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27M1 and 27M2

for light operated relays, film scanning, facsimile transmission, and many Research and Laboratory investigations involving low light levels.

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Either the 27M1 or the 27M2 may be used as a plug-in replacement for the American type 931A. A special stabilised power unit providing a highly stable H.T. supply for photo-multipliers is available.

Full details on request.

EDISWAN

MAZDA
RADIO DIVISION
THE EDISON SWAN ELECTRIC COMPANY LIMITED
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For the detection of frequency modulated signals it is necessary to convert frequency changes into amplitude changes and to recover the intelligence contained in the original signals from the amplitude modulated carrier. The method most widely used for this purpose employs a form of phase discriminator known as the ratio detector. The particular advantage of the ratio detector is its excellent suppression of any amplitude modulation which may be present on the F.M. carrier as a result of noise or variations of gain in the earlier stages of the receiver. This type of circuit has good sensitivity and eliminates the expense of providing additional limiting stages.

A typical form of ratio detector circuit is shown in Fig. 1, and it will be noted that two diodes with independent cathode connections are necessary. The Mullard EABC80 is recommended for use in this type of circuit. This valve is a combined triple diode and voltage amplifying triode, with a heater rating of 6.3V, 0.45A, and it is mounted on the B9A (noval) base. One diod (a'd) is provided with a separate cathode (pin 3), the other two diodes and the triode sharing a second cathode (pin 7). The ratio detector circuit employs two of the diodes (a'd and a''d) which have low impedances (about 2000) whose ratio never exceeds 1.5. The other diode (a'd) is suitable for use in A.M. reception as a conventional detector and generator of A.G.C. voltage. The triode section is designed to be used as an audio amplifier following the detector during both F.M. and A.M. reception. Its electrical characteristics are similar to the triode section of the Mullard EBC41.

In the circuit illustrated, the primary winding L1 of the ratio filter is in the anode circuit of the final I.F. valve. The secondary coil, L2, is tuned to the intermediate frequency (10.7 Mc/s). The voltages in the two halves of L2 have a 180° phase difference, and their magnitudes depend upon the sweep frequency of the F.M. signal. The tertiary winding, L3, consisting of a few turns wound over the anode end of the primary, matches the anode circuit of the preceding I.F. stage into the diode circuit.

The ratio detector can take the form of a balanced circuit in which two equal capacitors are placed across the load resistor, R3, and their common connection taken to earth. In Fig. 1 the unbalanced type of circuit is given. Here only one capacitor, C1, has been retained, from which the audio output is taken. The 5µF electrolytic capacitor, C3, is then necessary to stabilise the voltage across R3.

The value of load resistance (56kΩ) is a compromise between that required for optimum gain and the necessary A.M. suppression. Good A.M. suppression is also achieved by using a relatively high resistance, 1.2kΩ, in series with the tertiary coil. Further increase in the value of load resistance (say, to 68kΩ), whilst resulting in larger output voltage, requires more satisfactory balancing in the preceding circuit in order to keep the rejection of A.M. to an acceptable value. Thus a trimmer capacitor could be connected from the centre-tap on the secondary to earth, and a small series resistance included in the lead from the centre-tap to the tertiary coil L3. These modifications will lead to a considerable improvement in suppression and some increase in sensitivity, but the preliminary adjustments to the trimmer are much more involved.

As a further refinement, some suppression can be sacrificed by connecting the stabilising capacitor across only a part of the total diode load (Fig. 2). With suitable values for R4 and R5 the suppression will depend to a much smaller extent on spreads in the forward resistance of the diodes and on variations in the amplitude.
Authority and Independence

We have now had ample time to study the new Television Act, which became law just after our last issue appeared. The Government’s plan for an “additional” television service, though somewhat involved, is not on the face of it, difficult to understand, though we must admit to doubts as to how some of the details will work out in practice.

To us, the most interesting section of the Act is that in which the Postmaster-General is given what appears to be very wide powers over the technical activities of the Independent Television Authority. In this matter, at least, there appears to be little independence and no authority! Of course, it is a fact that in Great Britain the P.M.G.’s power over every form of radio activity is sweeping; he may make regulations prescribing “the things that are to be done or are not to be done” by any one of his licensees. Of course, he may intend to keep these powers up his sleeve, and allow the I.T.A. as much technical autonomy as is enjoyed by the B.B.C. If he does not, one is tempted to ask, what is the purpose of the I.T.A.? It would surely have been less wasteful of national resources and effort to leave the technical means of television distribution in the hands of the B.B.C. The Government’s quarrel with the B.B.C. monopoly was that it represented a monopoly in the dissemination of ideas; that objection would have been overcome much more economically by setting up a chain of transmitters operated by the B.B.C. but fed with programmes under the control of a truly independent body getting its revenue from advertisements.

The Post Office decision, announced before the new Authority came into being, that the I.T.A. transmissions were to be polarized like those of the B.B.C. in the same areas, may or may not lend colour to the idea that the P.M.G. intends to make himself responsible, not only for controlling technical policy, but for shaping it as well.

Further support for the same idea comes from the fact that one of the members of the Authority has any radio-technical qualifications or experience, and so must depend entirely on the engineering staff they may appoint or on outside advisers. And, of course, there is still another body that comes into the picture: the P.M.G.’s decisions on technical policy for both the I.T.A. and B.B.C. will be affected by the recommendations of the Television Advisory Committee.

Fortunately, there is a good deal of flexibility in the Act, and plenty of room for second thoughts. The word “may” occurs much more often than “shall” and the P.M.G. can make new regulations at short notice. Throughout all the debates, the Government has wisely kept to the principle of leaving a loophole for subsequent changes.

It is wrong to shoot the pianist who is doing his best, and still worse to shoot him before he has played a single note. The I.T.A. needs the full support of everyone concerned with radio in implementing the complicated scheme laid down in the Act. Wireless World’s only fear is that, with so many secondary problems to overcome, attention may be distracted from the primary task of planning the long-term technical development of television.

