. 2 amps.  
Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused.



Only **45/9** carr. 3/6.

## ASSEMBLED CHARGERS

6 v. 1 amp. .... 19/9  
6 v. or 12 v. 1 amp. .... 25/9  
6 v. 2 amps. .... 29/9  
6 v. or 12 v. 2 amps. .... 38/9  
6 v. or 12 v. 4 amps. .... 56/9  
Above ready for use. Carr. 2/9

## HEAVY DUTY KIT

12 v. 30 amp. Suitable for Garage or firm with a number of vehicles. Mains input 200/250 v. 50 c/s. Outputs 12 v. 15 amp. twice. Consists of Mains Trans. 2 Metal Rectifiers, 2 Meters, 4 Fuses, 4 Terminals, 2 Rheostats and circuit. Only 9 gns., carr. 15/-

## BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case, Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.  
6 v. or 12 v. 1 amp. .... 22/9  
6 v. 2 amps. .... 25/9  
6 v. or 12 v. 2 amps. .... 31/6  
6 v. or 12 v. 4 amps. .... 49/9

## BATTERY CHARGER KIT

Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and variable charge rheostat with knob. Only 45/9.



## Assembled 6 v. or 12 v. 4 amps.

Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for **69/6** use with mains and output leads. Carr. 3/6.

## SELENIUM RECTIFIERS

L.T. Types	6/12 v. 6 a. .... 19/9
2/6 v. 1/2 a.h.w.	1/9
6/12 v. 1/2 a.h.w.	2/9
F.W. Bridge Types	120 v. 40 mA. .... 3/9
6/12 v. 1 a. .... 5/9	250 v. 50 mA. .... 5/9
6/12 v. 2 a. .... 8/9	250 v. 80 mA. .... 7/9
6/12 v. 3 a. .... 12/9	250 v. 150 mA. .... 9/9
6/12 v. 4 a. .... 16/9	300 v. 275 mA. 12/11

CO-AXIAL CABLE. 75 ohms lin., 8d. yard. Twin screened feeder, 11d. yard.

T.V. CABINETS. Console type for 15, 16 or 17in. tube. Half length doors, 9 gns. Table model with doors for same size tube, 69/6. Table type for 12in. Tube 29/6. All famous manufacturers surplus.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000 pfd. (.001µF). .002 mfd. (2,000 pfd.). All at 6d. each, 3/9 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.2 a., 6/9 doz.; 6.5 v. 0.3 a., 6/9 doz.; 4 v. 0.3 a., 5/9 doz.

ELECTROLYTICS (current production). NOT Ex-Govt.

Tubular Types	Can Types
8µF 450 v. .... 1/9	8 mfd. 350 v. 1/3
8 mfd. 500 v. .... 2/6	8 mfd. 600 v. 2/11
16µF 350 v. .... 2/3	16 mfd. 500 v. 3/9
16µF 450 v. .... 2/9	16 mfd. 350 v. 1/11
16µF 500 v. .... 3/9	16µF 450 v. .... 2/9
32µF 350 v. .... 3/9	32µF 350 v. .... 2/11
32 mfd. 500 v. .... 5/9	32 mfd. 450 v. 4/9
8-16µF 500 v. 4/11	100 mfd. 450 v. 4/9
25µF 25 v. .... 1/3	8-8µF 450 v. .... 2/11
50µF 12 v. .... 1/3	8-16µF 450 v. .... 2/11
50µF 50 v. .... 1/9	16-16µF 450 v. .... 2/11
100 mfd. 12 v. 1/9	16-32µF 350 v. 4/9
100 mfd. 25 v. 2/3	32-32µF 450 v. 5/9

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

VIBRATORS. Oak 2 v. 7 pin, synchronous, 7/9.

## EX GOVT. E.H.T. CONDENSERS

.5 mfd., 2,500 v. Blocks	3/9
.5 mfd., 3,500 v. Cans.	3/3
.1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated)	9/6

## EX GOVT. METAL BLOCK PAPER CONDENSERS

2 mfd. 500 v.	1/9	8-8 mfd. 500 v.	5/11
4 mfd. 500 v.	2/9	15 mfd. 500 v.	7/9
4 mfd. 1,000 v.	4/3		
4 mfd. 400 v. plus 2 mfd. 250 v.	1/11		

EX GOVT. VALVES. VR137, EA50, EB34, 11d.; SP61 2/3, 4SHA 1/3. EL32 3/9.

EX GOVT. UNITS, type RDF1 in original sealed cartons with 14 valves including 524G etc., trans., L.F. choke, Rectifier etc., etc. We cannot enter into correspondence regarding these units which represent a really exceptional bargain at 29/9. Carr. 7/6. Transmitter Receivers type TR9D complete with all valves 45/-, carr. 6/6.

CONTROL PANEL with 1 six-position 3-wafer Yaxley switch, 1 pointer knob, 2 S.P.S.T. switches, various plugs and sockets. Only 1/9.

## OIL FILLED BLOCK CONDENSERS

Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

## EX GOVT. MAINS TRANSFORMERS

All 230 v. 50 c/s. input.	
8.8 v. 4 a., 9/9.	
300-0-300 v. 150 mA. 4 v. 3 a. .... 9/9	
120-0-120 v. 40 mA. .... 5/9	
250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a. .... 11/9	
Potted 41-31-3in. .... 22/9	
460 v. 200 mA., 6.3 v. 5 a. .... 22/9	
0-16-18-20 v. 35 a. 79/6	Carriage 5/- extra.

## MANUFACTURERS SURPLUS TRANSFORMERS

Fully shrouded upright. Primary 200-230-250 v. Sec. 425-0-425 v. 150 mA. 6.3 v. 3 a. 5 v. 3 a., 33/9. Clamped type 250-0-250 v. 70 mA., 6.3 v. 2.5 a. 9/9, post 1/9.

## EX GOVT. SMOOTHING CHOKES

250 mA., 10 H., 50 ohms. .... 14/9
250 mA., 3 H., 50 ohms. .... 8/9
150 mA., 10 H., 50 ohms. .... 10/11
150 mA., 6-10 H., 150 ohms., Tropicalised 6/9
100 mA., 10 H., 200 ohms., Tropicalised 3/11
50 mA., 50 H., 1,000 ohms. .... 6/9
L.T. type 1 amp., 2 ohms. .... 2/9

SPECIAL OFFERS. Small 2 gang variables .0005 mfd., 4/9. 8-8 mfd., 450 v. Electrolytics (midget) in lots of six, 1/6 ea.

# R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5 1/2 x 4 1/2 x 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagrams 39/9, or ready for use, 46/9.



Type BM2. Size 8 x 5 1/2 x 2 1/2in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2v. ACCUMULATORS. When connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit of parts with diagrams and instructions 49/9, or ready for use 59/6.

TYPE BM1A. An all dry battery eliminator size approx. 5 x 4 x 1 1/2in. Supplies approx. 69 v. at 10-15 mA. and 1.4 v. at 250 mA. For 4 valve receivers using L.T. current of not less than 230 mA. Complete kit 35/9 or ready to use 42/6.

# R.S.C. TRANSFORMERS

FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED

## MAINS TRANSFORMERS

Primaries 200-230-250 v. 50 c/s.

### FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a., Midget type, 21-3-3in. .... 17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. .... 19/9
250-0-250 v. 100 mA., 6.3 v. 4 v. 4 a., c.t., 0-4-5 v. 3 a. .... 25/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. .... 23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a. for R1355 conversion. .... 31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. .... 23/9
300-0-300 v. 100 mA., 6.3 v. 4 v. 4 a., c.t., 0-4-5 v. 3 a. .... 26/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. .... 23/9
350-0-350 v. 100 mA., 6.3 v. 4 v. 4 a., c.t., 0-4-5 v. 3 a. .... 26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. .... 33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. .... 33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a. c.t., 5 v. 3 a. suitable Williamson Amplifier, etc. .... 49/9
450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a. .... 69/6

### TOP SHROUDED DROP-THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2.5 a. .... 13/9
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. .... 16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a. .... 18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. .... 22/9
300-0-300 v. 100 mA., 6.3 v. 4 v. 4 a., c.t., 0-4-5 v. 3 a. .... 23/9
350-0-350 v. 100 mA., 6.3 v. 4 a. c.t., 5 v. 3 a. .... 22/9
350-0-350 v. 100 mA., 6.3 v. 4 v. 4 a. c.t., 0-4-5 v. 3 a. .... 23/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. .... 29/11
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. .... 29/9

E.H.T. TRANSFORMERS, 2,500 v. 5 mA., 2-0-2 v. 1.1 a. 2-0-2 v. 1.1 a., for VCR97 VCR517 36/6

## FILAMENT TRANSFORMERS

Primaries 200-250 v. 50 c/s.	
6.3 v. 1.5 a. .... 5/9	0-2-4-5-6.3 v. .... 16/9
6.3 v. 3 a. .... 8/11	4 a. .... 16/9
12 v. 1 a. .... 7/9	6.3 v. 6 a. .... 17/6
6.3 v. 2 a. .... 7/6	12 v. 3 a. or 0-4-6.3 v. 2 a. .... 7/9
	24 v. 1.5 a. 17/6

## CHARGER TRANSFORMERS

All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1 1/2 a., 11/9; 0-9-15 v. 3 a., 0-3.5-9-17 v. 4 a. 18/9. 0-9-15 v. 5 a. 19/9. 0-9-15 v. 6 a., 23/9.

## ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s. 120 v. 40 mA.	7/11
130 v. 50 mA., 6.3 v. 3 a.	14/9
120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v., 250 mA.	9/11

## OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	3/6
Small Pentode, 5,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000 to 3Ω	4/9
Battery Pentode, 10,000 ohms to 3 ohms.	4/9
Multi-ratio 40 mA. 30 : 1, 45 : 1, 60 : 1, 90 : 1, Class B Push-Pull	5/6
Push-Pull 8 Watts 6V6 to 3 ohms.	8/9
Push-Pull 10-12 Watts 6V6 to 3Ω to 15Ω, sectionally wound	16/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms.	21/9
Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9
Williamson type exact to spec.	85/-

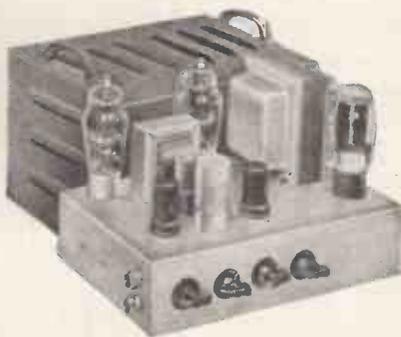
## SMOOTHING CHOKES

250 mA., 5 H., 100 ohms.	11/9
150 mA., 7-10 H., 250 ohms.	11/9
100 mA., 10 H., 200 ohms.	8/9
80 mA., 10 H., 350 ohms.	5/6
60 mA., 10 H., 400 ohms.	4/11

# R.S.C. A6 ULTRA LINEAR 30 WATT AMPLIFIER

WE ARE PROUD TO INTRODUCE OUR NEW 1956 DESIGN. A high Fidelity Push-Pull Unit employing six valves. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 30 millivolts minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.

Price in kit form with easy-to-follow wiring diagrams. Only 9 GNS. Carr. 10/- Or Factory built with 12 months' guarantee, 50/- extra H.P. TERMS ON ASSEMBLED UNITS: DEPOSIT 28/6 and 12 monthly payments of 21/-. If required an extra input with associated vol. control can be provided so that two separate inputs such as "mike" and gram., etc., can be simultaneously applied for mixing purposes. Extra cost for this 13/-. Cover as illustrated 17/6 extra.



Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 17 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response  $\pm 3$  D.B. 30-20,000 c/c.s., 12 D.B. "lift" at 50 c/c.s., 12 D.B. "lift" at 12,000 c/c.s. Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue crackle. Overall size 12 x 9 x 9 in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/c.s. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc.**

We can supply Microphones, Speakers, Rotary Converters, etc., at keen cash prices or on H.P. terms with amplifiers.

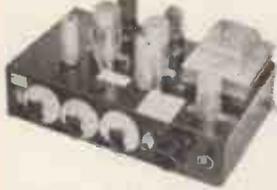
## EXPORT ENQUIRIES INVITED

**R.S.C. TA1 HIGH QUALITY TAPE DECK AMPLIFIER FOR ALL DECKS WITH HIGH IMPEDANCE RECORD/PLAYBACK AND ERASE HEADS.** Such as Lane, Trivox and Collaro 3-speed transcriber chassis. Size 12-7-3in. Overall size 12-7-6in. For 230-250 v. 50 c/c.s. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum input required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Can be used as gram. amplifier with input of 0.75 v. R.M.S. Negative feedback equalisation. Linear frequency response x 3 D.B. 50-11,000 c/c.s.

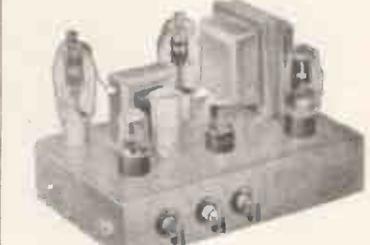
**11** Ready for use. 9 GNS. Carr. 7/6

Facilities for recordings at 15in., 7 1/2in., or 3 1/2in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. PERFORMANCE IS COMPARABLE WITH UNITS AT OVER TWICE THE COST. LEAFLET 6d.

H.P. TERMS. Deposit 4 gns. and 6 monthly payments 1 gn.



# R.S.C. ULTRA LINEAR 12 WATT AMPLIFIER



NEW 1956 Model A8 High-Fidelity Push-Pull Amplifier with "Built-In" Tone Control, Pre-amp. stages. High sensitivity. Includes 6 valves (807 outputs). High Quality sectionally wound output transformer, specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut."** Frequency response  $\pm 3$  db 30-30,000 c/c.s. Six negative feedback loops. Hum level 71 db. down. ONLY 70 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and practically all microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. FOR MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 20 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. H.P. TERMS ON ASSEMBLED UNITS. DEPOSIT 25/6 and nine monthly payments of 22/4. Size approx. 12-9-7in. For A.C. mains 200-230-250 v. 50 c/c.s. Output for 3 and 16 ohm speakers. Kit is complete to last out. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Unapproachable value at 27/15/-, or factory built 45/- extra. Carriage 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 17/6.

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). Speed 33 1/3 r.p.m. BRAND NEW. CARTONED. Only 23/19/6 (approx. half price). Carr. 5/- (for 200-250 v. A.C. Mains).

MICROPHONES. High fidelity crystal types. Acos 33-1 hand or desk type, 50/-. Piezzo with heavy floor base and telescopic stem, 26/19/6.

PLESSEY SINGLE SPEED AUTO-CHANGERS with Crystal Pick-up for standard 78 r.p.m. records 10in. or 12in. Very limited number. Only 25/17/6, carr. 5/6.

## R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible, being 71 D.B. down, 15 D.B. of negative feedback is available. H.T. of 250 v. 20 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/c.s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only 24/15/-, or assembled ready for use 25/- extra. plus 3/6 carriage.



**R.S.C. MASTER INTERCOMM. UNIT.** With provision for up to 4 "Listen-talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. Supplied with walnut veneered wood or brown bakelite cabinet. Mains input is 200-250 v. 50 c/c.s. H.T. line 300 v. CHASSIS IS NOT "ALIVE". Ideal for use as "Baby Alarm". Sound amplification 4 watts. Price only 7 gns. carr. 5/-. "Listen-Talk Back Unit" in bakelite or walnut veneered cabinet can be supplied at 35/- each.

**COLLARO HIGH FIDELITY MAGNETIC PICK-UPS.** Low impedance with matching tones, brand new, boxed at fraction of normal price. Only 33/-.

## THE SKY FOUR T.R.F. RECEIVER



A design of a 3-valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. It employs valves 6K7, 8P6, 6P6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-Point wiring diagrams, instructions and parts list, 1/2-. This receiver can be built for a maximum of 24/19/6 including cabinet. Available in brown or cream bakelite veneered walnut.

## FOUR-STAGE RADIO FEEDER UNIT

Design of a HIGH FIDELITY L. and M. wav T.R.F. Unit with self-contained heater supply and thorough H.T. decoupling. Only 250-400 v. 15-20 mA. H.T. required from main amplifier. Three valves and Low Distortion Germanium Diode Detector. Flat topped, remote response characteristic. Loaded H.F. coils. Two variable Mu controlled H.F. stages, 3 gang condenser tuning. Cathode follower output stage. Switch position for Gram. and Gram. input and output sockets. Performance comparable with the best in Feeder Units. For A.C. mains 200-230-250 v. operation. Size 11-8-7 1/2 in. Illustrations full set or easy-to-follow wiring diagrams and instructions and individually priced parts list 2/6. This unit can be built for only 23/15/-, including Dial and Drive knobs and every item required.

## R.S.C.A73-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1.5 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only 23/15/-, carr. 3/6 or factory built 22/6 extra.

**DEFIANT RECORD PLAYING TURNTABLE COMPLETE WITH MAGNETIC PICK-UP.** Pick-up is high impedance type. Unit is housed in a beautiful walnut veneered cabinet of attractive design. For all standard records (78 r.p.m.), Limited number Brand new, cartoned, 25/19/6, carr. 7/6.

**W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS.** HP1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. 24/6/8.

# Radio Supply Co. (LEEDS) LTD.

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Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5d. Open to Callers 9 a.m. to 5.30 p.m. Saturday until 1 p.m.

# GEE RADIO LTD

**R.C.A. BRAND NEW 15in. 15 ohms 30 watt P.M. SPEAKERS.**  
Snip price £9/19/6. Carriage 12/6.

**R.C.A. PRESSURE UNITS.** 15 ohms. P.M. 20 watts. Complete with Exponential Horn, length 14in. dia. 17in., £5/19/6. Carriage 10/-

**COMMUNICATION RECEIVERS P.C.R.** 2 waveband 13-49, 200-600, 800-2,100 metres. P.C.R.3. 13-49, 49-120, 200-550 metres. Both types in brand new condition. Fully tested before despatch. Price £7/10/- each. Carriage 7/6.

**POWER PACKS** for the above models available. A.C. mains. Built as for the R1155A and 1132A receivers. £5. Carriage 7/6.

**R 1155A RECEIVERS.** In good condition. £8/10/-. Carriage 7/6.

**R 1132A RECEIVERS.** In good condition. £3/17/6. Carriage 7/6.

**POWER PACKS** for the above, complete with speaker built into very attractive polished 8in. extension speaker cabinet. Ready for use on A.C. mains 200-250 v. £5/10/-. Carriage 7/6.

**RECEIVER TYPE 109** in good condition. Freq. range 1.8-3.9 Mc/s. and 3.9-8.5 Mc/s. continuous. Operates on 6 v. battery. Price £4/7/6 Carriage 10/6.

**POWER PACK** for the above £4. Carriage 5/6.

**TELE-F.** Sound powered telephones with ringing generator. Complete in wooden carrying case. Used but in sound condition. 37/6. Carriage 3/6.

**50 WATT EX GOVT. AMPLIFIER** with 4-KT66's in paralleled push-pull. Standard 200-250 v. A.C. input. Output impd. 600 ohms. Line. High Imp. gram and mike input. Bass boost control fitted. Quality amplifier housed in strong metal case ready for use. Terrific performance. Bargain price £25. Carriage extra.

## METERS

1-0-1 milli-ammeters, flush mounting 4in. scale. 45/-.

0-300 v. A.C. flush mounting 2½in. scale. 25/-.

0-25 amp. D.C. flush mounting 2½in. scale. 12/6.

0-15 v. and 0-250 v. D.C. pocket volt-meter 2½in. 15/-.

AR-77 "S" meters 2in. 30/-.

0-200 v. A.C. meters flush mounting 3½in. Grade I. 40/-.

