APRIL 1956

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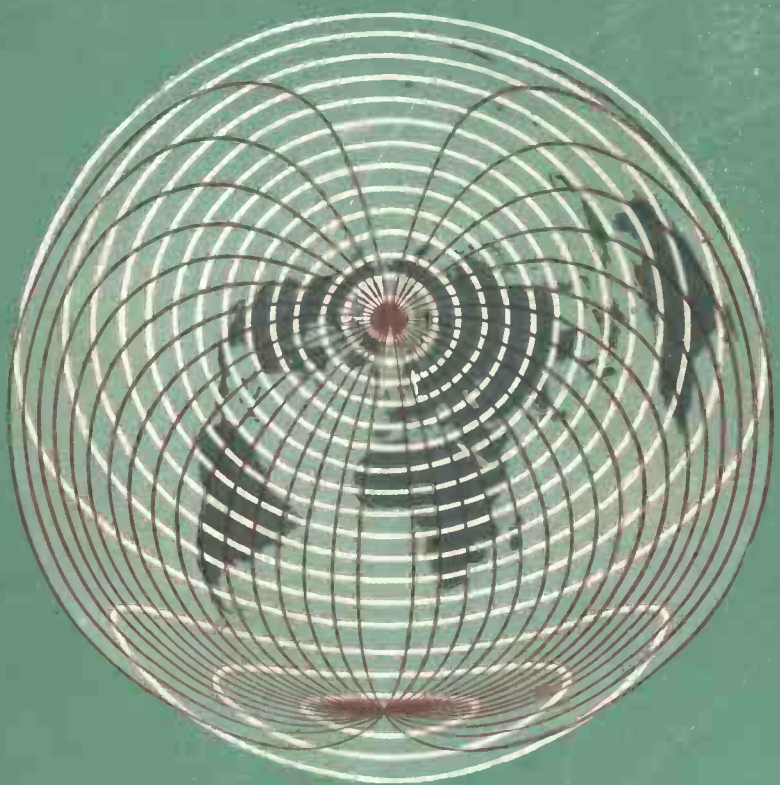

FORTY-SIXTH YEAR OF PUBLICATION

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Wireless World

ELECTRONICS, RADIO, TELEVISION

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In This Issue

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Wireless World

APRIL
1956

Vol. 62 No. 4

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 television 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

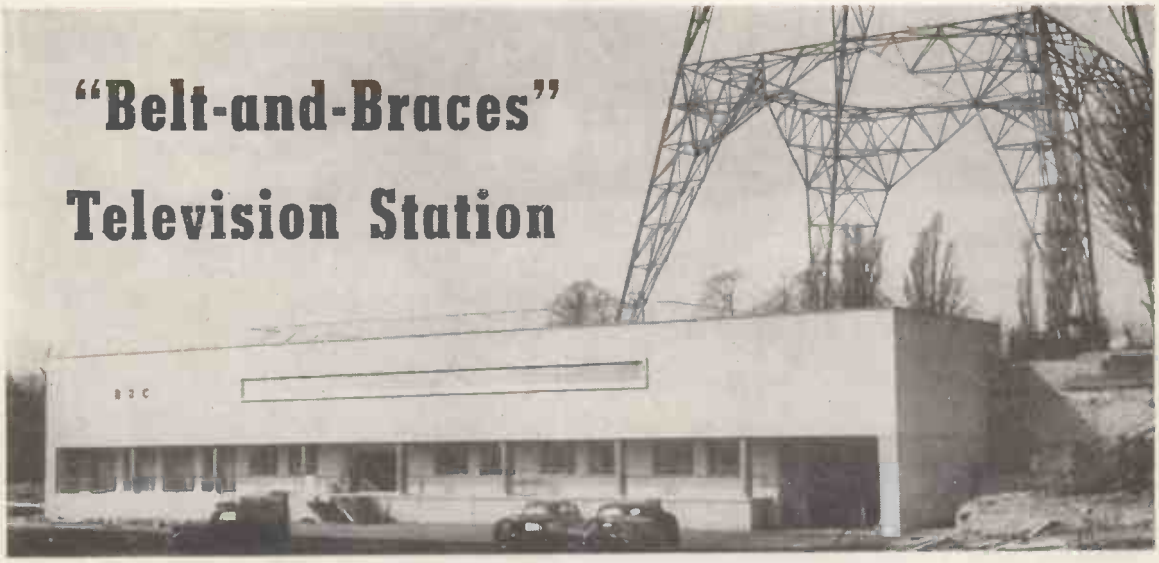
FOR many years the annual exhibition organized by the British Sound Recording Association has had to turn away potential exhibitors—including many influential firms—for lack of space. The London Audio Fair* held this month found room for most of the big firms in the industry, but was still not big enough 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).

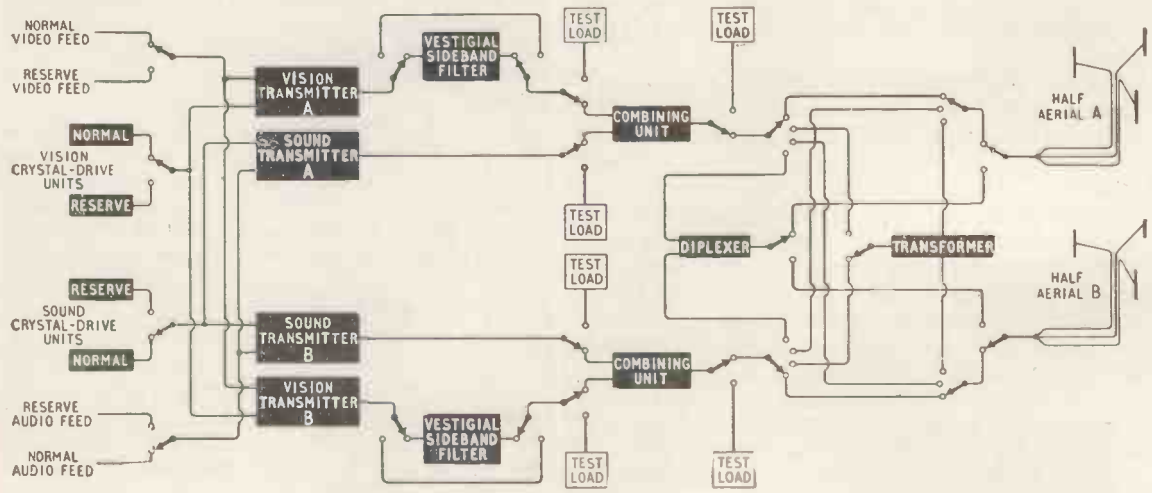
Under normal conditions all four transmitters are working simultaneously. The outputs of vision transmitter A and sound transmitter A are combined and fed to one section of the aerial, while the outputs of vision transmitter B and sound transmitter B are combined and fed to the other section. If there 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

Vision Equipment (2 transmitters)	
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 ±2%
Sound Equipment (2 transmitters)	
Frequency	41.5 Mc/s
Output power (each)	3.75 kW
Distortion	<1% at 95% modulation
Present Aerial (temporary)	
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.

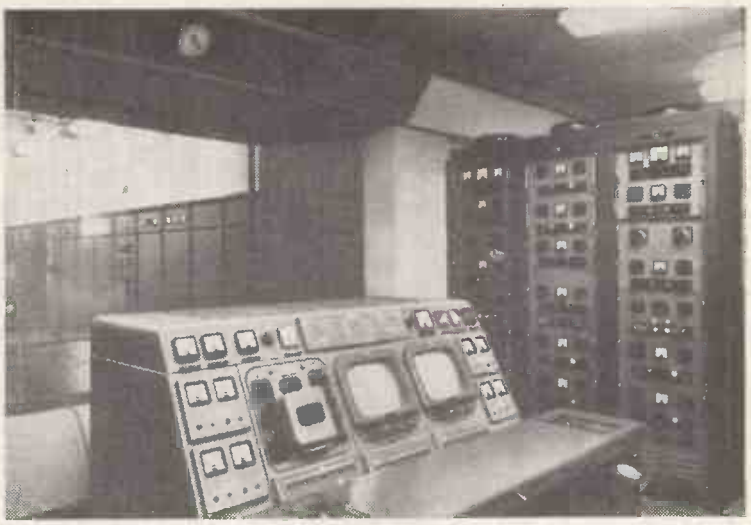


sections to be made. This is brought into action if the fault cannot be cured quickly, the idea being to permit a combination of transmitters and aerial sections that will give an output power reduced by only 3dB instead of 6dB. For example, both pairs of transmitters can be switched to either half of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

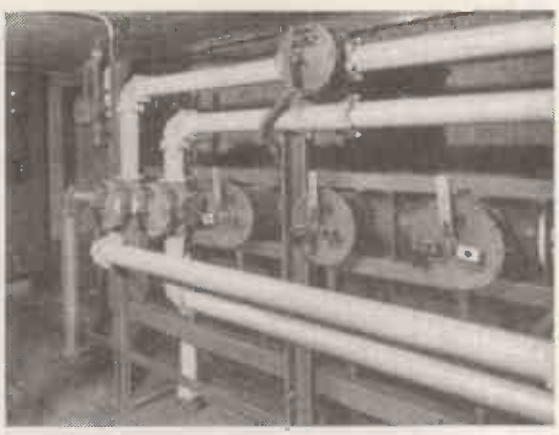


Main control desk, with a view through the window of the transmitter hall. The cubicles on the right contain the crystal-drive and phasing equipment.

The 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.



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

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*.* 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 convertor 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.

*"Amateur Colour Television," *Wireless World*, April, 1954.

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

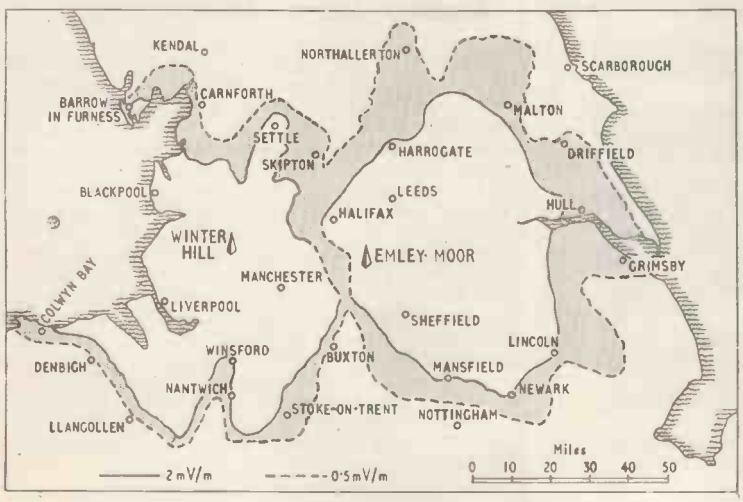
The exhibition, which is the eighth organized by the Association, opens at 10.0 on both days and closes at 6.45 and 6.0, respectively. Admission is by catalogue, price 2/-, obtainable from S. W. Stevens-Stratten, 3, Coombe Gardens, New Malden, Surrey, after May 14th, or at the exhibition.

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 Gresham 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—Detectron; 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. $\frac{3}{4}$in × $\frac{1}{2}$in × $\frac{1}{4}$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 Fireflash" 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

IN 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

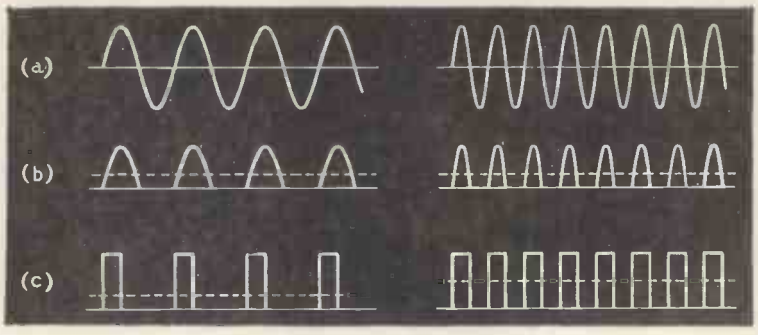


Fig. 1. At opposite peaks of modulation, a f.m. carrier wave has different numbers of cycles in a given period of time, as shown at (a). The rectified and smoothed output (b) is the same for both, but if pulses of constant size are substituted (c) the output, shown dotted, is exactly proportional to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

Discriminator

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

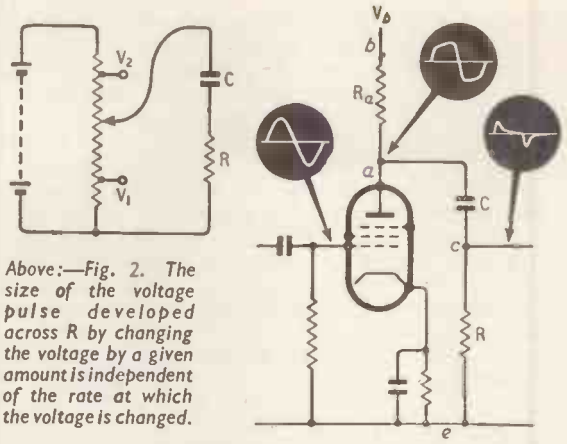
voltage across C to become constant, there can be no current flowing through R and so no voltage across it, and point *c* in Fig. 3 must be at the same potential as *e*, as shown at the start of Fig. 4. The large anode current through R_a brings the anode *a* down to, say, 25 volts, which is therefore 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 ($V_b = 70$, $R_a = 10\,k\Omega$ and $R = 1\,k\Omega$). 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 $10\,k\Omega$ 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" throughout 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



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.

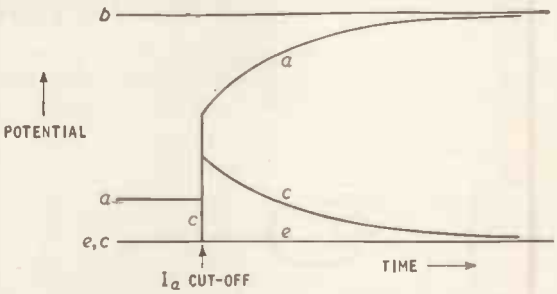


Fig. 4. If the anode current in Fig. 3 is cut off instantaneously by the down swing of a arge input signal, the potentials of the various points are affected as shown. The desired voltage pulse is obtained at c.

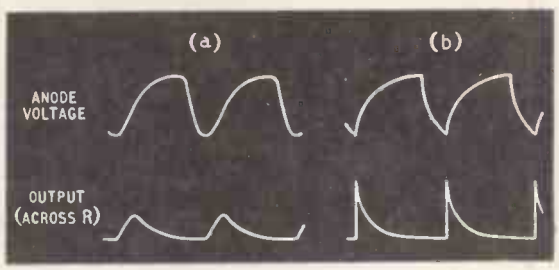
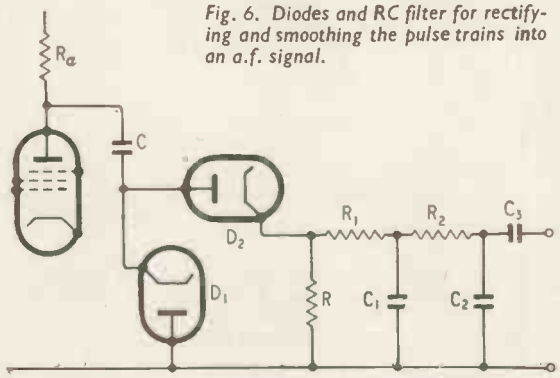


Fig. 5. Actual waveforms obtained in a circuit of the Fig. 3 type (with rectifier added to remove negative pulses), with (a) small and (b) large input signal amplitudes. Despite the very different peak values and shapes of the output pulses, they are equivalent, thanks to the principle illustrated in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

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 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.

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



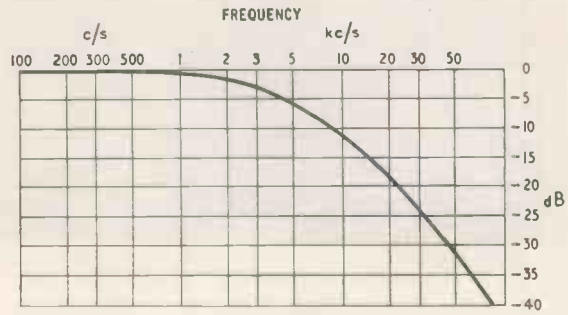


Fig 7. Measured frequency characteristic of output filter with component values as in Fig. 9.

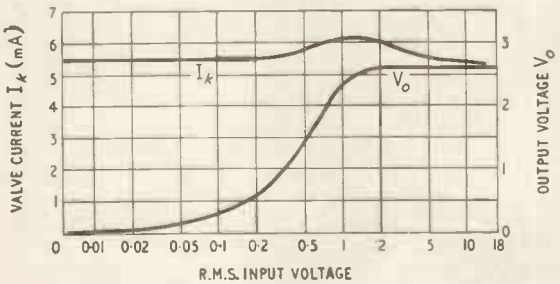
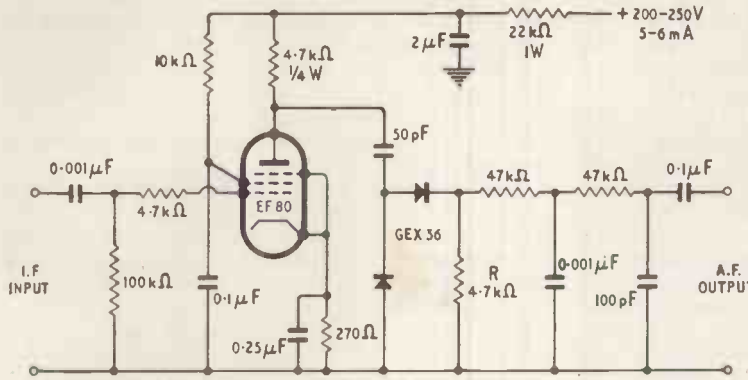


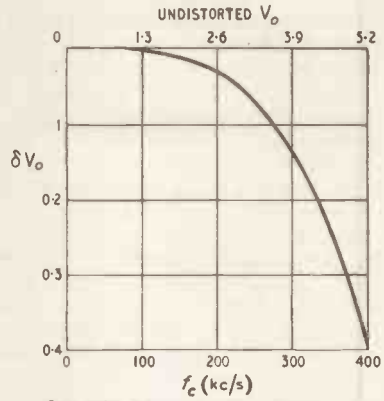
Fig. 8. Z.f. output across R (V_o) and cathode current (I_k) against r.m.s. input voltage: circuit as in Fig. 9.

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 μsec.; that is to say, $C_1R_1 = 50 \times 10^{-6}$. At the same time R_1 must be large enough not to shunt R heavily; about 50 kΩ is suitable, in which case C_1 would be $50 \times 10^{-6}/(50 \times 10^3) = 10^{-9}$F or 1,000 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 kΩ and the cut-off frequency (−3 dB) is 30 kc/s, C_2 works out at about 100 pF. The two-stage filter just specified gives slightly more cut than that calculated on a separate-stage basis, and the standard values 47 kΩ 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 MΩ and capacitance not much more than 10 pF. Fig. 7 shows the measured voltage/frequency characteristic.

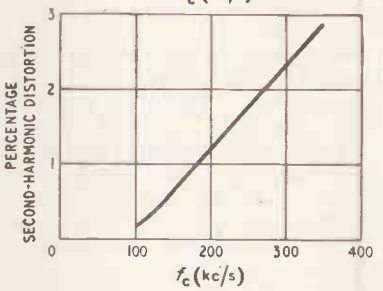
We have estimated that $R_a + R$ should preferably not exceed about 10 kΩ, but the best individual values have yet to be settled. We know that for a given V—the difference in anode voltage between the bottomed and cut-off states—the output is proportional to R. If $R_a + R$ is kept constant and R is 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 kΩ for R to 3.5 kΩ for R_a. As R_a is reduced, however, the limiting action becomes less good and valve currents increase; so, since 5 kΩ:5 kΩ gives nearly as much output that ratio was adopted. It gives about four times the output of the 1 kΩ:10 kΩ 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_aC 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 δV 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 kΩ, C = 50 pF, and f_c = 150 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 kΩ, C = 40 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, 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 kΩ, R_{g2} = 10 kΩ, and R_k = 250 Ω. 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 Ω, 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.

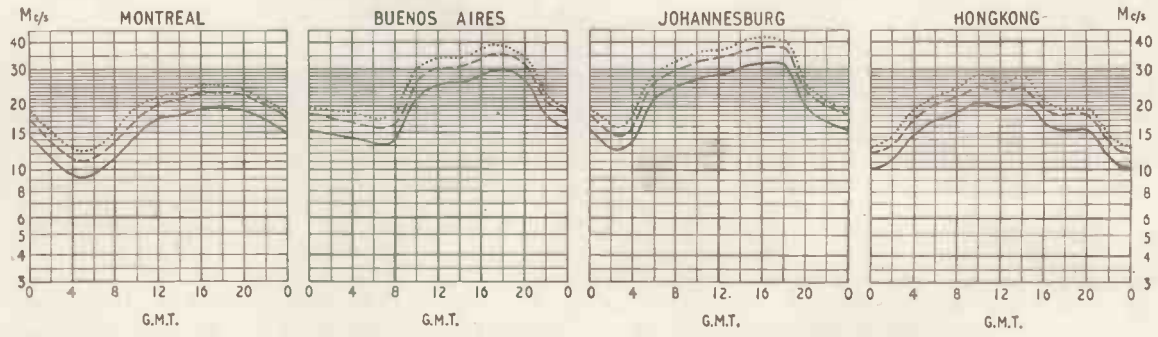
What appears to be the first description of the counter discriminator‡ made use of it for measuring distortion elsewhere, and therefore had to be virtually distortionless itself; its z.f. output/frequency characteristic is claimed to have departed less than 0.02% from perfect linearity from 50 to 250 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

INSTEAD 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 μsec duration with a repetition frequency of 70 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 μsec.

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—70-Mc/s band. It can be used to measure group delays of up to 200 mμsec with an accuracy of $\pm$0.5 mμsec, and the amplitude response from zero to 20 dB. The apparatus has an oscillator sweeping from 50 Mc/s to 70 Mc/s with a repetition rate of 50 c/s. It is frequency modulated at 1 Mc/s with a deviation of 0.5 Mc/s. After passing through the network under test, and being delayed by it, this signal is compared with the original 1-Mc/s modulation. From the comparator, an output at 1 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-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 19–230 Mc/s of fundamental frequencies; there is an i.f. range covering 9.5–12 Mc/s operating on the b.f.o. principle. The maximum deviation is 110-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-Mc/s bars.

A compact direct-reading frequency-meter by Gertsch Products of Los Angeles covers 20–1,000 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 kc/s to 220 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 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 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 dB up to 3 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.

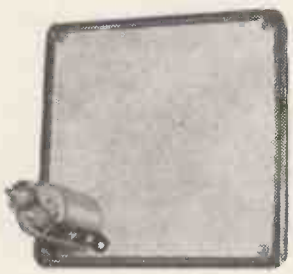
Ediswan demonstrated equipment for determining the optimum grading of turns in a deflector coil. The assembly is made with a normal frame winding and a line coil split into two parts. All windings are fed at 50 c/s and the grid of the tube is pulsed

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".

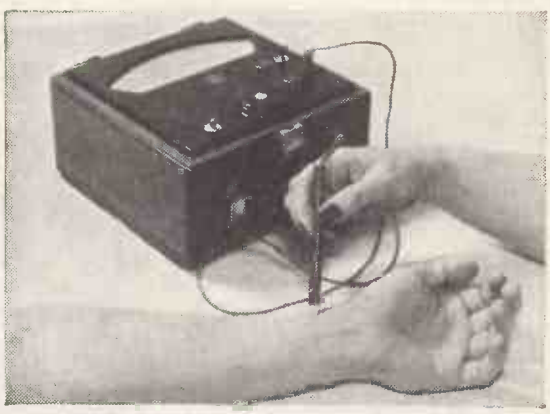
Belling-Lee displayed a rotating aerial mechanism with electrical remote control of its orientation. It can be used, and was so demonstrated, in continuous rotation in plotting the directional characteristics of an aerial. A calibrated v.h.f. receiver for field-strength measurement was also shown.

Another instrument of this character is the J.S.F. field-strength meter shown by Fielden. It is claimed to have an accuracy of ±10% on Band I and ±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.

MANY 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 reactance. 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-

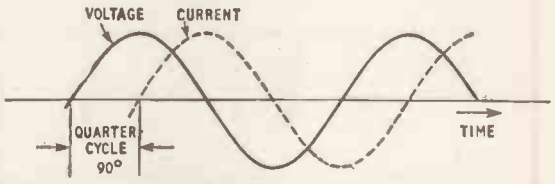
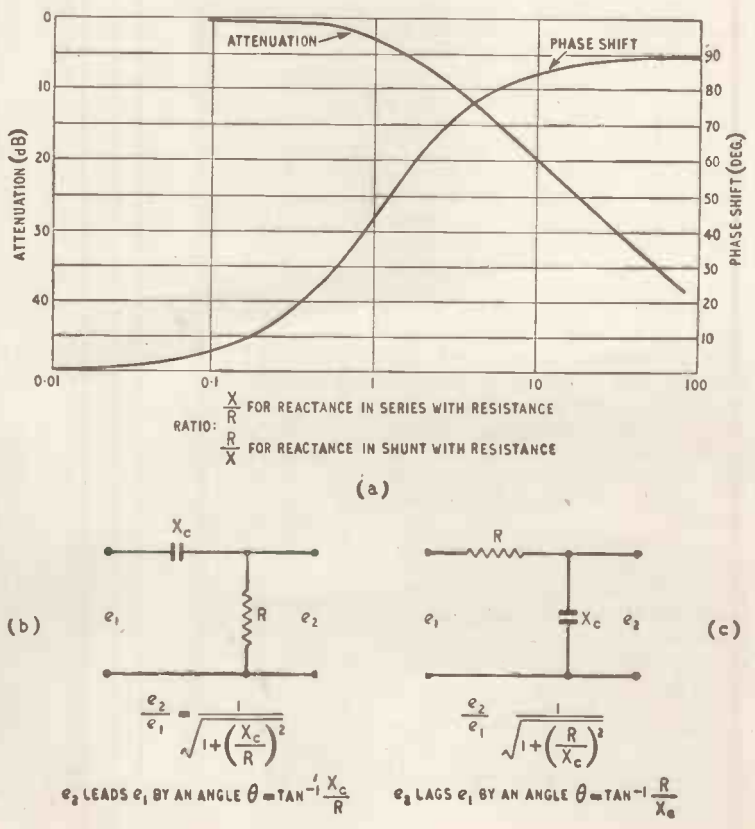


Fig. 1. Conditions in a reactive circuit with voltage and current waves displaced by 90° or one quarter cycle.

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.

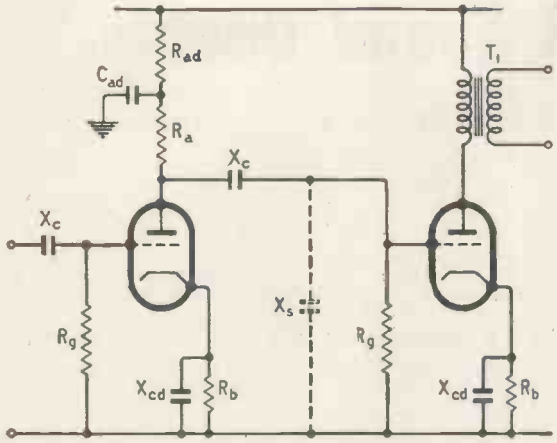


Fig. 3. Elementary amplifier showing sources of phase shift.

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_s —	„	„	lags	„	„	„	high	„
T^1 —	„	„	leads	„	„	„	low	„
T^1 —	„	„	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.

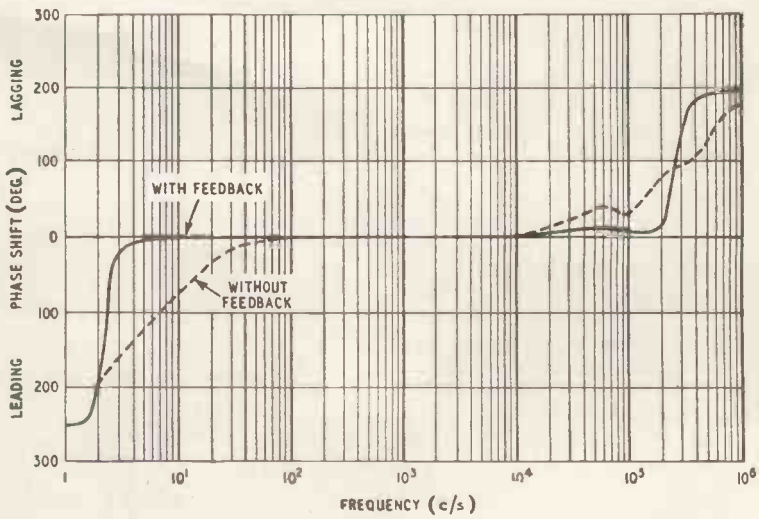
The change of phase with frequency appears to be fairly rapid, even with the simple circuits, but basically it is the change in the *time* of transmission with frequency that introduces waveform distortion. Further investigation shows that the time of transmission between input and output terminals of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

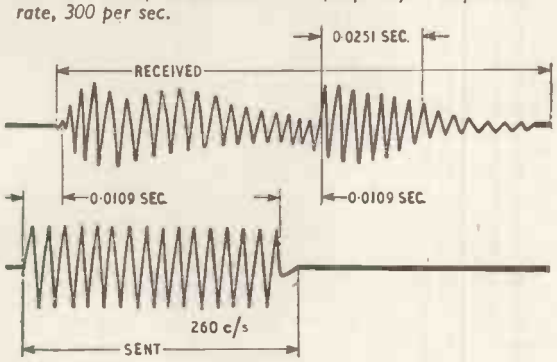


Fig. 6. Distortion of tone pulse due to phase shift.

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°. 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.

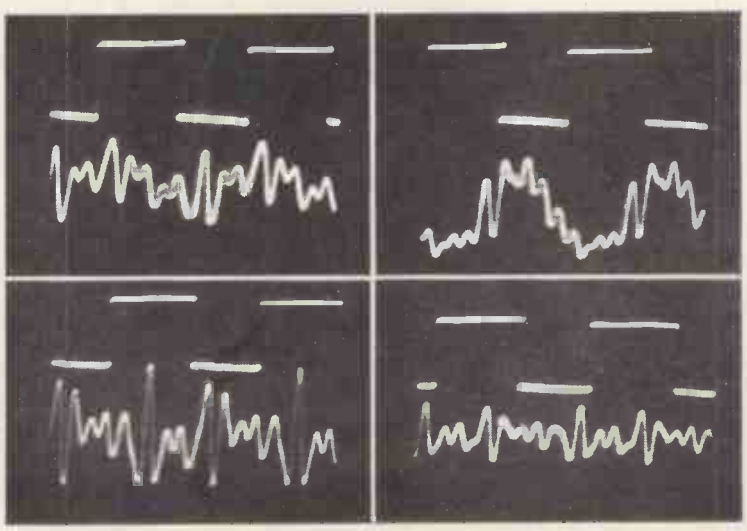
To the best of the writer's knowledge these results remain as authoritative, no subsequent investigation having thrown the slightest suspicion on the results of van der Pol, Lane and Steinberg.