Radio Eavesdropping

A GOOD deal of publicity has been given in the daily Press to a recent case in a London magistrate’s court, where two men were charged with contravening the section of the Wireless Telegraphy Act that forbids the interception and disclosure of messages. It was stated they had listened to police and fire-service v.h.f. transmissions and passed on information so gained to news agencies and fire assessors. The defendants, who pleaded guilty and said they had no idea they were acting unlawfully, were ordered to pay £8 8s and £2 2s costs, respectively.

Newspapers, in reporting the case, made play with the fact that this was the first prosecution of its kind. That may be true enough, but no new principle is involved. Lack of secrecy has always been a skeleton in the radio cupboard and for 50 years the Postmaster-General has rightly had the power (which he has used widely) to make regulations against unauthorized interception and disclosure of messages.
The Television Act

Summary of the Main Provisions

Well over two years ago, the Government first declared their intention of establishing a new television service, alternative to that conducted by the B.B.C. Two basic principles for the proposed scheme were affirmed by Government spokesmen: it was to be competitive and was to be financed by advertisements. Since then, many methods of attaining the desired end have been debated, only to be abandoned or modified later; even the basic principles have been watered down to some extent. Now, at last, a cut-and-dried plan has appeared in the final form of an Act of Parliament. In view of all the changes that have taken place and in spite of the vast number of words that have been written in the Press, readers may like to have a summary of those provisions of the Act most likely to affect them.

The Television Act, 1954 (H.M.S.O., price 9d) makes "provision for television broadcasting services additional to those provided by the British Broadcasting Corporation, and to set up a special authority for the purpose... to be called the Independent Television Authority." The I.T.A. is to provide, for the period of 10 years, television services "of high quality, both as to the transmission and as to the matter transmitted," and shall be composed of a chairman, deputy chairman and eight others. These under the chairmanship of Sir Kenneth Clark have now been appointed by the Postmaster-General. They comprise an assemblage of persons distinguished in the Arts, literature, industry and the world of affairs. It is stipulated that none of them shall have any interest in an advertising agency, in the selling of radio equipment or in programme contracts. The members are to be paid, and, in addition to membership, may perform other salaried work in the Authority.

The I.T.A. is to be a "body corporate" but not a body exercising functions on behalf of the Crown. It enjoys no special privileges under the Wireless Telegraphy Act, and will need the Postmaster General's licence for its stations. The aim is that the Authority shall be financially self-supporting as soon as possible, but it may be granted by the P.M.G. up to £750,000 a year. Initial capital expenditure is to be met by a grant of up to £2M, spread over five years.

First and foremost, the function of the I.T.A. is to build and operate television broadcasting stations. It must also arrange for studios to be provided, or if need be, itself provide them. By arrangement with the P.M.G., the I.T.A. may also arrange for wired distribution of programmes through relay companies.

Provision of programmes is primarily a matter for "programme contractors," but the Authority itself may when necessary transmit its own material, in which paid advertisements may be inserted. The programme contractors will, in effect, "buy time" from the I.T.A., recouping themselves by charging fees for advertisements which will be transmitted during the intervals between items or at natural breaks in the programmes. There is to be no "sponsoring"; advertisements must not be directly associated with the programmes.

The matter of the programme contracting companies is still somewhat obscure. From our point of view, virtually all we know from the Act is that it will be the duty of the I.T.A. to secure "adequate competition" between a number of them to supply programmes. It is not known how the time of the various I.T.A. stations is to be divided between the various contractors.

Wide powers of control over the contractors are conferred by the Act on the I.T.A., who may impose heavy penalties for breach of contract. They are bound by the Act to observe certain rules as to the pay and conditions of their staff. The Authority, in its turn, is subject to pretty drastic Government control of their day-to-day activities. The P.M.G. or any other Minister of the Crown may require them to broadcast any announcement, while the P.M.G. may at any time impose a ban on the broadcasting of "any matter or classes of matter." He also has the power to determine the hours of broadcasting, both as to maximum and minimum hours per day and as to the actual times of the transmissions.

On the technical side the Authority is subject to equally rigorous control under the powers conferred on the P.M.G. by the Act. They may be required to use "such technical measures or processes as may be specified" or to set up additional stations thought to be necessary to extend coverage.

There are a number of secondary provisions, including permission for the I.T.A. to do various things arising out of its main function and to embark on ancillary business enterprises that may be found necessary. The I.T.A. must not, however, manufacture or sell radio equipment.

The rest of the Act—in fact, the greater part of it—is concerned with detailed control of broadcast matter. An obligation is put on the Authority to see that programmes do not offend good taste or decency, do not incite to crime or lead to disorder or offend public feeling. They also have the responsibility of ensuring balanced programmes, of presenting news accurately and impartially and of showing no political bias.

Resistor and Capacitor Preferred Values

A British Standard for the preferred values and tolerances of resistors and capacitors used in telecommunications equipment is now obtainable from the British Standards Institution, 2, Park Street, London, W.1 (price 2s.). The standard specifies a series of rounded values based on the 12th root of 10 system and with tolerances of 5, 10 and 20%. The 10% series is compiled by omitting alternate terms in the "s" series; likewise the 20% omits alternate terms in the 10% series.

While the 20% series is well known the other two are possibly not common knowledge and we give below the 5% series. Values are in ohms for resistors and in picofarads for capacitors.

**Five per cent values:** 1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2 and 9.1. The other two series start with 1.0 and are thus easily compiled from this list.
Jubilee of the Valve

IT WILL be fifty years on November 16th since Sir Ambrose Fleming took out the fundamental thermionic valve patent, No. 24850—"Improvements in Instruments for Detecting and Measuring Alternating Electric Currents." To mark the jubilee the I.E.E. has arranged an exhibition of historical apparatus and three lectures on the development of the valve will be given by Sir Edward Appleton, Professor G. W. O. Howe and Dr. J. Thomson.

The lectures will be given on the actual anniversary and the proceedings will be opened by the Lord President of the Council, the Marquess of Salisbury.