**WAVEMETER CLASS D.** Freq. band 1,900 kc/s-8,000 kc/s. (158-37.5 m.) in two ranges, 1,900 kc/s-4,000 kc/s. Also 4,000 kc/s-8,000 kc/s in perfect working order. Supply 6 v. D.C. input. £8/5/-. Carriage paid.

**CONDENSERS.** 2 mfd. 7.5 kv. wkg. at 15 kv. test (Dubilier). Brand new in original crates. £2/10/-. Carriage 5/-.

**VARIABLE VOLTAGE REGULATOR TRANS.** Input 230 v. A.C. at 21 amps. Output 57.5 amps. in 16 equal steps to 230 v. at 21 amps. Ex. Govt. in perfect condition. Price £12/10/-. Carriage extra.

**H-DUTY TRANSFORMERS LT.** 230 v. PRI-11-12.5 v. SEC at 70 amps. £5/10/-. Carriage 7/6.

**DON "8" TWIN TELEPHONE CABLE** on 1 mile and ½ mile drums. £5 per mile, 25/- per ½ mile. Carriage extra.

**"AVO" MODEL 7.** In perfect condition with leads and batteries (cases available). £13/10/-. Post 3/6.

**WESTON BATTERY OSCILLATORS.** Model E 692 Type 2. in perfect condition. Coverage 100 kc/s-20 Mc/s. Audio output approx. 400 c/s. Complete with instruction books and charts. £5/19/6. P.P. 4/6.

**VALVE TESTER** (by Radio City Products, U.S.A.). Model No. 314. Brand new, unused with instruction manual. 110-220 v. A.C. 50 c/s. Will test most American valves from 1.1 v. to 200 v. Price £10/10/-. Carriage 5/-.

**AMERICAN DYNAMOTOR TYPE P.E. 103A.** Heavy duty power supply. Input 6 v. @ 21 amps. or 12 v. @ 11 amps. Output 500 v. @ 16 amps. Rating continuous. Complete with connection cable and mounting rack in new and unused condition. Sealed in original crates. £15. Carriage extra.

**ROTATABLE LOOP AERIALS (BENDIX) TYPE MN.** 24 c. (motor driven). 18in. loop. New and unused. £3/15/-. Carriage 5/-.

**R.C.A. PRE-AMPLIFIERS.** Comprising 2 6J7 valves and connections. Available for photo cell input 250 v. H.T. 6.3 v. L.T. supply required. Output control. Complete unit. New and unused. £5. Carriage paid.

**COLLINS RADIO RECEIVERS TYPE 46159A.** Freq. range 1,500-12,000 kc/s. Input 12 v. or 220 v. D.C. Less crystal and power pack. This unit is part of TCS-12-Trans. Receiver equipment. In clean and good condition. Limited quantity. £15. Carriage 7/6.

**RECORD MEGGERS.** 0-500 v. 0-20 meg. with carrying case. £8/5/-. Post paid.

**CARRIAGE CHARGES APPLY TO ENGLAND ONLY**  
QUOTATIONS TO THE TRADE FOR BULK SUPPLIES. ALSO  
ACTUAL ENQUIRIES WELCOMED. MANY OTHER LINES IN STOCK.

**15, LITTLE NEWPORT ST., LONDON, W.C.2.**

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## TWIN SPOTLIGHTS !!!



The new PrimaxA Soldering Gun has twin spotlights each with its own lens to light each side of the special Alloy Bit. Rated at 100 Watts this new Gun is more powerful than the Primax which has been acclaimed by Service Engineers and Amateurs. In 6 seconds the bit reaches the right temperature. You only consume current when actually soldering.

Available in 110-200/220, 220/250 v. Weight 34 ozs. Effective soldering area 1/64 sq. inch. One Year Guarantee (except on Soldering bits)

# PRIMAXA

MODEL 100 96/6

THE PRIMAX  
Solderer  
72/6  
still as popular  
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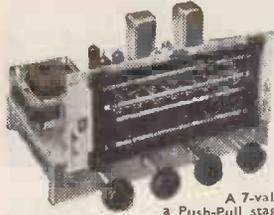
Precision Crystals of all types in a wide variety of bases covering the complete range 40 kc. to 18 Mc. in fundamental frequencies. All are made to extremely fine tolerances and frequency adjustment can be given up to 0.05%. Plated electrodes of gold, silver or aluminium with wired in spot welded contacts are available. Quotations can be given for any type of cut or mode of oscillation, including a complete range for filter circuits with zero temperature co-efficient over a sensibly wide temperature range. Our new works is equipped with up-to-the-minute production technique methods, X-ray orientation ensuring accuracy of all cuts. Artificial aging by etching and plating by evaporation under vacuum ensure long term stability of the final calibration. Early delivery can be given of most types. Our regrind service is still available and in some cases we are prepared to quote for lowering the frequency of your existing crystals.

### SPECIAL OFFER:

200 kc. DT cut, zero temperature coefficient over the range -30° centigrade to +55° centigrade. Frequency adjustment .005% or better. Mode: Face shear. Silver-plated electrode, wire mounted. Basing ½in. pin spaced. Other bases to order, £1 each.

## THREE REALLY GENUINE PRICE REDUCTIONS

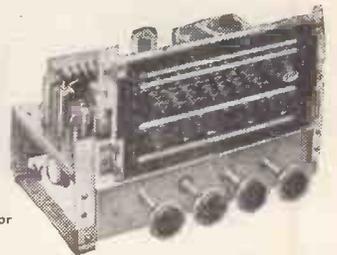
A BULK PURCHASE ENABLES US TO OFFER these RECEIVER CHASSIS at SUCH LOW PRICES Each are Brand NEW and FULLY GUARANTEED



**THE MODEL AW3-7**  
A 7-valve 3-waveband superhet chassis having a Push-Pull stage for approximately 6 watts output.

PRICE £12/19/6

H.P. TERMS. Deposit £6/9/6 and 8 monthly payments of 18/9  
COMPLETE SPECIFICATION and ALL RELATIVE DATA ON THESE THREE CHASSIS IS AVAILABLE—SEND S.A.E. for the ILLUSTRATED LEAFLET.



**THE MODEL B3PP**

A 6-valve 3-waveband superhet with two type 6BW6 valves in Push-Pull for approximately 6 watts output.

PRICE £12/9/6 H.P. TERMS. Deposit £6/9/6 and 8 monthly payments of 18/9

**THE MODEL B3**

A 5-valve 3-waveband superhet, identical in appearance to the Model B3PP illustrated above, but having a single valve (type 6BW6 output) for approximately 4 watts.

PRICE £10/17/6 H.P. TERMS. Deposit £5/18/7 and 7 monthly payments of 18/5.

### EXCEPTIONAL OFFER for

**CASH ONLY** This Latest B.S.R. MONARCH 3-SPEED AUTOCHANGER is offered for **£7/19/6** (NORMAL PRICE £13/10/0)

- These units will autochange on all three speeds. 7in., 10in. and 12in.
  - They play MIXED 7in., 10in. and 12in. records.
  - They have separate sapphire for L.P. and 78 r.p.m., which are moved into position by a single switch.
  - Minimum baseboard size required 14 x 12 1/2 in., with height above 5 1/2 in., and height below baseboard 2 1/2 in.
- A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.



### Stern's "Compact 5" Amplifiers

EXPRESSLY DEVELOPED FOR VERY HIGH QUALITY REPRODUCTION OF GRAM. RECORDS AND PARTICULARLY SUITABLE FOR HIGH QUALITY REPRODUCTION OF THE F.M. TRANSMISSIONS: TWO MODELS ARE AVAILABLE:

**The "Compact 5-2"**  
A 2-stage high sensitivity amplifier having SEPARATE BASS and TREBLE CONTROLS and designed to give up to approx. 5 watts with very pleasing quality. PRICE £5/15/-

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A 3-stage version of the "5-2" model, but in this case having an additional stage and incorporating negative feedback. PRICE £6/16/-



### STERN'S Complete Kit for "High Quality" 8-10 Watt Design



THE IDEAL AMPLIFIER FOR GENERAL HOME USE

Price of COMPLETE KIT including Valves and Kitted Chassis, etc. **£7/10/0**

We supply it COMPLETELY BUILT for **£9/10/0**

Designed for High Quality reproduction up to an output level of 10 watts, having 6V6s in Push-Pull and Incorporating negative feedback. It is suitable for use with all types of Pick-up and most types of microphone and the output transformer provides for use of 3- and 15-ohm speakers.

### STERN'S "F.M." TUNING UNITS



A 5-valve Tuner incorporating the latest Mullard Permeability Tuning Heart and a "Magic Eye" Tuning Indicator. The performance of this is genuinely well up to the standard of the higher priced commercially made units and we recommend it with the utmost confidence.

THE COMBINED AM-FM TUNER is precisely similar in appearance to the above and incorporates 7 valves. It provides complete coverage of the F.M. Transmissions and the MEDIUM WAVEBAND thereby giving a good selection of foreign stations.

ALL COMPONENTS TO BUILD THESE AMPLIFIERS, TUNERS, ETC., ARE AVAILABLE FOR SALE SEPARATELY CONSTRUCTORS CAN THEREFORE GRADUALLY BUILD ANY UNIT.

### The B.S.R. Model TU.8 3-Speed Record Player

Supplied complete, including the new lightweight "Turnover" type Crystal Pick-up. **£4/12/6** or we supply it without the Pick-up but including Turntable for **£2/18/0**

### THE NEW ARMSTRONG FC48

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This is a "mixer" unit and incorporates the "Studio O" Crystal Pick-up. H.P.: £5 Dep. and 7 months at 17/2.

WE ALSO HAVE IN STOCK THE MODEL 2010 PX TRANSCRIPTION RECORD PLAYER.

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THE COMPLETE SPECIFICATIONS OF THE FOLLOWING UNITS ARE AVAILABLE FOR 1/6 EACH.

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- STERN'S F.M. TUNING UNIT . . . This is illustrated and briefly described here and can be completely built for £10/0/0. It is now available.
- STERN'S COMBINED AM/FM TUNING UNIT . . . Precisely similar in appearance to the F.M. Tuner and can be completely built for £13/0/0. Will be available early May.
- THE DENCO F.M. TUNING UNIT . . . The complete set of SPECIFIED COMPONENTS to build this can be supplied for £7/2/9, this includes the Denco Dial and Drive Assembly.
- NOTE TO CONSTRUCTORS . . . Where desired our technical staff will, at a reasonable charge, tune and align either of the above units.
- STERN'S "fidelity" PREAMPLIFIER . . . TONE CONTROL UNIT . . . A design for the "Hi-Fi" enthusiast!!! Briefly, it has inputs for MICROPHONES, HIGH and LOW GAIN PICK-UPS, and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL, (b) STEEP CUT FILTER, (c) Continuously variable BASS and TREBLE CONTROLS and a VARIABLE OUTPUT CONTROL which enables its use with any make or type of Amplifier . . . THE COMPLETE KIT OF PARTS is available now for £6/6/0.
- STERN'S "fidelity" 10 WATT AMPLIFIER . . . This design comprises the MAIN AMPLIFIER of the famous MULLARD 5-10 design and our own "fidelity" PREAMPLIFIER-TONE CONTROL UNIT which we describe briefly above. We incorporate the latest GILSEN ULTRALINEAR OUTPUT TRANSFORMER and the combination of these two units undoubtedly provides reproduction of extremely high quality, in fact the complete Amplifier is comparable to the very expensive commercially made High Fidelity models. We offer the COMPLETE KIT OF PARTS FOR £15/15/0. Will be available at the end of May.
- STERN'S HIGH QUALITY 8-10 WATT AMPLIFIER . . . This is illustrated and briefly described here. It is one of the most successful Amplifiers (in the lower price range) yet offered to the Home Constructor. We can supply the complete kit ex-stock.
- STERN'S JUNIOR "PREAMPLIFIER-TONE CONTROL UNIT . . . Provides full control of BASS and TREBLE in conjunction with main VOLUME CONTROL and can be used with any Amplifier. The unit contains its own POWER SUPPLY . . . THE COMPLETE KIT OF PARTS is available at £3/16/9.
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**TRANSFORMER SNIP.** Admiralty pattern. Primary 230 volts 50 cycle. Three secondary windings, each 10 volt centre-tapped 5 amps. This will give any voltage between 5 and 30 volts in 5 volt steps at 5 amps. Supplied brand new. ONLY 29/6 each.

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**AMERICAN M/C HEADPHONES.** Really first quality. Impedance 20 ohms. Supplied brand new complete with ear-muffs and connector leads, 17/6 pr.

**ADMIRALTY POWER UNIT 234.** Input 200/250 volt 50 cycle. Output 240 volts 200 ma., 6.3 volts 6 amps. Double choke and paper condenser smoothed. Fitted with 2½ in. moving iron meter reading A.C. input volts and D.C. output volts. Mounted in grey metal case for 19" rack mounting. Supplied in perfect condition, 69/6 each. Ideal for use with receivers R.1132, R.1392, R.1155.

**EXTENSION DESK TELEPHONES.** Can be fitted to standard switchboard. Supplied complete with handset and bell but have no dialling system. American pattern, brand new and boxed, 59/6; English pattern 49/6. Handsets only 12/6 each.

**ROTARY CONVERTERS.** Input 24 volts D.C. Output 230 volt A.C. 50 cycle 100 watts. Supplied brand new 92/6 each.

**SUB-STANDARD VOLTMETERS.** These portable precision instruments are supplied brand new in polished wood case. Six ranges, 0-7.5/15/30/60/150 and 300 volts D.C. 6 in. mirror scale with knife edge pointer calibrated 0-150 volts. Accuracy 0.3% 68° fh. Price £4/19/6 each.

**PHOTO-ELECTRIC CELLS.** Type VA.16' Brand new 8/6 each. 6 volt exciter lamps 1/6 each

**MAGNETIC COUNTERS.** P.O. type. Coil res. 2300 ohms. Range 0-999. Fitted with reset mechanism 10/6 each. Ditto less reset, range 0-9999, coil 6 or 2300 ohms, 4/3 each.

**FREQUENCY METERS.** For 230 volt 50 cycle mains. 5 in. scale calibrated 45-55 cycles. Perfect condition, £5/10/0 each.

**P.O. JACK LEADS.** Brand new 6ft. screened leads fitted with two standard post office jack plugs, 3/- each.

**DEAF-AID UNITS.** Still a few available. Complete, less only outside bakelite case. These contain 3 sub-miniature valves, crystal mike, tone and volume controls. Battery space on chassis (22½ and 1.5 v.). Hundreds of applications. Price only 19/6 each. Miniature earpieces to match, 3/6. Leads 1/-. Batteries 2/9 pair.

**TRANSFORMER BARGAIN.** Admiralty pattern. Primary 230 volt 50 cycle. Secondary 14 volt centre-tapped at 12 amps. 100% safety rating. Brand new 42/6 each.

**YAXLEY METER SWITCHES.** Single pole 12 way, 8 bank, 7/6 each.

**EDDYSTONE 12 VOLT POWER UNITS.** Input 12 volt D.C. Output 180 volts 65 ma. Housed in grey metal case and complete with all smoothing, 19/6 each.

**50 MICROAMP METERS.** GRAND offer of brand new test sets containing a flush mounting 2½ in. 50 microamp meter housed in grey instrument complete with chromium-plated handle. Ideal basis for sensitive test-meter, valve-voltmeter or output meter. This unit also contains a VR92 diode and many other useful components. Price 59/6 each.

**BRAND NEW AMERICAN "PANORAMIC ADAPTORS."** Few only in original transit cases. 200/250 volt 50 cycle A.C. mains operation. Mid-point frequency 450-470 kc/s. Sweep frequency 200 kc/s. Uses 3BPI C.R.T. Price, only £30 each.

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**PARMEKO TRANSFORMERS.** Input 230 volt 50 cycle. Output 620/0/620 volts 250 ma. tapped 550/0/550 volts and 375/0/375 volts. Two 5 volt 3 amp. windings. Ample space for 6.3 volt windings. Price 39/6 each.

**RELAYS AND KEY SWITCHES.** We have comprehensive stocks of all types of relays and key switches. Send us your enquiries.

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50 microamps.	2½ in. rd. F.M. M.C. 59/6
100 microamps.	2½ in. rd. F.M. M.C. 39/6
500/0/500 microamps.	2½ in. rd. F.M. M.C. 25/-
50 microamps.	2 in. sq. F.M. M.C. 7/6
200 microamps.	2½ in. rd. F.M. M.C. 9/6
1 amp.	2½ in. rd. F.M. R.F. 6/9
1 amp.	2½ in. rd. Pj. R.F. 5/-
4 amp.	2 in. sq. F.M. R.F. 5/-
300 volts D.C.	2 in. sq. F.M. M.C. 10/6
300 volts A.C.	2½ in. rd. F.M. M.I. 25/-

**G.E.C. STARTER RELAYS.** 12 volt. Brand new 4/6.

**BATTERY CHARGER KITS.** Kits contain mains transformer, rectifier, mains and L.T. switch, mains selector, necessary wire and battery clips.

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6 or 12 volt 2 amp.	32/3
6 or 12 volt 4 amp.	37/6

**A.R.88 TUNING DRIVES.** Brand new and boxed, 10/6 each.

**R.1294 RECEIVERS.** Superheterodyne receiver covering 500/3000 mc/s. (10-60 cm.). Input impedance 70 ohms. 2 detector stages, 4 I.F. amplifier stages, 2 L.F. amplifier stages. I.F. frequency 13.5 mc/s. Bandwidth 3.5 mc/s. Price £35 each in perfect condition. A.C. mains power packs for this receiver can be supplied at an extra cost of 52/6 each.

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**18 PIN UNITERS.** Brand new 3/6 pair.

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(a) 6500 ohms, 12 v. 2 ma. 6/6.  
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(c) Double pole aerial changeover relays, 12 v. 7/6 each.

**PORTABLE SUB - STANDARD MILLIAMMETERS.** Manufactured by Elliott Bros. Basic movement 1 ma. Seven ranges 0/1/5/20/50/100/200/500 ma. Accuracy 0.6% 68° fh. 6 in. mirror scale calibrated 0/100 ma. with knife-edged pointer. Supplied brand new with leather carrying case. £12/10/0 each.

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EF80	10/6	EF91	9/6	5U4G	7/6	SP61	2/-
EBF80	14/6	PCF80	12/6	5V4G	8/6	6AUG5	4/-
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ECC84	12/6	6SN7	6/6	6V6G	6/6	EF36	4/6

**SPECIAL OFFER GRAM MOTORS.** Garrard 200/250 volt A.C. gram motors complete with turntables. Variable speed 0-45 rpm. Can be used for latest type 33 rpm. or 45 rpm. records. Absolute snip, 22/6 each.

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#### TRANSFORMER BARGAINS. All

200/250 volt input.

- 250/0/250 volt 60 ma. 6.3 v. 3 a. 5 v. 2 a. Shrouded, 18/6.
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- 350/0/350 volt 80 ma. 6.3 v. 4 a. 5 v. 2 a. Tapped 4 v., 18/6.
- Tapped L.T. Trans. 3/4/5/6/8/10/12/15/18/20/24/30 volt 2 amp., 18/6.
- Auto Transformer. 110/200/250 volt 150 watts, 21/-.

Filament transformers. 6.3 v. 1.5 amp., 5/9; 6.3 v. 3 amp., 10/6.

Admiralty types. 230 volt input.

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**H.R.O. VIBRATOR PACKS.** 6 volt D.C. input. Output 165 volts 80 ma. and 6.3 volt 3 amp. Choke and Condenser smoothed, uses 6X5 rectifier, 29/6 each.