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.

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"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 96μH. 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

THE 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.

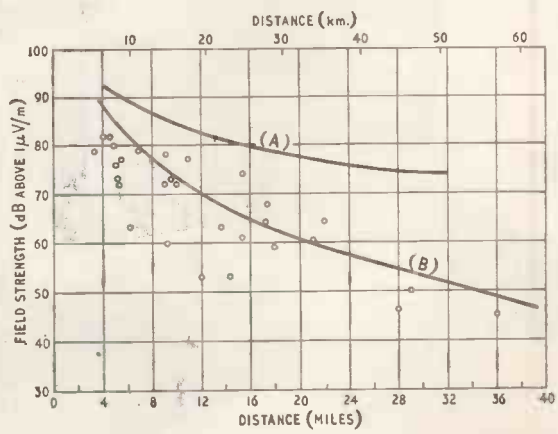
Some experience in this direction has already been obtained in the United States where a number of experimental television stations operating in the u.h.f. band have been set up during the past few years. Early experiments by the Radio Corporation of America have emphasized that it is important that 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 ±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 μV/m); and this would appear to agree favourably with the target which has been set by the F.C.C. at 1.6 mV/m (64 dB above 1 μV/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 μV/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 frequencies. 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 × 11in × 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 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.

Murphy mobile and fixed station radio-telephone equipment.

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.

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

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

U.H.F. Communications Receiver

IN the description of the Eddystone 770U receiver on page 118 in our March issue the bandwith 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
(b) 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 0.001in.

(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.

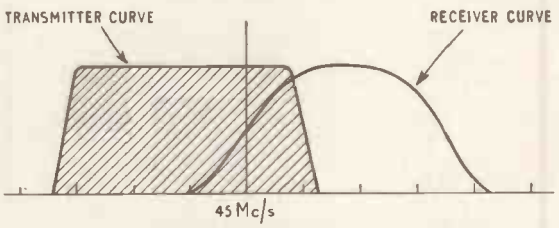
3. Sentimentally there is a case for retaining for as long as possible (and at least until there are no receivers using both sidebands) the superior performance possible with double sideband operation in this special case of the world's first high-definition television service.

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_{in}-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_{in} 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-μF 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 1μA. 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

THE 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‖ but 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 μsec. 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 μsec. 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 μsec, 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 μsec, 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 offsets 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

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.

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.

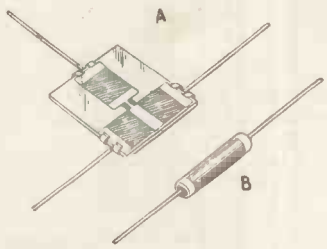
A new development in the metallized glass resistors made by Painton is to deposit a microscopically thin film of precious metal on to a glass fibre little thicker than a hair and then wind this metallized fibre, like wire, on a ceramic former. Very high resistance values are obtained in a small volume.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

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

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.

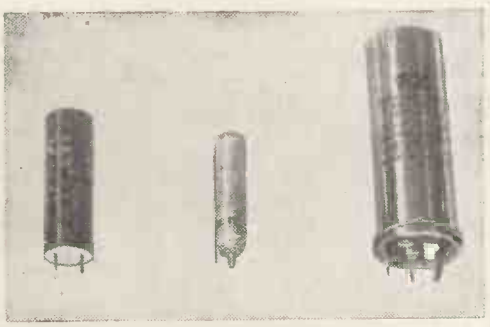
Manufacturers: A.B. Metal Products, British Electric Res., Colvern, Dubilier, Egen, Electronic Comp., Electrothermal, Erg, Eric, Labgear, Morganite, N.S.F., Painton, Plessey, Salford, Walter Instruments, Welwyn, Zenith, W.B.



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

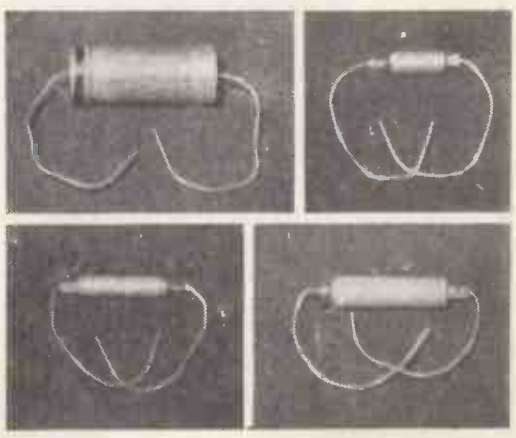
CAPACITORS

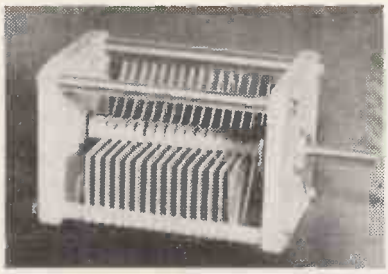
A DEVELOPMENT of more than usual interest is the introduction by Erie of a capacitor having voltage-sensitive characteristics. It provides a controlled change in capacitance with applied d.c. voltages and would appear to have useful applications in f.m. receivers and a.f.c. circuits generally. The dielectric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



T.C.C. printed circuit capacitators, showing a 50-μF Picapack, 32 + 32 + 16 μF, 350 V electrolytic and CP19ON 0.27 μF, 350 V moulded-case type.

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





Eddystone Type 839 transmitting capacitor of 390 pF.

Right: Daly 32 + 16 μF, 270 V with 25 μF, 25 V electrolytic capacitors in a case only 1in in diameter for printed circuits.

75 to 100 pF larger values should eventually be obtainable.

In general the changes in design of capacitors are of a superficial kind and concerned mainly with making existing types more adaptable for use in printed circuits. While many of the current ceramic and tubular types are small enough for this purpose their usefulness has been extended either by repositioning the connecting wires or by fitting wires more suitable for the dip-soldering technique of printed circuit assembly.

One example is the T.C.C. CPI9ON, a 0.27-μF 350-V tubular housed in a $\frac{5}{8}$in diameter moulded plastic case $1\frac{7}{8}$in long with *both* wires brought out through a hard resinous wax seal at one end. Hunt had some new ceramics in disc and tubular form with connections positioned to suit printed circuit assembly and, in addition, a low-leakage range of polystyrene film capacitors.

Dubilier showed a new range called "Terecaps" which employs a Terylene film dielectric. In size they fall midway between metallized paper and separate paper and foil types and their principal characteristic of interest is that they can be used without derating up to 125 deg C. They are fully tropicalized, being hermetically sealed in metal cases.

Electrolytic capacitors are in general somewhat smaller this year for a given capacitance and in order to cater for printed circuit requirements there is an increase in the number of multiple-capacitor types modified for this purpose. The principal modification is in the positioning and shape of the fixing lugs and contacts. All these are located at one end of the capacitor. Whilst it is customary to restrict the multiple types to either high- or low-voltage capacitors, Daly have a range of mixed voltage types, one, for example, being 32+16 μF at 275 V working with 25 μF at 25 V working; these are in cases only 1in in diameter and $2\frac{1}{4}$in high.

On all the new models of printed-circuit metal-cased electrolytic capacitors the fixing lugs and base connections have an agreed shape and spacing and this generally conforms to the American standard for this type of capacitor.

Variable capacitors have not undergone much change, but some new models were seen. One of these was an Eddystone (Stratton) transmitting type which is assembled on $2\frac{1}{2}$-in square ceramic end-plates with all the metal parts heavily silver plated. It has a maximum capacitance of 390 pF and one of its applications is in π-type networks for matching random-length aerials to the output valve.

Manufacturers: Cyldon, Daly, Dubilier, Erie, Hunt, J.B., L.E.M., Mullard, Plessey, Stability Radio, Static Cond., Stratton, Suflex, T.C.C., T.M.C., Wego, Wingrove and Rovers, W.B., Walter Instr.

COILS AND TRANSFORMERS

AS one might expect, there were no major changes in iron-cored chokes and transformers, although a good deal of stress was laid upon the C-core types. There was, too, perhaps more than ever before, great emphasis upon hermetic sealing and, for the smaller varieties, encapsulation.

As extremes in miniaturization, the Fortiphone transformers for transistor circuits are noteworthy, since the smallest types are only slightly larger than the average transistor.

For r.f. circuits, tuning coils and i.f. transformers were shown by many firms and have changed but little. Among new components a discriminator transformer for an f.m. ratio detector is interesting in being designed for 38 Mc/s. It was shown by Cyldon and can be used with either thermionic or crystal diodes. The bandwidth is 820 kc/s; it is intended for use in television receivers which provide Band II reception.

Mullard showed a range of wideband matching transformers wound on Ferroxcube E cores and also adjustable Ferroxcube pot cores, which can be supplied wound. These are for high-Q inductors and, as an example, Q values up to 350 can be obtained in the inductance range of 10-300 mH.

Manufacturers: Bulgin, Cyldon, Eddystone, English Electric, Ferranti, Fortiphone, Haddon, Lion, Mullard, Parmeko, Partridge, Plessey, Rola, Weymouth, Whiteley, Wireless Telephone, Woden.

TELEVISION COMPONENTS

PARTS which are special to television comprise, in the main, scanning and focusing components, but it is also convenient to include tuners among them, although they are more in the nature of sub-assemblies than components.

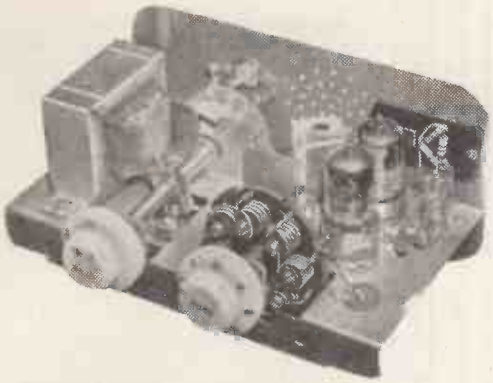
The increasing use of 21-in tubes of 90° deflection angle has resulted in more deflector-coil assemblies for such tubes being produced. Some models were shown last year and the general form of the design on view this year was much the same, although detail differences exist. The castellated iron circuit, so common in assemblies for 70° tubes, is not used in the 90° types. Instead, a plain ferrite ring is employed; this is wound with four coils for the frame deflection so that these coils are of the so-called toroidal type. The line coils, however, are of the bent-up end kind and the front ends are flared to fit around the conical part of the c.r. tube. With the increasing scan power, insulation is becoming much more important and, in the Plessey assembly, it is provided by a polyethylene moulding; it is claimed that ionization does not start below 4.5 kV and, as the normal peak voltage is around 3.5 kV, there is a reasonable factor of safety.

A tendency to fit small permanent magnets to deflector-coil assemblies was noticed. They are in the form of rods, mounted vertically, one on each side of an assembly and on the outside. Their purpose is to correct for pincushion distortion of the raster.

Line-scan transformers are becoming almost conventional in their general form although detail changes are constantly being made. The core is invariably ferrite, or some material with similar electrical properties, with one window, the winding usually being on one limb only. Resistance wire is commonly used for the e.h.t. overwind to reduce ringing effects and supplies of 16 kV, and even 18 kV, are obtainable.

Focus components and ion traps remain substantially unchanged in form. The favourite arrangement is a pair of cross-magnetized rings acting in opposition and with adjustable spacing as a focus control. James Neill, however, retain the form which they introduced two years ago of three equi-spaced radial bar magnets within a pressed steel case. The case is in two parts movable with respect to each other, to give a variable air gap as a control of the focus field.

Turning now to tuners, there is little or no change in circuitry and the cascode r.f. stage with a triode-pentode frequency changer is normal. The turret tuner is common but the incremental-inductance type with switch selection is also widely used. The changes are in



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.

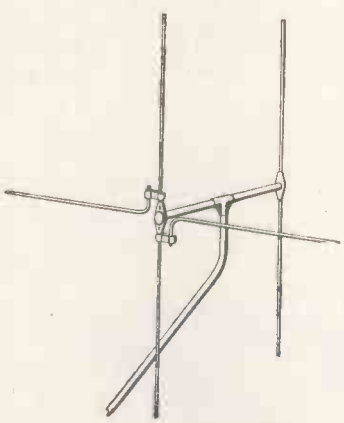
There were, of course, quite a number of coil packs and filter units to be seen. Of particular interest on the Dubilier stand was a u.h.f. suppression filter, covering 200-1300 Mc/s, for insertion in the power supply leads of transmitting equipment. It is a double-T network, using two disc capacitors 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.

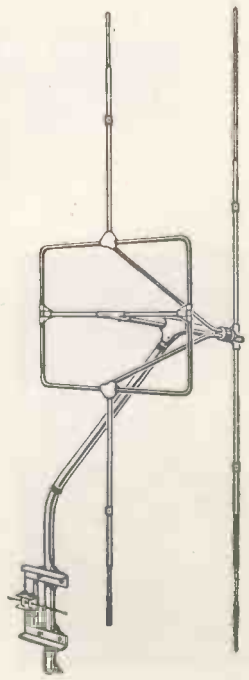
AERIALS

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 FM 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.

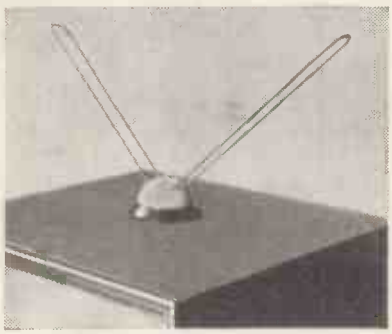
The skeleton square plus "V" section form the Band III system, and this is said to exhibit the unusually broad bandwidth of 170 to 230 Mc/s without the voltage standing-wave ratio exceeding about 1.5 to 1. The Band I section, consisting of the vertical rods and the two vertical sides of the square in 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 aerials and where the receiver has provision for f.m. reception.

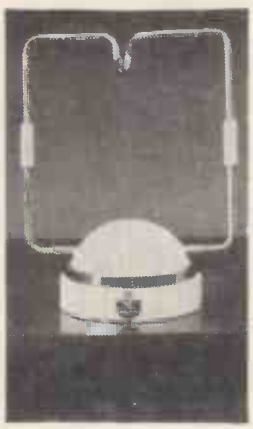
More attention has been given to indoor Band III aerials, as it appears that within 5 to 10 miles of an I.T.A. station this kind of aerial can quite often be used successfully. Wolsey have a small square aerial for standing on top of the receiver which they call the "HI-Q"; it consists of a full-wave 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 aerials 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.



Aerialite "Viking" Band III indoor folded dipole.



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

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 repaced 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.

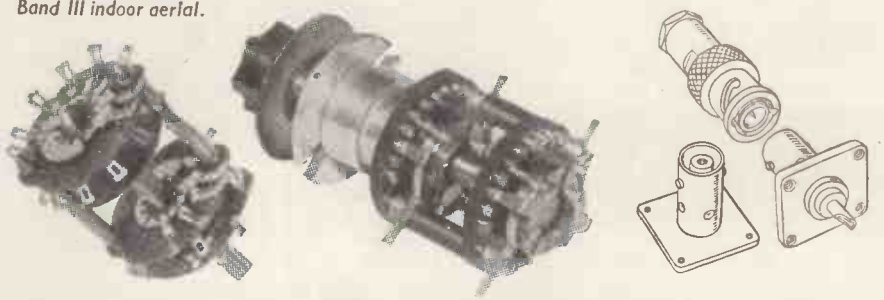
Manufacturers:* A.B. Metal Products (L, P, PA, R, S); B.E.R.C.O. (R); Bulgin (L, M, P, R); Diamond H (L, R); Electronic Components (P, R); N.S.F. (L, P, R, S); Painton (L, P, R); Plessey (L, P, PA, R, S); Pullin (R); Pye (M); T.M.C. (L, P); Walter (L, P, R, S); Whiteley (P, R, S); Wright and Weaire (R).

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

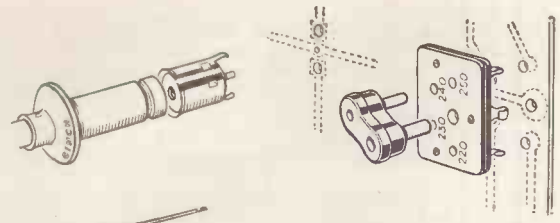
CHASSIS FITTINGS

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

(*Continued on page* 179)

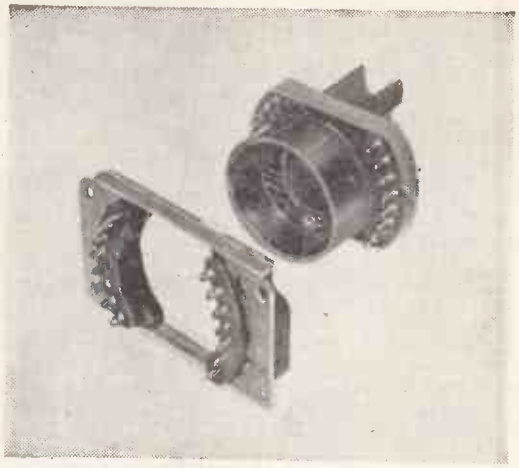


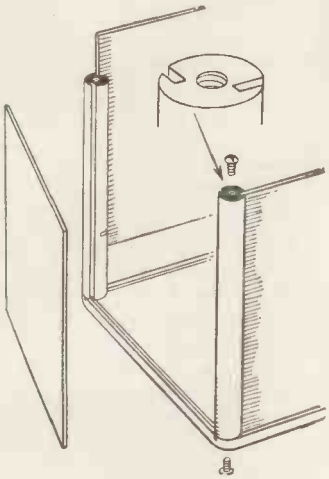
Above: Plessey rotary switch of improved construction. Centre: Electronic Components 4-pole 10-way instrument stud switch. Right: Besson and Robinson coaxial connectors with bayonet locking.



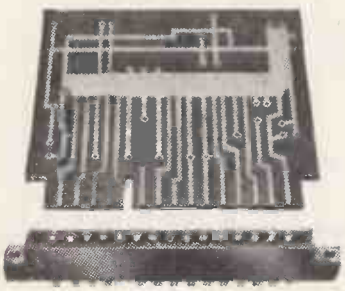
Above: Carr Fastener coaxial socket and mains-voltage elector for printed circuits.

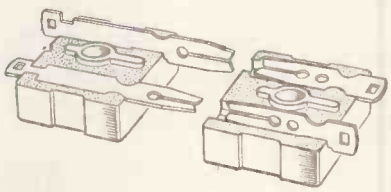
Right: Unusual Ediswan Clix holder for alphabetical indicator tube (16 contacts).





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





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: Aerlalite, 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 Eyelet, 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 Nettlefolds (B); Hellerman (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

THIS 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

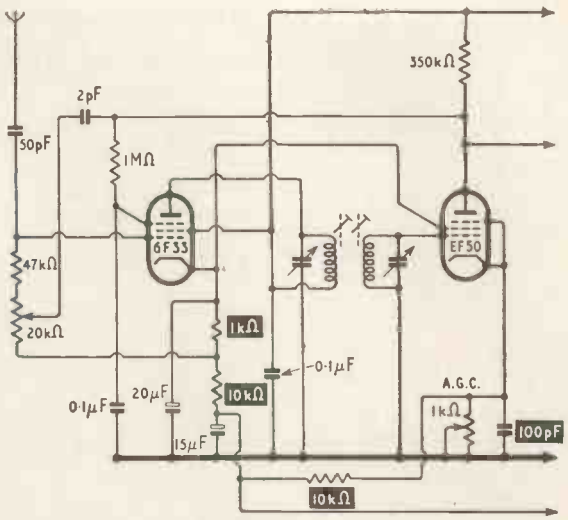
CIRCUIT CHANGES FOR OPTIMUM PERFORMANCE WITH 6F33 VALVE

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 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 modified circuit discussed in the text.

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 reorganized 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. Wheele (G3AKJ), 56 Burlington Gardens, Chadwell Heath, Essex.

Cheekheaton.—"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)

IN 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

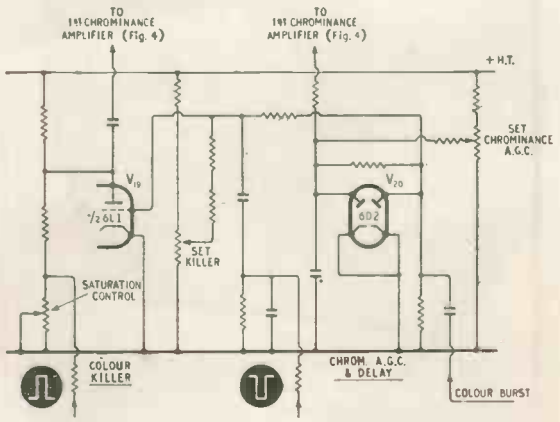


Fig. 7. The colour killer and chrominance a.g.c. stages.

* 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.

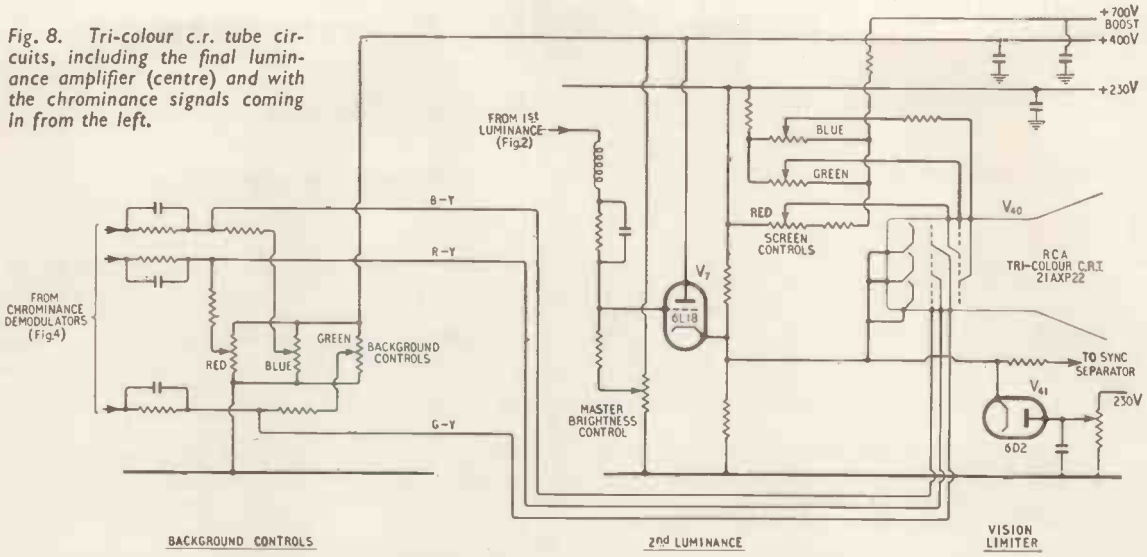
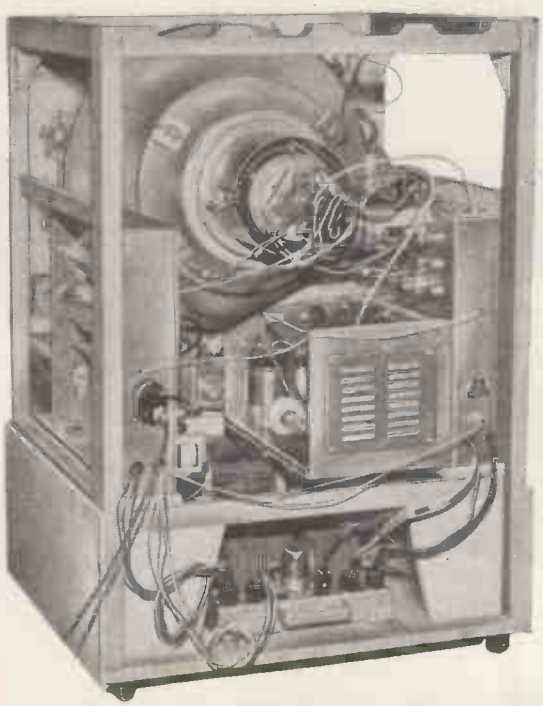


Fig. 8. Tri-colour c.r. tube circuits, including the final luminance amplifier (centre) and with the chrominance signals coming in from the left.

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.



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.

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)

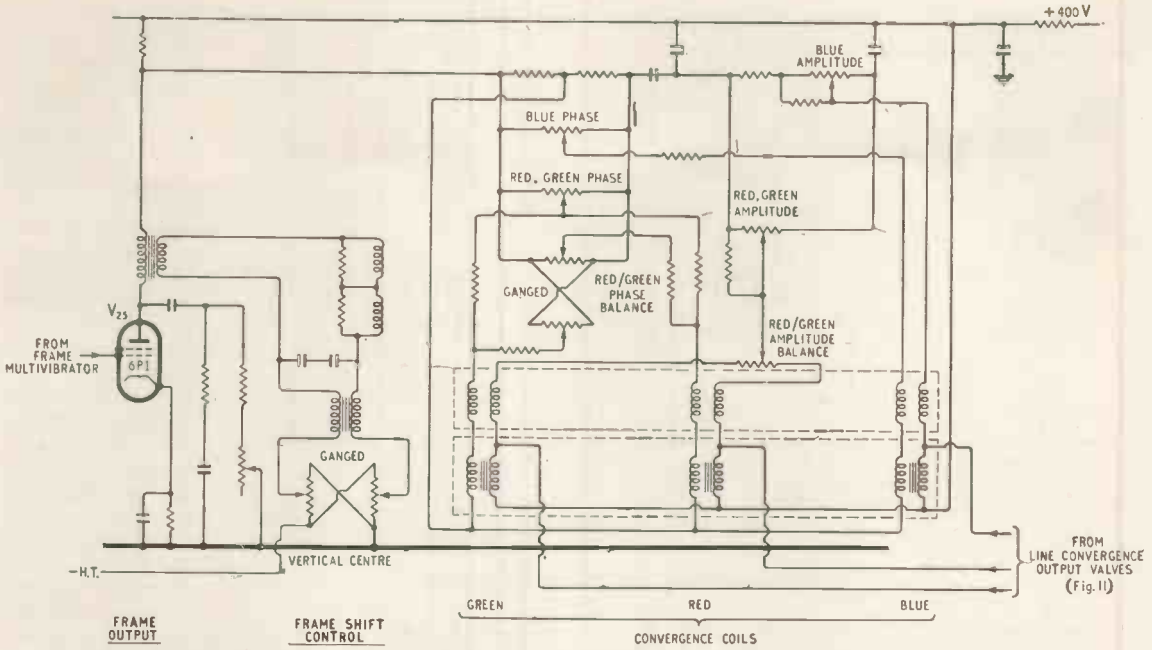


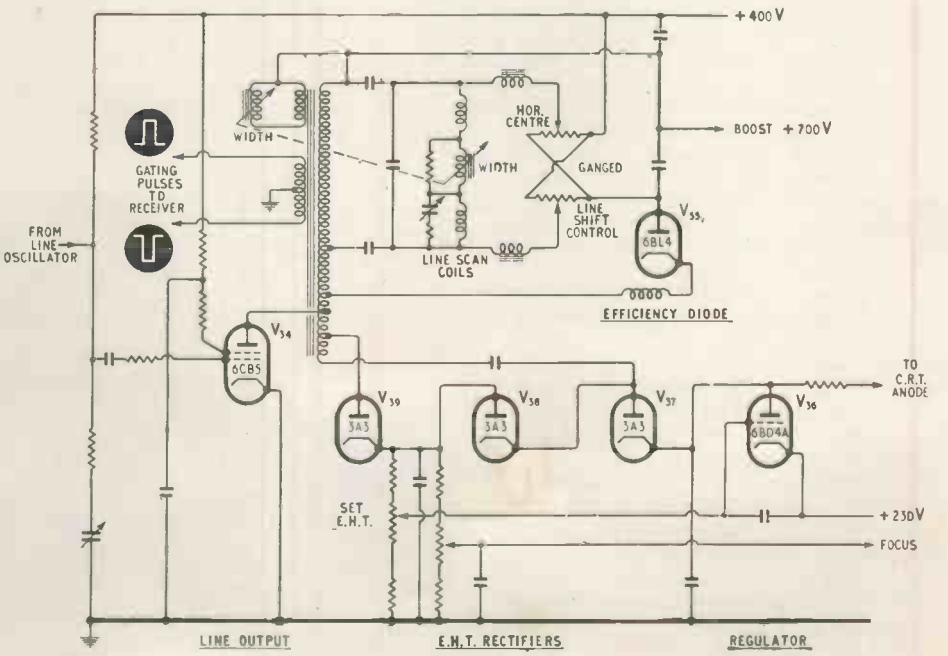
Fig. 9. Frame convergence circuits, including the frame timebase output valve (left) and the convergence coils.

through the scanning coils themselves, and as the scanning currents must not be short-circuited through the power supply, suitable decoupling chokes must be provided. As it is desirable to be able to shift the picture both ways, dual cross-connected potentiometers are provided. The frame shift control (Fig. 9) is isolated from the scanning circuit by a suitable transformer and high-value electrolytic capacitors while the line shift (Fig. 10) is isolated by chokes and the d.c. prevented from getting into the line transformer by isolating capacitors.

Before dealing with the time bases themselves, and taking the last of the display requirements peculiar to the shadow-mask tube, we come to the convergence circuits. These are circuits for energizing an additional scanning assembly known as the convergence yoke. Into this assembly are fed currents of suitable amplitude and phase for adjusting the beam position of all three guns so that they coincide all over the face of the tube. The convergence yoke differs from the ordinary scanning coils in that it has three coil assemblies on it, each one of which has its greatest effect on one gun only. Into each individual coil assembly can be fed currents derived from the line and frame timebases.

The form of the currents required for convergence in a vertical direction is largely parabolic and can be

Fig. 10. Line timebase output, showing line shift control circuit and e.h.t rectifiers.