Ionospherists Meet

AS already announced a conference on "The Physics of the Ionosphere" is being organized by J. A. Ratcliffe, F.R.S., reader in physics at Cambridge University, in collaboration with the Physical Society. It will be held at the Cavendish Laboratory from September 6th to 9th, and will be devoted mainly to discussions of the following topics: (a) the lowest ionosphere; (b) irregularities and movements in the ionosphere; (c) the F2 layer; (d) the mathematics of wave propagation through the ionosphere.

As the conference follows the meeting of the International Scientific Radio Union at Amsterdam many foreign delegates will be among the 200 or more participating.

Abstracts of the sixty papers presented and the surveys summarizing the present position in each of the subjects discussed will be published later by the Physical Society.

U.S. Colour Television

THE cost, and more especially, the size of the three-colour tube have been cited as the main reasons for the slow "get-away" of colour television in the United States. So far colour tubes have had only comparatively small screens and have, therefore, been unacceptable to viewers who have become accustomed to 21-in and even larger monochrome screens.

Answers to both criticisms have been given by C.B.S.-Hytron who have produced a 19-in tri-colour tube at $175. The principle employed for the production of these tubes, which, it is stated, will be at the rate of 400 a day by the end of September, was briefly described in our January issue.

Radio Research

A START was recently made on the new building to be erected for the Radio Research Station of the D.S.I.R. at Ditton Park, Slough, Bucks.

Naturally everything is being done to reduce interference to a minimum. The building is over 200 yards from the nearest road, the adjoining 100 acres has been acquired to ensure isolation and as a further precaution to minimize disturbance with experimental work, the waste outlet from the building will be conveyed in a non-metallic pipe to the main district sewer.

The building has been designed specifically to meet the requirements of the Radio Research Station, of which Dr. R. L. Smith-Rose is the director with a staff of just over 100 who are at present in temporary accommodation.

Increased Exports

THE radio industry's exports during the first six months of the year increased by £2.25M compared with the same period in 1953. Of this figure £1.7M was accounted for by increased exports of communication and navigational equipment which totalled £5,974,841—approximately 46 per cent of the whole industry's exports. Increased exports are also recorded for components (£893,000), p.a. equipment and loudspeakers (£58,000) and sound reproducing gear (£38,000).

The six-months' total was £12,996,603.

Industrial Television

INCREASING use is being made by leading U.S. industrialists of closed-circuit television for nationwide sales conventions. Instead of salesmen and distributors from all over the country travelling at considerable expense to a central meeting they merely
go to the studios of local television stations, which are linked with a central station where the company's executives are gathered to present their wares.

According to a report in the *Financial Times* on the activities of Box Office Television, Inc., which specializes in such "telecast conventions," Westinghouse Electric recently saved $375,000 by introducing its new receivers and appliances to 2,000 distributors through a television convention.

**Valve Data**

ELECTRICAL characteristics and base connections of over 2,000 British and American valves and British transistors and some 200 cathode-ray tubes are given in the latest edition of "Radio Valve Data." The valves are classified under main headings according to their type—frequency changers, screened tetrodes, pentodes, etc. In each of these sections, they are listed under makers' names and are further classified as current, replacement or obsolete types.

Seventeen British valve manufacturers co-operated with *Wireless World* in ensuring that the information is accurate and up to date. Additional features included in this edition are a list of equivalents, which is combined with an index, and special quality valves.

* "Radio Valve Data," fourth edition, 100 pages (11in x 81/2in), published for *Wireless World* by Iffie & Sons Ltd., price 3s 6d.

**PERSONALITIES**

Sir Ben Lockspeiser, F.R.S., secretary of the Department of Scientific and Industrial Research since 1949, is to receive the honorary degree of Doctor of Science at Oxford University. The presentation will precede the opening of the 116th annual meeting of the British Association for the Advancement of Science on September 1st.

E. P. B. Metcalfe, appointed engineer-in-charge of the Isle of Wight television station, which is coming into service in November, has been engineer-in-charge of the temporary Brighton station since May last year. He joined the B.B.C. in 1936 and was a maintenance engineer at various sound stations before becoming senior maintenance engineer at the Wenvoe television station in 1952.

E. J. Power, head of Murphy Radio, has been invited to become a member of the Council of the Royal College of Art. This may be taken as a tribute to the part played by his firm in the development of modern art; it was in the early thirties that Murphy first produced a receiver cabinet that set a new standard in functional external design.

J. P. Salter, the contributor of the article in this issue on the measurement of small voltage differences, is a senior engineer in the Armament Design Establishment of the Ministry of Supply. He served throughout the war in the Royal Artillery as an instructor in fire control (anti-aircraft radar). Before joining the Ministry of Supply for work on fuses, on which he was engaged for six years, he was for a short time at R.R.D.E., Malvern.

C. E. Knight Clarke, who had been publicity manager for Decca Radar for two years, is now running his own business producing technical literature. Before joining Decca's he was with the G.E.C. publicity organization, where he handled the production of radio and valve technical literature. His address is 36, Denbigh Street, London, S.W.1. (Tel.: Victoria 5394.)

**IN BRIEF**

The increase in licensed viewers in the U.K. during the first six months of the year was 454,200. The June increase was 13,512,725. The total number of Broadcast Receiving Licences at the end of June (including the above and 236,057 for car sets) was 13,512,725.

November 12th has been given by the B.B.C. as the date for the opening of the Isle of Wight Television Station. When this permanent station at Rowridge comes into service the temporary booster transmitter on Trulzhill, near Brighton, which has been in operation since May, 1953, will be closed down. The new station will operate in Channel 3 (56.75 and 53.25 Mc/s) and use vertical polarization as the Brighton booster has done.

The ninth Electronics Course covering the design, use and maintenance of electronic instruments used in nuclear physics, radio chemistry and in work with radio isotopes, will be held at the Isotope School, at Harwell, from November 1st to 5th. Physicists and electronic engineers, holding a degree or equivalent qualification, can obtain application forms from the Electronics Division, A.E.R.E., Harwell, Didcot, Berks. Attendance is limited and the fee is 12 guineas, excluding accommodation.