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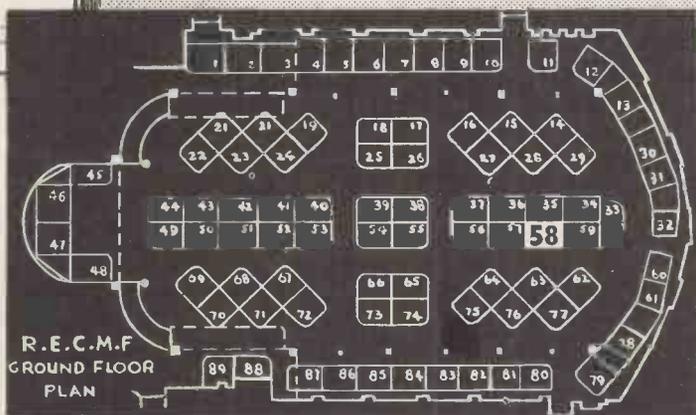
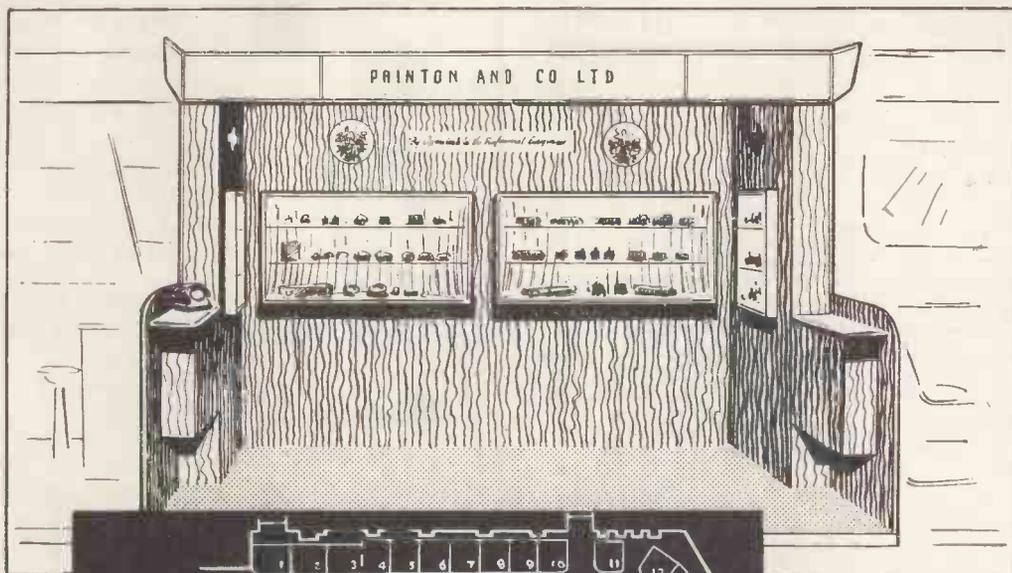
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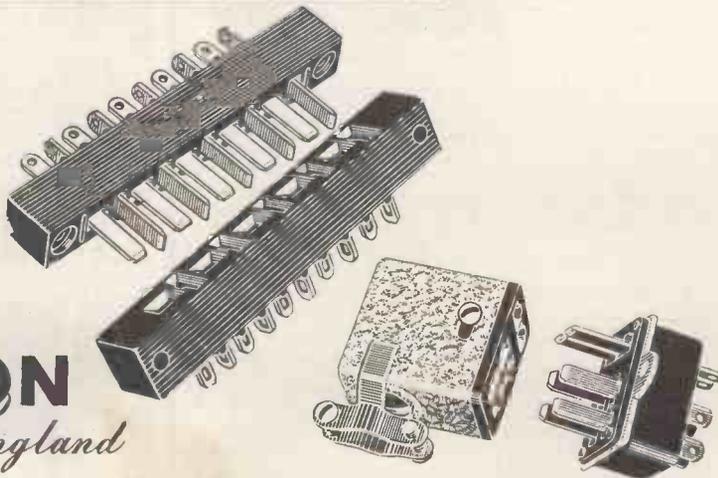


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18 x 4½ x ½in., 1/- each; 10 x 10 x ½in., 1/- each; 20 x 10 x ½in., 2/-.

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Carbon ½-watt 2/6; ¼ watt 3/-; 1 watt 4/-; 2 watt 6/- per doz. WIRE WOUND AND VITREOUS. 5-watt 1/6; 10 watt 2/6; 15 watt 3/-; 20 watt 3/6 each.

HIGH STABILITY. ½ watt 5% 6d.; ¼ watt 5% 9d.; 1 watt 5% 1/3 each. A few values in 1% and 2% still available.

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AIR SPACED TRIMMERS, 5, 10, 15, 20, 25, 50 and 75 of pre-set and spindle types 2/- each.....doz. 21/-

PYE PLUGS AND SOCKETS 1/6 per pair, "Tee" plated...each 1/9

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POST OFFICE LAMP JACKS No. 10 1/- each.....doz. 9/-

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OUTPUT TRANSFORMERS. Multi-ratio 5/- each; Pentode or power.....each 4/-

WESTECTORS. WX6, WX12, W12, W4, 1/- each.....doz. 9/-

ARCOLECTRIC (Whitney Lamp), Red, Green, Clear, 1/6 each doz. 15/-

SIGNAL LAMP HOLDERS. Panel mounting, complete with adjusting lampholder, 2/- each.....doz. 21/-

BELLING-LEE. L356 fuse holders.....each 2/6

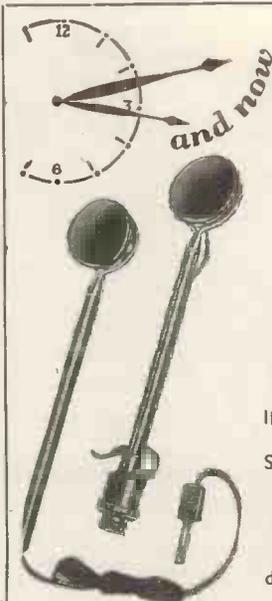
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Handphones with individual volume control. Ideal for use with church and cinema deaf aid installations or for individuals with impaired hearing. They provide the essential clarity of reception when listening to Radio and T.V.

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This magnificent bureau type cabinet is in specially selected walnut veneer exterior, with a light sycamore lining. It gives you two large-sized storage compartments



Overall dimensions:  
Length 32" Height 34"  
maximum depth 16"  
minimum depth 11"  
Motor board size: 15½" x 13"  
Scale aperture size: 10½" x 14½"

NET TRADE PRICE £13.13s.0d.

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Continuous 2.3/8 lb. at 1"  
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100% PRODUCTION INSPECTION  
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Also Transformers to 6 KVA 3 Phase

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18 FOREST ROAD, KINGSWOOD, BRISTOL.

PHONE 74065

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Primary, 200-250 v. P. & P. 2/-, 300-0-300, 100 mA. 6 v. 3 amp., 5 v. 2 amp., 22/6.

Semi-shrouded drop-through 380-0-380 v., 120 mA., 6.3 v. 4 amp., 5 v. 2.5 amp., 22/6.

Drop thro' 350-0-350 v. 70 mA. 6 v. 2.5 amp., 5 v. 2 amp., 14/6.

Chassis mounting or drop-thro'. Pri. 110-150 v. Sec. 350-0-350, 250 mA., 6.3 v. 7 amp., 6.3 v. 0.5 amp., 5 v. C.T., 0.5 amp. 4 v. 4 amp. P. & P. 3/6. 32/6.

Chassis mounted and fully shrouded, 80 mA., 6 v. 3 amp., 5 v. 2 amp., 14/6.

Drop thro' 270-0-270 60 mA., 6 v. 3 amp., 11/6.

250 v. 350 mA., 6.3 v. 4 a., twice 2 v. 2 a., 19/6.

Auto-trans. Output 200/250 H.T. 500 v. 250 mA., 6 v. 4 a., twice 2 v. 2 a., 19/6.

Auto-trans. Input 200/250 H.T. 350 v. 350 mA. separate L.T. 6.3 v. 7a., 6.3 v. 1 1/2 amp., 5 v. 3 amp., 25/-, P. & P. 3/-.

Mains Transformer, fully impregnated. Input 210, 220, 230, 240. Sec. 350-0-350 100 mA., with separate heater transformer. Pri. 210, 220, 230, 240. Sec. 6.3 v. 2 amp., 6.3 v. 3 amp., 4 v. 6 amp. and 5 v. 2 amp., 30/-, P. & P. 5/-.

350-0-350 75 mA. 6.3 v. 3 a. tap 4 v. 6.3 v. 1 a., 13/6.

500-0-500 125 mA. 4.3 C.T. 4 a., 4 v. C.T. 4 a., 4 v. C.T. 2.5 a., 27/6.

500-0-500 250 mA. 4 v. C.T. 4 a., 4 v. C.T. 5 a., 4 v. C.T. 4 a., 39/6.

6 1/2 in. M.E. Speaker. 1,000 ohm field, 15/-.

R. & T.V. energised 6 1/2 in. speaker with O.P. trans. field coil. 175 ohms 9/6. P. & P. 2/6.

R. & A. 6 1/2 in. M.E. speaker, with O.P. trans. field 440 ohms, 10/6. 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, 2, 1/2, and 1 meg., 4/- each, 10K and 50K, 3/6 each, 1 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., 10/-.

Twin Gang .0005 Tuning Condensers, 5/-, With trimmers, 7/6.

Twing Gang .0005, with feet, size 3 1/2 x 3 x 1 1/2 in., 6/6.

3-gang .0005, with feet, size 4 1/2 x 3 x 1 1/2 in., 7/6.

T.V. Coils, moulded former, iron-cored wound for re-winding purposes only. All-can 1 1/2 x 1 1/2 in., 1/- each, 2 iron-core All-can 2 1/2 x 1 1/2 in., 1/6 each. The above coil formers are suitable for the "Wireless World" F.M. tuner.

Used Metal Rectifier, 250 v. 150 mA., 6/6. Metal Rectifier, 250 v. 45 mA., 6/-.

Metal Rectifier, RM2 125 v. 150 mA., 3/6.

**OUTPUT TRANSFORMERS.** Standard type 5,000 ohms imp., 4/9; 42-l with extra feed-back windings, 4/3. Miniature 42-l, 3/3. Multi-ratio 3,500, 7,000 and 14,000, 5/6. 10-watt push-pull, 6V6 matching, 7/-, 90-l 3 ohm speech coil, 6/6.

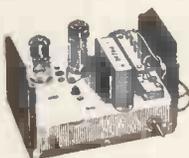
**SPECIAL OFFER. VERY LIMITED QUANTITY**

**7-VALVE PUSH-PULL RADIOGRAM CHASSIS**

A.C. MAINS 200/250 v. 3 wave band, coverage short wave 16-550m, medium wave 187-550m, long wave 900-2,000m, 4 controls, volume control on-off, tone control, tuning and wave change with gram position. Valve line up X79, W727, two DH77's, two EL41's and EZ30. Output 7 watts. Size of chassis 16in. x 7in. x 2 1/2in. Size of scale 12in. x 4in. Overall height including back plate 7 1/2in. BRAND NEW. Fully guaranteed. P. & P. 7/6. £9/19/6.

**T.V. CONVERTER**

For the new commercial stations, complete with 2 valves. Frequency can be set to any channel within the 186-196 Mc/s band. I.F. will work into any existing T.V. receiver between 42-68 Mc/s. Input arranged for 80 ohm feeder, EF80 as RF amplifier, ECC81 as local oscillator and mixer. The gain of the first stage, R.F. amplifier 10DB. Required power supply of 200 D.C. at 25 mA., 6.3 v. A.C. at 0.6 amp. Input filter ensuring freedom from unwanted signals. Simple adjustments only, no instruments required for trimming. Will work into T.R.F. or superhet, Band Switch, and wire wound gain control. Fully screened in black crackle finished case, size 5 1/2 in. long, 3 1/2 in. wide, max. overall height 4 1/2 in. £2/19/6. P. & P. 2/6. As above, complete with built-in power supply A.C. mains 200/250 v. £3/19/6. Post & Packing 2/6.



**BAND III CONVERTER KIT**

comprising 5 channel tuner, mains transformer, metal rectifier, electrolytic, 2 valves 12AT7 and EF80 and all necessary components for A.C. Mains operation. Complete with conversion data £215/0. P. & P. 2/6.

P.M. SPEAKER, 6 1/2 in. closed field, 18/6. 8 in. closed field 20/6. 10 in. closed field 25/-, 3 1/2 in., 16/6. 12 in. closed field, 25/-, P. & P. on each 2/-.

EXTENSION SPEAKER in polished walnut, complete with 8 in. P.M. P. & P. 3/-, 24/6.

B.S.R. MONARCH three speed automatic changer, current model. Brand new. Will take 7 in., 10 in., or 12 in. records mixed. Turnover crystal head. A.C. Mains 200/250. Pre-Budget Price while stocks last. £7/15/0. P. & P. 3/-.

1,200ft. High Impedance Recording Tape on aluminium spool, 12/6 post paid. Radiogram Chassis, 5 valve A.C./D.C. 3 wave-band superhet 196/255 v. 19-49, 200-550 and 1,000-2,000 metres. I.F. 470 Kc. size of chassis 13 x 6 1/2 x 2 1/2 in., size of scale 7 1/2 x 3 1/2 in. Valve line-up 10C1, 10F9, 10LD11, U404 and 10P14. Twin mains filter input, 2 dial lights and 8 in. P.M. £8/17/6. P. & P. 5/-.

SPECIAL OFFER. 8 in. P.M. speakers, removed from chassis, fully guaranteed. All by famous manufacturers. P. & P. 1/6. 12/6.

**3-speed TRANSCRIPTION MOTOR**

BY FAMOUS MANUFACTURER

Complete kit of parts comprising accurately balanced precision made heavy turntable with rubber mat, large constant speed condenser starting motor, base plate. Can be assembled in half an hour. A.C. Mains 200/250v. Fully guaranteed. Parts sold separately. £6-19-6 Post Paid



P. & P. 3/- 17/6

**40-WATT FLOURESCENT KIT** A.C. mains 230/240. Comprising choke, power-factor condenser, 2 tube holders, starter and starter holder. No metal-work or tube.

**20-WATT A.C. or D.C. 200/250 v. FLOURESCENT KIT** comprising trough in white stove enamel finish, two tube holders, starter and holder and barretter. Post and packing 12/6. 12/6.

**POLISHING ATTACHMENT** for electric drills. Quarter inch spindle, chromium plated Sin. brush, 3 polishing cloths and one sheepskin mop mounted on a 3 in. rubber cap. Post and pkg. 1/6. 12/6. Spare sheepskin mops, 2/6 each.

**POTATO AND VEGETABLE PEELER.** By famous manufacturer. To suit models A200 and A700. Capacity 4 1/2 lb. complete with water pump. All aluminium construction, white stove-enamelled finish. Originally intended for adaption on an electric food-mixer, can be easily converted for hand operation. 39/6. P. & P. 3/-.

**STANDARD WAVE-CHANGE SWITCHES.** 4-pole, 3-way, 1/9; 5-pole, 3-way, 1/9; 3-pole, 3-way, 1/9; 9-pole, 3-way, 3/6; Miniature type, long spindle, 3-pole, 4-way, 4-pole 3-way and 4-pole 2-way, 2/6 each. 2-pole 11-way, twin-wafer, 5/-; 1-pole 12-way single wafer, 5/-, P. & P. 3d.

Ion Traps for Mullard or English Electric tubes, 5/-; post paid. Standard 465 Kc. iron-cored I.F.s, 4 x 1 1/2 x 1 1/2 in., per pr., 7/6. Wearite standard, iron-cored, 465 Kc., I.F.s, 3 1/2 x 1 1/2 x 1 1/2 in., per pr., 9/6.

Iron-cored 465 Kc. Whistle Filter, 2/6. 465 Kc. MIDGET I.F.s, Q-120 size, 1 1/2 in. long, 1 1/2 in. wide, 3/4 in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, 12/6.

3-speed automatic changer by famous manufacturer. 10 Records, turnover crystal head, brand new, current model. A.C. mains 200/250v. (list price £14-10), £8-19-6. P. & P. 5/-.

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**PERSONAL SHOPPERS ONLY** 9 in. Enlarger, 17/6; 12 in., 27/6. Germanium Crystal Diode, 1/6, post paid. Used 9 in. Tube with ion burn, 17/6. Post paid.

Line O.P. Transformer in aluminium can mounted in rubber, 12/6 Line and E.H.T. Transformer, 14 Kv., using ferrocat core, complete with line and width control, and corona shields U37 rectifier winding, 35/-.

Line and E.H.T. Transformer, 9 Kv., using ferrocat core, complete with built-in line and width control. Mounted on small all-chassis. Overall size 4 1/2 x 1 1/2 in. EV51 rec. windings, 27/6.

Scan coils, low line low impedance frame, complete with frame transformer to match above, 27/6. P. & P. 2/-.

Line and E.H.T. Transformer, 9 Kv. ferrocat core, EY51, heater winding, complete with scan coils and frame output transformer, and line and width control, 35/-, P. & P. 3/-.

As above, but complete with line and frame blocking transformers, 5 Henry 25 mA. choke, 100 mfd. and 150 mfd., 250 wkg. 380 mA. A.C. ripple. £2/9/6. P. & P. 3/-.

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32 mfd., 350 wkg. .... 2/-  
16 x 24, 350 wkg. .... 4/-  
4 mfd., 200 wkg. .... 1/3

16 x 8 mfd., 500 wkg. .... 4/6  
16 x 16 mfd., 500 wkg. .... 5/9  
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32 x 32 mfd., 350 wkg. .... 4/-  
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 1/6  
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100 mfd., 350 wkg. .... 4/-  
100 mfd., 450 v. wkg., 280 mA.,

A.C. ripple ..... 3/11  
150 mfd., 350 v. wkg., 230 mA.,

A.C. ripple ..... 4/6  
200 mfd., 275 wkg. .... 7/6  
16 x 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 x 100 mfd., 280 wkg. .... 7/6  
50 mfd., 12 wkg. .... 11d.  
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Miniature wire ends moulded, 100 pf., 500 pf., and .001, each 7d.

Combined 12 in. mask and escutcheon in lightly tinted Perspex. New aspect edged in brown. Fits on front of cabinet, 12/6. As above for 15 in. tube, 17/6.

Frame Oscillator Blocking Trans. 4/6.  
Line Osc. Blocking Trans., 4/6.  
CHOKES:

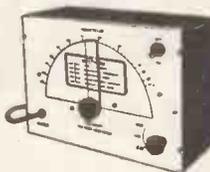
2-20 Hen., 150 mA., 15/-, P. & P. 3/-.  
6 Hen., 275 mA., 15/-, P. & P. 3/-.

100 Hen., 40 mA., 15/-, P. & P. 3/-.  
250 mA., 10 Henry, 10/6; 5 Henry 250 mA. 60 ohms, 8/6.

Wide Angle P.M. Focus Units. Vernier adj. state tube, 15/-.  
P.M. Focus Units for Mullard tubes with vernier adjustment. P. & P. 2/-, 15/-.