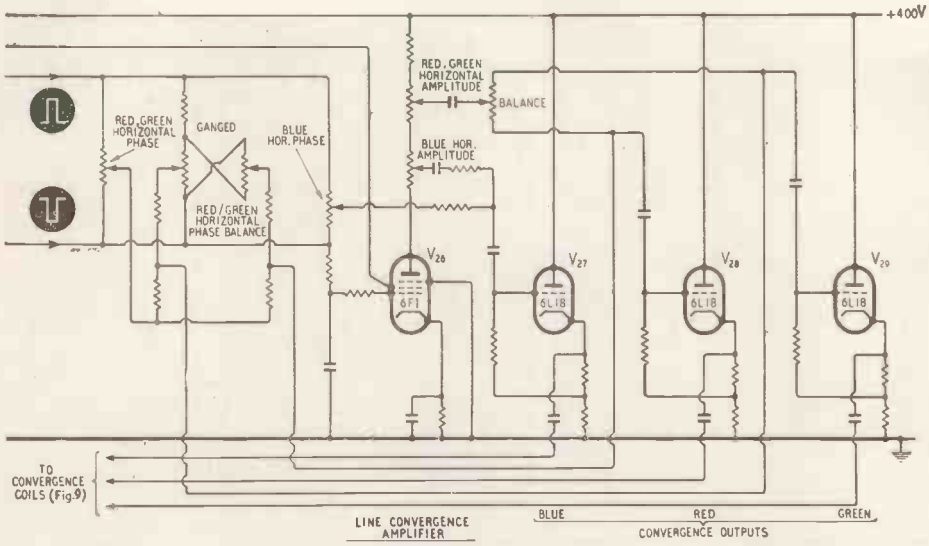


Fig. 11. Line convergence amplifier and output valves.

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 fed on to the grid of the amplifier valve 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 somewhat 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.

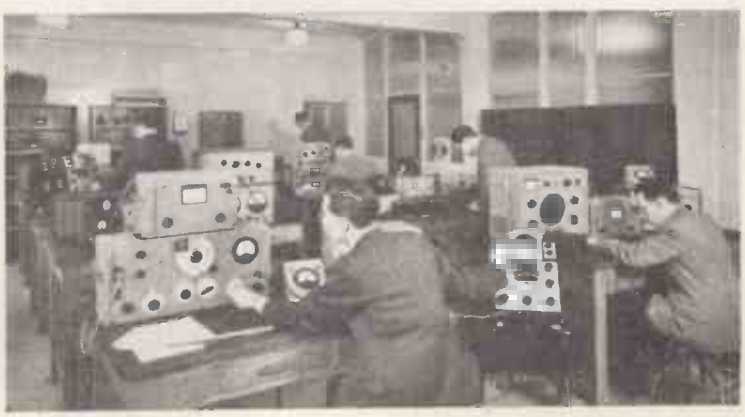
A receiver using 40 valves and a 21-in cathode-ray tube is naturally no small object, and when it is considered that the RCA shadow-mask c.r. tube has a metal cone at a potential of 25 kV it will be realized that something special has to be done to ensure the safety of the personnel operating it.

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 $\frac{1}{8}$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 interdependent, 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-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.

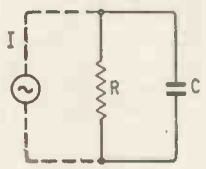


Fig. 1. The voltage set up across a resistance by a given signal current decreases with increasing frequency of current if there is a capacitance (intentional or otherwise) across it.

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 than 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.

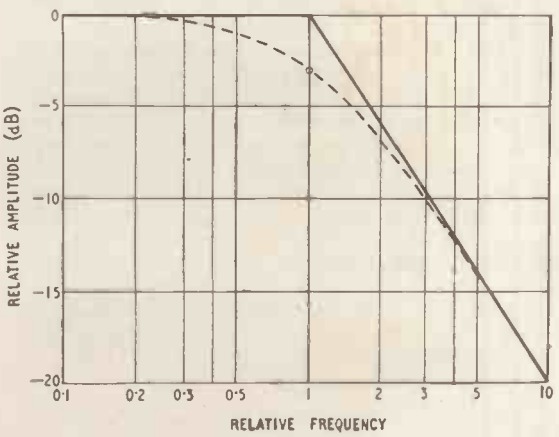
Not only does this particular Z decrease in magnitude with increasing frequency, but an increasing phase difference develops between the current I and the voltage. So there are three interrelated quantities—amplitude (or magnitude of Z, denoted by $|Z|$), phase difference (denoted by ϕ), and frequency (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, and the ratio of one to the other is practically 1, 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.



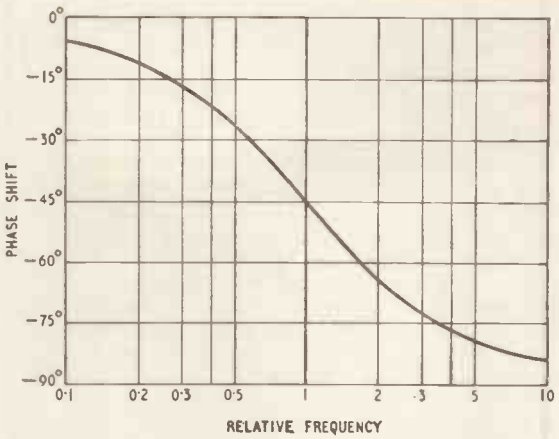


Fig. 3. Phase shift corresponding to amplitude loss shown in Fig. 2.

$1/2\pi fC$, 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, ϕ, 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 ϕ to be 45°. Strictly speaking it is −45°, because the phase is lagging. Calculating a few more points to plot, we get Fig. 3.

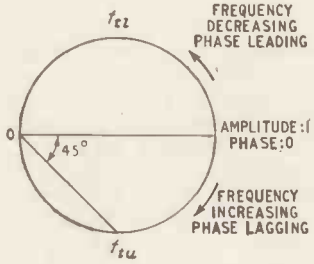


Fig. 4. The circle is the track of the tip of a vector hinged at O, representing signal voltage in a circuit where there is "single-order" cut-off at both high and low frequencies, as the frequency is varied. The vector Of_{tu} corresponds to the marked point at -3 dB in Fig. 2.

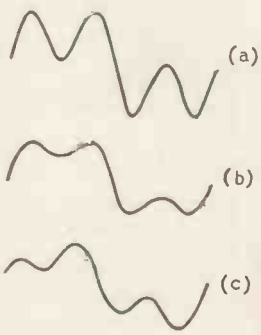


Fig. 5. Waveform (a) is made up of two sine waves of equal amplitude and 3 : 1 frequency ratio. When the amplification of the higher frequency is reduced relatively to the lower by 7 dB, (b) is the result. The accompanying phase shift further distorts the waveform to (c).

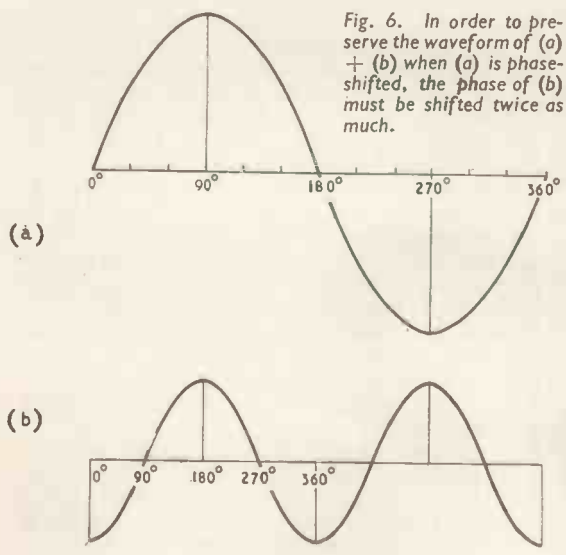


Fig. 6. In order to preserve the waveform of (a) + (b) when (a) is phase-shifted, the phase of (b) must be shifted twice as much.

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°—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°, 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*.

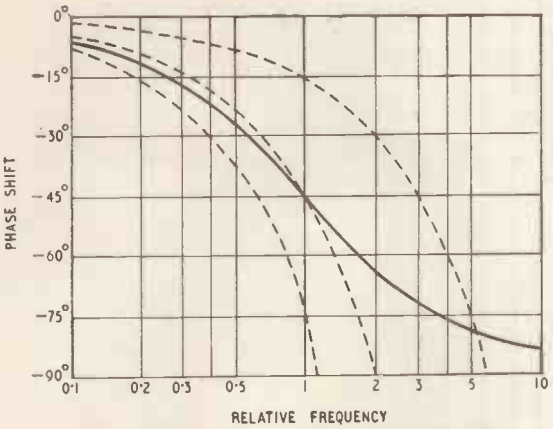


Fig. 7. To the actual phase-shift curve of Fig. 3 are added dotted curves all of which represent zero phase/frequency distortion.

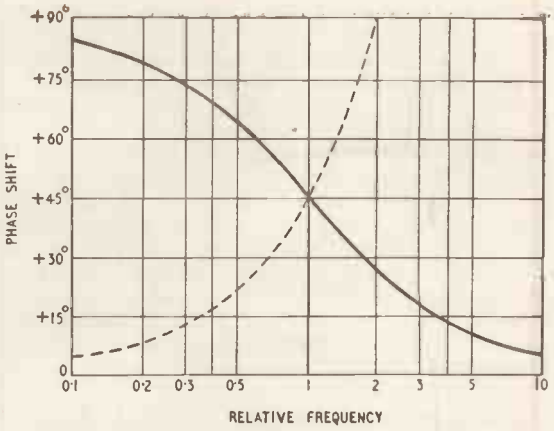


Fig. 8. Whereas the actual phase-lag curve in Fig 7 causes hardly any phase distortion up to the high-frequency cut-off, the phase-lead down to and beyond low-frequency cut-off falls right across the no distortion lines, one of which is shown here.

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

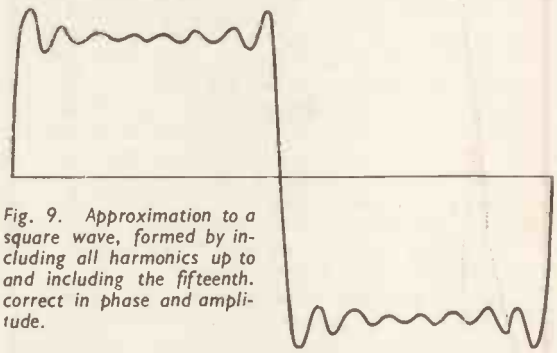


Fig. 9. Approximation to a square wave, formed by including all harmonics up to and including the fifteenth. correct in phase and amplitude.

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

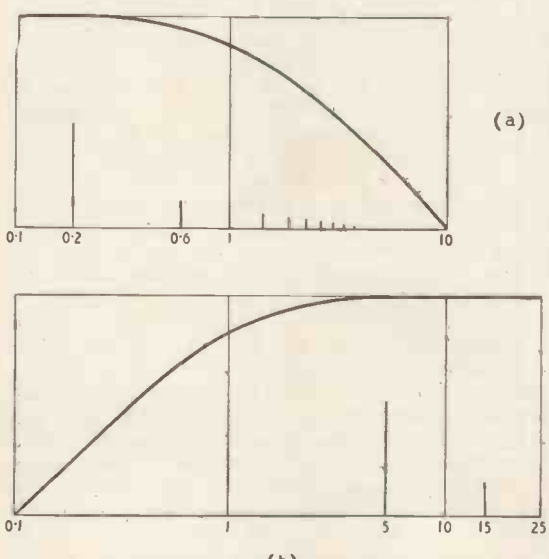
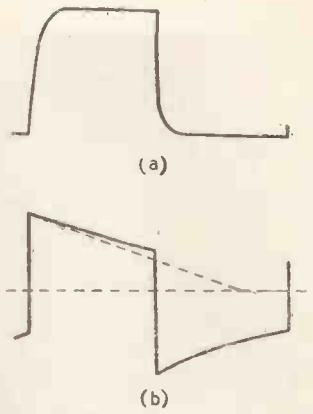


Fig. 10. These two diagrams show the relative amplitudes and frequencies of the first few components of a square wave, in relation to (a) high and (b) low frequency cut-off curves. In (a) the fundamental of the square-wave is one-fifth the cut-off frequency (=.1) and in (b) it is five times, giving the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

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.



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° and one starting at 11.3°, both of them having an amplitude $4/\pi$ times that of the square wave.

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 waveform 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.

SHIPS 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 waveband 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 demands 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.

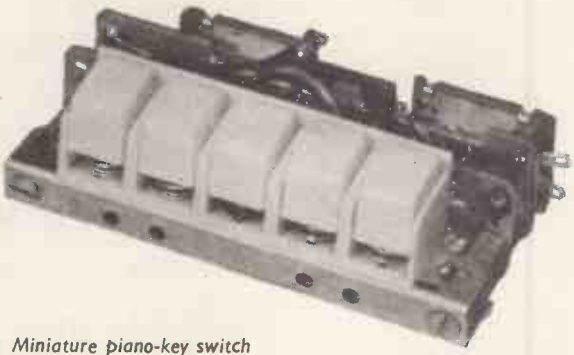
A new method due to E. Meili depends on the reduction by smoke particles and other products of combustion of the current induced in an ionization chamber by a minute radioactive source. To compensate for normal variations due to atmospheric pressure and temperature a second ionization chamber, to which 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.

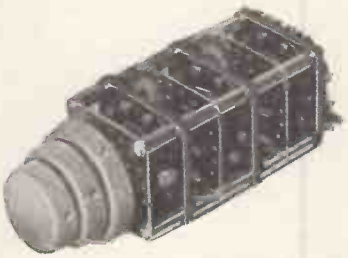
French Components Show

THE 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



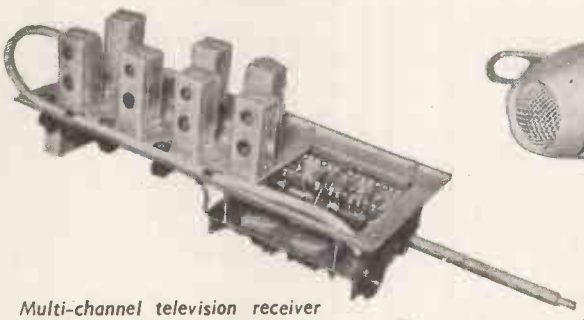
Miniature piano-key switch shown by Oplix.



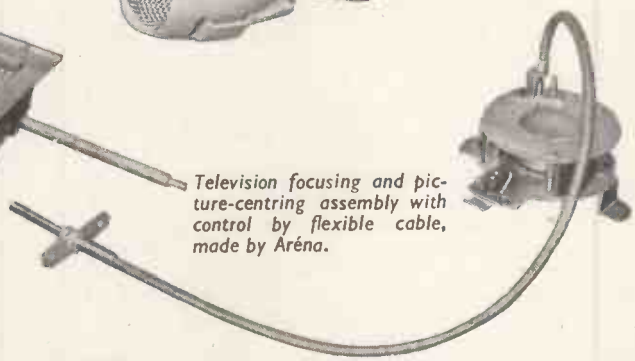
Triple coaxial rotary switch made by Dyna.

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.

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



Multi-channel television receiver "front-end" shown by Cicor.



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

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

Left: A miniature gramophone turntable (45 r.p.m.) made by Eden-Dentzer. 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.

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 successively 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 ("Irises 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.

Thoughout, 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 MΩ.

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 meeting 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.

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. programme 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 supose 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

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 $\frac{1}{8}$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!

UNBIASED

By FREE GRID

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 Petruchio. Even this may one day become an exact science.

Both equally intractable.

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 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.

Desert island delights.

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.

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

Avo in action...

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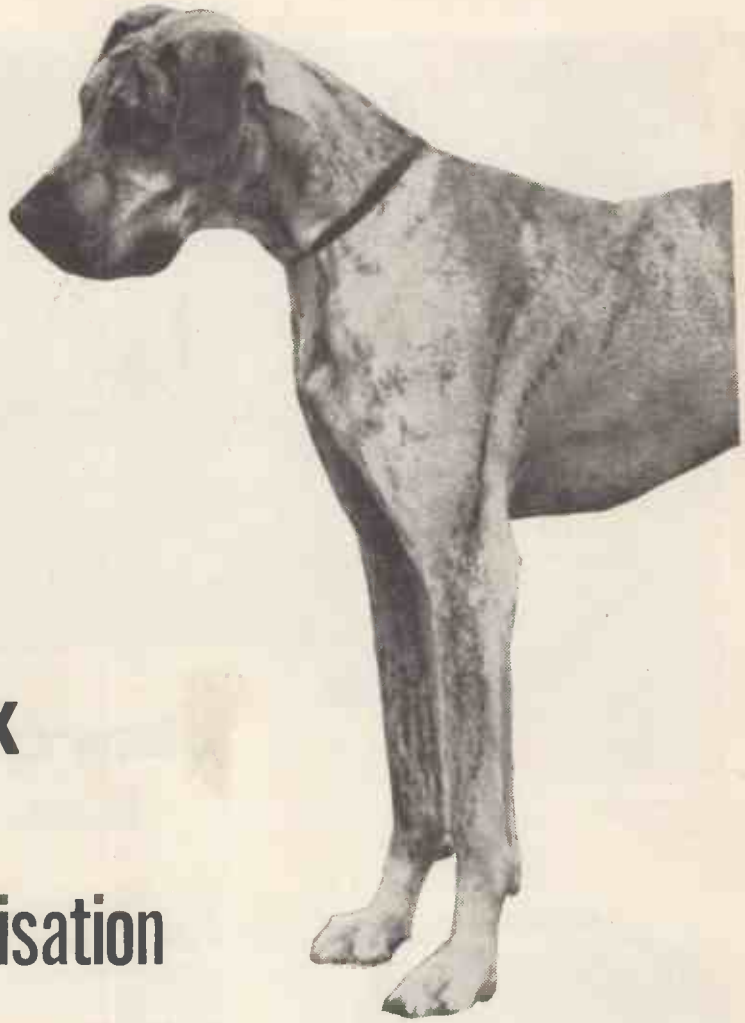

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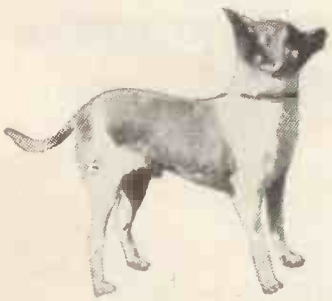

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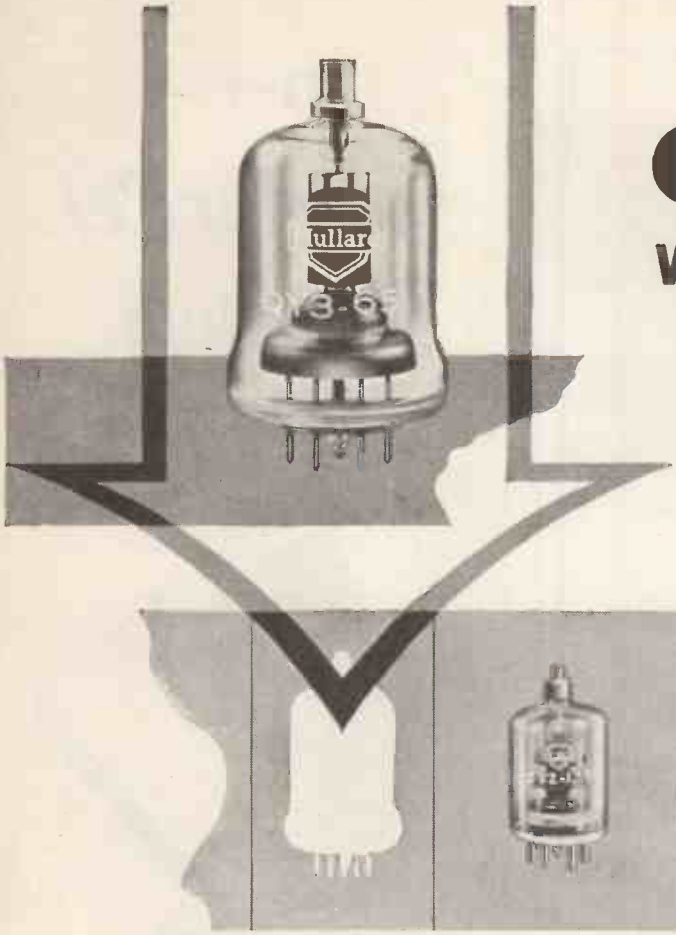

QY3-65

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.

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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)	%	
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

Mullard

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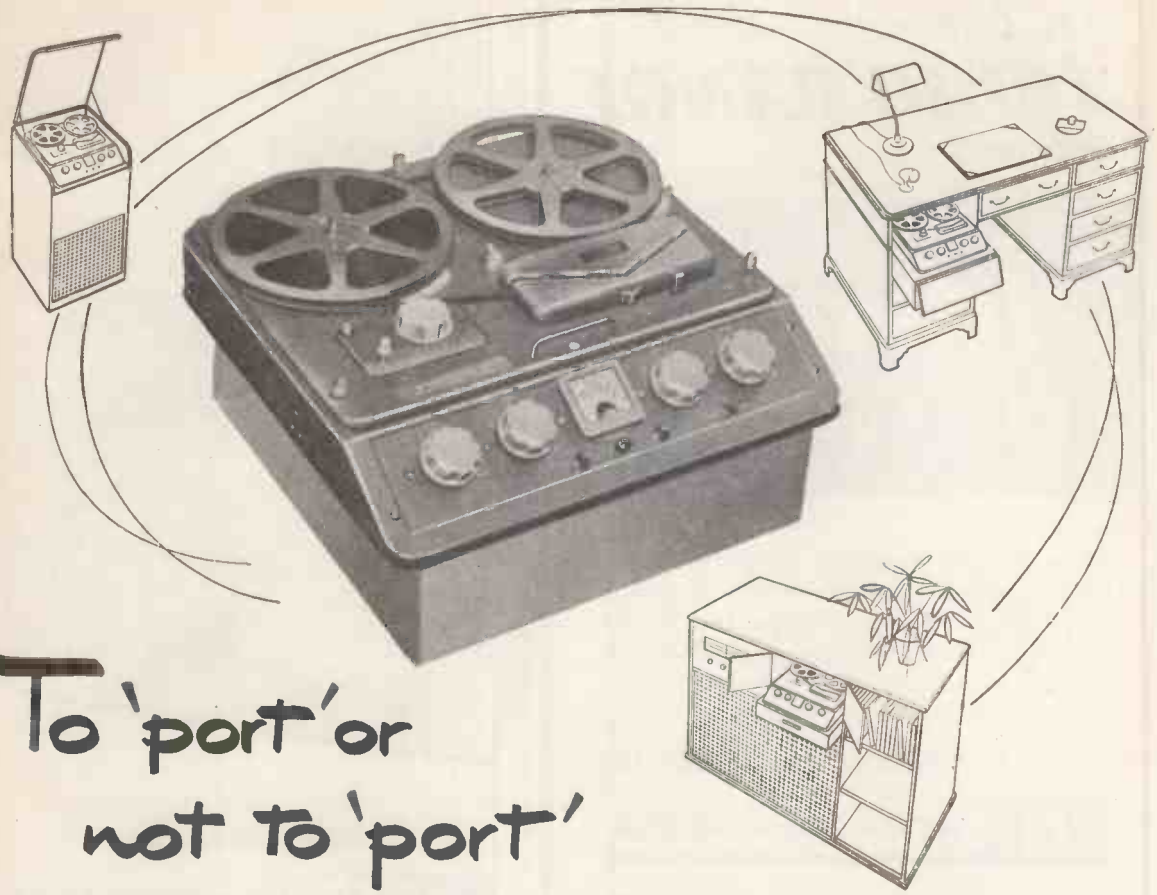
MVT184



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 $15\frac{3}{8}'' \times 16\frac{1}{2}''$ 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.

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$3\frac{3}{4}''$ & $7\frac{1}{2}''$ p.s.
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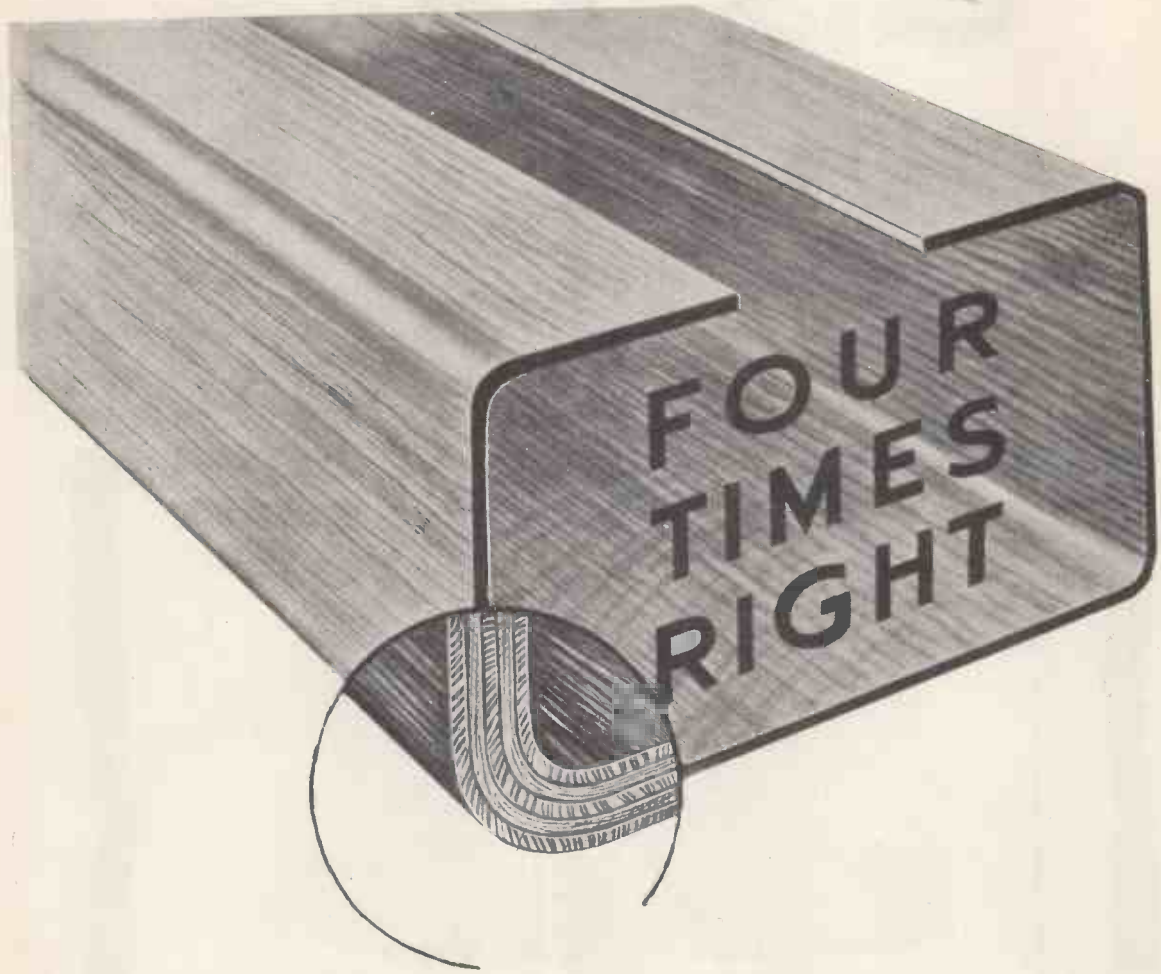

The SPEARS-LAMINA plywood shell has four complete right angles, pre-formed without cutting, steaming or stressing, and giving immense strength to the structure. The shell is made in thicknesses from 2 millimetres to 2 inches, radii from $\frac{1}{2}$in. upwards, dimensions from a few inches to 6 feet every way. Besides rectangles, any shape can be made which does not include a concavity. Minimum quantities are 10,000 of a pattern, and delivery at the rate of 500 to 5,000 per week.

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.

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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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D.C. Rating 70° C. Wkg.	Test	13/16"	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.	
4.0 kV.	8.0 kV.	0.01 µF.		0.02 µF.		0.03 µF.	
5.0 kV.	10.0 kV.	0.0075 µF.		0.015 µF.		0.02 µF.	
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.	