The operating frequency of the Lugo, Spain, Consol Station has been changed from 303 kc/s to 285 kc/s. The Seville station recently changed from 311 to 315 kc/s.

**I.E.E. Students.—**The new chairman and vice-chairman of the London Students' Section of the I.E.E. are M. C. Gubbins (Pye, Ltd.) and M. H. F. Collins (B.T.-H.), respectively.

**I.P.R.E.—**At the inaugural meeting of the Yorkshire section of Incorporated Practical Radio Engineers (previously the Institute of Practical Radio Engineers), over 150 servicemen and traders were present. The local secretary is P. A. Senior, 5, Calverley Moor Avenue, Thornbury, Bradford, 3.

A miniature TV camera, manufactured by Pye, Ltd., was used recently at the Hospital for Sick Children, Great Ormond Street, London, to enable 100 surgeons to watch a series of operations. The surgeons were attending the inaugural meeting of the British Association of Pediatric Surgeons.

A new Third Programme Transmitter is to be built by the B.B.C. at Swansea, Glamorgan. Rated at 1 kW, it will operate on 1546 kc/s (194 metres).

**Tape Letters.—**A miniature spool of 120ft of tape, weighing less than 1½ oz and, therefore, particularly suitable for recording messages for posting, has been produced by Grundig. The "Mailspool," which permits six minutes recording on each track at 34 in/sec, costs 6s 9d (export price 4s).

**Hungarian TV.—**Preparatory to planning the country's television service experimental transmissions are being radiated in Budapest. Some 200 foreign-made television receivers are said to be in use in the city for this investigation.

**Indian Manufacturers.—**A new class of membership—associate members—has been introduced by the Radio Manufacturers' Association of India to provide for smaller manufacturers. The member-firms constituting the R.M.A.I. committee are:—General Electric Company of India; Gramophone Company; International General Electric Company (India); Murphy Radio of India; National Ekco Radio & Engineering Company; Philips Electrical Company (India) and Radio & Electrical Manufacturing Company.

**Glass being one of the many raw materials used in radio and electronics, we make no apology for drawing readers' attention to the information centre provided by the Glass Manufacturers' Federation at its new headquarters at 19, Portland Place, London, W.1.**

**Electronic Cooking.—**The first electronic bakery in France is being set up by the French Ministry of Agriculture in Paris. It is planned to produce up to 30 tons of bread a day. Radio-frequency cooking has been used on a small scale in the United States for the commercial preparation of foodstuffs, but, according to our contemporary, *Electronics*, domestic r.f. cookers are being "home tested," and mass production at $1,000 each is planned for 1955.

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“W.E.” Editorials—The index to Dr. Howe’s editorials in Wireless Engineer during the past twenty-eight years, to which we referred last month, has been prepared personally by Dr. A. J. Small, of the Department of Electrical Engineering, The University, Glasgow, W.2. We omitted to state that the index, which is obtainable direct from Dr. Small, costs 5s.

No fewer than 2,500 British Standards, current at March 31st, are listed and briefly described in the 1954 edition of the “British Standards Yearbook.” It also gives particulars of work in hand by the various Industry Standards Committees. The Yearbook is obtainable from the British Standards Institution, 2, Park Street, London, W.1, price 12s 6d.

Readers concerned with the Transport of Goods may like to know of the publication of the new “ABC Goods Transport Guide,” published by Motor Transport. It includes a directory of operators of regular, long-distance road transport services and of specialist carriers. It costs 3s 6d (inc. postage).

Nottingham Central Library has issued a catalogue of some 200 books and periodicals on radio, television and radar which are available through its various branches. Journals are kept for three months, except in the case of Wireless Engineer, which is available from 1936, and Wireless World for the past six years.

EDUCATIONAL OPPORTUNITIES

The course of ten lectures on “Crystal Valves and Transistors” at the Borough Polytechnic, London, S.E.1, which proved so popular last year that it was run in triplicate with a total attendance of some 300, is being given in duplicate this year. The lectures, by members of the Mullard research and development staff, will be given on Tuesdays at 3.0 and 7.0 beginning on October 19th. The fee is 2 guineas. For the fourth successive year the Borough Polytechnic is also arranging a course of lectures on “The Fundamental Principles of Pulse Techniques.”

A thirteen-week intensive Course in Electronics, designed to give those unable to take a long course an insight into the underlying principles and some of the applications of electronics, is provided by the Norwood Technical College, London, S.E.27. The college also provides a three-year full-time course in telecommunication engineering, one-year courses for the 1st and 2nd Class P.M.G. Certificates, and part-time day and evening courses in radar principles and techniques, radio and television servicing, television theory and for the Brit.I.R.E. Graduate examination.

The prospectus of Evening Courses arranged by the Electrical Engineering Department of The Polytechnic, Regent Street, London, W.1, includes approved telecommunications courses for the award of the Ordinary and Higher National Certificates and courses in radio and television servicing in preparation for the examination of the Radio Trades Examination Board.

Day and Evening Classes covering communication engineering (National Certificate courses), City and Guilds telecommunication engineering, and radio and television servicing, are listed in the prospectus of the Department of Electrical Engineering and Applied Physics of the South East London Technical College, Lewisham Way, S.E.4.

Amateur Classes—We have been notified of a number of establishments providing classes during the coming session in preparation for the Radio Amateurs Examination. Among them are the Wembley Evening Institute, Copland School, Wembley Hill, Middx. (Mondays); Ilford Literary Institute, Cranbrook Road, Ilford, Essex (Wednesdays); South East London Technical College, Lewisham Way, S.E.4 (Tuesdays); and the Grafion School, Eburne Road, Holloway, London, N.7 (Mondays). Courses commence on or after September 20th.