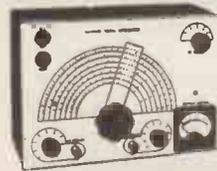
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**PATTERN GENERATOR**



Coverage 40 Mc/s-70 Mc/s.  
A.C. Mains 200/250v. £3-19-6  
or 29/- deposit, 3 pyts. of £1.  
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## 18 S.W.G. ALUMINIUM CHASSIS

8in. x 6in. x 2 1/2in. 7/6	14in. x 8in. x 2 1/2in. 9/6
10in. x 6in. x 2 1/2in. 8/3	14in. x 8in. x 2 1/2in. 10/6
12in. x 6in. x 2 1/2in. 8/6	14in. x 10in. x 2 1/2in. 11/-
12in. x 8in. x 2 1/2in. 9/6	17in. x 10in. x 2 1/2in. 12/6

## 18 S.W.G. STEEL CHASSIS

14in. x 8in. x 2 1/2in. 9/8	17in. x 10in. x 2 1/2in. 11/3
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G.E.C. OSRAM 912 AMPLIFIER DRILLED CHASSIS	21/-
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CONNOISSEUR Variable Speed Transcription	£28 11 0
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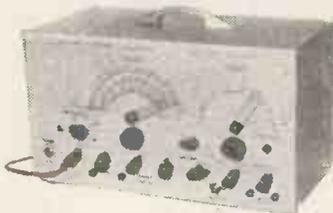
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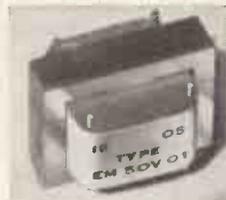
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**C.R.T. ISOLATION TRANSFORMERS**

For Cathode Ray Tubes having Heater/Cathode short circuit or for C.R. Tubes with falling emission.  
 Type A. Low leakage windings. Ratio 1:1.25 giving a 25% boost on Secondary.  
 2 volt ..... 10/6 each With Tag  
 4 volt ..... 10/6 each Panel and  
 6.3 volt ..... 10/6 each Solder Tags  
 10.5 volt ..... 10/6 each  
 13.3 volt ..... 10/6 each  
 Ditto with mains primaries 12/6 each.  
 Type B. Mains input 220/240 volts. Low Capacity. Multi Output 2, 4, 6.3, 7.3, 10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for all Cathode Ray Tubes. With Tag Panel 21/- each.  
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 All Isolation Transformers are individually boxed, labeled and clearly marked with relevant data.  
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**RESISTORS.** All values. 10 ohms to 10 meg., 1/4 w., 4d.; 1/2 w., 6d.; 1 w., 8d.; 2 w., 1/-.

**HIGH STABILITY.** 1/4 w., 1%, 2/-. All preferred values 100 ohms to 10 meg.

**WIRE-WOUND RESISTORS** 1/3  
 5 watt ..... 100 ohms-10,000 ohms ..... 1/6  
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 15 watt ..... 25 ohms-10,000 ohms ..... 2/-  
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**WIRE-WOUND POTS. 3 WATT LAB. COLVERN ETC.**  
 Pre-Set Min. T.V. Type Standard Size Pots, 2 1/2in.  
 Knurled Slotted Knob Spindle High Grade All  
 All values 25 ohms to 30 Values, 100 ohms to 50 K.,  
 K., 3/- ea. 50 K., 4/- 5/6; 100K., 6/6.

Ditto Carbon Track 50 K. W/W EXT. SPEAKER  
 2 Meg. 3/- CONTROL 100 3/-  
**WIRE-WOUND FORMERS.** Hewitt Duty 50 m.a., 4/6. Ditto,  
 tapped primary 4/6. Multitap, push pull, 6/6. Tapped  
 small pentode, 3/6. Hygrade Push Pull 7 wts., 15/6.  
 L.F. CHOKES 15/10 H. 80/85 m.A., 5/-; 25/20 H. 100/120  
 m.A., 11/6; 20/15 H. 120/150 m.A., 12/6; 5 H. 250 m.A., 15/-  
**MAINS TRANS.** 350-0-350, 80 m.A., 6.3 v. tapped 4 v. 4/-,  
 5 v. tapped 4 v. 2/-, ditto 250-0-250 80 m.A., etc., 21/-

**I.F. TRANSFORMERS.** 465 kc. Pye Radio, midget size,  
 2 1/2in. x 1 1/2in. x 1 1/2in., 7/6 pr. With data sheet.

**HEATER TRANS.** Tapped 200/250 v. 6.3 v. 1 1/2 amp., 7/6.  
**COPPER PLATED AERIAL RODS.** 1/2 x 12in. push fitting,  
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**ALADDIN FORMERS** and cores. 1in., 8d.; 1 1/2in., 10d.  
**FORMERS** with Case and Core. 1in. sq. x 1 1/2in. and  
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**SLOW MOTION DRIVES.** Epicyclic ratio 6:1; 2/3.  
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**LINE CORD.** 3 amp., 60 ohms, per foot, 2 amp., 100 ohms  
 per foot, 2 way 6d., per foot, 3 way 7d., per foot.

**CRYSTAL MIKE INSERT.** Famous make, precision  
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 6/6. No transformer required.

**LOUDSPEAKERS P.M. 3 OHM.**  
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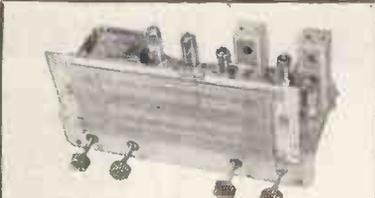
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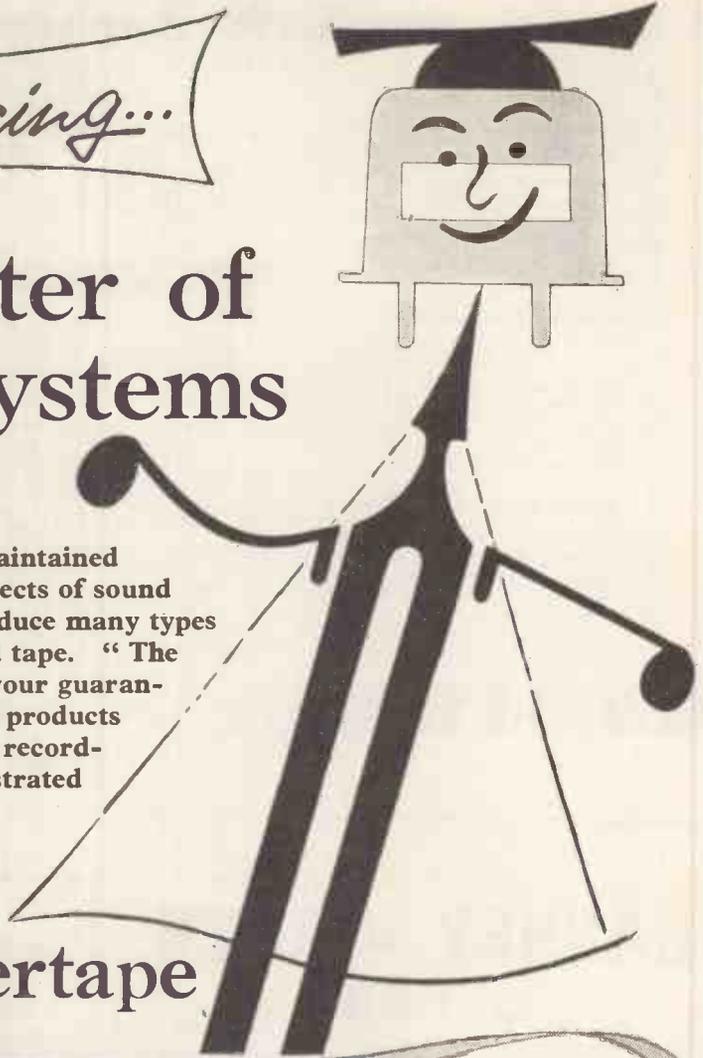
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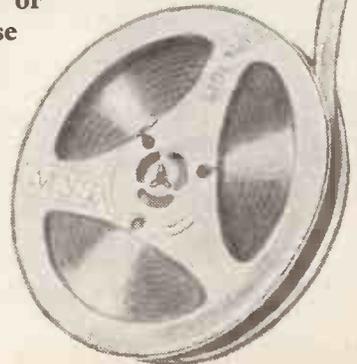
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500 Microamp.	D.C. M/C	2 1/2in.	27/6
500-0-500 Micro-amp.	D.C. M/C	2 1/2in.	25/-
1 Milliamp.	D.C. M/C	2 1/2in.	22/6
10 Milliamp.	D.C. M/C	2 1/2in.	10/6
100 Milliamp.	D.C. M/C	2 1/2in.	10/6
150 Milliamp.	D.C. M/C	2 1/2in.	7/6
200 Milliamp.	D.C. M/C	2 1/2in.	10/6
1 Amp.	Thermo-couple	2 1/2in.	6/9
4 Amp.	Thermo-couple	2 1/2in.	6/9
20 Amp.	D.C. M/C	2 1/2in.	7/6
30-0-30 Amp.	D.C. M/I	2 1/2in.	5/-
15 Volts	A.C. M/I	2 1/2in.	8/6
300 Volts	A.C. M/I	3 1/2in.	30/-
300 Volts	D.C. M/C	2 1/2in.	10/6

**METER RECTIFIERS.** 1 mA. Salford Instruments, 8/6; 5 mA. Salford Instruments, 6/9; 2 mA., S.T.C., as used in E.M.I. Output Meter, 5/6. All are full wave bridge and brand new.

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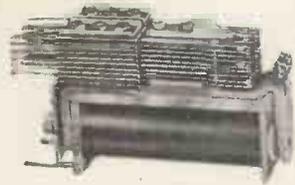
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1 "	2 in. 50/87	MC/FS Elliott	27/6
5 "	2 in.	MC/FS	10/6
30 "	2 1/2 in.	MC/FR	12/6
50 "	2 in.	MC/FS	10/6
100 "	2 1/2 in.	MC/FR	12/6
200 "	2 1/2 in.	MC/FR	12/6
250 "	2 1/2 in.	MC/FR	12/6
500 "	2 1/2 in.	MC/FR	12/6
1 Amp.	2 1/2 in.	MC/PR	17/6
20 "	2 1/2 in.	MI/FR	25/-
30 "	2 in.	MC/FS	10/6
50 "	2 in.	MC/FS	12/6
50 "	5 in.	MI/PR	60/-
15 Volt	2 1/2 in.	MI/FR	15/6
20 "	2 in.	MC/FS	10/6
40 "	2 in.	MC/FS	10/6
100 "	2 1/2 in.	MCR/FR	30/-
300 "	2 1/2 in.	MI/FR	25/-
300 "	5 in.	MI/PR	60/-
600 "	3 1/2 in.	MI/FR	37/6

**TERMINAL BLOCKS.** 2 way No. 5C/430 fully protected, 4/- per doz., 50 for 15/-; 100 for 25/-. 3 way, 8/- doz., 30/- for 50. Post 1/6.

**TRIMMING CONDENSERS.** Air spaced miniature 1.5 to 8 pf., 1.5 to 20 pf., 2 to 32 pf., 20 pf. All at 1/- each or 9/- per doz. Post 1/-.

**CONDENSERS, METALMITE,** 350 vt. wkg., .001, .002, miniature, 12/- doz., .005, .01, .02, 10/- doz., .05, 12/- doz., .1, 13/6 doz., .25 Metalpack, 16/- doz., 1.0 Metalpack, 24/- doz. Post 1/-.

**CONDENSERS, Block type.** Large range available including 4 mfd., 3/6 ea., 8 mfd. 7/6, 10 mfd. 8/6. Post 1/-.

**VERNIER DRIVES.** Muirhead, scaled 0-180 deg. 38 to 1, diam. 3in., 10/6. Post 1/-.

**BULKHEAD FITTING.** 9in. diam., flat tripod type, suitable for lamps up to 100 watt, complete with pushbar switch lampholder. Ideal for farm buildings, garages, greenhouses, etc. Brand new 17/6, post 2/6.

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**MOTOR.** 12 v. D.C. 1 1/2 in. x 2 in. approx., 3,000 R.P.M., with speed regulator in end cap. A precision job, 12/6, post 1/6.

**GEARED MOTORS.** 4 R.P.M. at 12 v., 8 R.P.M. at 24 v. Very powerful, supplied with a suppressor which can easily be removed. 35/-. Post 2/-.

**INSPECTION LAMPS,** with wire guard, strong clip, S.B.C. holder, 22ft. C.T.S. flex. Ideal for all car owners. 22/6, post 2/6.

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**WHEATSTONE RESISTANCE BRIDGE.** 1 to 10,000 ohms. Plug type. 25.

**AUTO TRANSFORMER VARIABLE.** Input 230 v. A.C., 21 amp. Output 57.5 v. to 228 in 16 steps with current limiting reactor. £12 each, cge. 10/-.

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Post Office type 11A, counting up to 9,999, 2 to 6 volts D.C. 3 ohm coil, 12/6 each. Post 1/- . Many other types in stock.

**ROTARY CONVERTERS.** Input 24 volt D.C. Output 100 watts at 230 volt A.C., 150 watts at 200 volt A.C., 92/6. Also available in a metal case with switch, 105/-. Cge. 7/6.

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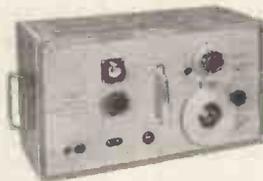
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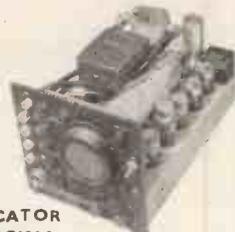
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5 x 6K7, 2 x 6N7, 2 x 6J5, 1 x 6B8, 1 x 6L7, 1 x 6F6. Frequency 3.4-7 Mc/s. 325-695 kc/s., 150-325 kc/s. 28 v. Dynamotor. Loose stored, good condition, £3/10/-. Carriage 6/6.



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24 volt relay operated, approximately 30 seconds delay, press button set, beautifully made. 5/11, post free.



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With 14 valves. 3-12S17, 4-12SH7, 2-12H6, 1-VR150, 2-VT121, 2-9004. Plus magnetic sounder, relays, precision resistors etc., etc., with 12 volt dynamotor 59/6, less dynamotor 39/6. In original cartons.



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RT-34/APS-13, 17 valves, including 5-616 1-VR105, 9-6AG5, 2-D1. Brand new American equipment in original cartons with instruction manual complete with dynamotor, 79/6.



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Velvet faced earpads complete with lead and plug 12/6. Postage 1/6.

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**ELECTROLYTIC CONDENSERS**. 32 mid. 450 v., cartons of 10 condensers, fully guaranteed, 10/-, post paid.

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**BOSTIK CEMENT**. 8-oz. tubes, with nozzle and wind, 1/6, post 10d.

**BOWDEN DRIVE CABLE**, inner 5-ft. long, outer black braided 4 1/2 ft. long, with control lever, new unused, 1/6, post 7d.

**RATCHET SPANNERS**, 10in. lever, reversible to screw or unscrew, 1in. Whit. socket, weight 23 oz., value 25/-. Our price, new, boxed, 4/9, post 1/3. 2 for 10/-, post paid.

**CARBON BRUSHES**, fitted springs and pigtails, 25 assorted pairs, small, medium and large, new unused, 5/-, post 1/-.

**BURGESS MICRO SWITCHES**, normally open, new unused, 1/9, post 4d.; 18/- doz., post 1/3.

**SIEMENS HIGH SPEED RELAYS**, 145 ohm coils, single pole changeover platinum contacts, in superior metal cases fitted terminal block, brand new, worth 35/-. Our price, 5/-, post 1/3.

**THERMOSTATS**, glass enclosed, contacts break at 90 deg. "F." Overheating and fire protection, new, unused, 1/-, post 4d.; 10/- doz., post 1/3.

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Many other bargains; send stamped addressed envelope for lists.

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In silver hammer case (as illustrated) with polished grille, handle and four feet of screened lead. Only 21/-

Inland post paid



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12 v. input, output 360/310 v. 30 mA., c.c.s. or 70 mA. i.c.a.s. Only 4 1/2 x 2 1/2 in. overall. Only 17/6 each, or 30/- for 2. Post and packing 1/6.

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**MEGGER SAFETY OHMMETERS.** Perfect, £3.

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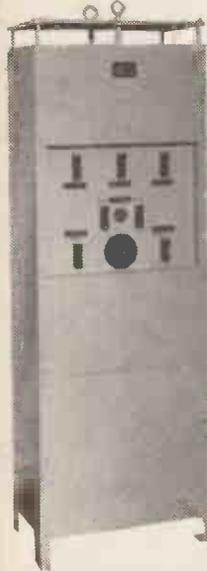
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The famous K8 deck; twin track, two speed, with push buttons and SERVO braking, is a beautifully finished job at only £19/19/-. Post free. Or H.P. terms on application.

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The HATFIELD amplifier is complete with oscillator as above, and magic eye, less speaker, at £12/15/-. Or H.P. terms on application.

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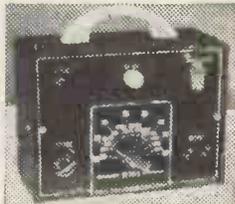
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This is the lowest possible price consistent with high quality. No radio knowledge whatever needed... can be built by anyone in 2-3 hours, using our very simple, easy-to-follow diagrams. This terrific new circuit covers all Medium and Long Waves with optional negative feedback, has razor-edge selectivity, and exceptionally good tone. Price also includes ready drilled and punched chassis, set of simple, easy-to-follow plans—in fact, everything! All parts sparkling brand-new—no junk! Every single part tested before despatching. Uses standard octal-base valves: 6K7G high-frequency pentode feeding into 6J6G anode-bend detector triode, coupled to 6V6G powerful output beam-power tetrode, fed by robust rectifier. For A.C. Mains, 200-250 Volts (low running costs—approximately 18 Watts). Size 12in. x 6in. x 5in. Send £5/7/6 for all parts and set of plans. (Add 3/6 for packing and post). C.O.D. 1/6 extra. Priced Parts lists 2/-.

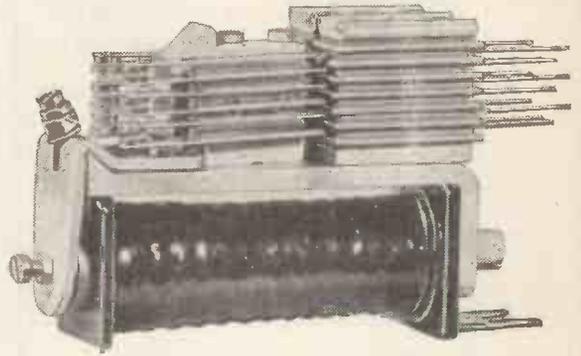


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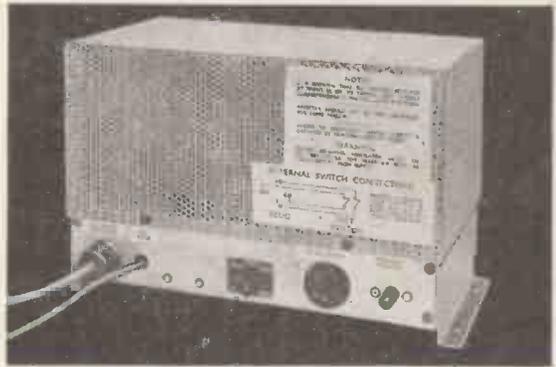
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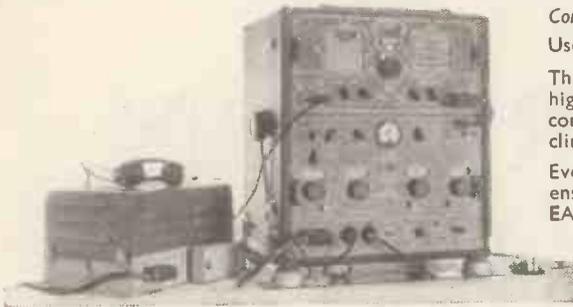
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The performance of these installations is of the highest order and meets the requirements of commercial telecommunication working in all climates and conditions.