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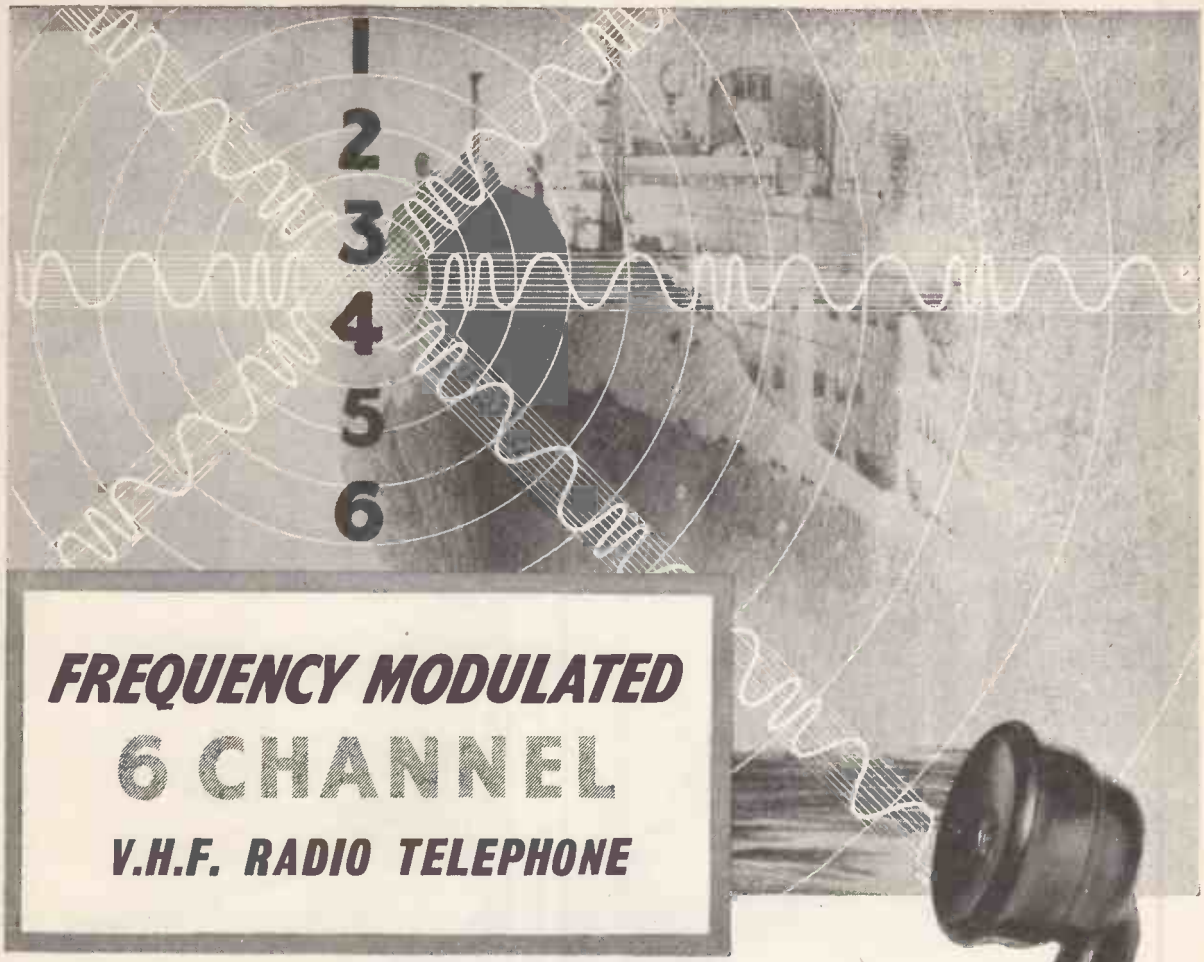

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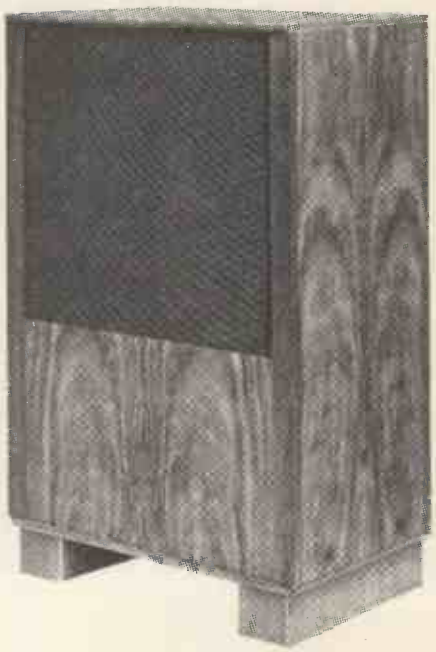

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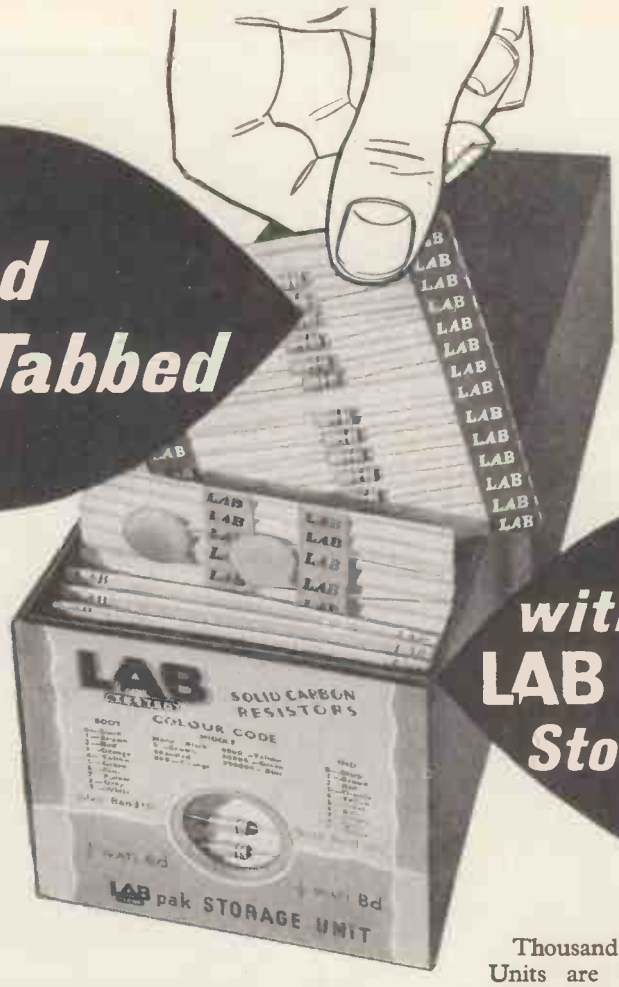

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WIREWOUND RESISTORS					
LM	5 & 10	—	5 to 100K	72	300
LP	5 & 10	—	5 to 100K	72	300
CERAMICAPS					
CER	Tubular	500	3 to 470pf	141	500
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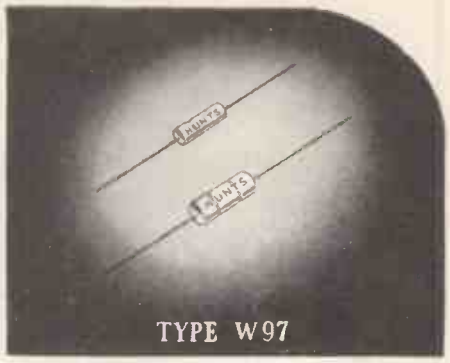

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FULLY APPROVED TO JOINT SERVICES STANDARD R.C.S.136/A CATEGORY 40/100, CLASS H.1.

TEMPERATURE RANGE : — 100°C to +100°C

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

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

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

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

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

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

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

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

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

TYPE W97 STANDARD RANGE

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

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

A. H. Hunt (Capacitors) Ltd, Wandsworth S.W.18 · BAT 1083
And in Canada: HUNT CAPACITORS (Canada) Ltd., AJAX, ONTARIO.

REGISTERED TRADE MARK
HUNTS
CAPACITORS
THE TRADE MARK OF RELIABILITY

REAL HIGH FIDELITY *at modest cost . . .*

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

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

No. 1 "SYMPHONY" AMPLIFIER is a 3-channel 5-watt Gram/Radio Amplifier with astonishingly flexible tone control. You can lift the treble, the bass, or—and here is the unique feature—the middle frequencies to suit your own ear characteristics and the record or radio programme being heard. It is thus possible to arrange the frequency-response of the amplifier to a curve equal and opposite to the resultant curve of the other items in the chain so that what finally registers in the brain is as per original. This flexibility of control is even more important than the nominal linear response of the amplifier, as the pickup, speaker, etc., are not linear. Independent Scratch-Cut is also fitted and special negative-feedback circuit employed. The Amplifier can accommodate a wide variety of records from old 78s to new L.P.s. Input is for all types of pickup of 0.1 v. output or more and there is full provision (and power) for Radio Tuner. It is available to match 2/3 or 15 ohms speakers. Price 11 gns. (carriage 5/-). Fitted in portable Steel Cabinet, 2 gns. extra.

No. 2 "SYMPHONY" AMPLIFIER as No. 1 but with 10-watt Push-pull triode output and triodes throughout. Woden mains and output transformers and choke. Output tapped 3, 7.5 and 15 ohms. Full provision and power for Tuner. Competes with the most expensive amplifiers on the market yet costs only 16 gns. (carriage 5/-). Fitted in portable Steel Cabinet 2 gns. extra.

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

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

"SYMPHONY" RADIO FEEDER UNITS

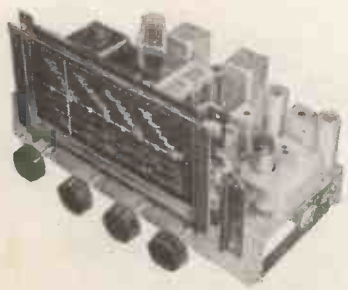
No. 1 "SYMPHONY" T.R.F. TUNER £7/15/-.

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.

No. 2 "SYMPHONY" AM/FM TUNER.



Combining all the specifications of the Long, Medium and Short wave Superhet AM Tuner and our No. 1 FM Tuner. Separate Coil Assemblies and I.F.s. Fully self-powered on one chassis. 26 gns.

N.R.S. EMPRESS FM/VHF TUNER/ADAPTOR. Fine little job, will plug into any radio and add F.M. £13.15.0. Magic eye assembly £1 extra if required. Ditto mounted in beautiful dark walnut cabinet complete with magic eye 16½ gns. Carriage 7/6.

"SYMPHONY" AM/FM RADIOGRAM CHASSIS. Very high grade radiogram chassis combining Long Medium and Short and V.H.F. bands. Large engraved dial. Push/pull output for high quality. Complete with 10in. Goodmans speaker 26 gns. Carriage and packing 7/6.

GRAMOPHONE UNITS

COLLARO 3-SPEED SINGLE RECORD UNIT AC3/554 and COLLARO 3-SPEED MIXED-RECORD AUTOCHANGER RC54. Both above fitted with either Studio Type "O" or Studio Type "P" pickup heads with permanent sapphire styli. Prices £9/6/- and £13/17/- respectively. Transcription cartridge 7/- extra.

GARRARD MODEL TA WITH TURNOVER HEADS AND MODEL TB for 3-pin plug-in heads available with a variety of pickup heads. Unit only £9.

GARRARD MODEL RC80M AUTOCHANGER special batch with extremely silent motor available with a variety of different pickup heads. Details in catalogue. The unit only £15/5/-.

TRANSCRIPTION UNITS

COLLARO 2010, less pickup, £14/15/-, with Studio pickup and transcription cartridge £19/10/-.

LENCO GL50, 4-speed continuously variable from above 78 r.p.m. to below 16 r.p.m. Special Autostop. Price with Studio "O" or "P" head or Goldring variable reluctance head £21/17/10.

LENCO GL55, as above but without pickup and autostop but fitted with Special Device for Groove Location and knob which completely disengages drive-wheel. Suitable for use with any pickup, especially transcription types and B.J. Arm. Price £17/10/4. Immediate delivery guaranteed.

LENCO GL56, as GL55 but with pickup, £23/7/-.

CONNOISSEUR 3-variable speeds, £28/8/-.

GARRARD 301, 3-variable speeds, £26/8/-.

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/-. Head fitted Collaro transcription cartridge to fit, £3. Super 90, £16/3/5.

EQUIPMENT & LOUDSPEAKER CABINETS

"SYMPHONY" BASS REFLEX CABINET KITS. 30-in. high, consist of fully-cut ¾-in. thick, heavy, inert, non-resonant, patent acoustic board, deflector plate, felt, all screws, etc. and full instructions. 8-in. speaker model, 85/-, 10-in. speaker model, 97/6, 12-in. speaker model, £5/7/6. The design is the final result of extensive research in our own laboratory and is your safeguard of optimum acoustic results. Carriage 7/6. Ready built, 15/- extra.

"SYMPHONY" BASS REFLEX CABINETS. As above but fully finished in figured walnut veneer with beautiful moulding and speaker grille 10-in., £11; 12-in., £11/10/-. Other veneers to order.

GOODMANS NEW TYPE AXIOM ENCLOSURES Model 172 CS ready-built unveneered 8 gns. Carriage and packing 12/-. Resistance unit 55/3.

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

NORTHERN RADIO SERVICES

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

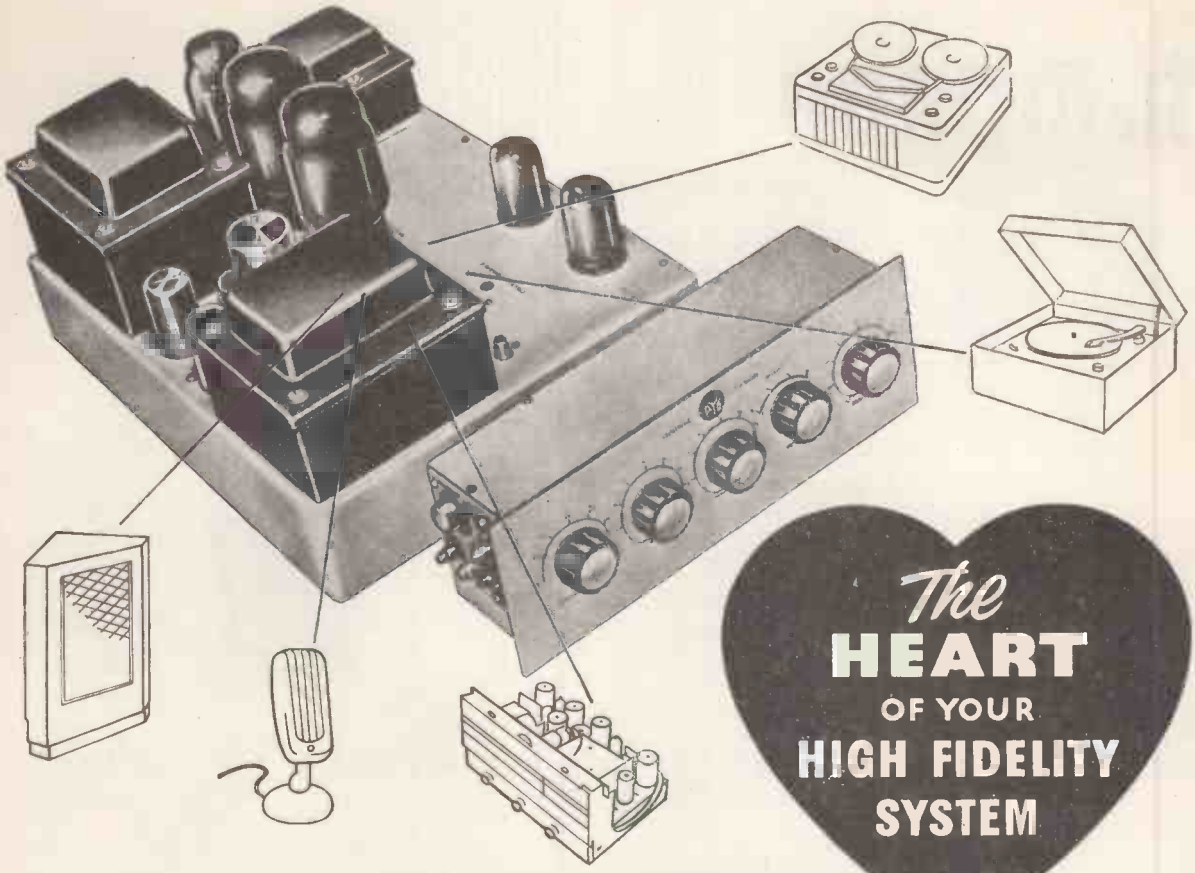
CONSOLE AMPLIFIER CABINETS, 33in. high, lift-up lid with piano hinge, take Tape Deck, Gram Unit or Autochanger, Amplifier, Pre-Amplifier, and Radio Feeder Unit, finished medium walnut veneer. De luxe version, price 12 gns. Oak or mahogany veneers and special finishes to order. Carriage according to area. We will quote by return.

RECOMMENDED LOUDSPEAKERS. We recommend and stock the following makes of speakers suitable for use with high-fidelity equipment:—Wharfedale; Goodmans; G.E.C.; Bakers; Tannoy, W.B.; Stentorian.

REVOLUTIONARY NEW SPEAKER. The Lorenz 12-in. p.m. speaker with two built-in Electromagnetic High-Frequency Treble Units (not simply metal-coned tweeters), mounted on a steel bracket across the face of the main speaker so as to effectively give 360 degrees spherical binaural response. Impedance of main speaker 15 ohms. Frequency response of triple speaker as a system 15 cycles—22,500 cycles, essentially level output. Power capacity 25 watts. Price £14/19/6. Treble units available separately for adding to your main speaker (without cutting the cabinet), 39/6 each. Send for illustrated leaflet.

OTHER PEOPLE'S AMPLIFIERS & RADIO FEEDER UNITS 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.

COME AND HEAR the above amplifiers, Tuners, and Gram units playing through a variety of loudspeakers in appropriate Acoustic Cabinets in our Showroom. The experience and information gained will save you time, money and trouble.



The HEART OF YOUR HIGH FIDELITY SYSTEM

★ **25 WATTS UNDISTORTED OUTPUT**

★ **INFINITE DAMPING FACTOR**

★ **PLUG-IN PICKUP COMPENSATORS**

PRICE

40 GNS

COMPLETE

POWER AMPLIFIER

26 db. negative feedback and an output from 2-160,000 c.p.s. ● 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. ● Output transformer specially designed to meet exacting specification of amplifier ● Amplifier can be controlled from distances up to 20 ft (6m). Cathode follower output from remote control unit minimises cable losses.

REMOTE CONTROL UNIT

Smooth, highly flexible controls and facilities for record player, tape recorder, microphone and radio tuner inputs ● 5 types of plug-in compensators available to match all known types of pick-up ● 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 ● Continuously variable lift and cut controls for bass and treble with clearly marked level positions ● Treble filter control gives three sharp cut-off frequencies and an unrestricted response position.

Provost POWER AMPLIFIER **HF25**

Proctor REMOTE CONTROL UNIT **HF25A**

Pye Corporation of America, 270 Park Avenue, New York.
Pye Ltd., Auckland, New Zealand.
Pye Ireland, Ltd., Dublin, Eire.
Pye (Canada) Ltd., Ajax, Canada.
Pye Radio & Television (Pty.) Ltd., Johannesburg, South Africa.
Pye Limited, Tucuman 829, Buenos Aires.
Pye Pty. Ltd., Melbourne, Australia.
Pye Limited, Mexico City.

PYE LIMITED • CAMBRIDGE • ENGLAND

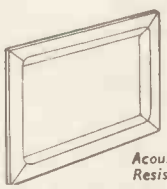
NOW...

for higher fidelity

The exciting possibilities of high fidelity are nowhere so well demonstrated as in Goodmans AXIOM range.

There are the Axiom 101 and 102 for use where it is desirable to limit space but not quality; the renowned Axiom 150 Mk II and 22 Mk II; and the Axiom 80 (free suspension) only recently introduced in this country. Make every opportunity you can to hear and see them for yourself.

● *Right, top to bottom: Axiom 101: Axiom 102: Axiom 22 Mk II: Axiom 150 Mk II: Axiom 80*



Acoustical Resistance Unit

Axiom Enclosures

Axiom

LOUDSPEAKERS and ENCLOSURES

incorporating the

Acoustical Resistance Unit

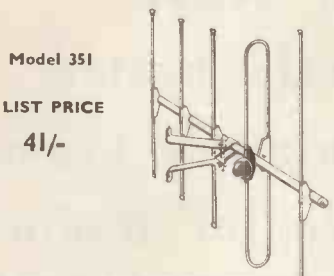
(Patent Pending)

★

If you have not already had details of all these units write now!

Goodmans

GOODMANS INDUSTRIES, LTD.
AXIOM WORKS, WEMBLEY, MIDDX.
Telephone: WEMbley 1200



Model 351

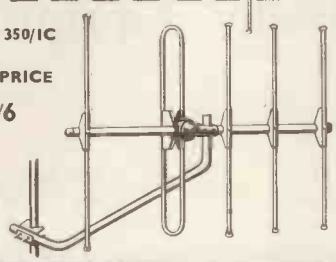
LIST PRICE

41/-

The Loft mounting models 331 and 351 are equipped with a special bracket for easy mounting in the loft and have sealed connections to enable them to be fitted to the window frame if required.

The exclusive "U" series of fully assembled Indoor Aerials have telescopic rods and rotatable adjustment to provide pinpoint reception on any Band 3 channel.

LOFT AND ROOM



Model 350/IC

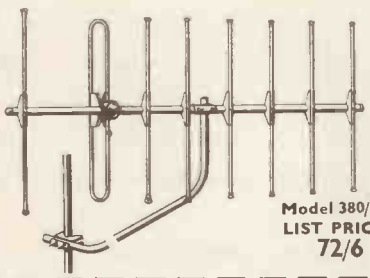
LIST PRICE

52/6

3 and 5 element arrays—which have proved to be the most popular aerials for Band 3 reception in the London area—are available with three alternative mounting arrangements. Models incorporating a "U" Bolt Clamp for attachment to existing masts, as illustrated, have been outstandingly successful.

3 and 5

ANTIFERENCE FOR BAND 3



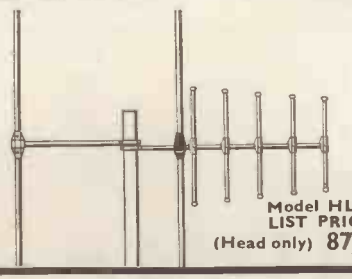
Model 380/IC

LIST PRICE

72/6

For areas where greater signal strength counts, the Antiference range contains 8 and 10 element arrays with a variety of mounting arrangements. All the exclusive Antiference design features are incorporated.

8 and 10



Model HL70

LIST PRICE

(Head only) 87/6

For Combined Band 1/Band 3 reception the HI LO range, using our unique electronic coupling, is the complete answer in every way. Several models are available—with or without masts and mounting equipment.

HI-LO

YOU CAN RELY ON

ANTIFERENCE

EXPERIENCE

★ *All Antiference aerials are fully covered and protected by patents or patents pending.*

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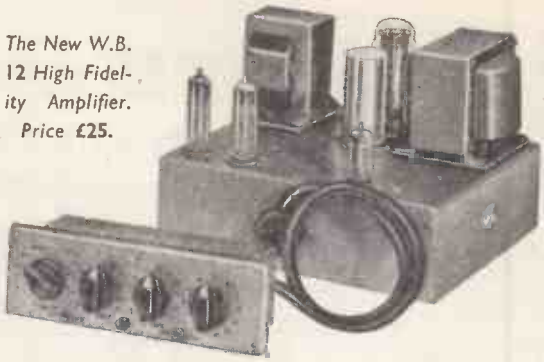
SYDNEY, AUSTRALIA

DHB/2519

Stentorian 12in. Concentric Duplex Loudspeaker, **£25.** *10in. Unit* **£10/19/6.**

The New W.B. 12 High Fidelity Amplifier. Price **£25.**



Stentorian High Fidelity 12in. Unit (HF 1214), **£9/15/6.**

THE *Stentorian* RANGE OF HIGH FIDELITY EQUIPMENT

Stentorian High Fidelity 10in. Unit (HF 1012), **£4/19/9.** *Others from* **47/6.**

Tweeter Units **£4/4/-** *and* **£12/12/-.**

Ready to assemble Cabinets from **£5/10/-.** *Bass Reflex Corner Console. Price* **£11/11/-.**

High Fidelity enthusiasts who have proved for themselves the quality of our products will forgive us if we repeat—for the benefit of those others who have yet to follow suit—that the Stentorian range has demonstrated that true High Fidelity is obtainable at very realistic cost.

The results of 30 years' experience in sound reproduction are embodied in all W.B. lines—in speakers, cabinets and in the amazing W.B.12 Amplifier. The success of our efforts is evidenced by the letters which arrive daily from all parts of the world, echoing the praise given by well-known experts in this country.

*** STOP PRESS**

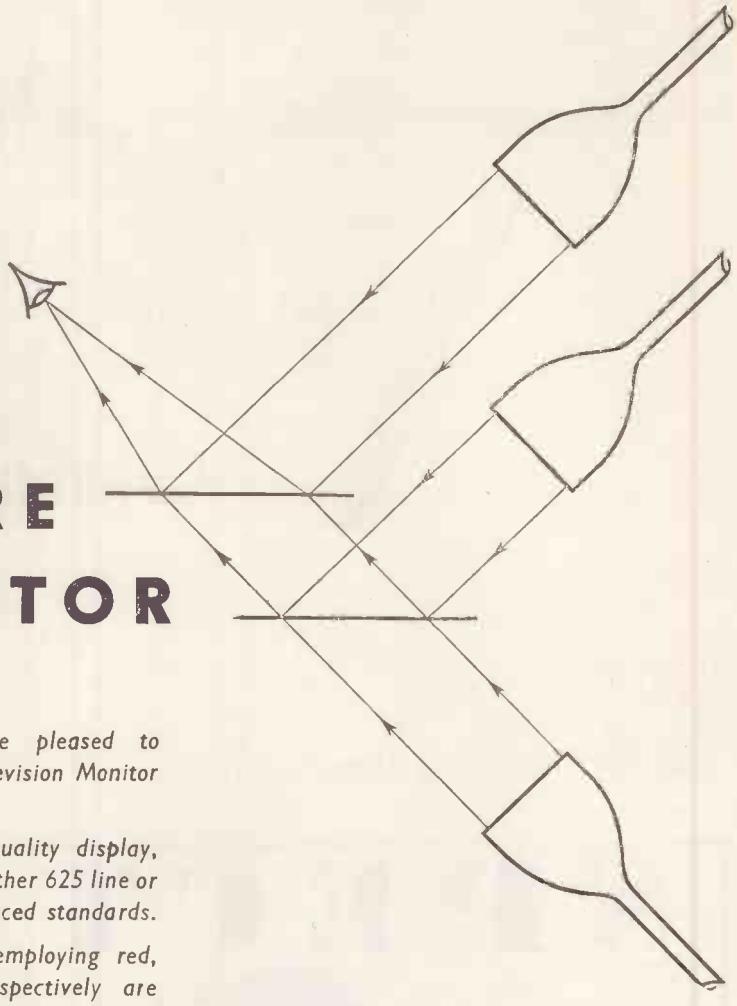
Hear the remarkable new Stentorian 8" Mid-range and High Frequency Unit, incorporating 16,000 gauss Alcomax magnet. Also 12" Unit (HF 1214) fitted with mid-range stabilisers.

AS EXHIBITED AT THE AUDIO FAIR

Descriptive leaflets sent on request. Ask your usual dealer to demonstrate, or see and hear all Stentorian products at our London office (109 Kingsway, W.C.2), any Saturday from 9 a.m. to noon.

WHITELEY ELECTRICAL RADIO CO LTD
MANSFIELD NOTTS

CINTEL T.V.



COLOUR PICTURE MONITOR

Cinema-Television Limited are pleased to announce that their Colour Television Monitor is now in production.

Designed to produce a high quality display, this equipment will operate on either 625 line or 405 line 50 frames 2 : 1 interlaced standards.

Three 12in. "Cintel" tubes employing red, green and blue phosphors respectively are optically superimposed by semi-transparent mirrors to produce a final picture which is visible in either a sitting or standing position.

Phosphors are to N.T.S.C. Colour Specification and the use of high grade tubes obviates the need of dichromic mirrors and trimming filters.

Full information on this and other "Cintel" Colour Equipment is available on request.

CINEMA TELEVISION LTD

A COMPANY WITHIN THE RANK ORGANISATION LIMITED

WORSLEY BRIDGE ROAD · LONDON · S.E.26

HITHER GREEN 4600

HIGH FIDELITY plus HIGH VERSATILITY

Behind the new RCA High Fidelity Amplifier stands over a quarter of a century's skill and experience in designing professional sound reproducing equipment. This Amplifier includes several exclusive features entirely new to audio engineering, thus making it many years ahead of its time both in design and construction.*

The resulting performance will be found to give a new meaning to high fidelity reception and a new realism to recorded music.

The RCA High Fidelity Amplifier can be incorporated successfully into any existing home audio system. The versatility of its input and output facilities coupled with the wide measure of control afforded by the Pre-Amplifier means that it can be used in conjunction with most high quality audio equipment.

RCA

New Orthophonic High Fidelity

RCA PHOTOPHONE LIMITED

An Associate Company of Radio Corporation of America

Lincoln Way, Windmill Rd., Sunbury-on-Thames Middx.

Telephone: Sunbury-on-Thames 3101.

PRE-AMPLIFIER

INPUTS—*Magnetic Pickup*
B.78. 16 mv input for rated output. 300 c/s Turnover. 6 DB Roll-off at 10 Kc/s.
A.78. 14 mv input for rated output. 500 c/s Turnover. 16 DB Roll-off at 10 Kc/s.
L.P. 13.5 mv input for rated output. 500 c/s Turnover. 12 DB Roll-off at 10 Kc/s. Flattened LF at 50 c/s to + 13 DB.
R.I.A.A. 11.5 mv input for rated output. 500 c/s Turnover. 14 DB Roll-off at 10 Kc/s. 3 DB Flattening at 50 c/s.★
Crystal Pickup. .35 volt with inbuilt equalisation from constant amplitude to constant velocity output enabling switched replaying characteristics to be accurately employed.
Radio/Tape High Level 200 mv. Flat characteristic. Low level 50 mv. Flat characteristic.
Microphone 6.5 mv for rated output. Flat characteristic.
Mixer Facilities for microphone input, with radio/tape gramo inputs.★
OUTPUT. 1.2 volts from cathode follower stage.
TAPE RECORDING OUTPUT. 1.2 volts cathode follower independent of monitoring.
BASS & TREBLE. Plus and minus 14 DB at 50 c/s and 10,000 c/s.
VOLUME. Twin ganged control giving correct gradation.★
LOW-PASS FILTER. Switched 10 Kc/s, 7 Kc/s, 5 Kc/s and Flat.
HIGH-PASS FILTER. Inbuilt, attenuating below 20 c/s.
FILTER SLOPE. Variable to 35 DB per octave.
POWER REQUIREMENTS. 375 v/7 ma, 6.3 v/1 amp.

MAIN AMPLIFIER

OUTPUT. 12 watts rated. Peak In excess of 20 watts over 25–20,000 c/s.★
DISTORTION. Total harmonic less than .1% at 10 watts—700 cycles.
NOISE LEVEL. 85 DB below rated output.
DAMPING FACTOR. Variable from positive to negative values.
FREQUENCY RESPONSE. Within 0.2 DB 20—25,000 c/s ± 0.5 DB 10—60,000 c/s.
FEEDBACK. 40 DB total.★
OUTPUT IMPEDANCES. 4 ohms, 7 ohms, 15 ohms.
INPUT VOLTAGE. 1.2 v. for rated output.
ANCILLARY POWER SUPPLIES. 375 Volts 45 milliamps. 6.3 volts 2.5 amps available for VHF Tuner, Pre-amplifier and Tape Reproducer amplifier.
POWER CONSUMPTION. 130 VA at full load. AC Input 100/150 and 200/250 volts.

SIEMENS

CONTACT COOLED SELENIUM RECTIFIERS

10,000,000 sold
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now dual dual trace

oscilloscope mark 2

. . . two input signals displayed for direct comparison and their characteristics accurately measured by the turn of a knob . . . such are the facilities and convenience afforded by the Mullard Dual Trace Oscilloscope, type L.101.

Well-engineered and reliable, the L.101 Oscilloscope is *the* oscilloscope where the demand is for a high grade general purpose instrument. It employs two identical amplifiers with bandwidths of 4 Mc/s irrespective of sensitivity. Each amplifier is aligned for good transient response, has a rise time of 0.1 μsec, and a maximum sensitivity of 20 mV pk-pk/cm.

The time base may be free running, synchronised or triggered. Its velocity is continuously variable between 0.1 μsec/cm and 10 msec/cm. Both time and voltage may be measured by the nul method and a well-regulated power supply preserves calibration accuracy.

mark 2 features

- **Post Deflection Acceleration** gives a brighter display at low repetition rates.
- **R.C. Probe** ensures that only negligible damping is imposed on high impedance circuits. (This probe is also available to users of the Mark 1 model.)
- **Improved Triggering Circuit** starts the time base with the minimum delay from either positive or negative signals of only 1½V amplitude.

Full details of the L.101 Mark 2 are readily available from Mullard at the address below or from any of their distributors.

Belfast: James Lowden & Co. Ltd., Tel. 57518. **Birmingham:** Gothic Electrical Supplies Ltd., Tel. CEN 5531.
Bristol: T. Neesham & Co. Ltd., Tel. 22732. **Glasgow:** Land Speight & Co. Ltd., Tel. CEN 1082.
Manchester: F. C. Robinson & Ptners. Ltd., Tel. Chorlton 5366. **Newcastle:** Electricals Ltd., Tel. 28617.
London: Mullard Equipment Division, Tel. CHA 8421.