The recently formed Electrical Section of the Wilsmslow Guild (Adult Education Centre), 1, Bourne Street, Wilmislow, Cheshire, is planning a series of classes of instruction in electronics. They will be held at 8.0 on Tuesdays beginning September 28th.

RADIO EXPORTS

Among the eight members of the new Export Panel formed by the British Standards Institution to advise on standards in relation to exports and how best B.S.I. can assist export trade are J. W. Ridgeway, of Edison Swan, and Leslie Gamage, of the G.E.C.

Navigational radar equipment, radio transmitters, receivers and associated test equipment are to be supplied by Marconi’s for five warships of the Egyptian Navy.

Radio-telephone equipment, including a 15-W fixed station, three smaller fixed stations and five mobile transmitter-receivers, has been supplied by Pye, Ltd., to the Lisbon Tramway Company.

Radio equipment, including receivers, transmitters, teleprinters, terminal equipment and aerials, is listed among the products to be secured by the Burma Purchasing Mission to visit this country.

U.S. Enquiry.—Details of British-made industrial electronic equipment, inter-communication systems and p.a. gear are being sought by Warrington, Woodcock and Williams, Inc., 423, South 11th Street, Minneapolis, Minnesota, U.S.A. Interested manufacturers should send literature and c.i.f. prices in U.S. dollars by airmail.

Colombian Agency.—Casa Diurna Ltda, Edificio Banco de Bogota, Oficina 632, Bogota, Colombia, have informed the British Embassy at Bogota that they are interested in
COMMERCIAL LITERATURE

Core Laminations made by Magnetic and Electrical Alloys are now available from H. W. Forrest, 349, Haslucks Green Road, Shirley, Birmingham, who are sole distributors in England. The latest catalogue of chokes and transformers from this firm includes isolating transformers for the heaters of c.r. tubes with heater-cathode shorts.

Transformers and Chokes as specified for the Osram 912 amplifier (see p. 430) are described in a leaflet from Partridge Transformers, Tolworth, Surrey.


Powder Cores and Magnets; their production and use described in a booklet "Gecalloy Low Loss Cores and Micropowder Magnets" which also gives technical specifications, performance graphs and suitable core designs for various applications. From Salford Electrical Instruments, Peel Works, Silk Street, Salford, 3, Lancs.

CLUB NEWS

Birmingham.—At the meeting of the Slade Radio Society on September 3rd, A. B. Cape, M.B.E., will speak on "The Balancing of Rotors." The subject for the meeting on September 17th is "The Possibilities of Inter-Planetary Travel," introduced by W. E. Merril. Meetings are held on alternate Fridays at 7.45 at the Church House, High Street, Erdington, 134, C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

QRP Exhibition.—Plans are being made by the QRP Society to hold an exhibition at Walton-on-Thames on October 30th. In addition to displays of amateur-con-structed gear—including television—there will be exhibits of components and commercial sound and vision receivers. Provisions are being made for the demonstration of high-fidelity equipment and radio-controlled models. The exhibition will be held in St. Mary's Parish Church Hall, admission 1s. Sec.: J. Whitehead, 92, Rydens Avenue, Walton-on-Thames, Surrey.

South Shields.—The opening meeting of the winter programme of lectures and demonstrations for members of the South Shields and District Amateur Radio Club (G3DD1) will be held at 8 on September 10th in the Trinity House Social Centre, 134, Laygate Lane, South Shields. The club is installing transmitting equipment at the South Shields annual flower show (August 26th to 29th) which will be in operation in the 20-, 40- and 80-metre bands, using the specially allocated call-sign GBSFS. Sec.: W. Dennell (G3ATA), 12, South Frederick Street, South Shields, Co. Durham.

MEETINGS

British Institution of Radio Engineers

London Section.—"Computing Circuits in Flight Simulators," by Dr. A. E. Cutler, B.Sc. (Redifon), at 6.30 on September 29th at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.

British Sound Recording Association

London.—Presidential address by N. Leevers, B.Sc., at 7.00 on September 24th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Manchester Centre.—"New Reproducing Equipment," by J. S. Holiday, at 7.30 on September 13th at the Engineers' Club, Albert Square, Manchester.

WIRELESS WORLD, SEPTEMBER 1954
V.H.F. Broadcasting : B.B.C. Plans

COVERAGE OF FIRST NINE F.M. STATIONS

A ROUGH idea of the approximate areas to be covered by the first nine v.h.f. stations which the Government has at last sanctioned can be gained from this sketch map, based on information provided by the B.B.C. At each of the nine stations six transmitters will be installed—two in parallel for each of the three programmes to be radiated. The first station to be brought into service will be at Wrotham, Kent, where there are already two transmitters which have been used experimentally since 1950. It will be in operation next May. The other eight stations, which will be at the sites of the existing and projected television stations and will use the same masts, are to be completed by the end of 1956. Pontop Pike and Divis will be the second and third stations to be brought into operation.

Details of the frequencies to be used have not yet been announced by the B.B.C. It is, however, presumed they will be within the framework of the Plan for Band II drawn up at Stockholm in 1952, although, in fact, the U.K. was not a signatory to the Plan because at that time it was not known what method of modulation would be employed. The frequencies allocated to each of the projected transmitters in the Stockholm Plan are tabulated below. The figure in brackets is the effective radiated power in kilowatts.

The B.B.C. has already placed orders with Marconi's and S.T.C. for 64 transmitters varying from 1 to 10 kW.