Every design feature has been incorporated to ensure: **RELIABILITY — ACCESSIBILITY — EASE OF SERVICING.**

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FREQUENCY RANGE: 1,500 Kc/s. to 12,500 Kc/s. in 3 bands, V.F.O. or CRYSTAL CONTROL with choice of five crystal positions.  
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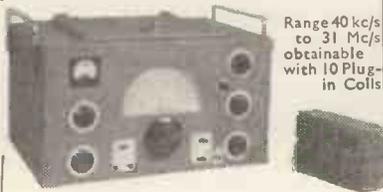
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Range 40 kc/s to 31 Mc/s obtainable with 10 Plug-in Coils

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Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee: Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

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FM receiver kits, as W.W. design, £5; alignment, 10/6; transistor receivers and other kits; March issue band III coil set, 40/-—Bel Sound Products, Co., Marlborough Yard, London, N.19. Arc. 5078. [0186]

**RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND**  
 FOR sale, Edison 680X, as new; accept best offer for quick sale.—Box 0400. [5754]

**ARMSTRONG FC48, FXP 125/C. super and twin—157, Bromsgrove St., Birmingham. Mid. 1054. [5661]**

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**COSSOR oscilloscope for sale, perfect order; £10.—Welsh, 382, Brockley Rd., S.E.4. [5830]**

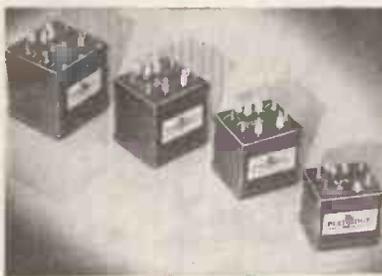
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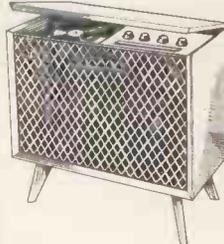
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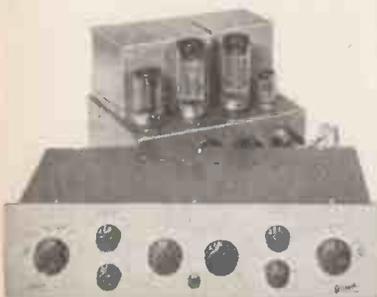
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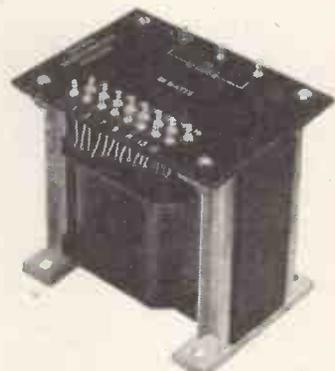
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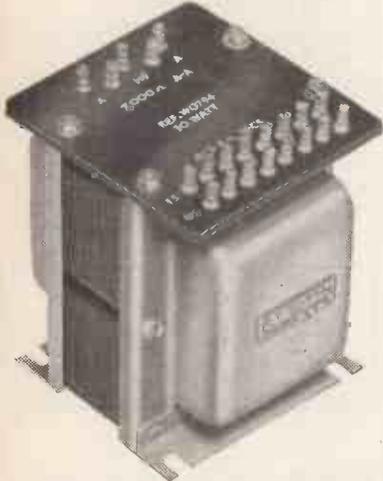


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APPLICANTS should be over the age of 28 and be Graduates of the Institution of Electrical Engineers or in possession of an Engineering Degree or Diploma recognised as granting exemption from Sections A and B of the Institution's examination. Experience in the radio industry or in the radio branches of Her Majesty's Services for at least two years is necessary but applicants need not have experience directly related to broadcasting.

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**L/P THE RECORD LIBRARY**

**L/P THE RECORD LIBRARY**

**SITUATIONS VACANT**

**R**ADIO Technician required by **CYPRUS** Government for service as **CHIEF Inspector of Police** (Communications Mechanic) on contract for four of four years in first instance. Salary according to experience in scale (including Overseas Allowance and present temporary allowance of 9% of salary)—£967 rising to £1,096 a year. Gratuity at rate of £100 a year. Free passages. Liberal leave on full salary. Candidates of good education must have thorough knowledge maintenance of low-powered VHF equipment, fixed and mobile, petrol driven alternators, etc. and good background workshop experience. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M1/3783/WF [5828]

**F**ERRY AIRPORTS, LIMITED. APPLICATIONS are invited radio mechanics and licensed radio engineers, permanent vacancies, hangar and flight duties, Bristol Freighter and Dakota aircraft. EXPERIENCE STR12D, STR9X, MR80, AD7092, B435G and Ultra I/C preferred not essential. Modern heated hangar, canteen and assisted travel facilities. Write to the Engineer Superintendent Ferryfield Airport, Lydd, Kent [5763]

**C**ENTRAL ELECTRICITY AUTHORITY. SOUTH Eastern Division. 4TH Assistant Engineer (Electronics) required in the Operation Department at Kingston for original development work as applied to Power Station operation; preference given to those suitably qualified and with previous experience in the design and construction of electronic circuitry; knowledge of Power Station operation an advantage but not essential; salary according to qualifications and experience within the range of £630-£824 5s per annum including London Allowance in accordance with Class X/DX Grade 6.—Detailed written applications should be sent to the Establishments Office, Central Electricity House, Lower Ham Rd., Kingston, to arrive by May 4, 1956. [5881]

**A**SSISTANT Signals Officer required by **SIERRA** Leone Government Civil Aviation for two tours each of 18/24 months. Appointment will be either (a) on contract with salary scale (including Expatriation Pay) £859 rising to £1,359 with gratuity up to £150 a year or (b) with prospect of pensionable employment with salary scale (including Expatriation Pay) £797 rising to £1,297 a year. Outfit allowance £60. Liberal leave on full salary. Free passages for officer and wife. Assistance towards cost children's passages or grant up to £150 annually for maintenance in U.K. Candidates should be experienced MF, VHF, VHF/DF and auxiliary equipment and should hold P.M.G. Cert. or equiv. Preference for C. & G. Cert. in Radio. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41565/WF. [5832]

**H**UDDERSFIELD TECHNICAL COLLEGE. PRINCIPAL: Dr. W. E. Scott, M.B.E. DEPARTMENT of Electrical Engineering. REQUIRED as soon as possible, Assistant Grade A to teach particularly in the radio and television servicing courses. Candidates should possess the City and Guilds of London Institute R.T.E.B. Certificates in both radio and television servicing and have had industrial experience. Teaching experience an advantage. BURNHAM scale, at present £450×£18—£725 p.a. plus appropriate allowances for training, etc. FURTHER particulars and forms of application which must be returned as soon as possible obtainable from the Principal, Technical College, Queen Street South, Huddersfield. H. GRAY, CHIEF Education Officer. [5706 26TH JANUARY, 1956.]

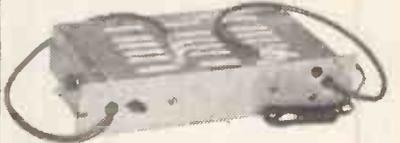
**W**IRELESS Operator Mechanics required by **FALKLAND** Islands Dependencies Survey for service at isolated British bases in Antarctic. Must be able transmit and receive morse at 20 words a minute (plain language or code) and be capable elementary maintenance wireless transmitting and receiving equipment. Salary according age in scale £330 rising to £420 a year with all found, including clothing and canteen stores. Keen young men, between 20 and 30 years required preferably single, of good education and high physical standard with genuine interest in polar research and travel willing to spend 30 months under conditions testing character and resource. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41540/WF [5827]

**I**BM United Kingdom, Ltd., Spango Valley, Greenock ENGINEERS and Technicians with electrical, electronic or mechanical qualifications and experience required by the Technical Department to assist in the development and production of accounting machines, electronic computers, etc.; the work is interesting and offers permanent progressive employment in pleasant surroundings.—Applications should be made in writing stating age, experience, etc., to the Personnel Manager. [5872]

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COMPLETE RANGE OF EQUIPMENT FOR EXTENDED AERIAL AND WIRED T/V SYSTEMS.

WIDE BAND AMPLIFIERS



Mark III—40 to 220 mc/s (covering ALL Bands 1, 2 and 3) Gain 20 db ± 2 db. 75 ohms in and out. Rack Mounting.  
Mark IV—A cheaper version of the impeccable Mark III. Same performance, steel case.  
Type 3—40 to 70 mc/s (Band 1) Gain 33 db ± 1 db. Wall Mounting. Indoor or Outdoor Cases. Line powering facilities. 75 ohms in and out. Extensively used for urban T/V relay systems.

**ALSO** SOURCE CONVERTER UNITS. Converts any channel (Bands 1 or 3) to any Band I channel, applies up to 40 db A.G.C. on both vision and sound. Input range 10 uv to 10 m/v. Rack Mounting.  
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**MAJOR  
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The Fidelia range of real high fidelity equipment includes three models giving VHF/FM reception as well as the normal wavebands and superb gramophone reproduction. All our equipment is designed and built throughout by ourselves and constructed entirely of British made components. Brief details of the three AM/FM models are:—  
Fidelia Major AM/FM, 12 valves, separate amplifier, independent bass and treble controls, etc. £44/-.  
Fidelia de Luxe AM/FM, 11 valves, 7 watt triode push-pull output, C/R tuning indicator etc. £33/12/-.  
Fidelia standard AM/FM, 9 valves, 5 watt triode output with all Fidelity features. £30/-.  
Fidelia F.M. Tuner Unit, Triode R.F. stage, Triode mixer, two I.F. stages, Ratio detector, full vision tuning scale, economical current consumption. £14/3/-.

Full details of these and other models willingly on request.



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DEVELOPMENTS**

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HEADS, DESKS, TAPE, ETC.

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Lightweight High Resistance (4,000 ohms). Complete with cord.

17/6

Ideal for CRYSTAL SETS  
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Replacement Elements and Bits always available.

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### SITUATIONS VACANT

**FULHAM and Kensington Hospital Management Committee.**

**TECHNICIAN** required to assist in maintenance of electro-medical apparatus; qualification at least of Ordinary National Certificate; knowledge of mechanical engineering an advantage.

**SALARY** (at age 26+) £520, rising to £650. **APPLICATIONS** with full particulars to Group Engineer (W.W. 43), 5, Collingham Gardens, S.W.5, immediately. [5860]

**PYE TELECOMMUNICATIONS, Ltd.,** Ditton Works, Cambridge.

**HAVE vacancies** for both Senior and Junior Engineers in the aeronautical division, for the development and installation of ground to air projects.

**APPLICATIONS** containing full details of experience, etc., should be addressed to the Personnel Manager. [5825]

**NORTHAMPTON POLYTECHNIC, St. John St., London, E.C.1.**

**APPLICATIONS** are invited for the post of research assistant in the department of electrical engineering for investigation work in connection with network analysers.

**APPOINTMENT** is in the first instance for two years, but can be extended to cover a third year. **SALARY** £350 p.a. **LETTERS** of application to Head of Department. [5699]

**BRITISH ACOUSTIC FILMS, Ltd.,** have vacancies for experienced

**DESIGN Draughtsmen and DRAUGHTSMEN.**

The work is of an interesting nature in connection with Precision Optical, Mechanical and Electronic Instruments, also Sound Recording and Reproducing Equipment.

**H.N.C.** in Electrical or Mechanical Engineering desirable, but applicants must have reached **O.N.C.** standard or equivalent qualification.

**PERMANENT** and pensionable appointments. Canteen. Sports and Welfare facilities. **PLEASE** apply to Personnel Manager, British Acoustic Films, Ltd., Woodger Rd., London, W.12. [5869]

**DEVELOPMENT Engineers** (Electrical and Mechanical).

**ENGINEERS** to work on Relays, Solenoids, Rotaries, Printed Circuit Connectors, etc., etc., in a factory in East Anglia, engaged in manufacturing electrical components.

The prospects are above average as the Company is rapidly expanding.

**APPLICATIONS** in writing in strictest confidence, stating age, qualifications and salary required, to Box 0549. [5779]

**SENIOR** position offered to those selected to undertake work in the following fields.

1. Application of transistors.
  2. Application of printed circuitry.
  3. U.H.F. transmitter receiver development.
  4. Recording on wire and tape.
  5. Electronic instrumentation.
- A full understanding of Ministry procedure will be an asset in certain positions; excellent working conditions provided in new laboratory. **PLEASE** write, giving full details of age, qualifications and previous experience, to Box 0976. [5861]

**SERVICE** engineer for radio and public address equipment; preferably own transport.—Tel. Gensign Abbey 5588. [5762]

The following post is vacant with one of the largest telecommunications firms in the United Kingdom.

**SYSTEMS Planning Engineer.** This post involves assessment work on V.H.F. radio systems together with station engineering involving the planning and lay-out of V.H.F. stations; previous experience in V.H.F. radio-telephone work desirable together with a knowledge of propagation in the V.H.F. spectrum and if possible a certain amount of field experience with this type of equipment. The applicant would be required to work under the supervision of a senior engineer and while in general would be located in the United Kingdom, it is possible that visits overseas may be necessary at intervals.

This post is pensionable, assistance with housing would be considered for married personnel; state previous experience, age and salary expected; all applications will be treated in confidence.—Box 1025. [5873]

**BRITISH OVERSEAS AIRWAYS CORPORATION** invite applications for the post of Simulator maintenance engineer, based at H.Q. Building, London Airport.

**DUTIES** will include maintenance, overhaul and modification of flight simulators employing electronic analogue computers.

**CANDIDATES** should have a radio or electronic engineering background with mathematics to the standard of elementary calculus.

**DESIRABLE** additional qualifications: (a) **KNOWLEDGE** of mechanics and aerodynamics.

(b) **PASSES** in one or more subjects in the City & Guilds Telecommunications group.

(c) **POSSESSION** of an aircraft radio maintenance engineer's licence.

(d) **EXPERIENCE** in the design, construction or maintenance of electronic computers. **COMMENCING** salary will depend upon qualifications, but will be within the range £13/10/6 to £15/15/6.

**ATTRACTIVE** pension scheme; excellent insurance, sickness and holiday entitlements; sports and social club facilities.—Applications to Asst. Staff Manager (Appointments), B.O.A.C., London Airport, Hounslow. [5748]

## Excellence in design..

Specialists in Subminiature Telecommunication Components.



### STAND OFF INSULATOR

For 1500 volt working  
Overall height 1.1".  
Over chassis .86".  
Silver plated spill .35".  
6 BA hexagon stud  
chromium plated

(Illustrations approximately actual size)

### MINITRIMMER

Standard maximum capacities up to 13pF. Voltage 500 DC. Base 1/2" square with fixing centres for 10 BA 1/4" apart.



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<b>WIRELESS WORLD FM TUNER UNIT</b>	
DENCO FM TUNER	circuits 1s. 6d.
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Truvox Amplifier Switch Type 12119/B3 : 14/6d.

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Degree or similar qualification necessary. Candidates who have been associated with production will receive preference.

Duties include the design of domestic radio and television, high fidelity audio equipment and miniature transmitter receivers.

Apply Managing Director :

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### FERRITE ROD AERIALS

Wound on high permeability Ferröxcube rod, Medium wave, 8/9. Dual wave 12/9.

Type HAX. Selective crystal diode coil for tape and Quality amplifiers  
 ● High Q ● Litz wound  
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 HAX.L. (LW), 3/6 ea.  
 Dual wave TRF. coils, matched pairs (as illustrated) 7/- pr. Transistor coils—L.F.T.'s, etc., etc.

BAND III Converter Coil Set 15/-. Circuit and Wiring Diagram 3d. Available from leading stockists

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## SITUATIONS VACANT

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**CANDIDATES** must produce evidence of having reached a prescribed standard of education, particularly in a science or technical subject. At least two years' experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces essential in one of the following groups of scientific subjects:  
 (i) **ENGINEERING** and physical sciences.  
 (ii) **CHEMISTRY**, bio-chemistry and metallurgy.  
 (iii) **BIOLOGICAL Sciences.**

(iv) **GENERAL** (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).

**INCLUSIVE salary scale** £280 (at 18) to £575 (men) or £502 (women). Starting pay up to £425 (men) or £395 (women) at 25. Women's pay subject to improvement under Equal Pay scheme. Somewhat less in provinces. Opportunities for promotion.

**FURTHER** particulars from Civil Service Commission, Scientific Branch, 50, Old Burlington Street, London, W.1, quoting No. 559/56. Completed applications should be returned as soon as possible and in any case not later than 31st December, 1956. [5692

**ATOMIC ENERGY RESEARCH ESTABLISHMENT,** Harwell, invites applications for the following posts in its Electronics Division. REF. 519. Senior Scientific Officer to direct fundamental research into electronic circuit techniques with special reference to transistors and magnetic devices. Expected to supply original ideas and within wide limits free to choose line of research. Some post-graduate research experience is essential. THE laboratory is pleasantly situated and its working facilities and conditions extremely good. Publication of results is encouraged. REF. 517. Scientific Officer to assist in the direction of a group engaged on fundamental research in the same field as for the preceding post. Will be expected gradually to assume more responsibility. Publication of results is encouraged. Previous experience would be an advantage but not essential for the right type of person.

**APPLICANTS** for both posts should possess a 1st or 2nd class Honours Degree in Science (or equivalent). **SALARY Scales.** SENIOR Scientific Officer: £1,105-£1,270. SCIENTIFIC Officer: £528-£948.

**CONTRIBUTORY** pension scheme, five-day week; excellent working conditions and generous leave allowances. **MARRIED** officers living outside the Establishment's transport area will be eligible for housing under Authority arrangements or, alternatively, substantial assistance towards local expenses incurred in house purchase will be available. SEND postcard for application form to Establishment Officer, A.E.R.E., Harwell, Didcot, Berks, quoting appropriate reference. [5857A

**FURZEHILL LABORATORIES, Ltd.,** have vacancies in their laboratories at Watford for engineers and junior engineers in the following categories.  
 (1) **DESIGN** engineers to assist in the development of a wide range of precision laboratory equipment. Applicants should have previous design experience, education to H.N.C. or degree standard preferred.  
 (2) **TEST** engineers to work on transmitter measuring instrument. Applicants should have experience in communication receiver alignment and measurement and in C.R. Oscilloscope work; there will be opportunity to transfer to development work from this post. THE above appointments are permanent and carry considerable technical responsibility, salaries are dependent upon age, qualifications and experience.—Apply stating full details to Chief Engineer, Furzehill Laboratories, Ltd., 57, Clarendon Road, Watford, Herts. [5765

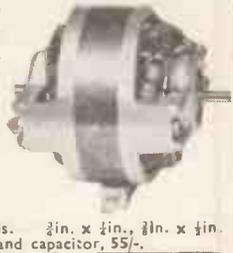
**PHILIPS ELECTRICAL INDUSTRIES, Ltd.,** have vacancies for two assistant engineers in their Central Standardisation Department at Waddon, Surrey. ONE of these should be a man possessing experience of development or production in the radio or allied industries and whose duties would comprise standardisation work in connection with telecommunications and electronic apparatus, materials and components. The other should possess drawing or design office experience, not necessarily in the electrical industry, and would be required to undertake standardisation work in basic engineering subjects such as drawing office practice. THESE posts are permanent and pensionable, and appropriate and progressive salaries will be paid. MEN who are H.N.C. level of education and are interested in this type of work as applied in a large manufacturing organisation, are invited to write in confidence to the Personnel Officer, Philips Electrical Industries, Ltd., New Rd., Mitcham Junction, Surrey. Quoting reference.—P./2. [5806

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**UNREPEATABLE OFFER LESS THAN HALF MANUFACTURER'S COST**

Brand new single phase motors suitable for tape recorders, radiograms, work-shops, etc., etc. Has many uses. Reversible 200-230 v. 5in. oz. torque. 1,400 r.p.m. Capacitor start. Weight 4½lb. Length overall 5in., spindle both ends. ½in. x ½in., ¾in. x ¾in. Price, inc. P.P. and capacitor, 55/-.



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**H.T.31**  
 Input 11.5 v.  
 Output 250 v. at 125 mA.  
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 Input 11.5 v.  
 Output 490 v. at 65 mA.