Mullard Mullard SPECIALISED ELECTRONIC EQUIPMENT

MULLARD LIMITED, EQUIPMENT DIVISION, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

ME589

DATA for the Designers File

The Ediswan ESA.1500 is of particular interest to Designers of Industrial R.F. heating equipment.

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.

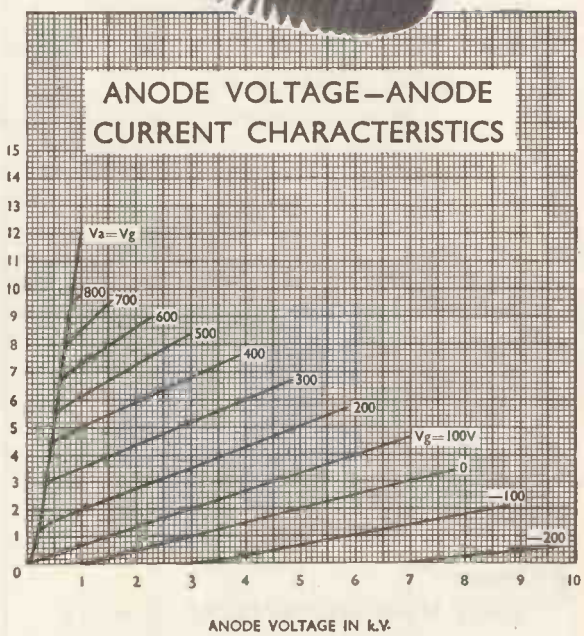
RATING

Filament Voltage (volts)	V_f	8
Filament Current (amps)	I_f	26
Maximum Anode Voltage (volts)	V_a (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	μ	*24
Anode Impedence (ohms)	r_a	*3,200
Maximum Operating Frequency at full rating (Mc/s)		40
R.F. Power Output (kW)		6

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

THE ESA. 1500 IS USED IN THE RADYNE MODEL C.50, 6 KW INDUCTION HEATER.

The Radyne C.50 induction heater has ample heat reserve for almost all brazing and soldering operations and can handle shrinking on, through heating and small hardening or melting jobs.
Maximum output current is over 1,000 amps.



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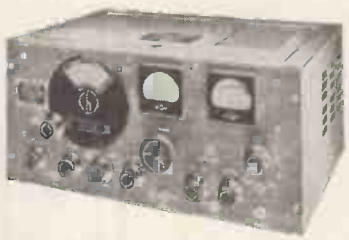

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Utilising the unique characteristics of Ferroxcube to the full, Mullard H.F. transformers are smaller, lighter, and less costly than transformers using alternative core materials. These advantages are particularly marked in transformers required to handle powers of up to 2kW, between the frequency range 2kc/s to 2Mc/s.

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Built to the highest specifications these chassis offer the finest value to the enthuslast.

Five valves, 3 wavebands superheterodyne, with full negative feedback and A.V.C. Full range tone control. Socket panel for aerial, earth, extension speaker and gram. pick-up. Full horizontal glass dial. Overall size 12in. length, 8¼in. depth and 8in. height. Supplied complete with selected set of knobs. 200/250 volts, 50 cycles, A.C. only. PRICE

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Cat. No. RC/A—latest fully automatic 3-speed mixer changer made by a famous manufacturer **£7.19.6**

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A very high quality Cabinet in a modern design. Exterior veneered in a highly figured Walnut. Solid blockboard lift-up top with all interiors veneered in Sycamore. Full slik front.

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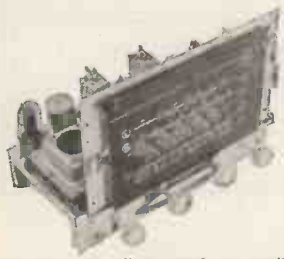

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A 9-valve A.M./F.M. chassis with 4 wavebands (long, medium, short and F.M.), push-pull output stage and magic eye for precision tuning. Specially designed for permeability tuned F.M. stage and a very high degree of I.F. amplification for fringe area reception, it offers the finest quality regardless of price. Automatic volume control and a special wide range tone control. Push-pull output stage and built-in compensated network for electrostatic treble speaker offers an output of 7 watts with the widest possible audio frequency range. Special large 10in. high-flux F.M. speaker with matched treble tone electrostatic speaker, supplied and included with the chassis. Co-axial socket for F.M. dipole aerial. Socket panels for aerial, earth, extension speaker, and gram pick-up. A.C. 200/250 volts, 50 cycles mains. Complete with matched set of knobs and full length edge lit glass dial. Size 15" long, 8¼" overall depth, 8" height. PRICE **26 Gns.**

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TYPE A 5 VALVES

TYPE A: 5 valves 3 wavebands Superhet with full negative feedback and A.V.C. Full range tone control. **10 Gns.**

Packing and carriage 12/6.

TYPE B 7 VALVES

TYPE B: 7 valves 3 wavebands Superhet with specially designed push-pull output stage. **£15/4/6**

Packing and carriage 12/6

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Designed for reception of medium and large wavebands with outlet for Tape Recorder on High Quality amplifier. Employing supersensitive Germanium Crystal Diode the tenor is housed in an attractive moulded plastic cabinet, size 6in. x 4in. x 3½in., weight 1lb. **£2/10/0**

Packing and Carriage 7/6.

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Cat. No. LS/10—10in. Standard	£1	10	0
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Electrostatic Loudspeaker LSH75, for treble response		12	6

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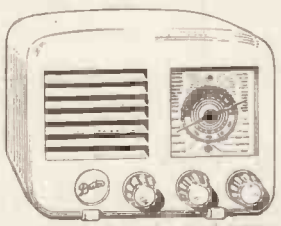

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Housed in an attractive cabinet this instrument is designed to enable viewers with single band TV receivers to obtain programmes on Band III transmission (I.T.A.). 200-250 volts A.C. only. Simple to connect. Full instructions enclosed. Only **£9/15/0**

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V914
V1120
V1906
V1907
V1924
V2023
V6566
VCR85
VCR97
VCR139A
VCR140
VCR140A
VCR263
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VS110A
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VU33
VU39(A)
VU71
VU72
VU113
VU120
VU120A
VU133(A)
VU134
VU504
VU508
VX3027
VX6010
VX7006
VX7056
VY2
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X150
XD2/OV
XG1
YF
Y63
Z14
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Z21
Z21M
Z22
Z62
Z63
Z66
Z77
Z90
Z142
Z150
Z729
ZA1
ZD17
ZD19
ZD152

THE NEW TAPE RECORDER

Complete in every detail and ready for use

★ Case finished in Brown and Antique Fawn. Size 15"×12¼" ×7½", with the very latest type continental gilt fittings. For A.C. mains 200-250 volts, 50 cycles.

£40 CASH OR

H.P. Terms. Deposit £20 and 12 Monthly payments of £1.16.8.

Plus Packing and Carriage 21/-

★ Two speeds 7½ and 3¾in. per sec., playing time of 1 hour and 2 hours.
★ Standard 7in. reels 1,200ft.
★ Drop-in tape loading.
★ Positive brakes, no tape "spilling" after braking.
★ Fast rewind forward or reverse without removing tape.
★ One knob deck operation.
★ Amplifier may be used for gramophone or microphone purposes giving high-quality reproduction.
★ Superb reproduction of pre-recorded tapes.
★ Microphone compartment.
★ Complete with reel of Scotch Boy tape (1,200ft.), spare reel and Acos type 33-1 microphone.
★ Latest type Lane Mark 6 Tape Deck.
★ Dual input channels providing mixing facilities.
★ Detachable lid and control cover.
★ Control panel finished in matching colours with the tape deck.
★ Elliptical speaker of the latest type 7in. × 4in.
★ Magic eye recording level indicator.

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Aluminium with four sides:

7×5½×2in.	4/-	10×9×3in.	7/-
7×3½×2in.	3/9	12×10×3in.	7/9
9½×4½×2in.	4/3	14×10×3in.	7/11
10×8×2½in.	5/6	16×10×3in.	8/3
12×9×2½in.	7/-	16×8×2½in.	8/-
14×9×2½in.	7/6		

ALUMINIUM PANELS 18 s.w.g.

7×6in.	1/3	7×4in.	1/-
9½×6in.	1/8	9½×4in.	1/5
10×9in.	2/2	10×7in.	1/11
12×9in.	2/8	12×7in.	2/5
14×9in.	3/2	14×7in.	2/11
16×9in.	3/8	16×7in.	3/5
20×9in.	4/8	20×7in.	4/5
22×9in.	5/2	22×7in.	4/11

ILLUSTRATED LIST AVAILABLE GIVING FULL DETAILS OF BUREAU TYPE CABINETS

A RANGE OF BAND 3 AND F.M. AERIALS IS NOW AVAILABLE

Air spaced co-axial wire, 1/9 per yard.

Teletron Ferrite Rod Aerials. Medium Wave 8/9. Medium/Long Wave 12/9.

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

Designed to meet the demand for an efficient variable ratio Output Transformer, 11 ratios from 13:1 to 80:1, all centre tapped and can be used to match any output valves either single or push-pull Class "A," "AB1," "AB2" or "B" to any low impedance speech coil or combination thereof. Primary Inductance 50 henries 15 watts audio 100 mA. Price 45/-.

MINIATURE TUNING CONDENSERS

2-gang ·0005 mfd. with trimmers, 6/9.

RECTIFIERS

E.H.T. Pencil Type S.T.C.			
Type K3/25	650 v.	1 mA.	4/7
,, K3/40	3.2 kV.	1 mA.	6/-
,, K3/45	3.6 kV.	1 mA.	8/2
,, K3/50	4 kV.	1 mA.	8/8
,, K8/100	8 kV.	3 mA.	14/8
,, N3/160	12 kV.	1 mA.	21/6
,, K3/180	14.4 kV.	1 mA.	24/6
H.T. Type S.T.C.			
Type RM1	125 v.	60 mA.	4/-
,, RM2	125 v.	120 mA.	4/6
,, RM3	125 v.	125 mA.	5/6
,, RM4	250 v.	250 mA.	18/-
L.T. Type Full Wave			
12 v. 1 amp.			8/-
12 v. 2.5 amp.			12/6
12 v. 4 amp.			19/6

BARGAIN OFFER

DARK SCREEN FILTER IN TRIPLEX GLASS 18" × 14" SUITABLE FOR ALL TUBES UP TO 17" 10/-. PLUS PACKING & POSTAGE 1/6d. LATEST TYPE RUBBER ESCUTCHEON SUITABLE FOR 17" RECTANGULAR TUBES AT A SPECIAL PRICE OF 10/-. PLUS PACKING & POST 1/6d.

ACCUMULATORS

2 volt 16 amp. 5/11

LOUDSPEAKERS

ELAC ELLIPTICAL 7in. × 4in.	21/10
PLESSEY 12"	37/6
ELAC—8in. dia. Moving Coil 3 ohms imp.	21/-
PLESSEY 8in. dia., Mains Energised, 3 ohms imp. (600 ohms field) with Pentode Transformer	12/6
PLESSEY—8in. dia. Mains Energised, 3 ohms imp. (600 ohms field)	10/6
PLESSEY—10in. dia. Moving Coil, 3 ohms imp.	23/6
GOODMANS—12in. dia. Moving Coil, 15 ohms Plus 5/- packing and carriage	£9/2/9
GOODMANS—Axiom 150	£10/15/9

Plus 5/- packing and carriage.

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-10 cycles. All primaries are screened.

SP175B, 175-0-175, 50 mA., 4 v. @ 1 a., 4 v. @ 2-3 a.	15/-
SP350A, 350-0-350, 100 mA., 5 v. @ 2-3 a., 6.3 v. @ 2-3 a.	21/-
SP351A, 350-0-350, 150 mA., 4 v. @ 2-3 a., 4 v. @ 3-6 a., 4 v. @ 1-2 a., 4 v. @ 1-2 a.	30/-
SP352, 350-0-350, 150 mA., 5 v. @ 2-3 a., 6.3 v. @ 2-3 a., 6.3 v. @ 2.3 a.	30/-
SP425A, 425-0-425 200 mA., 6.3 v. @ 2-3 a., 6.3 v. @ 3-5 a. 5 v. @ 2-5 a.	52/6
250-0-250, 80 mA., 6.3 v. @ 4 a., 5 v. @ 2 a.	19/6
350-0-350, 80 mA., 6.3 v. @ 4 a., 5 v. @ 2 a.	19/6
200-230-250 output 3 v.-30 v., @ 2 a.	17/6

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

PUSH-PULL OUTPUT TRANSFORMERS. 2×6V6 into 2/3 ohms, 5/6, post free.
T.1154. BRAND NEW COMPLETE WITH VALVES, £2/19/6, post and carriage, 7/6.
METER RECTIFIERS. Miniature type with leads 1-5 mA. 6/9, post paid.

MAKE YOUR OWN ROD AERIAL

Ferrite rod 6in. × ⅜in., complete with descriptive constructional details. These aerial rods are suitable for medium and long wave reception. Price 6/-, plus pkg. and post 6d.

PORTABLE TAPE RECORDER CABINETS

All Rexine covered

Tape Deck	Amplifier	Type	Price
Lane Mk. VI	Premier	Mk. VI	£4/19/6
Lane Mk. VI	Premier	de Luxe	£4/19/6
Truvox Mk. III	Truvox C	T.D.3	£4/4/-

Plus Postage and Packing 5/-.

We carry a comprehensive stock of components by all leading Manufacturers.

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

PREMIER RADIO COMPANY

207 EDGWARE RD., LONDON, W.2. *TELEPHONE: AMBASSADOR 4033 & PADDINGTON 3271*

MODEL SP/2

75 gns.

Designed

for real fidelity...

. . . and what is more, designed by engineers who have been in on the "art and mystery" of tape recording from the word go.

The Simon is one of the very few machines which can offer a frequency response of 50 - 12000 c.p.s. *plus or minus 3 db* at 7½ i.p.s. Its appearance is a delight—above and below the deck. Its performance is superb. An instrument of precision and versatility—a switch converts it from Tape Recorder to 10-watt Amplifier or Record Reproducer.

Ask for a copy of "Affairs of Tape." It gives the inside story of the SP/2 and its companion, the SP/3, which at 79 gns. has a walnut veneer cabinet.

1 tape recorder . . .

2 10 watt amplifier...

3 record reproducer

Simon is *Sound* recording

SIMON SOUND SERVICE LTD., 46-50, GEORGE STREET, PORTMAN SQ., LONDON, W.1.
Telephone : WELbeck 2371 (5 lines).

Northern Depot : J. D. MORRISON & CO. LTD., WAKEFIELD HOUSE, 11/13 NEW WAKEFIELD STREET, MANCHESTER, 1. *Telephone : Central 2959.*

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

In This Issue

VOLUME 62 NO. 4
PRICE: TWO SHILLINGS

FORTY-SIXTH YEAR OF PUBLICATION

PUBLISHED MONTHLY (4th Tuesday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (60 lines). *Telegrams:* " Ethaworld Sedist, London." *Annual Subscription:* Home and Overseas, £1 12s. 6d. U.S.A. and Canada $5.00 BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2 *Telephone:* Midland 7191. *COVENTRY:* 8-10, Corporation Street. *Telephone:* Coventry 5210. *GLASGOW:* 26B, Renfield Street, C.2. *Telephone:* Central 1265. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. OVERSEAS OFFICES: *U.S.A.:* 111, Broadway, New York. 6. N.Y. *Telephone:* Digby 9-1197. *CANADA:* 74, College Street, Toronto, 2. Ontario. *Telephone:* Walnut 4-5631.

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.

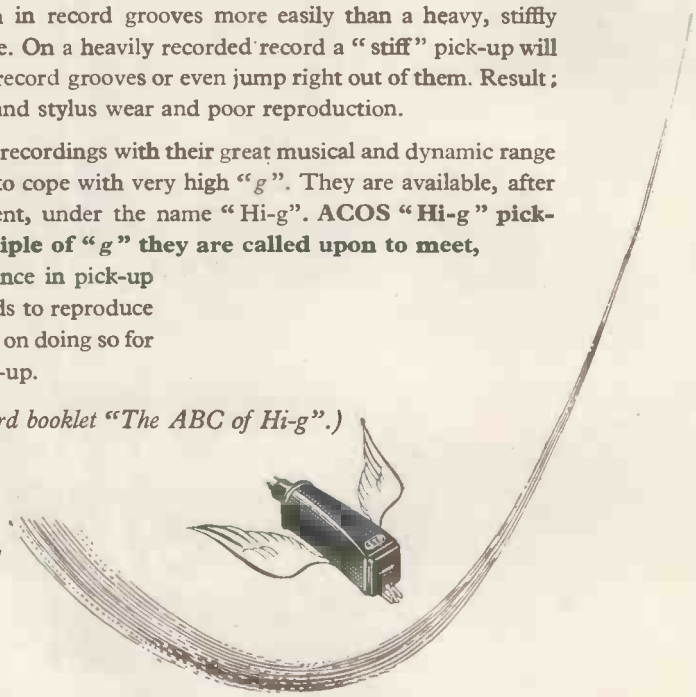
The stylus tip of a pick-up is subjected to the same acceleration but to an infinitely greater extent. The undulations of a record groove cause the stylus to vibrate as much as 10,000 times per second or more. It moves to one side of the groove, stops, moves to the other, stops again and so on throughout 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.

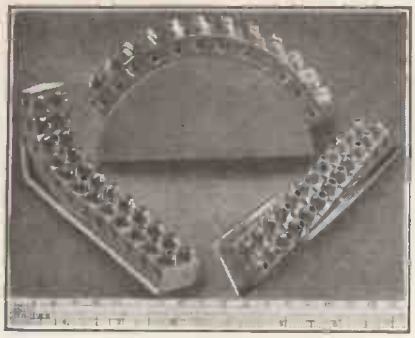
(Write for a free copy of the new Cosmocord booklet "The ABC of Hi-g".)

. . . always well ahead



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

COSMOCORD LIMITED • ENFIELD • MIDDX • TEL: ENField 4022



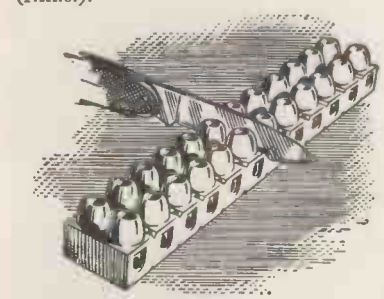
"BELLING-LEE" FLEXIBLE TERMINAL BLOCK

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 shockproof 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. × .750in. × .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
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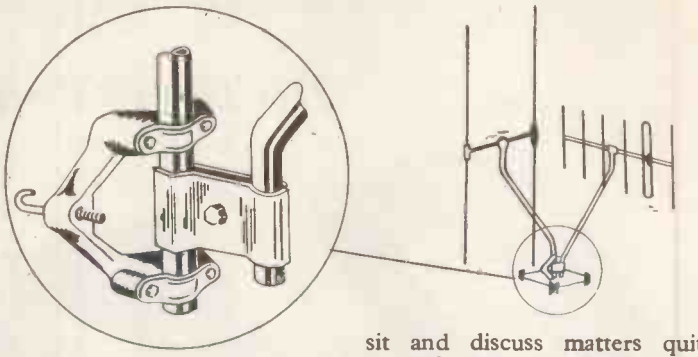
"BELLING-LEE" NOTES



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.

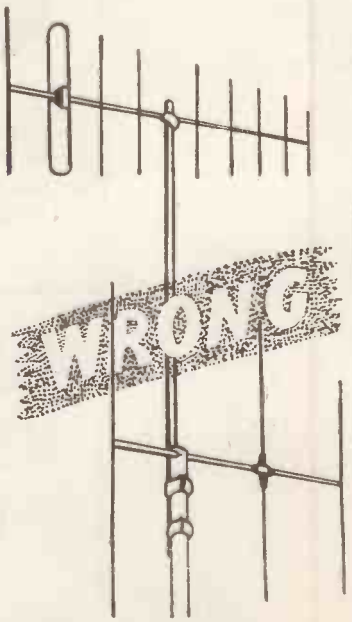
Unless combined aerials or independently mounted band I and band III aerials are being used we recommend the L.903/BS and L.904/BS (illustrated above) for their durability and sensitivity. The illustration shows in detail the original bracket and the special adaptor clamp. In this way none of the original 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.



Advertisement of
BELLING & LEE LTD.
Great Cambridge Rd., Enfield, Middx.
Written 5th March, 1956

E.M.I. INSTITUTES EXPANSION

Extension of Training Schemes for Electronic application

SCHOLARSHIPS FOR TWO COURSES

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.

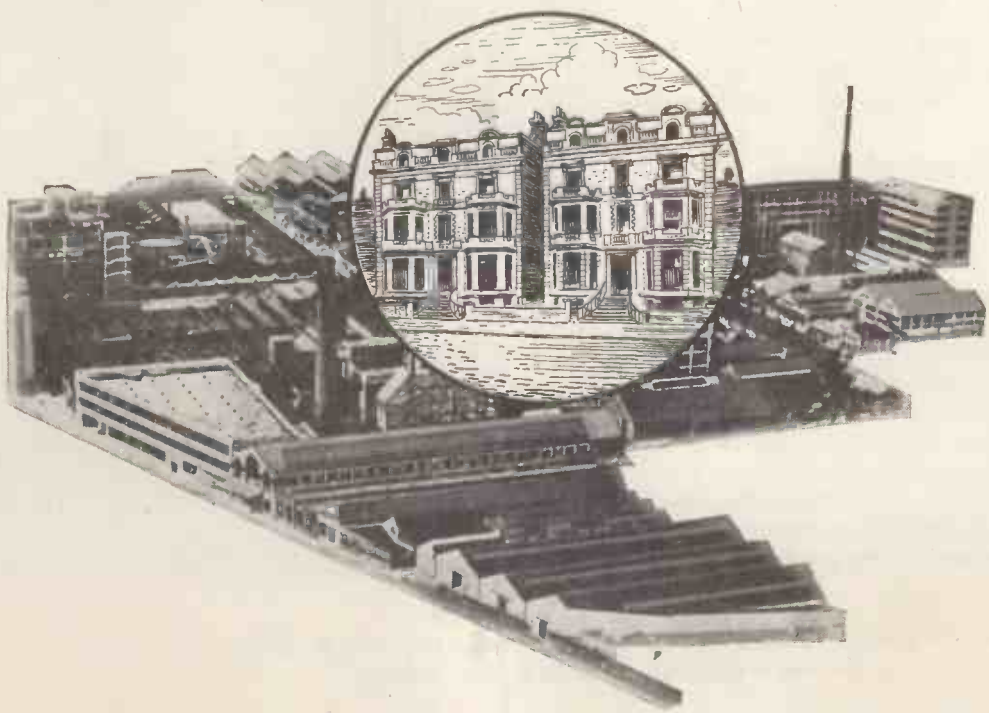
In addition to the courses listed below, E.M.I. Institutes are arranging special courses for the E.M.I. Group and the customers of the Group. Present activities and future plans include courses for Digital and Analogue Computers, Process Control and Automation.

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.



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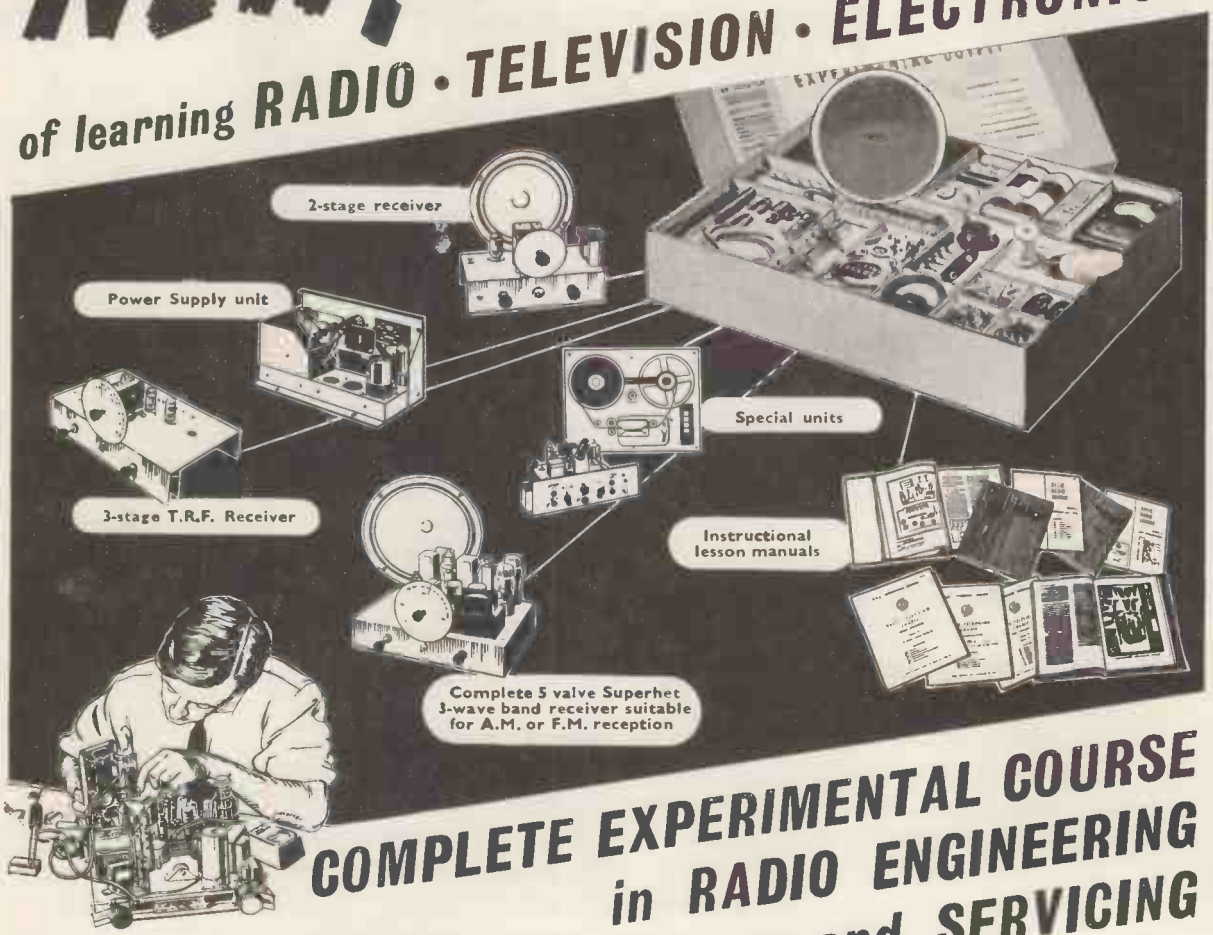
NEW! THE PRACTICAL WAY of learning RADIO • TELEVISION • ELECTRONICS

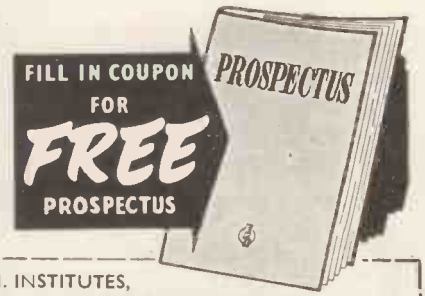


COMPLETE EXPERIMENTAL COURSE in RADIO ENGINEERING and SERVICING

An entirely new series of courses designed to teach Radio, Television and Electronics more quickly and thoroughly than any other method. Specially prepared sets of radio parts are supplied and with these we teach you, in your own home, the working of fundamental electronic circuits and bring you easily to the point when you can construct and service radio receivers, etc.

Whether you are a student for an examination; starting a new hobby; intent upon a career in industry; or running your own business — these Practical Courses are ideal and may be yours at very moderate cost.

With these outfits, which you receive upon enrolment and which remain your property, you are instructed how to build basic Electronic Circuits (Amplifiers, Oscillators, Power Units, etc.) leading to designing, testing and servicing of complete Radio and Television Receivers.



NEW TELEVISION COURSE including a complete set of equipment dealing with the design, construction and servicing of a high quality television receiver.

Courses (with equipment) also available in *many other engineering subjects.*

COURSES FROM 15/- PER MONTH

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An educational organisation serving the E.M.I. Group of Companies which include "HIS MASTER'S VOICE," MARCONIPHONE, COLUMBIA, ETC.

To E.M.I. INSTITUTES,
Dept. 127X, Grove Park Road, London, W.4.

Please send me your FREE book on Practical Courses.

Subject(s) of interest.....

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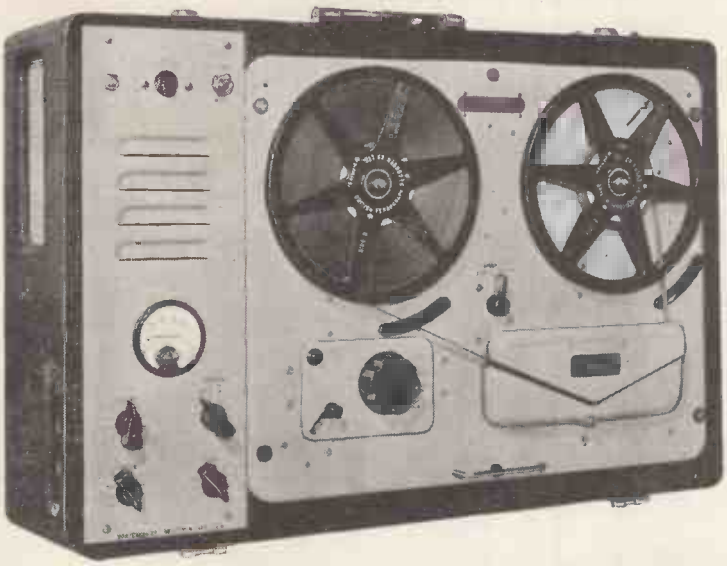
APRIL/56 IC.68A

VORTEXION TAPE RECORDER



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

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ The 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.

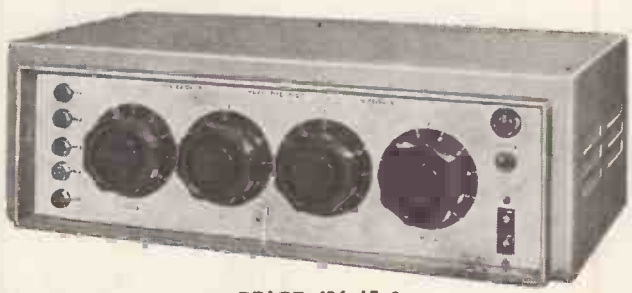
★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

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.