<table>
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<tr>
<th>Station Description</th>
<th>Frequency (MHz)</th>
<th>Effective Radiated Power (kW)</th>
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<tbody>
<tr>
<td>Wrotham, Kent [120]</td>
<td>89.1</td>
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<tr>
<td>Pontop Pike (Newcastle) [60]</td>
<td>88.5</td>
<td>90.7</td>
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<tr>
<td></td>
<td>90.1</td>
<td>92.9</td>
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<tr>
<td>Divis (Belfast) [60]</td>
<td>88.7</td>
<td>90.9</td>
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<tr>
<td></td>
<td>90.3</td>
<td>92.5</td>
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<tr>
<td>South Devon [60]</td>
<td>88.1</td>
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<tr>
<td></td>
<td>90.3</td>
<td>92.5</td>
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<tr>
<td>Meldrum, Aberdeenshire [60]</td>
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<td>90.3</td>
<td>92.5</td>
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<tr>
<td>Holme Moss (Manchester) [120]</td>
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<td></td>
<td>90.1</td>
<td>92.7</td>
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<tr>
<td>Sutton Coldfield (Birmingham) [120]</td>
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<td></td>
<td>90.5</td>
<td>92.7</td>
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<tr>
<td>Norwich, Norfolk [120]</td>
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<tr>
<td></td>
<td>91.1</td>
<td>93.3</td>
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Wireless World, September 1954
## 21st National Radio Show

**STAND-TO-STAND PREVIEW OF TECHNICAL EXHIBITS**

The annual exhibition of British domestic radio equipment opens at Earls Court on August 25th. The preview of technical exhibits presented in the following pages differs from that given in the past few years in that it is a stand-to-stand report instead of a tabulated list of products. Prepared from information given to us by exhibitors, it will inevitably be incomplete in that there are bound to be a few manufacturers who will await the actual opening of the show to uncover their latest productions. Despite this, we feel that the following pages will provide a useful guide to visitors and a comprehensive survey for readers unable to attend the show.

The Radio Industry Council, which organizes the show, has again arranged for collective displays of electronic equipment. There are four such displays — two on the ground floor (marked E1 and E2 on the plan opposite) and two on the first floor (E3 and E4). The exhibits will not, this year, be grouped together under "applications" except in the case of radio control gear. In all some twenty-five examples of applied electronics will be shown and demonstrated.

The industry, the Radio Trades Examination Board and some training establishments have co-operated in providing this year's Technical Training Display, located near the B.B.C. Studio, which, as usual, occupies a large part of the first floor. The focal point of the display is a 15-minute film on training in industry. To reach the cinema, which will hold about 50, one passes displays illustrating machine shop practice, glass manipulation, component manufacture, circuit testing, servicing and aerial techniques.

This year's television distribution system at the exhibition provides, in addition to a signal on Channel 4 (used to avoid interference from Alexandra Palace), a Band III signal superimposed on the same cable network. This signal will be a simple picture for demonstration purposes only.

### ALPHABETICAL LIST OF EXHIBITORS AND GUIDE TO THE STANDS

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* Demonstration rooms and offices are prefixed with "D".

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*Website: www.americanradiohistory.com*
This plan and the list of 112 exhibitors (arranged alphabetically under their trade names or abbreviated titles) opposite will enable visitors readily to locate a particular stand. Demonstration rooms and offices are prefixed with "D" and electronic displays with "E".

**PLACE:** Earls Court, London, S.W.5  
**DATE:** August 25th to September 4th  
**TIME:** 11 a.m. to 10 p.m.  
**ADMISSION:** 2s 6d (children 1s)
ACOS (44) Components employing piezoelectric crystals have always been one of the principal products of this firm. This year the "Hi-g" pickup movement, designed to track the highest record groove accelerations which are, or can be, engraved on a record, will be seen in a wide variety of types, including plug-in heads for most well-known proprietary gramophone units.

A recent addition to the range of crystal microphones is the Type MIC36 which is adaptable to a variety of applications.

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

AERIALITE (64) Aerials for sound and television broadcasting and cars, with a wide range of aerial accessories and cables of various kinds, will be found on this stand. There will be two new "Aerfringe" type television aerials, one a 3-element 7.5-db gain model and the other a 4-element 11-db model. Some specimens of Band III aerials will also be available, together with other v.h.f. types.

A new "Mastatic" aerial fitted with an 18-ft whip is of the anti-interference type. Another new item is a partially air-spaced 72-ohm coaxial cable of extra low-loss qualities to meet fringe area and Band III requirements.

Aerialite Ltd., Castle Works, Stalybridge, Cheshire.

ALBA (35) Two completely new television receivers, T321 (14in) and T324 (17in) have been added to the Alba range. These are designed for Band I and Band III and employ special valves in a 19-valve circuit using turret tuning. The specification includes a.g.c. and interference suppression on both sound and vision, frame flyback suppression, built-in aerial attenuation and a forward-facing loudspeaker.

In addition to the C114 miniature all-wave superhet and the 707 mains/battery portable radio-gramophone, the sound receiver range will include a new moderately priced 5-valve a.c./d.c. table model (3122) with built-in aerial.


AMBASSADOR (41) In all there will be five television models in the Ambassador programme, making use of completely redesigned chassis with turret tuners for Bands I and III stations. Sets will go out with Band I coils, and others will be supplied as additional programmes become available. The TV15CR is a combined television and sound receiver.

Four sound receivers will be shown, and two radio-gramophones, including the Viscount (Series III) with 8-waveband receiver, 3-speed record changer and storage for 200 records.

ANTIFERENCE (34) The range of television aerials made by this firm offers a wide variety of types for home and overseas requirements. Considerable emphasis is placed on the "Snapa-citor" feature which permits virtual assembly at the factory and also does away with actual metal-to-metal contacts in the electrical circuitry of the aerial.

Of particular interest to overseas visitors will be the wide range of television and v.h.f. aerials for the particular frequencies and polarizations used in other countries. The pre-assembly feature is also embodied in these models.


ARGOSY (8) Three-speed automatic record changers are used in all the latest radio-gramophones to be shown by this firm, while the receiver sections cover long, medium and short waves. In each model the 10in loudspeaker is fed from a pentode capable of giving 4 watts output at less than 5% distortion. Two superhet receivers will also be shown, the five-valve TR525 and the six-valve TR626/U.

Argosy Radiovision Ltd., Argosy Works, Hertford Road, Barking, Essex.
ARMY (202)
The space devoted to the Regular Army’s exhibit is shared by the Royal Corps of Signals—the operators of its telecommunications system—and the Royal Electrical and Mechanical Engineers, responsible for the maintenance of the equipment.