H.T.31, post 2/- H.T. 32 post 2/6.  
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Impedance 7½Ω  
 Handling cap. 8 watts  
 Price 2/4/6, post 3/-

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Brand new. Individually boxed. Special price for quantities: British 5/-, American, 6/- P. & P. 1/-.

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D.C. Output 285 volts, .075 amps. Price 57/6 ea. P. & P. 2/- D.C. Input 27 volts, 1.75 amps. Can be supplied in 12 volt.



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250 watts to carry 25 amps. Resistance 0.4 ohms. Suitable for charging board, etc. Size 9 x 4 x 6in. high. Brand new. Price 12/6. Post 3/-

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**TRANSCEIVERS.** Type "38" (Walkie-Talkie). Complete with 5 valves. In metal carrying case. Ready for use. Less external attachments, 30/- per set. **ATTACHMENTS** for use with "38" **TRANSCEIVER HEADPHONES, 15/6**; **THROAT MICROPHONE** with Lead and Plug, 4/6; **JUNCTION BOX, 2/6**; **AERIAL, 2/6**; **SPECIAL OFFER** of used "38" **TRANSCEIVERS** less valves but complete with **ALL COMPONENTS.** Excellent for **SPARES, 11/6** per set. P. & P. 2/-.

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**BOMBSIGHT COMPUTERS.** Ex-R.A.F. **BRAND NEW.** A wealth of Components. **GYRO MOTORS, REV. COUNTERS, GEAR WHEELS, etc.,** etc. Ideal for Model Makers. Experimenters, etc., £3.

**LUFBRA HOLE CUTTERS.** Adjustable 3/16 to 3/8 in. For Metal, Wood, Plastic, etc., 6/6. **RESISTANCES, 100 ASSORTED USEFUL VALUES.** Wire Ended, 12/6 per 100. **CONDENSERS, 100 ASSORTED.** Mica, Metal Tubular, etc., 15/- per 100.

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**CONTACTOR TIME SWITCHES.** In sound-proof case. Clockwork movement. 2 Impulses per sec. The mostatic Control, 11/6.

**REMOTE CONTACTORS** use with above, 7/6. **MORSE PRACTICE SET** with Buzzer on Base, 6/9. Complete with Battery, 9/6.

**MORSE TAPPERS, Std., 3/6**; **Midget, 2/9**. **CRYSTAL MONITORS.** Type 2. New in Transit Case. Less Valves, 8/-.

**METERS AND AIRCRAFT INSTRUMENTS.** Only need Adjustment or with broken Glass.

**TWELVE INSTRUMENTS,** including 3 brand new Aircraft Instruments, 35/- for 12.

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We specialise in manufacturing of Chassis in all metals, large or small quantities to your own specifications

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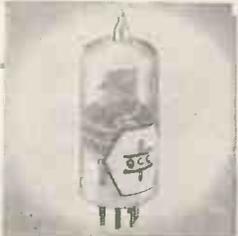
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Type B7



The type B7 unit is mounted in the standard B7G valve envelope and is hermetically sealed and fully evacuated.

Available for the frequency ranges from 100 kc/s. to 500 kc/s. and from 3 Mc/s. to 16 Mc/s. Gold electrodes applied by cathodic sputtering give permanence of calibration. Normal adjustment accuracy 0.01% Max. adjustment accuracy 0.003%.

Early delivery can be given of some frequencies, and we will be pleased to quote for your specific requirements.

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## SITUATIONS VACANT

**TV/service engineer** required as permanent staff. Ideal conditions; pension scheme.—Newquay Radio Service, 5a, Bank St., Newquay, Cornwall. Tel. 2590. [5663]

**RADIO Engineer, first-class,** required for overseas service—12 months. Large firm engineers, excellent opportunity; write experience, age, references.—Box 8760. [5628]

**SENIOR and Junior Electrical and Mechanical Draughtsmen** required for the Electronics drawing office at the Rugby Works of the B.T.H. Co., Ltd. Please apply in writing to:—**CHIEF Draughtsman, Electronics Drawing Office, British Thomson-Houston Co., Ltd., Rugby,** giving details of age, experience, etc. [5811]

**ELECTRONIC Test Engineers** are required by The General Electric Co., Ltd. Radio and Television Works, Spon St., Coventry, in the Departments concerned with:—

(a) **ALIGNMENT,** test and fault-finding on domestic TV receivers.  
(b) **TESTING** of Government contracts production and other electronic equipment.  
(c) **DEVELOPMENT,** manufacture and maintenance of test equipment.  
**EX-SERVICE** radio and radar technicians are particularly suitable for these posts but others with similar experience will receive equal consideration. Those interested should write giving details of experience to date, quoting reference E.T. to the Personnel Manager. [5771]

**PRODUCTION foreman** required, in Edgware, Middx, district for electrical and mechanical assembly good disciplinarian; please state wages req., experience and age.—Box 0591. [5787]

**SEMI-SKILLED** radio and television engineer required; salary £8 p.w.; permanent position.—Ritz Radio & Electrical Co., 306, Neasden Lane, Neasden, N.W.10. Gladstone 4983. [5676]

**WORK study engineer** required immediately for an established department in a Wembley light electrical engineering factory, salary £700 p.a.—Write full details of experience Box 0274. [5742]

**RADIO and TV Receiver Development Engineer, Graduate I.E.E. or Brit.I.R.E.** or equivalent. Age 25-35 for North-West London area. Salary £800-£1,000 according to experience.—Box 0914. [5844]

**DESIGN and Development Engineers** required, experienced in radio and television for work in Jersey, Channel Islands. Salary £900-£1,200 p.a. according to qualifications and experience.—Box 0686. [5812]

**ELECTRONIC Development Engineers.** Applications are invited from Electrical and Mechanical Engineers qualified to fill the following interesting posts on the Development Staff of a leading manufacturer.

(a) **DEVELOPMENT and engineering** of T.V. receivers for mass production.  
(b) **DEVELOPMENT** of colour T.V. systems as applied to receivers. Some experience in this line is desirable.

(c) **APPLICATION** of printed circuit techniques to T.V. and domestic radio receivers and other electronic equipment.

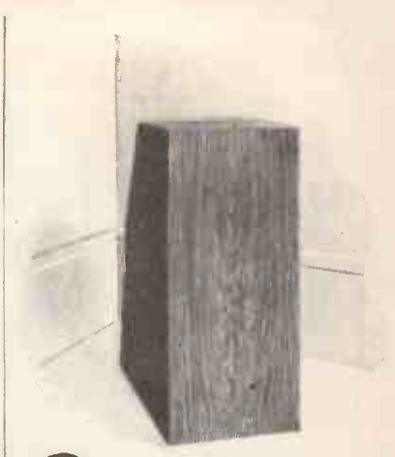
(d) **APPLICATION** of small scale electronic devices to electronic equipment and also to the mechanization of manufacture.

(e) **APPLICATION** of semi-conductor devices to existing electronic equipment and also the development of new designs involving these techniques.

THOSE interested should write, in confidence, giving brief details of qualification and experience, to the Personnel Manager, the General Electric Co., Ltd., Radio and Television Works, Spon St., Coventry. [5575]

**CHIEF Inspector** for checking and final testing of electrical control gear. Previous experience in like capacity an advantage. Excellent prospects for right person. Boreham Wood area.—Write giving brief details to Box 0563. [5784]

**RADAR Technician** required by the Nigerian Federal Government Meteorological Department for one tour of 12-24 months in first instance. Appointment either (a) on agreement with prospect of permanency in salary scale (including inducement addition) £750 rising to £1,410 a year, or (b) on contract in salary scale (including inducement addition) £910 rising to £1,530 a year with a gratuity at the rate of £100/£150 a year. Outfit allowance £60. Free passages for officer and wife. Assistance towards children's passages and grant of up to £150 a year for their maintenance in U.K. Liberal leave on full salary. Candidate must be competent radar mechanic and be able to maintain GL111 and other radar equipment at a radar wind station. They must also be able to take charge of a radar wind station.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and note M2C/41483/WF. [5693]



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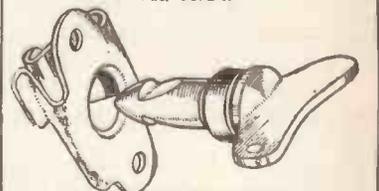
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### SITUATIONS VACANT

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(A) Ability to organise and control staff.  
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(D) Experience of A.I.D. and I.E.M.E. procedure an advantage.  
APPLY Personnel Officer, Airmec. Ltd., High Wycombe, Bucks. [5886]

**MURPHY RADIO, Ltd.**, have vacancies in their Electronics Division Laboratories for engineers and assistants on design and development work, and also on associated electro-mechanical problems. Applicants will be considered in the following categories:  
1. **CANDIDATES** with engineering or science degrees or equivalent who have experience in industrial design.  
2. **GRADUATES** who have completed Military Service but have no experience in design work.  
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**PHYSICISTS** or engineers with experience of electronic techniques, ability and enthusiasm, required for research and development work. Qualifications: honours or general degree or H.N.C. Cert. Some knowledge of acoustics would be of assistance but not essential. INTERESTING and challenging work in expanding laboratories, permanent and with good prospects. Salaries will be paid according to qualifications, experience and ability but are based on generous scales and adequate payment during illness and pension schemes, etc., are in operation.  
APPLY: Personnel Manager, Kelvin & Hughes, Ltd., New North Rd., Barking, Essex, quoting reference RES.11/55. [5633]

**MICHAEL RADIO, Ltd.**, Slough, Bucks, have vacancies from time to time for electronic engineers to be engaged on Government projects; those wishing to be considered are invited to write fully to the Chief Engineer, Equipment Division. [0198]

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£1000 p.a.—Young man 25/30 years of outstanding technical ability required as assistant to Managing Director of small successful firm of electronic instrument manufacturers, N.W. London; write giving details of education and experience—Box 0520. [5773]

**EXPERIENCED** radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wiremen and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238]

**JUNIOR** radio mechanic required; preference given to applicant who has completed National Service; the position is permanent; has good prospects, pension scheme available.—Write details to the Radio Manager, Ray Powell, Ltd., Eastern Ave., Ilford, Essex. [5882]

**ELECTRICAL** engineer required; capable of maintaining and repairing recording machines and radio chassis; ability to drive essential.—Please reply in writing to the Service Manager, Continental Radio Electronics, Ltd., 3, Farringdon Rd., London, E.C.1. [5786]

**QUALIFIED** engineer required to take charge of section concerned with research and development of tape recorders; pensionable appointment.—Write, with full details of experience and salary required, to Box A45/6, Strand House, Portugal St., London, W.C.2. [5857]

**OLD-ESTABLISHED** London radio and electrical business requires (a) Television Service Engineer; (b) Electrician; (c) Trainee for television or electrical work. Driving experience essential. Good prospects for capable men. State age and details of career.—Box 0615 [5796]

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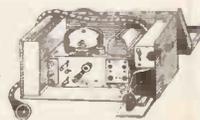
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**SITUATIONS VACANT**

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**SEND** postcard for application form to Establishment Officer, A.E.R.E., Harwell, Didcot, Berks., quoting reference 533. [5876]

**AUDIO AMPLIFIERS**—Engineer required by Post Office Contractor in S.E. London area for development work on specialised types of audio amplifiers in the line transmission field: Applicants should be aged 21-30 years and possess H.N.C. or equivalent or at present studying for H.N.C.  
**STAFF Bonus** and Pension Scheme after qualifying period.  
**APPLY** giving details of experience and qualifications to Box 3R H5132, A.K. Adv., 212a, Shaftesbury Ave., London, W.C.2. [5879]

**SENIOR** television development engineer with administrative experience required, capable of carrying out development projects with minimum supervision up to production stage; Kingston area—Write, giving full personal details, stating salary required, Chief Engineer, Box 5942. [0123]

**PHYSICIST** wide experience of electronic devices and circuits design; applicants should be capable of leading a development team; salary from £900, according to qualifications; age 26-36—Apply, Employment Manager, Southern Instruments, Ltd., Frimley Rd., Camberley, Surrey. [5751]

**TELEVISION** Maintenance Engineers for studio telecine and control apparatus. Engineers with knowledge of television techniques and circuitry and possessing initiative required.—Applications to Assistant General Manager (Staff), Associated-Rediffusion, Ltd., Kingsway, W.C.2, marking the envelope (A.M.E.). [5850]

**INTERESTING** and congenial position in London retail business of good standing; good English typing and figure work essential; applicant must have high standards of service; opportunity for well secured investment if desired; state age and details of career.— [5868]

**ENGINEERS** with experience of radio and television are required for development work in the design department of a firm situated some 10 miles south-west London, at salaries of £70 to £1,200 p.a.—Write giving particulars of qualifications, experience and salary required to Box 8887. [5647]

**JUNIOR** Technical Assistant required by London Chartered Patent Agency with view to training for qualifying as a Patent Agent. Degree standard in electrical engineering desirable.—Write giving details of age, experience, etc., to Box No. 3140, c/o White's, Ltd., 72/78, Fleet St., London, E.C.4. [5792]

**ELECTRONIC** engineers and physicists reqd. for rapidly expanding research dept. Candidates should have experience of electronic instrument development. Experience in pulse circuits or ultrasonics desirable but not essential. B.Sc. or H.N.C. standard.—Write full parties. to Glass Developments, Ltd., Brixton. [5596]

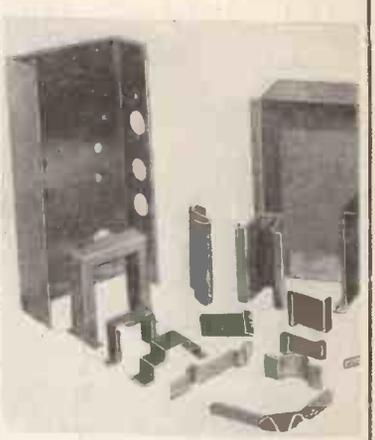
**ENGINEER** required to undertake complete design and testing of disc and tape recording equipment. Applicants should have had responsible experience in this field. Excellent working conditions and facilities provided in new laboratory.—Applications with details of previous experience should be sent to Box 0563. [5783]

**TEST** Engineers required for a wide variety of modern electronic test equipment; an ability to quickly diagnose faults and to work with minimum supervision are essential qualifications. This can become a staff position for suitable applicants apply—The Wayne Kerr Engineering Co., Ltd., Tolworth Close, Surbiton, Surrey. [5758]

**LABORATORY** Assistant for operation, maintenance, and development, of electrical apparatus for high temp. studies of alloys; knowledge of elec. instal., practice desirable; male ex. Nat. Ser. pref., sal. age 20, £300; age 25, £400 (max. on entry) to £550.—Apply to The Secretary, Rothamsted Experimental Station, Harpenden, Herts. [5910]

**FERRANTI, Ltd.** require charge hands in electronic test and test gear maintenance departments of their radar valve factory; H.N.C. in electrical engineering desirable, and experience of microwave equipment and radar circuits essential.—Apply in writing to the Personnel Supervisor, Ferranti, Ltd., King's Cross Rd., Dundee. [5856]

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### SITUATIONS VACANT

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TECHNICAL sales representative required to initiate sales programme for new electronic product; general radio background desirable, with sales experience in this field.—Write, giving full details of past experience and salary required, to Personnel Officer, British Communications Corporation, Ltd., Exhibition Grounds, Wembley. [5753]

SENIOR and Junior Electrical and Mechanical Draughtsmen required for the Electronics Drawing Office of the British Thomson-Houston Co., Ltd., Blackbird Rd., Leicester.—Please apply in writing to Chief Draughtsman, Electronics Drawing Office, British Thomson-Houston Co., Ltd., Rugby, giving details of age, experience, etc. [5643]

TWO radio and T.V. engineers, H.N.C. Graduate I.E.E. or Brit. I.R.E. or equivalent; age about 25; for duties as Liaison Engineers between regional works and field; duties will involve some travelling and field investigation; based at (1) Stockport, (2) Nottingham; salary £700-£800, according to ability.—Box 0817. [5843]

ELECTRONIC Design Draughtsman required for work on electronic instruments and electromedical apparatus. H.N.C. or equivalent desirable. Age 25-35 years. Salary £700-£800 per annum, according to qualifications.—Please apply to the Personnel Officer, Edison Swan Electric Co., Ltd., Duck Lees Lane, Ponders End, Middx. [5794]

UNIVERSITY OF SOUTHAMPTON.—Technician required to work on electronic equipment in the Mechanical Engineering Department; salary in the technical grade, according to qualifications; superannuation and sick pay scheme in operation.—Applications, in writing, to Secretary and Registrar, The University of Southampton, as soon as possible. [5874]

ELECTRONICS Technician required for the construction and maintenance of electronic apparatus for medical teaching and research; age 25 to 35. Salary according to age and experience with superannuation.—Apply in writing, stating age and giving details of experience to the Secretary, Guy's Hospital Medical School, London Bridge, S.E.1. (Reference 29.) [5855]

TELEVISION, radar and radio technicians are required by a leading Midlands manufacturer for the test department. First-class men with experience of testing and fault-finding in the electronic field will find these posts interesting and rewarding.—Write, quoting Ref. TRR, and giving brief details of career to date to the Personnel Manager, Box No. 8580. [5595]

THE TELEGRAPH CONDENSER Co., Ltd., require radio and T.V. engineer with laboratory experience for the application of printed circuits to radio and television techniques; H.N.C. standard; superannuation scheme.—Write, giving full details of education and experience, age and salary required, to Personnel Manager, T.C.C., Ltd., North Acton, W.3. [5735]

ELECTRONIC technician, senior laboratory technician—department of physics; maintain, repair, construct electronic and other equipment; salary about £1,000 year, rent subsidy and hospitalization plan, travel and moving expenses, one month vacation, pleasant climate, university atmosphere.—Applicants write to Chairman, Dept. of Physics, American University of Beirut, Beirut, Lebanon. [5859]

TECHNICAL assistants required for research and development in telecommunications and other electronic equipment, O.N.C. or H.N.C. an advantage; also, B.Sc. graduates or potential graduates are invited to apply; pensionable appointments.—Write giving full details of experience and salary required to British Communications Corporation, Ltd., Exhibition Grounds, Wembley. [5858]

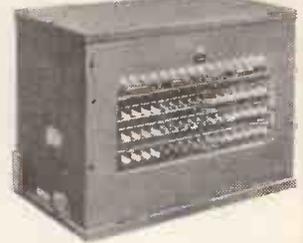
SALES manager required by a rapidly expanding company in Glasgow manufacturing low-power transformers and electronic devices; salary according to age and experience in the industry; a pension scheme is in operation, and a car is provided for candidate's sole use.—Full details in writing in the first instance, to Atkins, Robertson & Whiteford, Ltd., 100, Torrisdale Street, Glasgow, S.2. [5813]

ELECTRONIC engineer for design, construction and use of electronic equipment in connection with experimental work in the motor car industry. Some previous industrial experience and H.N.C. or its equivalent is necessary.—For further information or interview please write with full particulars to the Labour Manager, The Rover Co., Ltd., Lode Lane, Solihull, Warwickshire. [5734]

HOUSE available for first-class TV engineer; fully experienced man required at once by rapidly expanding; and old-established Manchester radio and television dealer; excellent prospects and good salary for conscientious engineer; superannuation scheme; an interview please write full details of experience and when available for interview; expenses paid.—Box 0243. [5739]

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E.K.E., 47, Arksey Lane, Bentley, Doncaster.