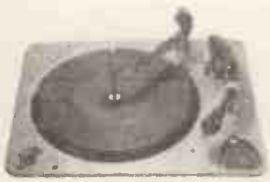


PRICE £36 15 0

Manufactured by

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

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



GRAMOPHONE AUTO-CHANGER

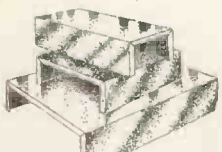
Latest types by all famous makers are invariably in stock at competitive prices. B.S.R., Monarch, Garrard, etc. Latest models from £7/19/6, plus 5/- carriage and insurance.

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 scale, slow motion drive, pointer, tuning knob, in fact everything needed to make the complete unit, is £6/12/6. 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, Cossor, 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 £1 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 Sparton, 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

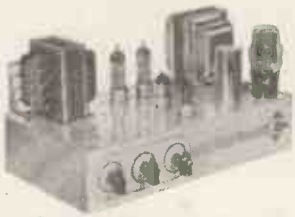
7×3½×2	3/9	14×10×3	7/9
9½×4½×2½	5/-	16×10×3	8/3
10×8×2½	5/6	16×12×3	8/8
10×5½×2½	5/-	19½×9×2½	8/3
12×9×2½	7/-	20×10×3	10/-
14×9×2½	7/6		

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 Collaro Studio and most other good pick-ups. The price of the unit completely made up and ready to work is £1[4]/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 £6/10/-, or H.P. terms available on request if required.

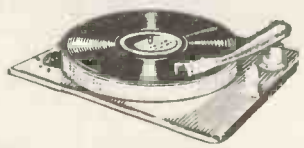
BUILD YOUR OWN CONVERTER

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 £3/10/- or £4/10/- 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 m/c., the other low-pass cuts out frequencies below. Price 27/6 each, postage 2/6.

RECORD PLAYER FOR £4/10/-.



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 £4/10/-, or 30/- deposit and four payments of 18/-, post and insurance, 5/-. Or fitted upon base, as illustrated, £5/10/-, 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 dispatched 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 16×14 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. 4½in. deep. Price £14/14/- 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 £4/17/6 each.

30 AMP ROTARY SWITCHES

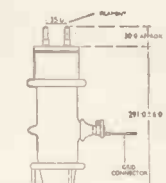
A very robust switch, made by one of our most famous firms. Will give lifetime of service. Price complete with pointer knob. 4 pole change over, 10/-. 6 pole change over, 17/6. D.P. on/off 15 amp., 4/6.

HIGH WATTAGE LAMPS

All G.E.S. Base

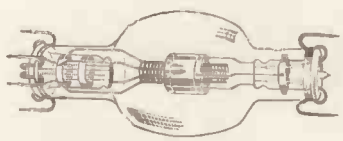
1,000 watt, 230 v., 7/6. 1,500 watt, 230 v., 9/6. 400 watt (fluorescent), 17/6.

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 £5 each. Carriage and insurance 10/-.



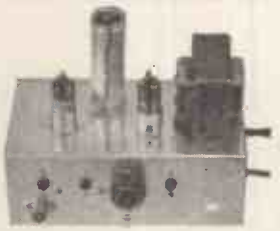
TETRODE TYPE VT31

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 14½in. long and 6½in. across the bulb.

Limited quantity only at £4 each, still in original packing. Carriage and ins. 10/-.

BAND 3 T.V. CONVERTOR 186/196 Mc/s.

("W. World," May 1954).



Kit of parts complete to build this most successful unit comprising drilled chassis 7 × 4 × 2½in., 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 transf. and met. rect., 30/- extra. Provision has been allowed on chassis for Band 1-Band 3 switching. 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 13½in. × 5½in. × 2½in. Attractive Glass Dial 10in. × 4½in. 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 neg. feed-back. A.C. mains 200/250 v. Double wound transf. 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 7in., 10in and 12in. record selector. Modern cream styling. Dual Xtal 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	
25/25 v., 50/12v.	1/9	8+8/450 v.....	4/6
50/50 v. 4/500 v.	2/-	8+16/450 v. ..	5/-
100/25 v.	2/-	16+16/275 v. ..	4/6
8/500 v.	2/6	16+16/450 v....	5/6
8+8/500 v.....	4/6	16+16/450 v. ..	6/-
8+16/450 v. ..	5/-	32/350 v.	4/-
16/450 v.	3/6	32+32/450 v. ..	6/6
16+16/450 v...	5/6	60+250v	6/6
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

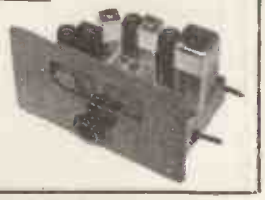
CONDENSERS.—Mica, Silver, Mica, All pref. values, 3 pf. to 680 pf. 6d. each, ditto ceramics 9d. each. Tubulars, 450 v., Hunts and T.C.C. .0005, .001, .005, .01, .02 and .1 350 v., 9d. .05, .1 500 v. Hunts. 1/-. .25 Hunts. 1/6. .5 Hunts, 1/9.

80 ohm CABLE CO-AXIAL

SPECIAL.—Semi-air spaced polythene, standard ½in. diam. Stranded core. Feeder losses cut 50%. 9d. yd.
COAX PLUGS 1/2
SOCKETS 1/-
COUPLERS 1/3
OUTLET BOXES 4/6
BALANCED TWIN FEEDER per yd. (80 ohms) 6d.
TWIN SCREENED FEEDER per yd. (80 ohms) 1/-.
50 OHM COAX CABLE 8d. per yd. ½in. dia.

SPEAKER FRET.—Expanded Bronze anodised metal 8in. × 8in., 2/3; 12in. × 8in., 3/-; 12in. × 12in., 4/3; 12in. × 16in., 6/-; 24in. × 12in., 8/6. etc.

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 mc/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. ½ w. 3d.; ½ w. 5d.: 1 w. 6d.; 2 w. 9d.
10% Tol. ½ w. 9d.; 5% Tol. ½ w. 1/-: 1% Hi-Stab. ½ 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—33,000 ohms, 5 w.. 1/9: 10 w.. 2/3.

ALUMINIUM CHASSIS

18 g. Plain undrilled. Folded 4 sides riveted corners, lattice fixing holes Depth 2½in., 7in. × 4in., 4/6; 9in. × 6in., 5/9; 11in. × 7in., 6/9; 13in. × 9 in. 8/6; 14in. × 11in. 10/6. etc.

S.T.C. RECTIFIERS

K3/25 2 kV., 4/3; K3/40 3.2 kV., 6/-; K3/45 3.6 kV. 6/6; K3/50 4 kV., 7/3; K3/100 8 kV., 12/6; K3/160 14 kV: 18/-; 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/-; HT50 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/-: 50,000 ohms to 2 Megohms (carbon) 3/-.

VOLUME CONTROLS

1in. semi Midget Type, Long spindles. All values 10,000 ohms to 2 Megohms. Less sw., 3/-: S.P. sw., 4/-: D.P. sw., 4/9 All individually boxed. Guar. 12 months.

TRS RADIO COMPONENT SPECIALISTS

TRS

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

Terms: C.W.O. or C.O.D. Kindly make cheques, P.O.s etc. payable to T R S. Post & Packing up to ½lb., 6d. 1lb.. 1/-. 3lb., 1/6. 5lb.. 2/-. 10lb., 2/6. Barrain Lists. 3d.

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.

Delivery of all the above is from stock. We can also supply the **LEAK F.M. TUNER.** Wharfedale, Goodmans and Tannoy loudspeakers, etc., Connoisseur Variable 3-speed Motors and all other Quality Equipment on EASY TERMS. Please let us have your requirements.

NOW TRY THE NEW REMINGTON SUPER 60

14 DAYS' LUXURY SHAVING FOR 5/- DEP.

SEND ONLY 5/- (returnable Deposit) for 14-day Free Trial . . then 15/- balance after trial if satisfied and 8 monthly payments of 24/6 (or 19/6 if you send your old shaver).

Cash Price £10/4/3.

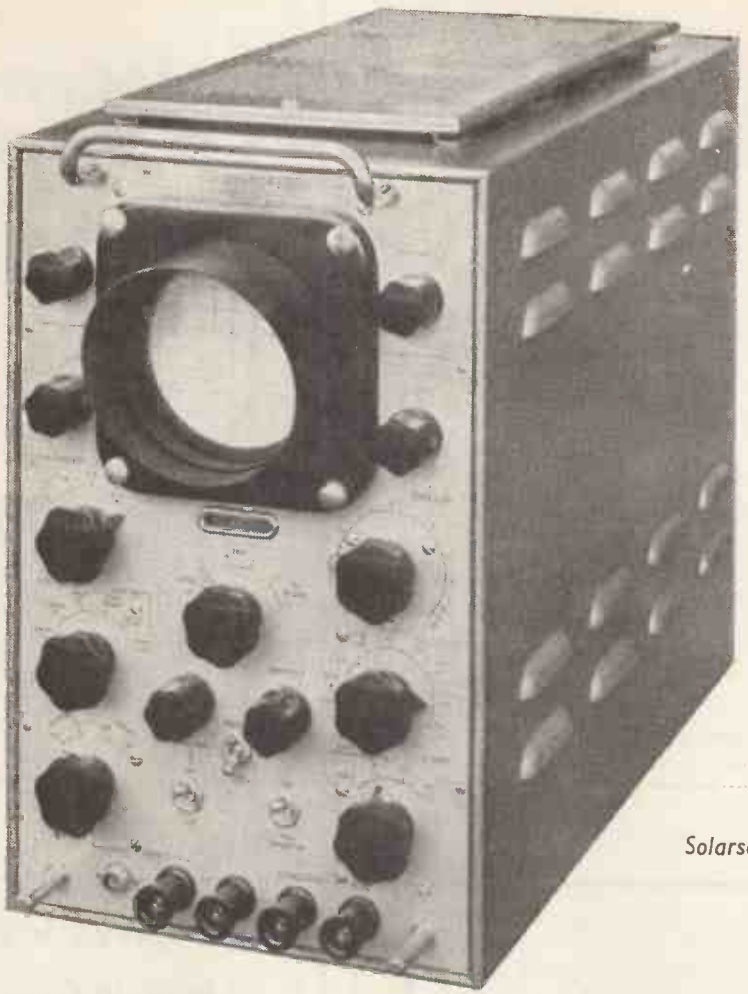
Here's The Supreme Shaving Instrument—the latest super-styled model, with larger effective shaving area. Double-insulated Built-in Motor. AC/DC 200 250 v. Immediate delivery in luxury Suede-finish presentation Case.

★ 40/- ALLOWED FOR YOUR OLD SHAVER—any make, any condition—if you buy a New Remington Super 60 after trial for Cash or Terms.

Send for FREE BROCHURES.

The L·R·SUPPLY CO., LTD.,

BALCOMBE · SUSSEX Telephone: Balcombe 254



Solarscope CD 513

An Outstanding Oscilloscope

A general-purpose D.C./A.C. Oscilloscope with facilities for direct time and voltage measurement on both continuous wave and pulse phenomena.

Max. Bandwidth :	D.C. to 10 Mc/s.
Sensitivity :	1 mV/cm. to 10 V/cm.
Time-Base :	0.1 μ sec/cm. to 100 m sec/cm. with expansion up to x 5.
Internal/External Sync. or Trigger.	
Dimensions :	16" x 10" x 23" long.
Weight :	Approx. 70 lb.

Call Solartron for an engineer to give you a demonstration

Also available : Solarscope CD 523.

★ **40 million to one T.B. velocity ratio.**

★ **Improved T.B. accuracy.**

★ **Long persistence C.R.T.**

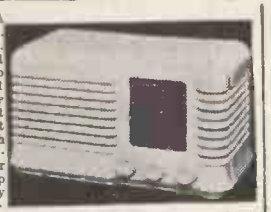
Developed from model CD 513, this new Solarscope has an extended T.B. range at the lower end, giving a 10 second sweep time coupled with higher calibration accuracy. The ideal oscilloscope for L.F. and servo work.

THE SOLARTRON ELECTRONIC GROUP LTD.

RELIABILITY—UNDER OUR 12 MONTHS' GUARANTEE COSTS HAVE NEVER EXCEEDED 0.2% OF SALES

Thames Ditton, Surrey.
Telephone : EMBerbrook 5522
Cables : Solartron, Thames Ditton.

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 6SG7, 6 X5GT and 6 V6GT. Chassis ready drilled. Cabinet size, 10½in. × 10in. wide. Maximum depth at base 5in. tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at **1/6** post free. Our price for complete kit, **£6/9/6!** Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wave-change switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at **45/-**, plus 2/6 packing and carriage. N.B.—Our kits are even supplied with sufficient solder for the job.

N.B. All our T.R.F. Kit circuits now include specially wound Denco "Maxi-Q" coils on polystyrene formers, improved performance! Price remains the same.

SURPLUS BARGAINS

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 2in.	M.C.	R.P.	50/-
50 microamp	D.C. 3½in.	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. 3½in.	M.C.	F.R.	95/-
100 microamp	D.C. 2½in.	M.C.	F.R.	45/-
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 Elliott)	25/-
1 mA.	D.C. 2½in.	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. 2½in.	M.C.	F.R.	10/6
.5 amp	R.F. 2in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2½in.	M.C.	F.R.	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. 2½in.	Thermo	R.P.	7/6
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
6 amp.	R.F. 2½in.	M.C.	Thermo F.R.	7/6
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
25 amp.	D.C. 2½in.	M.I.	F.R.	6/6
30 amp.	D.C. 2½in.	M.I.	F.R.	12/6
15 volt	A.C. 2½in.	M.I.	F.R.	10/-
20 volt (5 mA.)	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
300 volt	A.C. 2½in.	M.C.	F.R.	35/-
300 volt	A.C. 3½in.	M.I.	F.R.	30/-

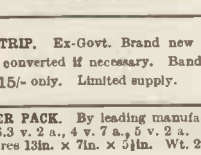
SPECIAL. U.S. 0-1 mA. 2½in. taken from equipment but perfect, **22/6** each. R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.

METER RECTIFIERS, 1 mA. by G.E.C., at 8/6, also 5 mA. by G.E.C., at 8/6.

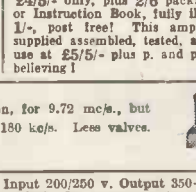
COMMUNICATION RECEIVER PCR.2 3-wave band, 13-50, 190-570, 900-2,000 metres. Valve line-up 6V6, EBC33, X61 and 3-EF.39. Illuminated calibrated dial, flywheel tuning, aerial trimmer. In black crackle case size 17½in. × 10in. × 8in. Output socket for 3 ohm speaker, or headphones. Absolutely brand new in original cartons, manufactured for Govt. by PYE 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.

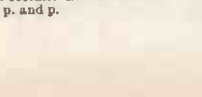


THE R.C. 3/4 WATT AMPLIFIER KIT.



Just released! Compare the advantages! Treble bass, AND middle controls! For crystal or magnetic pickup! A.C. Mains. 200/250 v. Valve line-up, 6V6GT, 6SG7, metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 4in. × 1½in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams, at **£4/5/-** only, plus 2/6 packing and post, or Instruction Book, fully illustrated, for 1/-, post free! This amplifier can be supplied assembled, tested, and ready for use at **£5/5/-** plus p. and p. Hearing is believing!

I.F. 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 measures 13in. × 7in. × 5½in. Wt. 22lb. Few only at **£4/19/6**, plus 3/6 p. and p.

THE R.C. RAMBLER ALL-DRY PORTABLE KIT

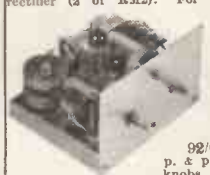
Full assembly details with practical and theoretical diagrams can be supplied at **1/6** post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, adds to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attache-case type cabinet: measuring only 9in. × 7in. × 5½in. Weight less batteries 4½lb., with batteries 6½lb. This set really has everything. Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up 3V4, 1R5, 1S5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of **£7/7/-** plus 2/6 p. 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 units kit for using our popular all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits snugly into battery compartment, can be supplied at **47/6**, plus 1/6 packing and postage. Price includes all required components, and full assembly instructions. N.B.—This unit is completely self-contained in a metal box measuring 7in. × 2½in. × 1½in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 v. L.T.

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 16½in. × 13½in. × 11½in. high. Motor board already cut for latest type B.S.R. Monarch Auto-changer. Provision at side for amplifier controls. Price **79/6** plus 5/- p. & p. Baffle fitted for 7in. × 4in. elliptical speaker for which we can supply latest 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 RM2). For A.C. mains, including separate treble and bass controls. Chassis measures 6in. × 5in. Front plate 6in. × 4½in. 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 TSL Lorenz LP312-2 12in. di-axial 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 LPH 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 5½ 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/- 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/-	DAF96	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
EBC41	10/-	DL96	10/6	UBC41	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	6AQ5	8/6
ECC85	10/-	EM80	9/-	6AT6	8/-
ECF82	15/-	EY51	12/-	6AU6	9/6
ECH42	11/6	EZ40	8/6	6BA6	8/6
ECH81	11/6	EZ80	8/6	6BE6	9/-
ECL80	11/6	PCF80	12/6	6BW6	8/6
EF41	10/6	PCF82	12/6	6X4	7/6
EF80	10/6	PCC84	12/6	35W4	7/6
EF85	10/6	PL81	13/6	50B5	10/-
EF86	12/6	PL82	10/6	50C5	10/-
EF89	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 C.R. TUBES.—By leading manufacturer, 12 in. equivalent to MW 31/74 **£11/19/6**. 14KP4A. 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 OC.71. 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 24½in. × 16in. × 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.

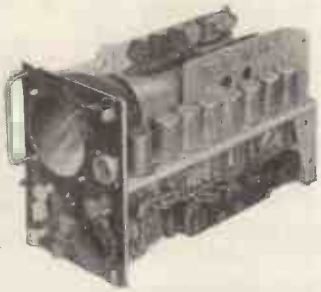
CLYNE RADIO LTD.

18, Tottenham Court Road, London, W.1.

There is a fine selection of equipment at

The Walk-around Shop

TYPE 62A INDICATORS



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: 8¾in. × 11¼in. × 18in. In wooden packing case. **£3**, carriage 7/6.

MINIATURE I.F. STRIPS. Size 10¾in. × 10¼in. × 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 RESPONSER UNIT: Type W.4790. This receiver tunes from 160-182 megs. Valve line up: VR.136 RF., VR.92 Mixer, VR.137 Osc., VR65s in 5 I.F. stages. VR.92 Det. output. Modification details avilable to tune over approx. 80-100 megs. 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 × 1½ × 3¾in., 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 × 1¾ × 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. × 10in. × 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. × 3¼in. Brand new, 12/6, plus 1/6 p.p.

TUNING UNITS Type T.U.5B

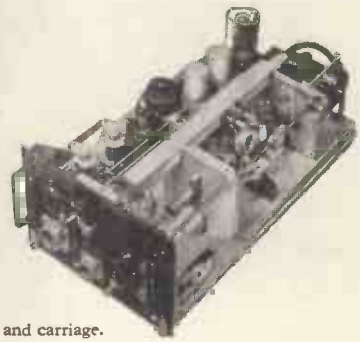
This well-known Tuning Unit has a frequency of 1500-3000 kc/s with 2% accuracy. Micrometer Dial that provides 2,500 divisions over 180° rotation of the tuning shaft which gives plenty of mechanical band spread from 3.5 Mc/s through 28 Mc/s. In addition the unit has a High C Tank Circuit with temperature 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. × 6in. × 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 guillotine 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	5/-	1A3	4/6	CV.18	4/-
6D6G	5/-	1A5	4/6	CV.6	2/-
6F6M	7/-	5U4G	7/6	CV.63	2/-
6A6G	6/6	807	5/-	CV.72	4/-
6K6.GT	5/6	809	7/-	CV.73	5/6
6SN7.GT	6/6	866A	10/-	CV.339	4/-
6AG5	5/6	12SH7M	5/6	CV.349	4/-
6V6GT	6/6	12SJ7M	5/6	2B7G	4/6
6V6M	9/-	ARP.38	5/6	6L6G	7/6
6AK5	5/-	VR.53	5/6	6X5GT	7/-
6J6	5/-				

MICRO SWITCH

Universal type (make or break on depression) 5A, 250 v., housed in strong aluminium casting. 2¼in. × 1¾in. × 1in., with roller on operating lever. Price 3/- p.p.

See these and other offers displayed at ➔

R.S.C. BATTERY CHARGING EQUIPMENT.

All for A.C. MAINS 200-250 v., 50 c/cs. 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. ½ a.h.w.	1/9	6/12 v. 10 a. ..	25/9
6/12 v. ½ a.h.w.	2/9	**H.T. Type H.W.**	
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 ¼in., 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.	3/11
100 mfd. 12 v.	1/9	16-32μF 350 v.	4/9
100 mfd. 25 v.	2/3	32-32μF 350 v.	4/9
		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 mfd. 500 v.	5/9
4 mfd. 500 v.	2/9	8-8 mfd. 500 v.	5/11
4 mfd. 1,000 v.	4/3	15 mfd. 500 v.	7/9
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 5Z4G 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. Potted 4½-3½-3in. 11/9
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 5½ x 4½ x 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/cs. 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 5½ x 2¼in. Supplies 120 v., 90 v., and 60 v., 40 m.A. 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/cs. 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 1⅞in. Supplies approx. 69 v. at 10-15 mA. and 1.4 v. at 250 mA. For 4 valve recelvers 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, 2½-3-3in. 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. 2a., 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.	
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. 1½ 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., 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 ± 3 D.B. 30-20,000 c/cs., 12 D.B. "lift" at 50 c/cs., 12 D.B. "lift" at 12,000 c/cs. Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue crackle. Overall size 12 x 9 x 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. 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, Truvox and Collaro 3-speed transcriptor chassis. Size 12-7-3in. Overall size 12-7-6¼in. For 230-250 v. 50 c/cs. 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 × 3 D.B. 50-11,000 c/cs.

11 GNS. Ready for use. Carr. 7/6

Facilities for recordings at 15in., 7½in., or 3¾in. 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.

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). 8speed 33⅓ r.p.m. BRAND NEW. CARTONED. Only £3/19/6 (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, £6/19/6.

PLESSEY SINGLE SPEED AUTO-CHANGERS with Crystal Pick-up for standard 78 r.p.m. records 10in. or 12in. Very limited number. Only £5/17/6, carr. 5/6.

BRAND NEW B.S.R. MONARCH 3-SPEED MIXER AUTO-CHANGERS. With crystal pick-up and dual point sapphire styli for standard or long playing records. Plays ten 7in., 10in. or 12in. intermixed. For A.C. mains 200-250 v. 50 c/cs. Supplied in sealed cartons with template and operating instructions. Only £7/19/6 plus 3/6 carr.

COLLARO HIGH FIDELITY MAGNETIC PICK-UPS. Low impedance with matching trans., brand new, boxed at fraction of normal price. Only 33/-.

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/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.

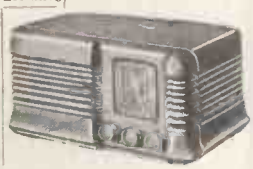
R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible, being 71 D.B. down, 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v., 50 c/s. 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 £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carriage.

R.S.C. A73-4 WATT QUALITY AMPLIFIER

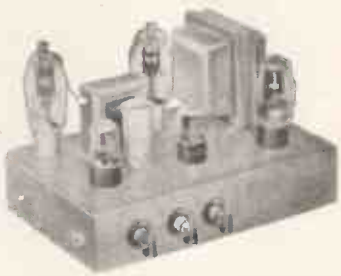
A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 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 £3/15/-, carr. 3/6 or factory built 22/6 extra.

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, 8P61, 6F6G, 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 £4/19/6 including cabinet. Available in brown or cream bakelite veneered walnut.

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 5 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 ± 3 db 30-30,000 c/cs. 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/cs. Output for 3 and 16 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Unapproachable value at £7/15/-, or factory built 45/- extra. Carriage 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 17/6. Where an extra input socket with associated volume control is required for mixing purposes this can be provided for 13/- extra.

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 response characteristic. Loaded H.F coils. Two variable Mu controlled H.F. stages, 3 gang condenser tuning. Cathode follower output stage. Switch position for Gram. and Gram. input and output sockets. Performance comparable with the best in Feeder Units. For A.C. mains 200-230-250 v. operation. Size 11-6-7½in. 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 £3/15/-, including Dial and Drive knobs and every item required.

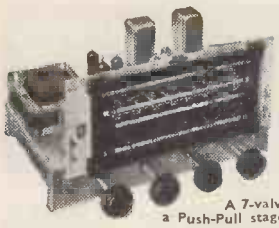
DEFIANT RECORD PLAYING TURNTABLE COMPLETE WITH MAGNETIC PICK-UP. Pick-up is high impedance type. Unit is housed in a beautiful walnut veneered cabinet of attractive design. For all standard records (78 r.p.m.). Limited number. Brand new, cartoned, £5/19/6, carr. 7/6.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance, £4/6/9.

Radio Supply Co. (LEEDS) LTD.

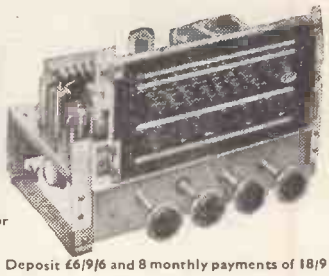
32 THE CALLS. — LEEDS, 2.

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 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.



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 **£12/19/6** 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 12¼in., with height above 5¼in., and height below baseboard 2¼in.

A bulk purchase enables us to offer these BRAND NEW UNITS at this *exceptional* price.

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

A high-quality replacement Radio or Radiogram Chassis having provision for an FM Feeder Unit and incorporating separate BASS and TREBLE CONTROLS.

PRICE ASSEMBLED and READY FOR USE. **£25/2/0**

H.P. Terms: £12/12/0 Deposit and 12 monthly payments of £1/3/2.

The Latest Collaro R.C.54 3-Speed Autochanger

This is a "mixer" unit and incorporates the "Studio O" Crystal Pick-up. **£9/19/6**

H.P.: £5 Dep. and 7 months at 17/2.

WE ALSO HAVE IN STOCK THE MODEL 2010 PX TRANSCRIPTION RECORD PLAYER.

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/-

The "Compact 5-3"
A 3-stage version of the "5-2" model, but in this case having an additional stage and incorporating negative feedback. PRICE £6/16/-

The Amplifiers are compact and very attractively designed, having a Bronze/Gold finish with a fully engraved front panel by which the entire Amplifier is conveniently mounted into a Cabinet, occupying no more space than a conventional Tone Control Unit. Fully described in our Leaflets.

POWER SUPPLY. A separate small Unit is available and this in addition to supplying power to the Amplifier has additional power available for RADIO TUNING UNIT, etc. PRICE £2/10/-.

DESIGNS FOR THE "HOME CONSTRUCTOR"

THE COMPLETE SPECIFICATIONS OF THE FOLLOWING UNITS ARE AVAILABLE FOR 1/6 EACH.

THESE MANUALS ALSO INCLUDE THEORETICAL and PRACTICAL WIRING DIAGRAMS, AND A COMPLETE COMPONENT PRICE LIST.

The "wire-to-wire" Practical Diagrams are very simple to follow and are drawn for the "inexperienced" constructor.

- **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.
- **STERN'S "PERSONAL SET" BATTERY ELIMINATORS** . . . Complete KITS OF PARTS to build Midget "Alldry" Battery Eliminators (a) Providing approx. 69 Volts at 10 m/a and 1.4 Volts at 250 m/a . . . Price 42/6. (b) Providing approx. 90 Volts at 10 m/a and 1.4 Volts at 250 m/a . . . Price 47/6.

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 Drilled 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.

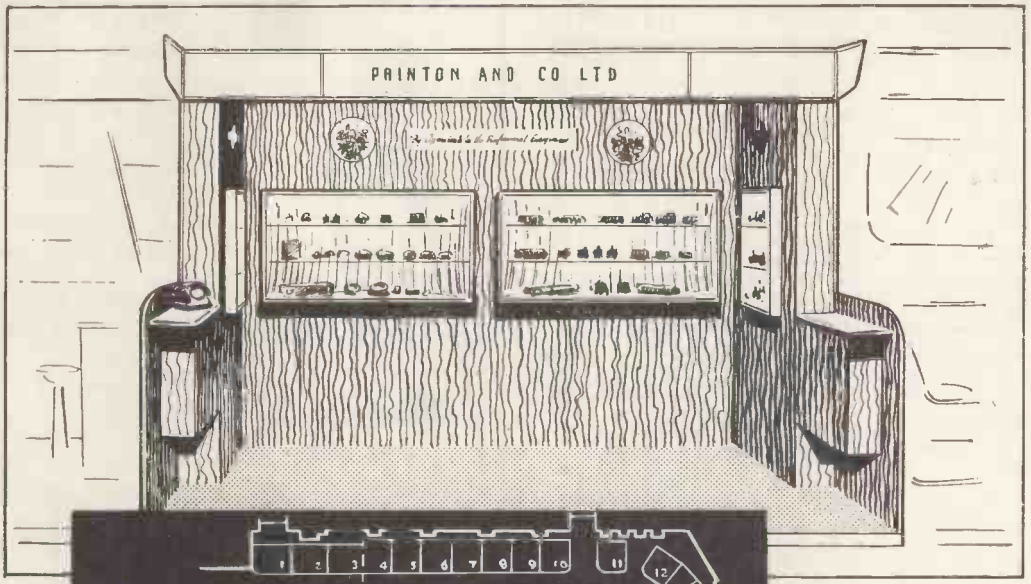
ALL COMPONENTS TO BUILD THESE AMPLIFIERS, TUNERS, ETC., ARE AVAILABLE FOR SALE SEPARATELY CONSTRUCTORS CAN THEREFORE GRADUALLY BUILD ANY UNIT.