An Air Support Signal Unit armoured vehicle, equipped with sets Nos. 52 and 62 and a v.h.f. transmitter-receiver, which provides direct communication between forward troops requiring air support and H.Q., will be on view. The supporting aircraft are “talked” on to the target through the v.h.f. set.

Some of the aids used in training telecommunication and radar mechanics and control equipment electricians will be displayed.


ASSOCIATED TECHNICAL MANUFACTURERS (85)
Manufacturers of cables, wires and sleeving for radio and industrial purposes. Special grades of heat-resisting sleeving will be shown in addition to standard p.v.c. and polythene coverings. Associated Technical Manufacturers Ltd., Vincent Works, New Islington, Manchester 4.

AYO (61)
While basically the existing range of Avmeters and test equipment will remain largely unaltered, usefulness is being extended by the introduction of some new multipliers to cover the higher voltages now encountered in television equipment. Expected to be shown will be one extending the range of the Model 8 Avometer and other 20-kV/V instruments to read up to 25 kV.

In addition to test equipment coil winding machines of various kinds will be available for inspection. Automatic Coil Winder and Electrical Equipment Co. Ltd., Winder House, Douglas Street, London, S.W.1.

B.B.C. (200)
Working models illustrating operational processes and pieces of equipment in operation are again a feature of this stand. Among the “how it works” exhibits are a model television camera illustrating the operation of the “zoom” lens, equipment for measuring the characteristics of telephone lines, a representation of the reflection of radio waves by the ionosphere and sound recording equipment.

Developments in technical facilities for the production of studio and outside broadcast sound programmes will be illustrated by several new pieces of equipment and visitors will see some of the methods used in producing sound effects for programmes. British Broadcasting Corporation, Broadcasting House, London, W.1.

BAIRD (88)
Some television receivers shown will have a turret tuner for Bands I and III. This tuner is normally fitted with coils for three Band I channels and two Band III channels, but up to seven further channels can be covered by extra coils. A 14-inch model and three 17-inch models will be available. Single-channel sets will also be on view.

All sets can be supplied as fringe-area models, with flywheel sync and a form of vision a.g.c. Hartley Baird Ltd., 37-39 Thurlow Street, South Kensington, London, S.W.7

BELLING-LEE (67)
Aerial equipment of all kinds, radio interference suppressors and a wide range of important items such as terminals, plugs and sockets and fuses, are the main exhibits to be found on this stand.

Television aerials will include, on the one hand, simple designs for indoor use and on the other quite elaborate multi-element systems for extreme fringe-area conditions. An amplifier installed at the masthead and requiring no special cabling is another fringe-area aid to better reception. Distribution amplifiers will also be included.

There will be a new and almost miniature television interference suppressor for fitting in the mains leads of small domestic appliances; it will carry up to 2 A and is described as the “Telefilter.” Belling & Lee Ltd., Great Cambridge Road, Enfield, Middlesex.

BRIMAR (6)
Among cathode ray tubes on show will be a new 21-in tube, type C21HM, which has an improved tetrode gun assembly giving better focusing and minimum astigmatism. A 17-in self-focusing tube, type C17JM, will also be displayed. This incorporates an internal focusing electrode and so avoids the need for external focusing magnets and controls.

The range of valves will meet the requirements of both high-quality and economical a.m./f.m. receivers, and various circuits for these will be displayed. There will also be special quality valves at lower prices than hitherto and valves for Band III tunable television receivers. Standard Telephones and Cables Ltd., Footscray, Sidcup, Kent.

BULGIN (99)
Connectors, signal lamps, knobs, switches and a host of other small, but quite vital, items in electronic and radio equipment comprise the main activities of this company. Among the newest items are a Lilliput lampholder no larger than a little-finger nail; miniature micro-switches which operate by almost a feather-weight touch and some new multi-pole connectors. One pattern is in the form of a strip with the plugs, or sockets, in line and self-centring;
A radio-gramophone with a three-speed motor and auto-changer will be shown. An exhibit of particular interest at the present time will be a v.h.f. broadcast receiver.

_Bush Radio Ltd., Power Road, London, W.4._

**CHALD (26)**

Showed by this firm will be a new indoor television aerial in the form of a single-turn square “loop” known as the “Squarial.” It is said to give a 20—% gain over a dipole, has a back-to-front ratio of 7 db and may be expected to give satisfactory reception up to 30 to 35 miles. It is less than 3 ft square.

_Chald Products Ltd., 184 Low Road, Leeds, 10._

**CHANNEL (214)**

Television pattern generators will be shown, one model, T1, for Band I and another, T2, for Bands I and III. Also on view will be television pre-amplifiers, multi-outlet distribution amplifiers, and t.v.i. suppression units.

_Channel Electronic Products Ltd., Burnham-on-Sea, Somerset._

**CHAMPION (33)**

This year Champion are concentrating on sound receivers, and in particular small portable and “midget” table models.

_Model 825, a “midget” table receiver for a.c./d.c. mains, is new and will be available in a plastic cabinet with a choice of colour. Ferrite rod aerials are used in the Model 822 battery suitcase portable and in the Model 820 “Radio Revler” transportable 3-speed radio-gramophone. The larger Model 781, which is a 7-valve superhet mains-battery portable of high sensitivity, is being continued. Record playing equipment includes the portable “Revler” with crystal pickup, amplifier and 5-in loudspeaker._

_Collaro Electric Corporation Ltd., Drove Road, Newhaven, Sussex._

**COLLARO (11)**

A new record changer, Model 54, which mixes 7, 10 and 12-in records and has a constant change time, irrespective of the turntable speed, will be shown; also a new inexpensive 3-speed motor unit with turnover pickup cartridge (AC3/554).

“Transcription” units (Models 2,000 and 2010) fitted with the Collaro “Studio P” crystal pickup will be of special interest to high-quality enthusiasts.