### SITUATIONS VACANT

**DEVELOPMENT** Engineers required to work on electronic development projects of an important nature; applications are invited from qualified men, preferably with background of several years' development experience of micro-waves, U.H.F. receivers, instrumentation, control systems or servomechanisms, etc. WRITE, giving full details of experience and qualifications to the Secretary, Barr and Stroud, Ltd., Anniesland, Glasgow, W.3. under reference 950a/T-15. [5760]

**ELECTRO-ACOUSTICS ENGINEER** required by Post Office Contractor in S.E. London area for audio frequency laboratory measurement work on line communication equipment; preferably aged 25-35 years with a degree or equivalent, but younger man just qualifying or older man with suitable background would be considered. STAFF bonus and pension scheme after qualifying period. APPLICATIONS, which will be treated as confidential, should give full details of experience and salary required and sent to Box 3R.H 5360, A.K. Adv., 212a, Shaftesbury Ave., London, W.C.2. [5880]

**SENIOR** electro-mechanical inspector is required by a firm operating on modern lines in a well-equipped factory; practical experience of electrical or electronic equipments necessary, together with sound knowledge of component manufacture; a good salary is offered to successful applicant who should, in the first instance, write stating qualifications and experience, to Box 8613, quoting A.N.I. [5600]

**ELECTRONICS** Technician required by Physics Department, University of Leeds, for development and constructional work on equipment for research and teaching; initial salary in the range £380-£545 according to qualifications and experience—Apply, giving references and synopsis of career to the Secretary, Department of Physics, The University, Leeds, 2. Closing date 19th May. [5875]

**AERODYNAMICIST** required for our London office; candidates should be 24-28 years of age, with a good degree and some experience of supersonics; duties will be of a varied nature, including thermodynamic work and liaison with trials teams.—Please write in detail, quoting Ref. 118 to The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5823]

**SHIFT** chemists (male) required for routine control of production processes in the capacitor field; preliminary period of training will be given, but applicants must be of either Inter. B.Sc. or G.C.E. (Advanced) standard, preferably with analytical experience—Applications in person or in writing should be made to The Personnel Manager, The Plessey Co., Kembrey St., Swindon, Wiltshire. [5725]

**STANDARD** Telephones and Cables, Ltd., have vacancies in their Transmission Laboratory for Engineers of degree standard and Assistant Engineers to undertake development work in connection with transmission line equipment and testing apparatus. This involves sine wave and pulse circuits operated by valves or transistors and covering a range of frequencies from audio to microwave. ALL posts are permanent and pensionable, include sickness and accident scheme, special insurance facilities and other generous welfare arrangements. Apply to Personnel Manager, Standard Telephones and Cables, Ltd., Corporation Rd., Newport, Mon. [5658]

**ASSISTANT** engineer-electronic engineer required for calibration department; varied and interesting work on electronic test equipment for electric automatic pilot; able to work from engineers' manuals and drawings; salary according to age and experience; write, giving full particulars, to Personnel Manager, Smiths Aircraft Instruments, Ltd., Bishops Cleeve, nr. Cheltenham, quoting ref. 67/EN/WW. [5802]

**ELECTRICAL** development engineer required with technical and practical experience of all branches of electric applicable to aircraft; must be willing to accept full responsibility and be qualified to carry out an extensive programme of test work and analysis of results; a commensurate salary will be paid.—Full particulars in writing to the Chief Engineer, The Farley Aviation Co., Ltd., Hayes, Middlesex. [5736]

**MECHANICAL** development engineer required for design and development of instruments and light servo mechanisms; qualifications include Degree or H.N.C. in mechanical engineering; experience of film cameras, small servo-mechanisms, etc.; salary £800-£1,000, according to experience and qualifications.—Apply, Employment Manager, Southern Instruments, Ltd., Frimley Rd., Camberley, Surrey. [5752]

**SENIOR** telecommunication engineer required for development of submarine repeaters; applicants should have several years experience in carrier telephony practice, e.g., in the design of filters and feed-back amplifiers; technical education: Honours degree in electrical engineering or equivalent qualifications; post is eligible for pension scheme, five-day week; applicants should give details of age, previous experience and salary required to PERSONNEL Manager, Telcon Works, Greenwich, S.E.10. [5885]

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All the above appointments are in the higher salaries group and remuneration will be commensurate with qualifications and experience.

Woodford is in the country 10 miles south of Manchester, within easy reach of the city itself and the Derbyshire hills.

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Successful candidates will have the advantage of being engaged on projects incorporating the most advanced Engineering, Electronic and Production techniques.

Applicants should have an Engineering Degree, or Higher National Certificate or equivalent qualification, workshop experience, and preferably some knowledge of production techniques.

The appointments are to the permanent staff and carry an excellent salary. The Company operates a Staff Pension Scheme. Candidates should apply in writing quoting reference LCL/25(W) to T. J. Lunt, Staff Manager, Ferranti Ltd., Hollinwood, Lancs., giving brief details of qualifications and experience. Interviews will take place in London. Saturday morning interviews can be arranged if necessary.

**LONDON COMPUTER LABORATORIES  
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have vacancies for  
SENIOR DESIGN DRAUGHTSMEN  
and  
DRAUGHTSMEN  
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- (1) Electronic Equipment.
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The appointments are of an interesting and progressive nature and in the case of the Senior Vacancies will include the design of prototype or production equipment. Technical qualifications should be up to HNC or O.N.C. standard and applicants should have electro-mechanical or light mechanical experience. Some workshop experience is desirable. The salaries are excellent with the benefit of a Staff Pension Scheme.

Applicants should apply in writing giving full details to T. J. Lunt, Staff Manager, Ferranti Ltd., Hollinwood, Lancs. Quoting reference LCC/26. Subsequent interviews will be held in London and on Saturday mornings if desired.

## SITUATIONS VACANT

**ELECTRONIC** Engineer required to take charge of technical development and activities of company in new factory close London, design and practical ability in V.H.F. band pass amplifiers, filter techniques, etc., of more importance than purely academical qualifications; well-equipped laboratory exists; staff appointment with good salary and unusual prospects for most interesting and progressive career.—Box 6932. [0001]

**ELECTRONIC** Engineers. The application of new techniques (semi-conductor devices, printed circuits and the like) to existing designs and the evolution of new designs involving these techniques, has created excellent opportunities with a leading manufacturer for men of development engineer status interested in a progressive career. Apply in confidence, stating age, qualification and experience, to the Personnel Manager (Ref. E.E.), Box 8409. [5577]

**LABORATORY** technicians required to undertake original investigations affecting production of capacitors; must be capable of working with minimum supervision and preference will be given to those applicants (male or female) holding a degree in either Chemistry, Physics or General Science.—Applications in person or in writing should be made to The Personnel Manager, The Plessey Co., Kembrey St., Swindon, Wiltshire. [5722]

**EX** radar mechanics or engineers with some knowledge pulse circuits required for (i) installation and servicing industrial electronic equipment home and overseas, liberal expense allowance while abroad, (ii) testing complex electronic equipment in a London laboratory; good salaries and permanent pensionable position; applicants' travelling expenses refunded.—Write stating qualifications J. F. Crossfield, Ltd., 2, Elthorne Road, London, N.19. [5816]

**THE MULLARD RADIO VALVE Co., Ltd.**, have a number of openings for University Graduates with good honours degrees in Science and engineering who have an interest in production in a field where their technical training will be essential; these vacancies will be at a new factory in Southampton, mass-producing semi-conductor devices, but an initial period of about 6 to 12 months will be spent at the Company's Mitcham Plant. [5835]

PLEASE apply in writing to the Personnel Officer, The Mullard Radio Valve Co., Ltd., New Road, Mitcham Junction, Surrey. Quoting reference—GBK/S.7.

**TECHNICAL** writer required to prepare aircraft instrument specifications from engineers data. Electrical mechanical engineering background essential, with ability to write clear concise English. Housing assistance will be considered. Pensionable available. Applications, giving full details, to Personnel Manager, Smiths Aircraft Instruments, Ltd., Bishops Cleeve, near Cheltenham, quoting Ref. 70/EN. [5834]

**DEVELOPMENT** engineers required by a company engaged in communications work. Harrow area. Applicants must have sound technical knowledge and preference will be given to those having experience in a similar capacity. Good prospects in a rapidly expanding field. Salary commensurate with experience and ability.—Applications, in writing, to Box No. 627, Sells, Ltd., Brettenham House, Lancaster Place, Strand, W.C.2.

**CIVILIAN** Instructors (male) Grade III in the trades of air radio fitter, air radar fitter, air wireless fitter and radar fitter, ground wireless fitter and instrument fitter required by Air Ministry in provinces. Appointments temporary but good prospects of becoming pensionable, trade training, practical experience and ability to teach are essential; pay £640 at age 26 rising to £785.—Application to Air Ministry, S.5(g), (CIV26), London, S.E.1. [5790]

**RADIO** technicians required by International Aeradio, Ltd., for overseas service; permanent and pensionable positions; inclusive salary from £894 per annum to £1,373 per annum, tax free, according to marital status; free accommodation; kit allowance; free air fares; generous U.K. leave. Qualified candidates, to whom replies only will be sent, please write, quoting RT to Personnel Officer, 40, Park St. W.1. [0262]

**RESEARCH** engineer.—An opportunity arises for young electrical engineer to enter field of miniature electro-acoustic engineering under skilled guidance to work on important Ministry contracts; suitable applicant must have good basic training in electronics and some industrial design experience; remuneration according to experience and present ability progressive.—Write or telephone Amplex, Ltd., Abbey Mnfgt. Estate, Wembley. Tel. 5906. [5824]

**ELECTRICAL** (electronic) development engineer required, age 23/30 years; minimum qualification H.N.C. or C. & G. certificates; permanent pensionable appointment after trial period; based in City of London; please write in strict confidence giving full particulars of education and experience to date, stating age and commencing salary expected; no other similar staff employed or contemplated.—Box A.660, c/o Central News, Ltd., 43, London Wall, E.C.2. [5801]

**CHIEF PRODUCTION  
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An opportunity has arisen for an outstanding man to establish and control a new Production Engineering Department in a leading firm manufacturing an extensive range of electronic test equipment.

This is a senior appointment calling for considerable organising ability and involving responsibility for eliminating difficulties at a pre-production stage which would otherwise interrupt the smooth flow of production.

A knowledge of electronic circuitry techniques and several years experience in the electronic field will be required, together with an understanding of modern work study methods.

*Apply in writing to the Personnel Director, The Solartron Electronic Group, Thames Ditton.*

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All appointments are permanent and pensionable and carry attractive salaries; they offer excellent prospects and the opportunity to work in newly equipped laboratories on a variety of interesting projects.

Applications will be treated as confidential and should be made to the Superintendent, Electronic Development Division,

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ALL DIAMETERS.

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### SITUATIONS VACANT

**DEVELOPMENT Engineers and Technical Assistants** required by expanding company in High Wycombe, in connection with industrial electronic control and the development of communication and electronic test equipment; positions are available at all levels in the salary range £450 to £1,200; commencing salary according to qualifications and experience; these are permanent staff appointments.—Apply Personnel Officer, Airmec, Limited, High Wycombe, Bucks. [5776]

**THE Plessey Company** require Sales Engineers; for technical liaison work with Radio, Television and Electronic Equipment manufacturers; knowledge of radio and television circuitry and ability to discuss them with engineers is essential; applications are invited from engineers resident in both the London and Midland areas.—Write, stating age, qualifications, experience and salary required to the Personnel Manager, The Plessey Co., Ltd., Kembrey St., Swindon, Wilts. [5807]

**ELECTRONIC Engineers**—A leading company in the guided weapon industry offers careers as technical representatives to engineers with industrial and service experience; comprehensive training will be given for these progressive appointments which carry expense allowances.—Details of age, education and experience, in confidence, quoting Ref. 120, to The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5815]

**WIREFORMAN**—There are a number of positions available within a Guided Weapon organization for grades wiremen on post in particular calls for a man able to work on his own initiative, interpreting rough sketches and verbal instructions into finished models; some design and testing knowledge is required; prospects for experienced men of high standard are excellent.—Please write in detail, quoting Ref. 75, to the Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5711]

**AERONAUTICAL INSPECTION SERVICE:** Radar and Wireless Divisions.—Vacancies exist for Examiners (unestablished) at Stafford, Stockport and Henlow; City and Guilds Intermediate group certificate in telecommunications engineering or equivalent theoretical knowledge required with experience in industry or services; salary range £565—£695 (men); prospects of promotion and establishment; no age limits.—Details and forms from Air Ministry S.2(q), Cornwall House (W.W.), Stamford St., London, S.E.1. [5855]

**MAKERS of T.C.C. Condensers, N. Acton, London,** invite applications for the positions of Technical Sales Representatives. The situations offer good prospects and are pensionable. Applicants, stating details as to age, qualifications, experience and salary required, will be considered in strict confidence. Only first-class men are being entertained—preferably those with experience in the radio and electrical industries.—Reply to Sales Director, The Telegraph Condenser Co., Ltd., North Acton, London, W.3. [5859a]

**THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Alesley, Coventry,** requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments, for work on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager, Ref. R.G. [0259]

**TELEVISION Development.** Applications are invited for the posts of development engineers in the laboratories of a leading television manufacturer. Qualified men with experience of, or an interest in, the latest techniques in this field, including colour television, will find considerable scope in these positions, which have been created by expansion of existing departments.—Applicants should write, in confidence, giving brief details of past experience, to the Personnel Manager (Ref. T.D.), Box 8408. [5576]

**SENIOR Technical Assistant** required to deal with technical correspondence and business matters concerning sub-contracts and liaison with outside firms; must be technically competent, preferably with experience of electronics, and accustomed to working from drawings; this is a senior staff position and applicants must be over 25 years of age.—Please write, giving full details of age, qualifications and past experience, quoting Ref. 79, to the Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5712]

**RAINBOW RADIO MFG. Co., Ltd., of Mincing Lane, Blackburn, Lancs.,** require the services of a young man, as personal assistant to our technical director; applicant must be one with drive and initiative, experienced in up to the minute radio and television technique, and capable of accepting responsibility; the position is permanent and offers excellent opportunities in a well established and progressive company; commencing salary £650 rising to four figures within a reasonable time to the right man.

WRITE, stating age, qualifications (if any) and background of experience.—Attention C. G. Clark, Technical Director. [5864]

## MULLARD OVERSEAS LTD.

require a young engineer up to 30 years of age with good technical qualification in physics, electrical engineering or radio to join the Radio Division as Technical Commercial Assistant. Duties will cover preparation of publicity material, some technical articles and reports and entail liaison work between design engineering, production and commercial departments. A knowledge of overseas market requirements would be an additional qualification. Applications in writing should be addressed to Personnel Officer, Century House, Shaftesbury Ave., London, W.C.2, quoting reference No. 802.

## COMMERCIAL T.V.

Commercial Television and F.M. broadcasting have resulted in vacancies becoming available for men interested in the development of V.H.F. tuners involving new techniques of design and manufacture. Salaries in the range of £650-£1,200 are offered to Engineers with the required experience, and prospects of future advancements are good. Write, in confidence, giving full particulars of experience and qualifications to Box No. 784.

## ENGINEERS

Vacancies exist in the Test Gear Laboratories of an Engineering Company located in the London area for the following staff:

**Design & Development Engineers**  
(Salary up to £1,000 per annum)

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(Up to £13.10.0 p.w.)

**Instrument Makers**  
(Up to £13.0.0 p.w.)

Applicants should have had previous experience of this class of work based on a sound knowledge of electronic principles. Please reply, giving full details to Box No. 748 c/o 'W.W.'

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An attractive opening is available for a first class **ELECTRONIC ENGINEER** with upwards of five years' experience in the design and development of UHF equipment. He must have some administrative ability as the post involves supervising the work of an able team of experienced engineers. Good academic qualifications are desirable but not essential.

Applications giving full details of age, qualifications and experience to Personnel Officer, Elliott Brothers (London) Limited, Airport Works, Rochester, KENT.

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### TELECOMMUNICATIONS LIMITED, DITTON WORKS, CAMBRIDGE

have interesting vacancies for senior and junior engineers, experienced in the design of airborne communication and navigation equipment. Experience in transistor circuitry will also be advantageous.

Apply giving full details to the Personnel Manager.

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- How to Make Aerials for T.V. Bands I  
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A sensitive low noise converter unit as the Type 30,  
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**SITUATIONS VACANT**

**A TELE-COMMUNICATIONS** organization of  
international repute has vacancies in the  
London area for electrical engineers on the  
development of a wide range of high frequency  
testing equipment associated with the design  
of telephone and television cables; applicants  
should have a degree or equivalent, with practical  
experience in electronics; well-equipped  
laboratory with access to all facilities of a  
large organization; permanent, pensionable  
position with commencing salary range £750  
to £850.—Write, stating experience, qualifica-  
tions, age, to Box 0819. [5842]

**MINISTRY OF SUPPLY**, London, requires  
experimental officer for security classifica-  
tion of research and development reports and  
other technical security work concerned with  
aircraft and electronics; qualifications—Higher  
School Certificate (Science) or equivalent;  
broad engineering knowledge, preferably with  
experience in the electronic field, required;  
minimum age 26; salary within range £790-  
£960. Application forms from M.L.N.S., Tech-  
nical and Scientific Register (K), 26, King  
St., London, S.W.1, quoting D 125/6A. Closing  
date May 8, 1956. [5848]

**LABORATORY** assistants are required in the  
research and development laboratories of  
a group working on a guided missile system;  
some experience of electronics essential; in  
addition one post calls for an applicant with  
knowledge of physics; successful applicants  
will be encouraged to improve their theoretical  
and practical knowledge; good promotion pros-  
pects exist.—Please write, giving full details  
of age, qualifications and previous experience,  
quoting Ref. 75 to: The Personnel Manager  
(Technical Employment) of Havilland Pro-  
pellers, Ltd., Hatfield, Herts. [5709]

**ELECTRONICS** engineer; an experienced  
engineer is required for design and develop-  
ment work on part of a guided weapon system;  
this is a post of great interest and respon-  
sibility; rapid promotion is possible for a man  
of initiative; knowledge, candidates should  
have at least 2 years' experience and be of  
degree standard, although applicants without  
this qualification will be considered.—Please  
write giving full details of age, qualifications  
and previous experience, quoting Ref. 75, to:  
The Personnel Manager (Technical Employ-  
ment), of Havilland Propellers, Ltd., Hatfield,  
Herts. [5710]

**ELECTRICIAN** required by a leading gold  
mine in West Africa; age preferably 25-  
35; general experience to include both a.c. and  
d.c. power supply and also v.h.f. radio; start-  
ing salary £7 per month; wife of new em-  
ployee does not accompany on first tour, but  
marriage allowance of £180 per tour paid;  
permanent employment offered with tours  
abroad of 15 months followed by 3 months'  
leave on full pay; passages, furnished quarter-  
ly and medical attention provided free; a staff  
assurance scheme is in operation.—Write, stat-  
ing age and experience, to Box E2960, Whites,  
Ltd., 72-78, Fleet St., London, E.C.4. [5772]

**WAR DEPARTMENT** requires Lecturers at  
R.E.M.E. Training Centre, Arborfield.  
Qualifications: An Engineering or Science  
Degree; lecturing experience, preferably as  
specialist knowledge of either Electrical En-  
gineering or Electronics, or Servo-mechanisms.  
Salary in accordance with Burnham Technical  
scale for Assistant B. Starting salary accord-  
ing to qualifications and experience; £115 non-  
pensionable allowance. Teacher's Superannua-  
tion. Full particulars and application forms  
from M.L.N.S., Technical and Scientific  
Register (K), 26, King St., London, S.W.1,  
quoting Ref. D 139/6A. Closing date, May 11,  
1956. [5855A]

**WAR OFFICE** requires an experimental  
officer (male) at Royal Military College of  
Science, Shrivenham, Berkshire, in Engineering  
Physics Branch of Department of Instrument  
Technology; degree in engineering or physics of  
H.N.C. in electrical or mechanical engineering,  
or equivalent qualifications and experience in  
instrumentation especially servomechanisms or  
computing (knowledge of guided weapon con-  
trol techniques highly desirable); inclusive  
salary: £745-£920; starting pay according to  
age and experience; age at least 26, preferably  
under 31 years; prospects of permanency.—Full  
particulars and application forms from  
M.L.N.S., Technical and Scientific Register  
(K), 26, King St., London, S.W.1, quoting  
reference D 38/6A. [5696]

**ELECTRICAL** Engineers and Physicists re-  
quired by Air Ministry Establishment in  
Norfolk for development and adaptation of  
radio equipment pulse techniques including  
aerials, power supplies and displays. Appli-  
cants should have 1st or 2nd class honours  
degree in electrical engineering or physics with  
a bias towards electronics. Previous experience  
of airborne radar systems would be an advan-  
tage. Salary according to age, and post  
graduate research experience in range Senior  
Scientific Officer (min. age 26) £1,030-£1,185;  
Scientific Officer (min. age 21) £448 10s-£885  
(Superannuable) and £448 10s-£885 (non-  
M.L.N.S., Technical and Scientific Register  
(K), 26, King St., London, S.W.1, quoting  
D.105/6A/EW. Closing date 8 May, 1956.  
[5814]

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sive range of servo components which includes Magslips,  
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each 3.15-0.3-15 v. at 1A. Screened. 3 1/2 x 3 3/4 in.  
Vertical or inverted mounting. 35/- each. P.P. 2/6.  
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deep, 1/4 in. dia. shaft 1 1/2 in. long. Complete with 2in.  
dia. knob engraved 0-10. 2/- each. P.P. 6d., 17/-  
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400 c.p.s. 115 v. Rotary Converters. 28 v. D.C. input.  
Conservatively rated at 45 W. E.D.C. manufacture.  
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**Miniature Thyratrons.** 2D21 (CV797) with delay  
switch VLS 631 (CV342). Sold only in sets of three  
2D21s and one VLS 631. 22/6 per set of four valves.  
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**Special Valve Offer.** Set of six valves comprising 2  
6V6s, 1 6F39, 3 6J7s, tested, 25/- per set. P.P. 1/9.  
**Miniature Relays.** Type 4184GD, 700 ohm for 24 v.  
operation, D.F.P.C.O. Hermetically sealed. 22/6  
each. P.P. 1/6.