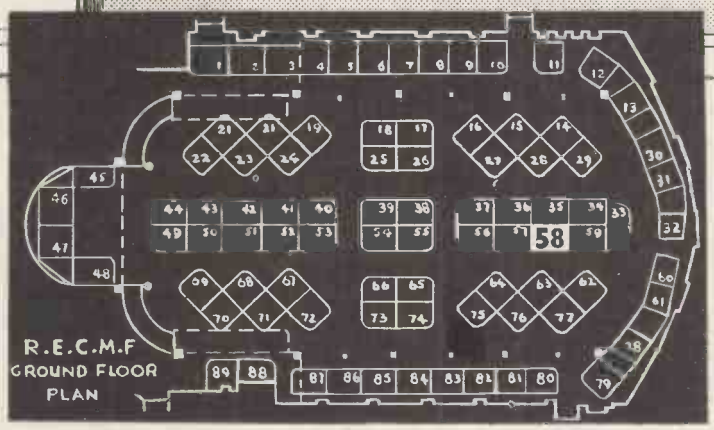
STERN RADIO LTD. 109 and 115 FLEET ST., LONDON, E.C.4

When Ordering Please Include 5/- Extra for Carriage and Insurance. Telephone: FLE. 5812/3/4

PAINTON

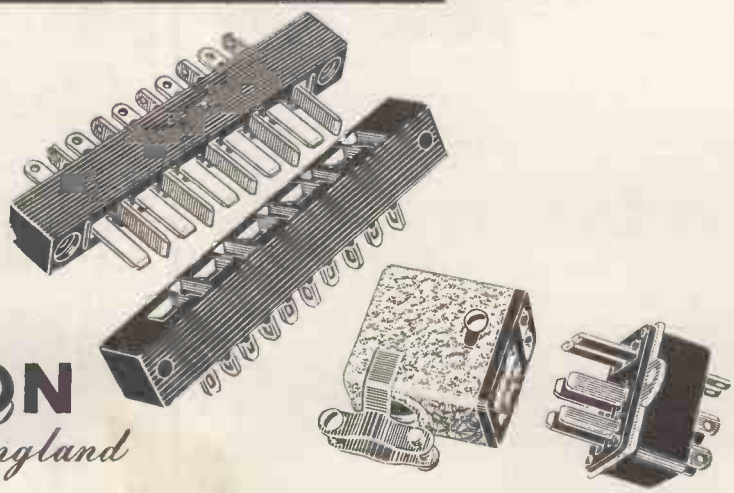
By Appointment to the Professional Engineer





You are cordially invited to visit Stand No. 58 at this year's R.E.C.M.F. Exhibition where the complete range of Painton products will be displayed.

The illustration shows the 10-in-line and the 6 way plugs and sockets from our 'MULTICON' range



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Northampton England

Manufacturers of

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

MAINS TRANSFORMERS

Primary, 200-250 v. P. & P. 2/-. 300-0-300, 100 mA. 6 v. 3 amp., 5 v. 2 amp., 22/6.

Semi-shrouded drop-through 380-0-380 v., 120 mA., 6.3 v. 4 amp., 5v. 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. 1½ 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.

6½in. M.E. Speaker. 1,000 ohm field, 15/-.

R. & T.V. energised 6½in. speaker with O.P. trans. field coil. 175 ohms 9/6. P. & P. 2/6.

R. & A. 6½in. M.E. speaker, with O.P. trans. field 440 ohms, 10/6. P. & P. 2/6.

Volume Controls. Long spindles less switch, 50K, 500K, 1 meg., 2/6 each. P. & P. 3d. each.

Volume Controls. Long spindle and switch, ¼, ½, 1 and 2 meg., 4/- each. 10K and 50K, 3/6 each. ¼ and 1 meg., long spindle, double pole switch, miniature, 5/-. P. & P. 3d. each.

Trimmers, 5-40 pf., 5d. 10-110, 10-250, 10-450 pf., 10d.

Twin Gang .0005 Tuning Condenser, 5/-. With trimmers, 7/6.

Twing Gang .0005, with feet, size 3¼ x 3 x 1⅝in., 6/6.

3-gang .0005, with feet, size 4⅛ x 3 x 1½in., 7/6.

T.V. Coils, moulded former, iron-cored wound for re-winding purposes only. Ali-can 1⅜ x 1¼in., 1/- each, 2 iron-core Ali-can 2⅜ x 1in., 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. 100 mA., 3/6.

OUTPUT TRANSFORMERS.

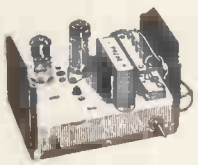
Standard type 5,000 ohms imp., 4/9; 42-1 with extra feed-back windings, 4/3. Miniature 42-1, 3/3. Multi-ratio 3,500, 7,000 and 14,000, 5/6. 10-watt push-pull, 6V6 matching, 7/-. 90-1 3 ohm speech coil, 6/6.

SPECIAL OFFER. VERY LIMITED QUANTITY

7-VALVE PUSH-PULL A.C. MAINS 200/250 v. RADIOGRAM CHASSIS

3 wave band, coverage short wave 16-50m, 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 2¾in. Size of scale 12in. x 4in. Overall height including back plate 7¾in. 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 5¾in. long, 3¾in. wide, max. overall height 4¼in. £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 £2/5/0. P. & P. 2/6.

P.M. SPEAKER. 6½in. closed field, 18/6. 8in. closed field 20/6. 10in. closed field 25/-. 3½in., 16/6. 12in. closed field, 25/-. P. & P. on each 2/-.

EXTENSION SPEAKER in polished walnut, complete with 8in. P.M. P. & P. 3/-. 24/6.

B.S.R. MONARCH three speed automatic changer, current model. Brand new. Will take 7in., 10in., or 12in. 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 6½ x 2½in., size of scale 7½ x 3½in. Valve line-up 10C1, 10F9, 10LD11, U404 and 10P14. Twin mains filter input, 2 dial lights and 8in. P.M. £8/17/6. P. & P. 5/-.

SPECIAL OFFER. 8in. 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 FLUORESCENT 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. **FLUORESCENT KIT** comprising trough in white stove enamel finish, two tube holders, starter and holder and barreter. Post and packing 1/6. 12/6.

POLISHING ATTACHMENT for electric drills. Quarter inch spindle, chromium plated 5in. brush, 3 polishing cloths and one sheepskin mop mounted on a 3in. 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 4½ 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 1½ x 1½in., per pr., 7/6. Wearite standard, iron-cored, 465 Kc., I.F.s, 3½ x 1⅜ x 1⅜in., per pr., 9/6.
Iron-cored 465 Kc., Whistle Filter, 2/6.
465 KC. MIDGET I.F.s. Q-120 size 1½in. long, 1in. wide, ⅜in. 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/-.

R. AND T.V. COMPONENTS (ACTON) LTD.

23 HIGH STREET, ACTON, LONDON, W.3

GOODS NOT DESPATCHED WHERE CUSTOMS DECLARATION IS APPLICABLE

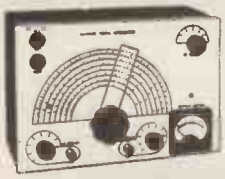
Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/6 up to 10/-, 2/- up to £1, and 2/6 up to £2. All enquiries S.A.E., lists 5d. each.

Mains Droppers, 0.3 amps., 460 ohms tapped 280 and 410, 1/6; 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, 1/6; 0.3 amps. 950 ohms, tapped 700 and 825, 2/6; 0.2 amp., 1,000 ohms, vitreous, tapped, 2/6; vitreous, 0.3 amp., 700 tapped 680, 640, 600, 3/6. P. & P. on each 3d.
T.V. Width Controls 3/6.
PERSONAL SHOPPERS ONLY
9in. Enlarger, 17/6; 12in., 27/6.
Germanium Crystal Diode, 1/6, post paid. **Used 9in. Tube** with ion burn, 17/6. Post paid.
Line O.P. Transformer in aluminium can mounted in rubber, 12/6
Line and E.H.T. Transformer, 14 Kv., using ferrocart core, complete with line and width control, and corona shields U37 rectifier winding, 35/-.
Line and E.H.T. Transformer, 9 Kv., using ferrocart core, complete with built-in line and width control. Mounted on small ali-chassis. Overall size 4⅜ x 1⅜in. EV51 rec. winding. 27/6.
Scan coils, low line low impedance frame, complete with frame transformer to match above, 27/6. P. & P. 2/-.
Line and E.H.T. Transformer, 9 Kv. ferrocart core, EY51, heater winding, complete with scan coils and frame output transformer, and line and width control, 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/-.
Valve Holders, moulded octal Mazda and loctal, 7d. each. Paxolin, octal Mazda and loctal, 4d. each. Moulded B7G, B8A and B9A, 7d. each. B7G moulded and B9A with screening can, 1/6 each.

32 mfd. 350 wkg.	2/-
16 x 24, 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
16 x 8 mfd., 500 wkg.	4/6
16 x 16 mfd., 500 wkg.	5/9
16 x 16 mfd., 450 wkg.	3/9
32 x 32 mfd., 350 wkg.	4/-
25 mfd., 25 wkg.	11d.
250 mfd., 12 v. wkg.	1/-
16 mfd., 500 wkg., wire ends	3/3
8 mfd., 500 v. wkg., wire ends	2/6
8 mfd., 350 v. wkg., tag ends	1/6
50 mfd., 25 v. wkg., wire ends	1/9
100 mfd., 350 wkg.	4/-
100 mfd., 450 v. wkg., 280 mA., A.C. ripple	3/11
150 mfd., 350 v. wkg., 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.
50 mfd., 50 wkg.	1/9

Miniature wire ends moulded, 100 pf., 500 pf., and .001, each 7d.
Combined 12in. mask and escutcheon in lightly tinted Perspex. New aspect edged in brown. Fits on front of cabinet, 12/6. As above for 15in. tube, 17/6.
Frame Oscillator Blocking Trans., 4/6.
Line Osc. Blocking Trans., 4/6.
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 Unit for Mullard tubes with vernier adjustment. P. & P. 2/-. 15/-.
Energised Focus Coil, low resistance mounting bracket, 17/6.

SIGNAL GENERATOR



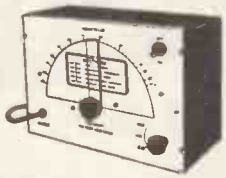
Coverage 120 Kc/s-84 Mc/s

A.2. Mains 200/250v. £4-19-6

or 34/- deposit, 3 pyts. of 25/-

P. & P. 4/- Extra

PATTERN GENERATOR



Coverage 40 Mc/s-70 Mc/s.

A.C. Mains 200/250v. £3-19-6

or 29/- deposit, 3 pyts. of £1.

P. & P. 4/- Extra

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
10.8 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.
Type C. Low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 230/240 volts, Output 2-2½-2½-2½-3 volts at 2 amps. With Tag Panel 17/6 each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE:—It is essential to use mains primary types with T.V. receivers having series connected heaters.

REISTORS. All values. 10 ohms to 10 meg., ¼ w., 4d.; ½ w., 6d.; 1 w., 8d.; 2 w., 1/-.
HIGH STABILITY. ½ w., 1%, 2/-. All preferred values 100 ohms to 10 meg.

WIRE-WOUND RESISTORS
5 watt, 10 watt, 15 watt } 25 ohms—10,000 ohms 1/3, 1/6, 2/-
15,000 ohms—50,000 ohms, 5 w., 1/9; 10 w. 2/3

WIRE-WOUND POTS. 3 WATT LAB. COLVERN ETC.
Pre-Set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 Meg. 3/-.
Standard Size Pots., 2½in. Spindle High Grade. All Values, 100 ohms to 50 K., 5/6; 100K., 6/6.
W/W EXT. SPEAKER CONTROL 10Ω 3/-.
O/P TRANSFORMERS. Heavy Duty 50 mA., 4/6. Ditto, tapped primary 4/9. Multiratio, push pull, 6/6. Tapped small pentode, 3/9. Hygrade Push Pull 7 wts., 15/6.
L.F. CHOKES 15/10 H. 60/65 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H. 120/150 mA., 12/6; 5 H. 250 mA., 15/-.
MAINS TRANS. 350-0-350, 80 mA., 6.3 v. tapped 4 v. 4 a., 5 v. tapped 4 v. 2 a., ditto 250-0-250 80 mA., etc., 21/-.

I.F. TRANSFORMERS. 465 kcs. Pye Radio, midget size, 2½in. × ½in. × ½in., 7/6 pr. With data sheet.

HEATER TRANS. Tapped 200/250 v. 6.3 v. 1½ amp., 7/6.
COPPER PLATED AERIAL RODS. ½ × 12in. push fitting, 3/- doz. Post 1/-.
ALADDIN FORMERS and cores. ½in., 8d.; ¾in., 10d.
½in. FORMERS with Case and Core. ½in. sq.×1½in. and ½in. sq.×2½in., 2/- ea.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYANA. Midget Soldering Iron. 200/220 v. or 230/250 v., 14/11.
SOLON MIDGET IRON. 25 w., 22/-.
MIKE TRANSF. Ratio 50 : 1, 3/9 ea., new and boxed.
MAINS DROPPERS. 3 × 1½in. Three Adj. Sliders, .3 amp. 750 ohms, 4/3. .2 amp., 1,000 ohms, 4/3.
LINE CORD. .3 amp., 60 ohms, per foot, .2 amp., 100 ohms per foot, 2 way 6d. per foot, 3 way 7d. per foot.

CRYSTAL MIKE INSERT. Famous make, precision engineered. Size only 1½ × 3/16in. Bargain Price, 6/6. No transformer required.

LOUDSPEAKERS P.M. 3 OHM.
5in. R.A., 17/6. 7in. × 4in. Goodmans, 21/-.
6in. × 4in. Rola, 19/6. 8in. Goodmans, 22/6.
6½in. Goodmans, 18/6. 10in. Rola, 30/-.
6½in. ditto w/Trans., 21/-. 12in. Plessey, 30/-.
8in. M.E. 9.5 k. or 2 k. field, tapped O.P. transf., 24/6.
CRYSTAL DIODE. G.E.C., 2/-. GEX34 4/-.
CRYSTAL SET CONSTRUCTION, 1/-.
40 CIRCUITS USING GERMANIUM DIODES, 3/-.
H.R. HEADPHONES, 4,000 ohms. Brand new, 17/6 pr.
SWITCH CLEANER Fluid, squirt spout. 3/9 tin.
TWIN GANG TUNING CONDENSERS. .0005 mfd. midget with trimmers 8/6; 375 pf. midget less trimmers 6/6; .0005 Standard size with trimmers and feet 9/-; less trimmers 8/-; ditto, soiled, 2/6.

PURETONE RECORDING TAPE

1,200ft. on standard fitting 7" Plastic reels. Brand new boxed 17/6

VALVE HOLDERS. Pax. int. Oct. 4d., EF50, EA50 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 and 9 pin, 1/- MOULDED Mazda and Int. Oct. 6d., B7G, B8A, B8G, B9A 9d., B7G with can 1/6, VCR97 2/6. B9A with can, 2/6. CERAMIC. EF50, B7G, Int. Oct. 1/-. B7G with can, 1/9. SPEAKER FRET. Woven Plastic TYGAN, Walnut tone. 12in. wide, 2/- per foot. Expanded metal, gold or silver, 9½in. × 12in., 2/- per piece. Silver 15½ in. x 9½in., 2/-.
WAVECHANGE SWITCHES.
5 p. 4-way 2 wfaer, long spindle 6/6
2 p. 2-way, 3 p. 2-way, short spindle 2/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle 3/6
3 p. 4-way, 1 p. 12-way, long spindle 3/6

KNOBS. GOLD ENGRAVED. Walnut or Ivory, 1¼in. diam., 1/6 each. "Focus" "Contrast" "Brilliance." "Brilliance—On/Off." "On-Off." "Volume." "Vol-On-Off." "Tone." "Tuning." "Treble." "Bass." "Wavechange." "Radio Gram." "S.M.L. Gram." "Record-Play." "Brightness." Ditto, not engraved, 1/-.

ALL WAVE RADIOGRAM CHASSIS

THREE WAVEBANDS S.W. 16 m.—50 m. M. W. 200 m.—550 m. L. W. 800 m.—2,000 m.
FIVE VALVES LATEST MULLARD ECH42, EF41, EBC41, EL41, EZ40
12 month Guarantee, A.C. 200/250 v. 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative feedback. 4.2 watts. Chassis 13½in. × 5½in. × 2½in. Glass Dial 10 × 4½in., horizontal or vertical available. 2 Pilot Lamps. Four Knobs. Walnut or Ivory, aligned and calibrated. Chassis isolated from mains.

BRAND NEW **£10.10.0** Carr. 4/6.
Matched 3-ohm speakers 8" 19/6, 10" 25/-

RECOMMENDED FOR ABOVE CHASSIS

Plessey
Multi Speed
Changer

(Limited period) **£8.19.6**

Brand new Plessey 3-speed Autochanger Mixed Unit for 7, 10 and 12in. Records. Twin Hi-Fi Xtal Head with Duopoint sapphire stylus. Plays 4,000 records. Sprung mounting. Baseboard required 15½ × 12½in. Height 5½in. Depth 2in. Super Quality. Post free. A.C. 200/250 v.

B.S.R. MONARCH

3-SPEED MOTOR & TURNTABLE, XTAL PICKUP, ACOS TURNOVER HEAD
SPECIAL OFFER the two **£4-15-6**
POST 2/6.

UNREPEATABLE BARGAIN

GERRARD 3 SPEED AUTOCHANGER
Mod. 75 our price **£8 - 19 - 6**
regret no C.O-D. Carr. 5/6

Teletron Band III Converter

For London, Midland and Northern Transmissions. Suitable all T.V. makes. T.R.F. or Superhet. Ready wound coils, two EF80 valves, all components, punched chassis, circuit diagram, wiring plans. COMPLETE KIT for mains operation 200-250 v. A.C. £3/10/-.

A8 ABOVE less POWER PACK. Requires 200 v. 20 mA. H.T. 6.3 v. .6 a. L.T. £2/5/-
Mains Transformer to above Spec. 10/6
Min. Westinghouse Rect., ditto 8/6
Punched and drilled chassis 3/9
Larger chassis for Mains Model 6/-
Teletron Coilset with plans 15/-
Full plans and circuit details ..... 6d.

VALVES

Manufacturers Surplus and ex-Government Types
Brand New Boxed All Guaranteed Perfect.

8/6	6AG5	10/6
1R5	6B8	6Z4
1T4	9D2	6L6
185	12BH7	6Q7
3S4	EF50 EQUIP.	12AT7
3V4	8P61	12K7
5U4	8P41	12K8
6AC7	PEN46	12Q7
6AM6	EF92/W77	25Z4
6AT6		35L6
6C4	1/6	35Z4
6F12	EA50	EBC41
6J6		EBF80
6J7	2/6	ECC81
6K8	2X2	ECH35
6SL7	CV6	ECL80
6SN7	EI148	ECH42
6V6GT	EB34	EF41
6U5/Y63	3/6	Mullard EF50
787	3D6	Mullard EF55
8D3	6H6M	EF80
DET18		EL41
DK91	6/6	EZ40
DF91	6AL5	KT33C
DAF91	6G6	MU14
DL92	6J5	PL81
DL94	6K6	PL82
EBC33	6K7G	PY82
EF50 8YLV.	6SK7	U25
RED	EB91	N78
EF91	HVR2 (near)	EY51
5/6	VR116	

7/6
OZ4, 1A3, 6BE6, 6BW6, 6C6/77, 6D6, 6F6, 6K7GT, 6K7M 6SA7, 6V6G, 6X4, 6X5, 12A6, 12AX7, 12BA6, 12BE6, 15D2, 807, EF39, EL32, HVR2A, PEN25, U22, UF41, VP23, V870.

12/6

ECF82	PCC84	PCF80	PCF82

12K8, 12Q7, 12K7, 35L6, 35Z4.
SPECIAL PRICE—37/6 THE SET

2/6 BRAND NEW 2/6
SUB-MINIATURE VALVES—WIRE ENDS—EX-DEAF, AID APPARATUS S.F. PENTODES. .625V.F.I.L. TYPES DF70 AND CK505AX.

T.V. PRE-AMP. FAMOUS MAKE
Will amplify output of your Band 3 Converter. Tuneable Channels 1 to 5. Midget size. High gain fringe model. B.V.A. Valve. Full Instructions supplied. READY FOR USE. (H.T. 200V., L.T. 6.3V., 3 amp required.) PRICE 25/- each. BRAND NEW SPECIAL MAINS POWER PACK for above, 25/- extra.

Volume Controls

Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg. No Sw. S.P.Sw. D.P.Sw. 3/- 4/- 4/9
EXT. SPKR. TYPE 3/-

80 ohm CABLE Coaxial

Semi-air spaced Polythene insulated. ¼in. dia. Stranded core. Losses cut 50% **9d.** yd.
STANDARD **8d.** yd.
¼in. Coaxial

COAXIAL PLUGS 1/- DOUBLE SOCKET 1/3
SOCKETS 1/- OUTLET BOXES 4/6
T.V. AERIALS. Band I. Indoor Inv. T., 13/6.
Band 3 Dipole indoor, 6/6. Band 3 Twigs, 7/6 pr.
BALANCED TWIN FEEDER per yd. 6d. 80Ω or 300Ω.
TWIN SCREENED BALANCED FEEDER 1/- yd. 80 ohms.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf., 1/3. 250 pf., 1/6, 600 pf., 750 pf., 1/9.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled, with 4 sides, riveted corners and lattice fixing holes, with 2½in. sides. 7 × 4in., 4/6; 9 × 6in., 5/9; 11 × 7in., 6/9; 13 × 9in., 8/6; 14 × 11in., 10/6; 15 × 14in. 12/6 and 18 × 16 × 3in., 16/6.

CHROMIUM PEN TORCHES with battery and bulb, 2/6.
BLACK CRACKLE PAINT. Air drying. 3/- tin.
WEARITE "P" coils 3/-. OSMOR "Q" coils 4/-.
P.V.C. CONN. WIRE, 10 colours, single or stranded 2d. yd.
5in. RADIO SCREWDRIVERS, 4½d. each.
NEON MAINS TESTER SCREWDRIVER, 5/6.

VCR97 TESTED FULL PICTURE £2

MULTICORE SOLDER 60/40. 18 s.w.g., 3d., 16 s.w.g., 4d. yard. ½lb. 2/6.
ALL BERNARDS BOOKS IN STOCK. List S.A.E.
VALVE MANUALS. Parts I and II, 5/- each part.

F.M. TUNER COIL KIT 22/6. H.F. coil, Aerial Coil, Oscillator Coil, two I.F. Transformers 10.7 Mc/s. Detector transformer and heater choke. With circuit

CONDENSERS. New stock. .001 mfd. 7 kV. T.C.C., 5/6. Ditto, 20 kV., 9/6; 100 pf. to 500 pf. Micas, 6d.; Tubular 500 v. .001 to .01 mfd., 9d.; .05 .1 1/-; .25 1/6; .5 1/9; .1/350 v., 9d.; .1/600 v. 1/3; .1/1,500 v., 3/6.

NEW ELECTROLYTICS. FAMOUS MAKES.

TUBULAR	TUBULAR	CAN TYPES
1/275 v. .. 2/-	100/25 v... 3/-	8+16/450 v. 5/-
2/450 v. .. 2/3	8+8/500 v. 4/6	1+16/500 v. 6/-
4/450 v. .. 2/-	16+16/500 v. 6/-	1g+24/350 v. 4/6
8/450 v. .. 2/3	CAN TYPES	32+32/350 v. 4/6
8/500 v. .. 2/9	Clips..... 3d.	32+12/450 v. 6/6
16/450 v... 3/6	16/500 v... 4/-	64+120/275 v. 7/6
16/500 v... 4/-	32/350 v... 4/-	64+120/350 v. 11/6
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500 microamps D.C.	2in. Flush square	27/6
1 m.a. D.C.	2in. Flush square	22/6
5 m.a. D.C.	2in. Flush square (scaled 0-100 m.a.)	10/6
10 m.a. D.C.	2½in. Flush circular (blank scale)	10/6
150 m.a. D.C.	2in. Flush square	7/6
200 m.a. D.C.	2½in. Flush circular	12/6
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100 Microamp.	D.C. M/C	2½in.	Flush circular, scaled 0-1,500	39/6
500 Microamp.	D.C. M/C	2in.	Flush square, Weston	27/6
500-0-500 Microamp.	D.C. M/C	2½in.	Flush circular, scaled 100-0-100 V.	25/-
1 Milliamp.	D.C. M/C	2in.	Flush square, Fe/NFe	22/6
10 Milliamp.	D.C. M/C	2½in.	Flush circular, blank scale	10/6
100 Milliamp.	D.C. M/C	2½in.	Flush circular	10/6
150 Milliamp.	D.C. M/C	2in.	Flush square	7/6
200 Milliamp.	D.C. M/C	2½in.	Flush circular	10/6
1 Amp.	Thermo-couple	2½in.	Projecting circular	6/9
4 Amp.	Thermo-couple	2in.	Flush square	6/9
20 Amp.	D.C. M/C	2in.	Projecting circular	7/6
30-0-30 Amp.	D.C. M/I	2in.	Proj. circ., metal cased, car type	5/-
15 Volts	A.C. M/I	2½in.	Flush circular	8/6
300 Volts	A.C. M/I	3½in.	Flush circular	30/-
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AVO No. 7, a.c./d.c., faulty on 400 and 1,000v ranges, otherwise O.K., £6; Ferranti micro amp 0-500mc, large scale, £2. T. W. PEARCE, 66, Great Percy St., W.C.1. [0011

A.P.T.5 transmitter, 300-1,600m/c, 30watt average output, offers; for sale, a few CK 722 transistors or would exchange for 3C 22 or 522 disc seal triode.—Box 0603. [5791

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0056

NEW DYNAMOS, MOTORS, ETC.

J.A.P. No. 2a, 1 2h.p. petrol engine, air-cooled, 4-stroke, starting rope, tools, instruction book, £17/10 delivered, lightweight, portable lighting plant, complete with above engine, 12V 150 watt, ammeter, voltage regulator, fuse, £20, can. £1. T. W. PEARCE, 66, Great Percy St., W.C.1 (near Angel). [0013

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

2,000c/s motor-alternator sets, input 220v d.c., output 80v, 1ph, 2,000c/s, 6.25amps, 500VA, complete with starter, fuses, control panel and voltmeter, all mounted in ventilated steel cabinet 14in×26in×49in high, new in original cases; £16, carr. extra. P. B. CRAWSHAY, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0096

BRIDGE rectifier units, quantity of new, unused, ex-Mins. of Supply, by S.T. & C., Ltd., 200-250/1/50 in 70-90-100v 16amp d.c. out, at tropical rating, up to 125°F, at normal temp. rect. output 32amp, rotary switches, fuses, v. meter, steel case, 4ft 6in h.×3ft 6in ×1ft 6in approx., wt. 30cwt, suit home or tropics, £25 each, carr. free England.
1 ONLY television and lighting small plant, self-start, 12v charging 150watts, separate 230/1/60 smoothed 250watts output for television, ammeter, A.C.V. meter, etc., £32/10; can, £1; new R.A.F. charging cut-outs, 12 and 24v, 40amp 12/6, 60amp 19/6; landing lamps, 12v 350watts, 24v 240 and 350watts, 1/6 each, 12/- per doz.
T. W. PEARCE, 66, Great Percy St., W.C.1. [0012

NEW GRAMOPHONE AND SOUND EQUIPMENT

LATEST tape recorders for sale or hire.—Recorded Sound, 27, Bryanston Street, W.1. [5733

TRANSISTOR pre-amps for tape play-back, junior 6gns; senior £9/15.
STEREOSONIC tape equipment, complete, from £130.
REFLECTOGRAPH tape-decks, £31/10; Lodestar.
JASON F.M., £16/12/7; kits, £6/18 complete; R/P amplifiers for Wearite, £25.
COLLARO. Truvox and all decks and amps available.
'PHONE Gladstone 1770.
HARDING ELECTRONICS, 120A, Mora Rd., Cricklewood, N.W.2. [0032

RECORDING tape, professional quality, plastic base, highly sensitive, tested, guaranteed, 1,200ft. (list 35/-), offered at 22/6 inc. post (20/- ea. 6 and above + 1/6 p. & p.), TAPE Recorders, Ferrograph, Leevers-Rich, and new design by M.S.S.: blank disks, disk Recorders, your tapes to disk, 78 & L.P.
"EROICA" RECORDING SERVICES, Recorder House, Peel St., Eccles, Manchester. Eccles 1624. Director, Thurlow Smith, A.R.M.C.M. [0122

CINE-VOX disc recording equipments, type C7J, for high-quality recordings from existing microphone equipment; price from 28gns; also available as a complete channel inclusive of mic., amplifier and playback equipment, at 70gns; type C7 for highest quality professional requirements—recorder mechanism at 48gns, or complete channel at 110gns; demonstrations arranged in London.
PLEASE write for details to K.T.S., Ltd., "Coplow," Park Rd., Braunton. N. Devon. Tel. Braunton 224. Callers by appointment only. [0210

PHOTO-OPTIX, the tape recorder specialists, offer you a complete range of recorders from "Ferrograph" to "Playtime" and especially recommend the new "Wyndsor" which represents outstanding value at 48gns; all available on easy terms; send for leaflets, or call and hear them demonstrated.—Photo-Optix (London), Ltd. (Dept. W.W.), 73, Praed St., London, W.2. Pad. 2891. (Distance no object.) [5631

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECONDHAND

TAPE RECORDER, C.J.R. type D5, monitor replay facilities; £75.—112, Alcester Rd. South, Birmingham, 14. [5870

LUSTRAPHONE LFV59; pencil microphone, £5; Leak Ruby 78 P/U, £3; HT215 loudspeaker, £7/10 or offers; all new condition.—Box 1043. [5883

L2B battery, portable, microphone, stethophones and canvas case, used for only 30 tapes and checked by E.M.I.; call or write—Mr. Hyme, 1, Peas Hill, Cambridge. Tel. 5349. [5675

RCA Loudspeaker Crossover Networks, complete choke condenser and resistance assembly mounted on small chassis, 15 ohms, crossover approximately 800 cycles, handling up to 20W, brand new units, £2 each; used but serviceable, £1/10 each.
BURGESS LANE & CO., Thornton Works, Thornton Ave., Chiswick. W.4. Chi. 5752. [5759

HI-FI Reproducing Equipment: Collara Transcription Player, B.J. Arm, Leak Amplifier, W.B. 12in Loudspeaker and Tweeter in Corner baffle, all in separate de luxe cabinets, cost £125 last December, will accept £90; also 2 Grundig Ribbon Microphones, table £7, Stand £15.—A. Hickish, 29, Barley Croft, Bristol, 9. [5829

NEW COMPONENTS

CRYSTAL Microphone Inserts (Cosmocord Mic 6/4), in popular demand by Hams and Sound Engineers, guaranteed newly made and boxed; 15/6, post free.—Radio-Aids, Ltd., 29, Market St., Watford. [0169

NEW COMPONENTS

CONSTRUCTORS.—Every type of component part supplied for constructors, brand new and all guaranteed, at below list price; all types of condensers, resistors, valves and transformers; stamp for lists; very quick M.O.S.—D. R. Smith, 47, Stannary St., Halifax. Tel. 66865. [0004

COMPONENTS—SURPLUS AND SECONDHAND

375 cathode ray tubes ARC1, 6in.—Box 0302 or Tel Mitcham 3471, ext. 122. [5746

PARTRIDGE output and mains transformers (loose leads), for Williamson' amplifier.—Box 0521. [5774

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London. W.1. Tel. Museum 9188.