**Siemens' High Speed Relays.** 250 plus 250 ohm coil.  
7/6 each. P.P. 1/-.

**Selenium Rectifiers.** 24 v. 4A, double bridge. 22/6  
each. P.P. 2/-.  
**Hot Wire Ammeters.** Range 0-1.2 A., calibrated in  
0.2 A. divisions. 1/4 in. projection mg. 25/- each.  
P.P. 2/6.

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flush mg. 20/- each. P.P. 2/-.  
**D.C. Motor.** 1/10 h.p. 220 v. D.C. compound wound.  
3/400 r.p.m., 1/4 in. dia. shaft, 1 1/2 in. long. 45/- each.  
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**Porcelain Insulator.** Stand-off type. Eddystone  
13111. Ribbed cone, 2in. base dia., height 1 1/2 in.  
2 B.A. terminal screw. 2/- each. P.P. 6d.

**20 A. doz. P.P. 2/6.**

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already well established in  
this field, is looking for a few  
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electronic calculating and computing  
machinery.

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a recognised degree in electri-  
cal engineering, physics or  
mathematics and practical ex-  
perience in the use of elec-  
tronics, preferably as applied  
to computing techniques.

Applications should be ad-  
dressed, in the first instance to  
Personnel Superintendent,  
quoting reference: WW/19.

SITUATIONS VACANT

MULLARD, Ltd., have a vacancy in their publicity division for a young man between 26 and 30 years of age with some knowledge of electronics and an ability to express himself in writing; duties connected with the preparation of technical advertisements, literature and exhibition stands; acquaintance with printing techniques would be useful additional qualification; the post is permanent and pensionable and carries a salary in the range of £525-£600 p.a. Replies, giving full details of age and experience, should be addressed to Personnel Officer, reference no. 799, Century House, Shaftesbury Avenue, London, W.C.2. [5732a

VACANCIES arise for good practical electronic engineers in a new department being set up to handle the overall assessment of reliability in the field of guided weapons, one or two of the positions offered will be senior appointments and the work will entail the collection of data, pursuit and analysis of faults at all stages from complete assembly down to basic detail; a short period of familiarisation with the equipment involved will be arranged. Please write in confidence, quoting Ref. 117, and giving full details of age, qualifications and previous experience, to The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5821

ENGINEER (min. age 26) required by Ministry of Supply, London Headquarters, to assist in development of radio and radar vehicle installations. Quals.—Higher School Certificate (Science) or equivalent, but a pass degree or H.N.C. in Electrical or Mechanical Engineering may be an alternative. Practical experience of installation of W.T. and radar equipment, preferably in mobile form, and knowledge of ancillary items such as aerials, power supplies and heat exchangers required. Salary within Experimental Officer range, £790-£950.—Application forms from M.L.N.S. Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D97/6A/EW. Closing date 14th April, 1956. [5793

V.H.F. radio electrician fully conversant with siting, installation, maintenance and servicing of V.H.F. equipment required at a Mining property in the Gold Coast; duties require some work to be undertaken underground in addition to equipment on the surface; permanent employment offered; starting salary £74 per month; tours abroad are of 15 months followed by three months' leave on full pay; wife of new employee does not accompany on first tour but marriage allowance of £180 per year paid; passages, furnished quarters and medical attention provided free; a staff assurance scheme is in operation.—Write, stating age and experience, to Box E5553, Whites, 72/78, Fleet St., London, E.C.4. [5835

TECHNICAL manager.—Imhofs invite applications from qualified electronic engineers for the post of technical manager of their radio and television service division; sound knowledge of modern electronic design and manufacturing techniques and experience in control of technical staff are required; ability to develop new ideas and to design testing set-ups will be an additional qualification; work includes contact with customers and interpretation of their requirements; salary in accordance with qualifications and experience; pension scheme.—Applications, in writing, giving personal details and an outline of previous experience, to The Secretary, Alfred Imhof, Ltd., 112-116, Oxford St., London, W.C.1. [5795

PHILIPS ELECTRICAL, Ltd., invite applications from young Graduate Engineers with an interest in the commercial development of amplifiers, tape recorders, record players and sound reproduction equipment; a knowledge of the application of these equipments for radio, television and public address purposes is desirable but not essential; appointments at a commencing salary of up to £900 p.a. will be made shortly in commercial departments of the London headquarters and prospects of further advancement in this rapidly expanding organization are good.—Applications, in writing, giving details of age, qualifications and experience, should be addressed to the Personnel Officer, Century House, Shaftesbury Ave., London, W.C.2. Quote Ref. 793. [5737

ILFORD, LIMITED, The Physics Research Laboratory, Brentwood, Essex, requires a Graduate, preferably under 28, to design electronic instruments and process control gear for use in the Company's Laboratories and Factories. He will be engaged also in research projects involving the use of d.c. amplifiers, timing circuits and servo-systems. A basic knowledge of optics and photography will prove useful but not essential. A physics, electrical power or communications degree is equally acceptable provided it is accompanied by imagination, enthusiasm and a practical knowledge of electronic circuitry. The successful candidate will work with one Senior Research Engineer and several assistants responsible for assembly and maintenance of equipment.—Apply in writing to Research Director, Ilford, Ltd., Ilford, Essex. [5708

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SITUATIONS VACANT

SENIOR Engineer required for broadcasting service, Cyprus, on contract for two years in first instance; salary in scale (including overseas allowance and present temporary allowance of 9% of salary) £1,161 rising to £1,548 a year; gratuity at rate of £100-£150 a year; free passages; liberal leave on full salary; candidates, preferably between 25 and 35, should have sound theoretical knowledge and practical experience of operation and maintenance of M.F. broadcast transmitters and aerial systems and be able to control and supervise junior staff; knowledge of studio engineering and recording desirable.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41601/WF. [5878

WAYNE KERR LABORATORIES have several vacancies for development engineers and assistants for work on the design of electronic test equipment; the company, which has an established reputation for integrity of design and quality of workmanship, is at present working on a wide range of projects, including precision audio oscillators, V.H.F. bridges, pulse generators and microwave equipment up to the G Band; the designs involve such techniques as encapsulation, printed circuitry, electro forming and advanced sub-miniature design; salaries are decided by individual ability rather than by fixed salary scales.—Please write for an appointment to the Wayne Kerr Laboratories, Ltd., Sycamore Grove, New Malden, Surrey. [5780

SENIOR Lecturer in Electrical Engineering required by School of Electronics (Ministry of Supply), Radar Research Establishment, Malvern, Worcs., to teach Electrical Engineering Measurements and Servo-mechanisms to post-Higher National Certificate standard and to be responsible for organising laboratories. Opportunities are available for research. Candidates should have a university degree and good industrial and/or teaching experience. Salary payable in accordance with Burnham Technical Report, at present £1,065 by £22 to £1,215. Appointment is subject to Teachers' Superannuation Acts. A house may be available to successful married candidate after a time. Details and forms from Principal, to whom completed forms should be returned within 14 days of this notice. [5837

RADIO technicians required immediately by Air Ministry for service in ocean weather ship based Greenock. Voyages approximately 12 months, 11-21 days in port. Applicants should have sound knowledge of radar to third year City & Guilds Telecommunications Engineering and practical experience in maintenance of ground radio, D/F systems and radar installations. Duties include radar operation, engagement, and subject to trade test, non-pensionable at first. Inclusive pay at age 25 and over is £506, rising by annual increments to £605. Lower rates below 25. Additional pay for excess hours. Food and accommodation free on board ship. Minimum six days' leave between voyages.—Applications, stating age, qualifications and experience, to the Shore Captain, Ocean Weather Ship Base (W.S.4), Great Harbour, Greenock. [5756

SOUTH MANCHESTER H.M.C., Christie Hospital and Holt Radium Institute, Manchester, 20.—Physics Research Technicians. Applications are invited for the following posts in the Physics Research Department: (1) Research Technician. Salary £490-£600 p.a. The duties attached to this post include the design, construction and maintenance of a variety of physical and electronic equipment under the general supervision of a Research Technician. (2) Student Research Technician. Salary £190 at 16 years of age, rising by £20 to £380. Candidates should have a practical outlook and possess a G.C.E. with Science and Mathematics. Prospects of promotion are good. Both these posts are superannuable and conditions of service are laid down by Whitley Council's P.T.B. Circulars 53/28 and 55/45. Applications, giving age, education, experience and the names of two referees, should be addressed to the Administrative Officer immediately. [5856A

RADIO Officer required by West Africa Airways Corporation based in Lagos. Applications are invited from radio officers with first-class flight radio telephony licence. Commencing salary £900 p.a. plus £300 p.a. expatriation pay—£1,200 p.a. Alternatively radio officers will be accepted with provisional licence at commencing salary £850 p.a. plus £300 p.a. expatriation pay—£1,150 p.a. provided they have sufficient previous communication experience. Arrangements will be made for conversion training in West Africa. In both cases a gratuity scheme is in operation of one-twelfth of the annual salary for each completed period of three months' service, and is in addition to the salary. Liberal leave on full pay is granted, first-class accommodation with allowances for electricity and school fee, together with a U.K. domicile allowance for children at school under 18 years. A car loan scheme is available, together with a generous home-to-duty allowance.—Applications to Personnel Officer (Associated Companies), P.406, B.O.A.C. Headquarters, London Airport, Feltham, Middlesex. [5894

**SITUATIONS VACANT**

**ELECTRONIC** Engineers required for installation and maintenance of television broadcast transmitters; should have previous transmission experience, but television experience, whilst desirable, is not essential. APPLICATIONS, giving brief details of background, should be addressed to Chief Engineer (ref. TXM), Pye, Ltd., St. Andrew's Rd., Cambridge. [5809]

**TRAINEE** Television Service Engineer required by old-established London retail radio and electrical business. Good opportunity for keen man with aptitude for this work. Driving experience essential. State age and full details of career.—Box 0614. [5795]

**AIR MINISTRY** requires two scientists in department of Scientific Adviser to lead teams concerned with study of (i) new techniques for improvement of R.A.F. electronic equipment (post A); (ii) technical supply and economic problems of operation of military aircraft, and guided weapons systems (post B). Qualifications: Post A, first- or second-class hon. in physics or electrical engineering, with interest in wider aspects of physics and good background of research or practical experience in fundamentals of design and calculation of performance of radar equipments of some closely allied electronic equipment. Post B, first- or second-class hon. in mechanical, electrical or aeronautical engineering, with industrial or research experience and preferably an interest in applied statistical methods. Appointments in London on Principal or Senior Scientific Officer scales £1,245-£1,670 or £1,070-£1,245 respectively according to experience. F.S.S.U. available.—Application forms, quoting D488/5A, from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1. [5749]

**SITUATIONS WANTED**

**TECHNICAL** writer, B.Sc. (Eng.), A.M.E.E., seeks change; prefer West London-Reading area.—Box 0961. [5781]

**EXPERIENCED** TV Engineer, now with leading manufacturers; excellent knowledge of recording equipment; requires post as field service engineer covering Midlands. Car owner.—Box 0469. [5769]

**ENGINEER**, married with family, requires progressive post in electronics field; no academic qualifications but 20 years' experience in all branches of the industry; anywhere in the world acceptable but accommodation essential overseas.—Box 1024. [5871]

**MANAGER** (35) of large, well-known and profitable service factory (turnover £40,000) serving high-class local multiple radio and TV organization wishes to change; excellent qualifications, references and managerial record; special knowledge of sound recording and reproduction, and experience also in electronic designing, and radio and line communications; present salary £1,400.—Box 0923. [5898]

**SITUATIONS WANTED**

**RADIO** and TV engineer, age 30, 9 years experience leading makes, 2 years with pre-married dealer; seeks position home or overseas; married, accommodation required.—Box 1054. [5887]

**TELEVISION** distribution specialist, ex-Cranwell apprentice, 10 yrs.' experience with R.A.F., H.M.V., English Electric, Canadian General Electric and R.C.A. Victor in monochrome and colour TV service, microwave station maintenance, estimating, designing, selling and installing multi-channel TV distribution systems for complete housing estates, hotels and apartment buildings; would return to U.K. for good opportunity.—Box 0592. [5789]

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**THE Institute of Practical Radio Engineers** have available home study courses in every phase of radio and television engineering, specialising in the practical training of apprentices in the retail trade, enrolments limited, fees moderate.—The Syllabus of Instructional Text may be obtained post free from the Secretary, I.P.R.E., Fairfield House, 20, Fairfield Rd., Crouch End, London, N.8. [0088]

**FREE!** Brochure giving details of Home Study Training in Radio, Television, and all branches of Electronics. Courses for the hobby enthusiast, or for those aiming at the A.M.Brit.I.R.E., City and Guilds, R.T.E.B., and other professional examinations. Train with the College operated by Britain's largest electronics organisation. Moderate fees.—Write to E.M.I. Institutes, Dept. WW28, London, W.4. [0179]

**WIRELESS** telegraphy.—Merchant Navy offers to youths 16 upwards after qualification, lucrative positions as radio officers.—Apply British School of Telegraphy, 179, Clapham Rd., S.W.9. (Est. 1906). Recognised by Ministry of Education, moderate fees, modern equipment, day and evening tuition; also postal courses in theory of wireless telegraphy for P.M.G. Certs. and Amateur Transmitting Licence. [0124]

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**"WIRELESS WORLD"**, Jan. '52 to date, less Nov. '52; offers.—Box 0298. [5745a]

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**BOOKS WANTED**

**WANTED**, the following numbers of "Wireless Engineer": Vol. IX, No. 101 February and No. 102 March, 1932; Vol. X No. 113 February, No. 115 April, No. 117 June and No. 122 December, 1933; Vol. XVI No. 195 December, 1939; Vol. XX No. 233 February, 1943; 15/- offered for each copy.—Box 0854. [5636]

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Apply in confidence, quoting reference number of position sought to: The Personnel Manager (Technical Employment), de Havilland Propellers Ltd., Hatfield, Herts.

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Applications are invited from Mechanical Design Engineers with experience in the design of electronic equipment, preferably to M.O.S. specification. These vacancies call for men of good design ability and attractive salaries will be paid to the selected candidates. Please reply, giving full details of experience to Box No. 695.

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Apply in writing to the Labour Officer, Imperial Chemical Industries Limited, Wilton Works, Middlesbrough, Yorkshire, or to any Ministry of Labour Office, quoting reference ICI/X/286/1.

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Applications are invited from Senior Project Engineers with a specialised knowledge of the manufacture of electrical and mechanical products. Applicants should have a good practical engineering background and a sound technical experience of tool design and planning and be capable of putting new projects on a sound production basis. These vacancies offer excellent opportunities to men seeking permanent and progressive positions. London area. Applications, which will be treated in confidence, should give full details of experience and salary required and be addressed to Box No. 747, c/o "W.W."

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Section Leaders and Assistants are required for small teams to prepare and field test Guided Weapons and to carry out further development in the laboratories. Section Leaders are required to have at least H.N.C. (or equivalent) and experience of one or more of the following:—microwave; pulse or communication techniques; small servos; gyroscopes; D.C. amplifiers or electro-mechanical instruments. Assistant Engineers should be up to O.N.C. standard and have, preferably but not essentially, similar experience. Suitable training and experience in H.M. Forces would be an advantage for either grades of these vacancies. These positions offer unique opportunities for advancement and the obtaining of higher qualifications is encouraged. Excellent salaries and bonus. Pension scheme.

Apply, quoting Ref. WW/59, to the Assistant Manager, The Fairey Aviation Co. Ltd., Weapon Division, Cranford Lane, Heston, Nr. Hounslow, Middx.

Electronic Engineers required for the modern Laboratories of a large and well-established Engineering Company situated in the Eastern Suburbs of London. Applicants should possess good qualifications and have at least 3 to 5 years' industrial design and development experience. Attractive salaries will be paid to the selected candidates. Please reply, giving full details of qualifications and experience to Box No. 692.

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### PLESSEY NUCLEONICS LIMITED

The Plessey Company has recently announced the formation of this new company which is to be located in the Northampton area. Several vacancies exist for the following staff:-

1. Senior and Junior Electronic Engineers
2. Senior and Junior Design Draughtsmen
3. Senior and Junior Physicists
4. Senior and Junior Laboratory staff
5. Senior and Junior Site Engineers
6. Production Manager and Progress control staff
7. Workshop personnel of all grades
8. Inspection personnel familiar with M.O.S. Procedure

For Senior posts, at least four years experience in a similar position is desirable, together with appropriate qualifications. Considerable scope for promotion is offered to suitable applicants, and salaries will be in accordance with previous experience and qualifications.

Interviews can be arranged either at Northampton or at Ilford. For further details please write to the Personnel Manager, The Plessey Company Limited, Ilford, Essex, quoting reference PN/1.

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Laboratory Assistants (Electronics) with experience in construction and testing of experimental and prototype apparatus.

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Applications will be treated as confidential and should be made to: The Research Department, J. F. Crosfield Ltd., 232, Old Street, E.C.1.

Engineers required for Telecommunications Laboratory. Must be experienced, realistic and practical, and able to work with a minimum of supervision. Knowledge of communications engineering for high duty and pan-climatic applications, largely in V.H.F. and U.H.F. fields, static, mobile and airborne is desirable. Much of the work is on advanced techniques and involves responsibility for development and engineering through type approval to production. Minimum qualifications are H.N.C. or C. & G. or equivalent. Salary up to £1,000 per annum. London Area. Please reply, giving full details of experience, to Box No. 694.

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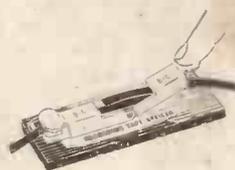
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