ELECTROLYTICS, capacity, voltage, size, type of mounting, price post paid: 400, 6v, 1×2in. lug, 1/6; 250+250, 6v, 1×2in. lug, 1/6; 25, 25v, ¾×1¾ W/E, 1/6; 500, 12v, ¾×1¾, W/E, 2/-; 1,000+2,000, 6v, 1×3, clip, 3/9, 250, 12v, ¾×1¾ clip, 1/9; 10, 25v, ½×1¼ clip, 1/3; 500, 50v, 1×3, clip, 3/9; 50+50, 150v, 1¼×2, clip, 2/9; 100, 275v, 1¼×3, clip, 3/6, 60+250, 275/350v, 1¾×4½, clip, 6/3; 24, 275, ⅞×2, clip, 3/-; 8, 450v, ¾×2, clip, 1/9; 16+16+8, 350/425v, 1⅜×2, lug, 4/3; 20+10, 450v, 1×3, clip, 4/-; 15+15, 450v, 20mf 25v, 1×3, lug, 4/3; 8, 500v, 1⅜×2¾, 2/6, 32+32+8, 350/425v, 1⅜×3, clip, 5/-; 32+32+2, 350/425v, 1⅜×2, clip, 4/3; 5, 150v, ⅝×1¼, W/E, 1/3; 8+8, 450v, 1×2, clip, 3/9; 100, 350/425v, 1¾×3, clip, 4/-; photo flash type, 1,000mf, 1¾×4½, clip, 12/6; all ali cans, some with sleeves, all voltages WKG, surge V where marked, new stock guaranteed.

TELEVISION chassis, cadmium plated, steel, size 14×13×2½in, complete with 13 valve holders (9-B9A Pax, 1-B9A Cer, 2-B7G Cer. 1-Int. Oct. amph). 20 various tag strip cut away for metal rect., line trans., etc.: 9/11 each, post paid.

FRONT and rear tube mounts to fit above chassis, 3/- pair post paid.

P.M. focus rings, wide angle, tetrode tube, fully adjustable, 12/- post paid.

SCANNING coils, wide angle, with mounting lugs, 19/6, post paid.

MAINS trans.: 340-220-0-220-340v, 220mA, 4v, 6.5A, 4v, 3A, 4v, 1.5A, 2v, 1.5A, 4v, 6.5A Pri. 0-205-225-245v, 30/- post paid.

MAINS trans., 250-0-250v, 120mA, 6.3v, 2.5A. 6.3v, 0.6A. Pri, 0-110-125-150-205-225-245. 16/6 post paid.

C.T.V.IF's 34Mc/s, 2nd, 3rd, 4th, vision, cans 13/16×13/16×2½, slug tuned, set of three 5/6 post paid.

RADIO CLEARANCE, LTD., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport St., London, W.C.2. See our displayed advertisement, page 168.

PARTRIDGE trans. PPO/1, £2; television (has worked), coils, chassis, transformers, etc., 18 valves, 12in C.R.T., mask and glass, no tubes, £2/10, buyer collects. T. W. PEARCE, 66, Great Percy St., W.C.1. [0009

GOVERNMENT Surplus Illustrated Catalogue No. 12, containing over 400 items of electrical, mechanical and radio equipment for experiments, etc.; price 1/6, post free.—Arthur Sallis, 93, North Rd., Brighton, Sussex. [0093

MAGSLIPS at low prices, fully guaranteed, 3 in Resolver No. 5 (AP 10861), 50v, 50c/s, unused, each in tin, 35/-, post 2/1; large stocks of these and other types.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0087

WANTED, EXCHANGE, ETC.

ACOUSTICAL corner ribbon and Decca corner horn required.—Box 0417. [5782

WANTED, receivers A.P.R.4, also T.N.16, 17, 18, 19, etc. and any radio test gear. LESLIE DIXON & Co., 214, Queenstown Rd., Battersea, S.W.8. Macaulay 2159. [0176

REQUIRED, Teleprinter terminal units SUR 7, SUR 13, rectifier 220v AC/24v DC.—Box 0635. [5798

WANTED, coil winding machine for fine wire gauges up to 46 S.W.G.; one impregnating plant also required.—Box 7753. [5454

WANTED, valves, TV tubes, televisions, radios, radiograms, tape recorders.—Stan Willetts, 43, Spon Lane, West Bromwich, Staffs. Tel. 2392. [5847

WANTED, HRO coils, Rxs, etc., A.R.88s, BS348s, S27s, etc.—Details to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

WANTED, B.C.610 Hallicrafters, E.T.4336 transmitters and spare parts for same; best prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Gerrard 2504. [5877

WANTED, British and American radio, television and transmitting valves, keenest cash prices paid; what have you to offer? May we quote.—Write or call Lowe Bros., 9a, Diana Place, Euston Rd., N.W.1. [4485

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estb. 18 years.—Call, send or 'phone Ger. 4638 Miller's Radio, 38a, Newport Court, Leicester Sq., W.C.2. [4824

WANTED, EXCHANGE, ETC.

TRANSMITTER.—Converter RT4/APS2, receiver-indicator R-7/APS2, mounting base MT-45/APS2, Antenna assembly AS-5/APS2, racked P.S.U. type 234A, desk control unit type 314, V.H.F. Dipole aerials, etc.
OFFERS to R. Gilfillan & Co., Ltd., 7, High St., Worthing, Sussex. Tel. Worthing 8719 and 30181. [5741

WANTED, signal generators types TF144G, TF517F, TF762A, frequency meters type BC221, TS174, TS175; also receivers types R1359 and R1294.—Send price and details to Hatfield Instruments, Ltd., 175, Uxbridge Rd., Hanwell, W.7. Tel. Ealing 0779/9857. [0037

WANTED, 6 motors by the Leland Electric Company, Ohio; specification—winding series, type D, form BVN JH FR 20, h. ½, D.C. V110, rpm 4,000, temperature rise 55°C, ½-hour rating.—Alexander Pettigrew, Ltd., Atlas Works, Coatbridge, Scotland. [5767

ALL U.S.A. V.H.F. test and communication equipment; TS174, TS175, TS47, B.C.221 freq. meters; receivers 1294, 1359; Hallicrafters S.27, S27CA, U.S.A.; APR4 and tuning units TN16, 17, 18 and 19, RCA AR88D-LF, Hallicrafters SX28; valves 707A-707B, 2K28, 2K39, 2K33, 2K41; highest offers given by return.—Ger. 8410 and 4447, Universal Electronics, 22, Lisle St., Leicester Sq., London, W.C.2. [0229

VALVES WANTED

VALVES purchased for cash, large or small quantities, why not make a parcel of your unwanted valves and send us full details with your price required in your first letter.—Walton's Wireless Stores, 48, Stafford St., Wolverhampton. [0102

METERS WANTED

WE urgently require meters of all types, meter components, test equipment, etc.; any quantity, large or small; prompt cash. ANDERS ELECTRONICS, Ltd., 91, Hampstead Rd., London, N.W.1. Euston 1639. [4663

CABINETS

LEWIS RADIO have the best selection and finest finish.—See page 160. [0224

WALNUT radiogram and television cabinets, soundly constructed; stamp for details.—R. Shaw, 69, Fairlop Rd., Leytonstone, E.11. [5849

REPAIRS AND SERVICE

MAINS transformers rewound, new transformers to any specification.
MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed.
F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 47898. [0113

MAINS transformers, E.H.T.s, chokes, field coils, etc., promptly and efficiently rewound or manufactured to any specification. LADBROKE REWIND SERVICE, Ltd., 820a, Harrow Rd., London, N.W.10. [0222

D. C. BOULTON for repairs to any loudspeaker, specialists on heavy and P.A. types; cone assemblies, field coils, repair accessories, pressure units, microphones; transformers rewound and to specification; motor rewinds.—Lumby St., Manchester Rd., Bradford. Tel. 22838. [0171

PAINTS, CELLULOSE, ETC.

PAINT spraying handbook, 3/6 post free, cellulose and synthetic paints and all spraying requisites supplied; catalogues free.—Leonard Brooks, 53, Harold Wood, Romford. [0207

BUSINESS AND PROPERTY

RECORD, music, radio and photographic, lock-up, main road, S.E. Coast town; H.M.V. and all makes musical instruments, electrical goods, 2 departments and repair dept.; several important agencies; est. 9 yrs., lease 20 yrs.; rent £275 p.a., rates £60, t/o £7-8,000 p.a.; price £3,000 s.a.v.—Box 0749. [5831

WORK WANTED

FREELANCE Draughtsmen require additional electronic work, IDP 13 experience circuits and drawings prepared from models.—Peuleve, Malden 4161, after 6 p.m. [5704

TOROIDAL, layer R.F. winding; polythene moulding; metal work and machining; prototype design and manufacture; A.I.D. approved capacity available.—Bel Sound Products, Co., Marlborough Yard, Archway, London, N.19. Arc. 5078. [0187

CAPACITY AVAILABLE

FACTORY Capacity available for the following categories:
PLASTICS Injection Moulding (3 oz).
ALUMINIUM Die-Casting.
LIGHT Engineering.
ELECTRONIC & Electrical Assembly. Location Wiltshire.—Box 0077. [0114

CAPACITY available for coilwinding, all types. Cable forming, small assembly, group boards, etc.—Box 0496. [5770

FACTORY capacity available Kent, Evesham and Dundee; 100 unskilled women at each; suitable for light assembly work March/May, 1956.—Box 8212, c/o "Wireless World." [5537

PRODUCTION Capacity available approx. 300 hours weekly. A.I.D. approved. Wiring and assembly of electrical/electronic items, test gear, development, etc. Experienced staff. Apply Box 0241. [5738

MISCELLANEOUS

BAND III Converters £4/12/6 trade, guar. 2 years.—G. A. Strange, N. Wraxall, nr. Chippenham, Wilts. [5777

METALWORK, all types cabinets, chassis, racks, etc., to your own specification; capacity available for small milling and capstan work up to 1in bar. PHILPOTT'S METAL WORKS, Ltd. (G4B1).—Chapman St., Loughborough. [0208

YOUR own tape recording transferred to disc 78s or L.P.s. Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio Recordings. [5797

LP & 78 discs from tapes. 30min 42/- unused prof. qual. plastic tape 1,200ft 21/- whilst stock lasts. Trade enquiries also invited. S.a.e. brochure.—SN Productions, 59, Bryanstone St., W.1. Amb. 0091. [5785

FLOWLINE conveyors for disposal in good condition, several units of different lengths available, all complete with motor drive.—Crompton Parkinson, Ltd., Crompton House, Aldwych, W.C.2. Chancery 3333, extn. 103.

WILLIAMSON amplifier and tone control unit, Goodmans AXIOM 22, Barkers 12c speakers, Wharfedale Super 5 and 30-watt cross-over 3,000 c.p.s., Avo test bridge, Avo meter No. 7.—Putnam, Sharnbrook, Beds. Tel. 259. [5862

APS3, APS4 & APS15 Radars complete and wkg., spare units inc. American VE display, Scanners, etc., 725A, 724A, IB24 & 5FP7s. Wanted 3,000 relays, 1000hm; Lacflim or quality horizontal cutter-head.—Crampin, 33, Abbey Rd., Grimsby. [5775

BUILD your own TV and learn about its operation, maintenance and servicing. Qualified engineer-tutor available whilst you are learning and building. Free brochure from E.M.I. Institutes, Dept. WW58, London, W.4. (Associated with H.M.V.) [0180

SUPER-TONIC Sun Ray Lamps, Ultra Violet Infra-Red combined. Superb Therapeutic quality, controlled output, automatic exposure. All mains, listed £7/10—Our price 80/-. S.a.e. for illustrated brochure, Dept. 22, Scientific Products, Cleveleys, Lancs. [5770A

COIL Winding Machine. Neville's. Type Montreal. Only had very little use. Perfect condition including electrical equipment and reel stand. Open to reasonable offer.—The Medical Supply Association, Ltd., 53, Park Royal Rd., N.W.10. Elgar 4011. [0197

NOTICES

BRITISH SOUND RECORDING ASSOCIATION. Details of membership, open to the professional sound recording engineer and all others interested in recording high quality reproduction and other branches of audio engineering, together with details of the London lecture programme and the Manchester, Portsmouth and Cardiff Centres, may be obtained from the Hon. Membership Secretary, H. J. Houlgate, A.M.I.E.E., 12, Strong bow Rd., Eltham, S.E.9. [0031

FINANCIAL PARTNERSHIPS

PARTNER wanted for small but progressive business; must have superior engineering abilities to share work, slight amount of capital expected; Home Counties, development area, housing possibilities.—Box 0107. [5747

PERSONAL

STUDENT requires private tuition for radio and television servicing up to R.T.E.B. certificate.—Box 0416. [5757

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

DESIGN Draughtsman.

A VACANCY exists for a Design Draughtsman to join a group engaged on the design and development of electronic equipment to exacting standards of quality and durability. Applicants should have a H.N.C. in mechanical or electrical engineering as a minimum qualification, together with an adequate background of experience.
CONSIDERATION will also be given to the possibility of engaging less well qualified applicants.
APPLY in writing to The Secretary, Barr and Stroud, Ltd., Anniesland, Glasgow, W.3, under reference 980/T-15. [5761

RESEARCH Laboratory.

ASSOCIATED ELECTRICAL INDUSTRIES. LIMITED.
ALDERMASTON COURT.
ELECTRONICS with physics.—Graduates required to work on electronic circuitry applied to electron physical research, good opportunities for advancement within a large group of companies.
THE laboratory is situated in pleasant rural surroundings near Reading, with a fast train service to London; excellent working facilities and freedom of publication, etc.
PLEASE write for application form quoting reference number EP/G/1 to the Personnel Officer,
RESEARCH Laboratory,
ASSOCIATED ELECTRICAL INDUSTRIES. Ltd., Aldermaston Court, Aldermaston, Berkshire. [5884

SITUATIONS VACANT

DRAUGHTSMEN.

EXCEPTIONAL vacancies exist for junior, semi-senior and senior position in the design and drawing offices 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 0548. [5778

SALES Liaison Engineers.

ENGINEERS who would like to widen their experience and feel they have a flair for selling are offered the opportunity of a career with The Plessey Company Collwinding Division. Applicants, who should be over 28, must possess a sound engineering background. A pleasant personality, good appearance and ability to mix easily are essential qualities. This Division of The Company sells to the radio, television and electronic industries and knowledge of these fields would be advantageous. The appointments carry an excellent salary dependent upon age and experience, are permanent and offer unusual opportunities for advancing in a rapidly expanding organization. The Company offers a generous life assurance and pensions scheme.—Please reply, giving full details, to The Employment Manager, The Plessey Company, Limited, Vicarage Lane, Ilford, Essex. [5745

SENIOR Planning Engineer.

RAPIDLY expanding company located near Aylesbury, Bucks, requires a Senior Planning Engineer to take charge of its radio and electronics planning department. Knowledge of airborne radio and radar equipment essential. —Full details of age, experience, qualifications and salary expected, to Box 0788. [5840

BROADCASTING Engineers.

APPLICATIONS are invited from radio engineers for eventual appointment as broadcasting engineers in the Government broadcasting services of Colonial and Overseas territories.
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.
SUCCESSFUL applicants will receive operational training in the B.B.C. and at any time within two years after initial engagement, they will be required to take up contract appointments with a Colonial or Oversea Government in any part of the world as broadcasting engineers. Choice of territory will be given where possible, but is not guaranteed.
TOTAL emoluments during training in the U.K.—£800 per annum. Salary on appointment to a Colonial territory will not be less than £1,000 per annum plus such allowances as are prescribed under the regulations of the territory concerned.
APPLY in writing to the Director of Recruitment, Colonial Office, Great Smith St., S.W.1, giving briefly age, qualifications and experience. Mention the reference number BCD. 96/02. [5800

SENIOR electronic engineer.

BRUCE PEEBLES & Co., Ltd., East Pilton, Edinburgh, 5, are forming an electronic development group, and have a vacancy for a senior electronic engineer to take charge of the group; applicants should have considerable experience in research and development in electronics and light current engineering; some service in H.M. Forces or at a research establishment on radar will be advantageous; qualifications should include an honours degree in electrical engineering or physics and preferably corporate membership of the Institute of Electrical Engineers; in general, applicants should be in their middle thirties, though a younger man with outstanding capabilities will be considered; the position requires a high degree of responsibility and carries a salary commensurate with this.—Applications, with full details, to Mr. O. L. Robson, Manager, Rectifier Department, at above address. [5865

CINEMA-TELEVISION LTD.

REQUIRE technical assistants and prototype wiremen for an expanding department engaged in the production of the highest grade television transmission equipment, including colour transmission equipment.
THE vacancies are:—
TECHNICAL assistants to possess good fundamental knowledge of television and radio, and to be conversant with the use of laboratory test equipment. Applicants should be capable of deciding own component layout and wiring prototype equipment to a high standard.
PROTOTYPE wiremen, to have good practical knowledge of television and radio technique, and capable of copy-writing to a high standard.
THE work is of an interesting nature as it is allied to prototype production and not quantity production. Good opportunities exist for suitable applicants, pension scheme, 5-day week, good canteen, 25 mins. Charing Cross. —Write, giving full details of experience, age and salary required to Cinema-Television, Ltd., Worsley Bridge Road, Lower Sydenham, S.E.26. [5755

SITUATIONS VACANT

EXPEDITION to Antarctica.

SCIENTIFIC Assistants (Ionospheric) required by FALKLAND Islands Dependencies Survey for service in the Antarctic for 30 months under conditions which are a test of character and resource. Commencing salary according to age in scale £400 rising to £540 a year with all found including clothing and canteen stores. Liberal leave on full salary. Candidates, preferably single and aged 21-28 years, must be of good education and high physical standard and have a real enthusiasm for hard work under trying conditions. They should have a sound knowledge of physics and radio maintenance and preferably hold a physics degree. Selected candidates will undergo three months' training in the U.K. before departure. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M3B/43201/WF. [5841

RADIO Officers required by EAST Africa High Commission Directorate Civil Aviation for one tour 30 to 36 months in first instance with prospect of permanency. Salary scale (including Inducement Pay and present 10% temporary allowance) £772 rising to £1,122 a year. Commencing salary according to experience. Good prospect promotion to Radio Superintendent (salary scale including Inducement Pay and 10% allowance rising to £1,280 a year). Free passages. Liberal leave on full salary. Outfit allowance £30. Candidates must be capable operating at 25 w.p.m. and should hold M.T.C.A. 1st Class Flight Radio Operator's licence or P.M.G. 1st Class Cert. Proficiency or Communicator (M.T.C.A. or equiv.) Knowledge of touch typing for teleprinter an advantage. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41538/WF. [5817

RADIO engineer required for SOCIAL development department, Tanganyika, on contract for tour of 30-36 months in first instance; salary scales (including inducement pay and present temporary allowance of 10% of salary) £898 rising to £1,782 and £1,003 rising to £1,498 a year according to qualifications; gratuity at rate of 13⅓% of total substantive salary drawn; outfit allowance £45; free passages; liberal leave on full salary; candidates, preferably under 35 and possessing a degree or similar qualification, should have experience of high-power transmitting equipment and be able to take charge of 20KW. 1.25KW and 250 watt R.C.A. transmitters at Broadcasting Station.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41312/WF. [5866

SENIOR Design Draughtsmen.

SENIOR design draughtsmen are required for a new Research laboratory of a long-established engineering company being set up in Romsey, Hampshire. The work of the laboratory consists of fundamental studies in various branches of electronics, and draughtsmen are required to work on the design of pre-prototype models and associated test equipment. These posts, which are permanent and progressive, call for men of high-class ability. Salary range from £700 to £950 per annum.—Please reply, giving full details of qualifications and experience, to the Personnel Manager, The Plessey Company, Limited, Vicarage Lane, Ilford, Essex. [5854

HER MAJESTY'S Oversea Civil Service.

ASSISTANT Controller of Posts and Telegraphs —Sarawak.

TO install and maintain all types of telecommunications equipment and systems including land-lines, cables, telephones, teleprinters, carrier, V.F.T. radio (including V.H.F.) and administration of telecommunications and postal services.

PENSIONABLE appointment, in salary range £1,141-£2,009, plus cost of living allowance. Point of entry determined by experience. Free passages provided for officer, wife and up to three children under 18. Four days leave for every month of resident service. Quarters provided: rental £28-£84 per annum.

CANDIDATES shou'd be graduate Members of the Institution of Electrical Engineers or possess a Degree or Diploma recognised by the Institution as granting exemption from Parts A and B of its examinations. Practical experience in telecommunications is necessary.

APPLY in writing to Director of Recruitment, Colonial Office, London, S.W.1, giving briefly age, qualifications and experience. Mention reference BCD 108/24/01.

INSPECTOR OF WORKSHOPS required for BROADCASTING Department, Gold Coast Local Civil Service for one tour of 18-24 months in first instance. Consolidated salary scale £990 rising to £1,230 a year with gratuity at rate £100-£150 a year. Outfit allowance £60. Free passages. Liberal leave on full salary. Candidates must have up-to-date knowledge broadcasting equipment. Should have at least ten years experience workshops practice in radio including five years in large broadcasting organisation, preferably B.B.C. or five years in large manufacturing firm in radio industry. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41020/WF. [5826

SITUATIONS VACANT

RADIO Technician required by CYPRUS Government for service as CHIEF Inspector of Police (Communications Mechanic) on contract for tour 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 M1/37835/WF [5828

FERRY 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, BC433G and Ultra I/C preferred not essential. Modern heated hangar, canteen and assisted travel facilities.—Write partics. Eng.neer Superintendent Ferryfield Airport, Lydd, Kent. [5763

CENTRAL 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

ASSISTANT 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 £1,257 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, HF, VHF, VHF/DF and ancillary 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

HUDDERSFIELD 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. 26TH JANUARY. 1956. [5706

WIRELESS 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

IBM 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

SITUATIONS VACANT

FULHAM and Kensington Hospital Management Committee.
TECHNICIAN required to assist in maintenance of electro-medical apparatus; qualification at least to Ordinary National Certificate; knowledge of mechanical engineering an advantage.
SALARY (at age 26+) £520, rising to £630.
APPLICATIONS with full particulars to Group Engineer (W.W. 43), 5, Collingham Gdns., 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 investigational 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. [5589

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. V.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 computors.
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 computors.
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

SITUATIONS VACANT

ASSISTANTS (Scientific). The Civil Service Commissioners invite applications for pensionable posts.
AGE at least 17½ and under 26 years of age on 1st January, 1956, with extension for regular service in H.M. Forces, but candidates over 26 with specialized experience may be admitted.
CANDIDATES must produce evidence of having reached a prescribed standard of education, particularly in a science or mathematical subject. At least two years' experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces essential in one of the following groups of scientific subjects:—
(i) ENGINEERING and physical sciences.
(ii) CHEMISTRY, bio-chemistry and metallurgy.
(iii) BIOLOGICAL Sciences.
(iv) GENERAL (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).
INCLUSIVE salary scale £280 (at 18) to £575 (men) or £502 (women). Starting pay up to £423 (men) or £385 (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, 30, Old Burlington Street, London, W.1, quoting No. 859/56. Completed applications should be returned as soon as possible and in any case not later than 21st 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 legal 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

SITUATIONS VACANT

TV/service engineer required as permanent staff; ideal conditions; pension scheme.—Newquay Radio Service, 5a, Bank St., Newquay, Cornwall. Tel. 2590. [5863

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 0814. [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 0593. [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) £810 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 mechanics and be able to maintain GL.III 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 quote M2C/41483/WF. [5693

SITUATIONS VACANT

A VACANCY exists for an engineer to take charge of an expanding department engaged on the testing of a wide range of electronic equipment; applicants should have the following qualifications:—
(A) Ability to organise and control staff.
(B) A sound technical background, with preferably a H.N.C.
(C) Experience of V.H.F. and pulse techniques.
(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.
3. CANDIDATES with lesser qualifications but who have considerable experience in industrial design.
4. CANDIDATES under 21 who are at present engaged upon H.N.C. part-time courses.
THE range of work involved is part of an interesting long-term programme in an expanding field and includes:
1. NAVIGATIONAL aids.
2. V.H.F. and U.H.F. transmitters and receivers.
3. PULSE systems.
4. MAGNETIC information recording systems.
5. AERIALS, V.H.F. and U.H.F., for vehicles, aircraft and fixed locations, together with associated feeders and filters.
6. V.H.F./U.H.F. mobile radio equipment.
7 V.H.F./U.H.F. multi-channel radio links.
8 TRANSISTORS and associated circuit applications.
THESE posts are permanent and pensionable, and offer good scope to men of ability. Applications, giving full details of qualifications, age, experience, and indicating in which branch of work interested, should be addressed to Personnel Department (EDL), Murphy Radio, Ltd., Welwyn Garden City, Herts. [5673

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. 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., Barkingside, Ilford, Essex, quoting reference RES.11/55. [5633

McMICHAEL RADIO, Ltd., Slough, Bucks, have vacancies from time to time for electronic engineers to be engaged on Government projects; those wishing to be considered are invited to write fully to the Chief Engineer, Equipment Division. [0198

CQ CQ CQ—A number of ex-radio officers with valid P.M.G. Certificates are urgently required to resume sea service in British merchant vessels; full salary and allowances at current rates; previous sea service taken into account.— Box 0767 [5838

£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, wirers 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

SITUATIONS VACANT

ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, requires a SENIOR ASSISTANT (SCIENTIFIC) in the General Physics Division to assist a small group in mechanical design and electrical testing of components of electronic valves needed in the High Energy Accelerator programme.
G.C.E. Ordinary level in four subjects including Science, or equivalent, is essential, and experience in vacuum practice and electronics as encountered in the radio transmitting valve industry is desirable.
SALARY: £618—£843.
CONTRIBUTORY pension scheme; 5-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 legal expenses incurred in house purchase will be available.
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. Advg., 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.—Box 1023. [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 £700 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 Agents with a 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 partics. 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, mtce., and developt., of electrical apparatus for high temp. studies of clays; knowledge of elec., instals., 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. [5810

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

SITUATIONS VACANT

OPPORTUNITIES are available for radio engineers, with several years' experience in development laboratories or forces workshops, to train as television transmitter installation and maintenance engineers. APPLICATIONS, giving brief details of qualifications and experience, should be addressed to Chief Engineer (ref. TXM), Pye, Ltd., St. Andrew's Rd., Cambridge [5808

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, The 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 schemes 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.) [5845

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; canteen facilities; state full details of experience and when available for interview; expenses paid.—Box 0243. [5739

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 microwaves, 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 980a/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. Advg., 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 electrics 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 Fairey 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 £600-£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

LONDON COMPUTER LABORATORIES

FERRANTI LTD.

DESIGN ENGINEERS
DEVELOPMENT ENGINEERS

Interesting vacancies have arisen in the Engineering Division of this rapidly expanding organisation for Mechanical and Electrical Engineers. The work covers most aspects of light mechanical engineering, precision mechanisms, electro-mechanical devices, the engineering of electronics, special components and tools for their production, light production machines, automatic controls and instruments.

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
FERRANTI LIMITED

have vacancies for

SENIOR DESIGN DRAUGHTSMEN

and

DRAUGHTSMEN

for

(1) Electronic Equipment.

(2) Mechanisms and Light Machines.

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 N. London laboratory; good salaries and permanent pensionable position; applicants' travelling expenses refunded.—Write stating qualifications J. F. Crosfield, 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. THE commencing salaries offered will be according to individual qualifications and experience and the general level of salaries in the organisation and its conditions of employment will be found to be attractive. PLEASE apply in writing to the Personnel Officer, The Mullard Radio Valve Co., Ltd., New Road, Mitcham Junction, Surrey. Quoting reference—GBK/S.7. [5835

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. Pension scheme 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, ground 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 electronics 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 Amplivox, Ltd., Abbey Mnftg. 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 ENGINEER

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.

A PROGRESSIVE CAREER WITH AN EXPANDING ORGANISATION is offered in one of the following fields to engineers of ability and suitable design experience:

INSTRUMENTATION AND COMMUNICATIONS EQUIPMENT, ELECTRO-MEDICAL EQUIPMENT.

SENIOR DEVELOPMENT ENGINEERS are required to undertake a responsible part in the design of a wide variety of specialised equipment. Candidates should preferably possess an honours degree or the equivalent.

DEVELOPMENT ENGINEERS are also invited to apply for a number of posts of varying seniority and requiring qualifications ranging from O.N.C. to degree standard. Specialised experience in one of the above fields is an advantage but is by no means essential.

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,

R. B. PULLIN & COMPANY, LTD., GREAT WEST ROAD, BRENTFORD, MIDDLESEX.

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

WIREMAN.—There are a number of positions available within a Guided Weapon organization for all grades of wiremen, one 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. Applications, containing 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, Allesley, Coventry, requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments, for work on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager, Ref. R.G. [0259

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

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, qualifications, age, to Box 0819. [5842

MINISTRY OF SUPPLY, London, requires experimental officer for security classification 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., Technical 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 prospects exist.—Please write, giving full details of age, qualifications and previous experience, quoting Ref. 74, to: The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5709

ELECTRONICS engineer; an experienced engineer is required for design and development work on part of a guided weapon system; this is a post of great interest and responsibility; rapid promotion is possible for a man of initiative and 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. 73, to: The Personnel Manager (Technical Employment), de 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; starting salary £74 per month; wife of new employee 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 and medical attention provided free; a staff assurance scheme is in operation.—Write, stating 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 preferable and specialist knowledge of either Electrical Engineering or Electronics, or Servo-mechanisms. Salary in accordance with Burnham Technical scale for Assistant B. Starting salary according to qualifications and experience; £115 non-pensionable allowance. Teacher's Superannuation. 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 control 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 required by Air Ministry Establishment in Norfolk for development and adaptation of radio equipment pulse techniques including aerials, power supplies and displays. Applicants 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 advantage. 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). Application forms from 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

Appointments with the British Tabulating Machine Company Limited, at Letchworth, Herts.

ELECTRONICS

In keeping with its expansion programme and ever increasing use of electronics for accounting and statistical problems, this Company, already well established in this field, is looking for a few senior men able to take charge of design and development of electronic calculating and computing machinery.

Desired qualifications include a recognised degree in electrical engineering, physics or mathematics and practical experience in the use of electronics, preferably as applied to computing techniques.

Applications should be addressed, 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 are 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 electronics 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 advantage. 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-£960.—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 tour paid; passages, furnished quarters and medical attention provided free; a staff assurance scheme is in operation.—Write, stating age and experience, to Box E3533, Whites, 72/78, Fleet St., London, E.C.4. [5833

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. [5756

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 £800 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 is 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

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 Q 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 £25 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 one month, then 11-21 days in port. Applicants should have sound knowledge radio/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, 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. [5750

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 Chief 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 or 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 African 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., providing 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-sixteenth 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. [5694

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 hons. 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 or some closely allied electronic equipment. Post B, first- or second-class hons. 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. [5858

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