_Collaro Ltd., Ripple Works, Bye-pass Road, Barking, Essex._

**COSSOR (57)**

In sound broadcast receivers the most interesting exhibits on the stand will be two models capable of receiving v.h.f. as well as existing programmes. The model 523 covers three wavebands and uses seven valves, while the model 522 is a radio-gramophone with an automatic record changer.

Most of the television receivers on show will either be tunable to Bands I and III or will have facilities for the addition of a tuner unit.

_A. C. Cossor Ltd., Cossor House, Highbury Grove, London, N.5._

**DECCA (39)**

Four television receivers with direct-viewing 14-in or 17-in tubes will be shown as well as a projection receiver (Model 1000). There will also be two television-radio-gramophones. The Model RG98 and 102 radio-gramophones have 3-waveband receivers and 3-stage audio amplifiers.

_Record reproducers made by this firm include a new “Panatrope”_ which is an inexpensive console incorporating a Garrard RC/111 record changer with a 3-stage negative feedback amplifier giving 2½ watts. Another interesting model is the “Decamatic II” portable player which employs a single pentode amplifier with a Collaro 3-speed motor and crystal pickup.

_Decca Record Company Ltd., 1-3 Brixton Road, London, S.W.9._

**DEFIANT (106)**

The five television receiver models exhibited cover both bands, being pre-set for any station in Band I and adjustable by the user to all eight channels of Band III. The
sets include a mains filter and the line time-base is completely screened.

Co-operative Wholesale Society Ltd.,
1 Balloon Street, Manchester, 4.

**DOMAIN (213)**
Television receiver tables of metal tubular construction will be on show here. They have undershelves for carrying sound receivers or record players. Equipment for dealers' showrooms will also be displayed.

*Domain Products Ltd., Domain Works, Barnby Street, London, N.W.1.*

**DUBLIER (83)**
Capacitors, resistors, fixed and variable, and radio interference suppressors comprise the main radio parts in which this firm specializes. Miniaturization being an all-important requirement today, attention is being given to this aspect of design and some midget moulded silvered mica capacitors in a useful range of values are now available.

Among the ceramic dielectric capacitors interest will be focused on the "Hi-K" feed-through, stand-off and bushing styles in view of their particular suitability as r.f. by-pass capacitors in v.h.f., and Band III television receivers.

DUBLIER will have one of the smallest insulated 1-W resistors made in the Type BTS and some pre-set "Q" type potentiometers with insulated knobs intended primarily for television sets.

*DUBLIER Condenser Co. (1925), Ltd.,
Ducon Works, Victoria Road, North Acton, London, W.3.*

**DYNATRON (103)**
A range of large radio-gramophones will be on this stand and among them the Ether Marshal, a new model, is noteworthy for its elaborate specification. It is a 5-band set with an earthed-grid r.f. stage on short waves. There is variable selectivity and provision for the connection of an f.m. tuner. The a.f. amplifier, on a separate chassis, has a push-pull triode output stage.

The model TV27C television receiver, for a.c. only, has a 17-in tube and a.g.c. on both sound and vision channels. There is a black-level stabilizing circuit, a black spotter, and an anti-flutter circuit.

A television "mast-head" pre-amplifier for fringe-area reception will be on view; also a range of nucleonic and electronic equipment.

*Dynatron Radio Ltd., The Firs, Castle Hill, Maidenhead, Berks.*

**E.A.R. (49)**
Portable electric gramophones are a speciality of this firm, and models are available, with three-speed turntable motors or record changers, all of which play with the lid closed. The Model T750 high-quality instrument is fitted with a 10-in x 6-in elliptical loudspeaker and separate bass and treble tone controls.

Other products of this firm include a console record reproducer with 8-watt push-pull output, a 12-watt portable a.c./d.c. amplifier for p.a. work, and a range of high-quality amplifiers for a.c. mains.

*Electric Audio Reproducers Ltd., 17 Little St. Leonards, Mortlake, London, S.W.1.*

**E.M.I. (9, 73)**
One of the chief exhibits on these stands will be the BTR/2 tape recorder, which is available in console or transportable form and with tape speeds of either 15 and 30 or 71 and 15 in/sec. Other tape recorders on show will be the transportable TR/50 with playing times of 64, 32 and 16 minutes (according to tape speed); the "Emicord" domestic type and the portable battery-driven model L/2 which weighs 14 lb.

Amongst test gear displayed will be a bridge for measuring resistive and capacitive impedance in situ and a signal generator covering the B.B.C. television channels.

*Electric & Musical Industries Ltd.,
Hayes, Middlesex.*

**EDISWAN (37)**
Aluminized cathode ray tubes will be the main feature of this stand and the range on show will include the latest 21-in rectangular type. A demonstration exhibit will show the 60 per cent increase in picture brightness obtained by aluminizing.

In valves, the 30L1 cascode double triode and the 30C1 triode pentode frequency-changer will be on view separately and as used in the Ediswan-Clix television turret tuner. This is a 12-position tuner, with pre-tuned r.f. and mixer stages, for multi-channel receivers operating in Bands I and III.

*The Edison Swan Electric Co. Ltd.,
155 Charing Cross Road, London, W.C.2.*

**EKCO (22, 92)**
The television receivers exhibited will be types having either a built-in 13-channel turret tuner for Bands I and III or provision for adding such a tuner when required. The tubes range in size from 12-in to 17-in; one of the larger models is the a.c./d.c. type TC209 with flywheel sync, and a form of vision a.g.c.; spot wobble is
included and the set is unusual in including an f.m. receiver for Band II.

Among the sound-broadcast receivers, the A239 is of especial interest because it provides for f.m. reception on Band II as well as the normal a.m. bands. It has a built-in Band II aerial and provision is made for the use of a tape recorder.

The New Radiotime is an a.c. set, including an electric clock which can act as an alarm or be set to switch the set on or off at predetermined times.


ENGLISH ELECTRIC (85)
The "40" series of television sets have a 17-in rectangular tube operating at 14 kV and they are of the a.c./d.c. type with a barretter for the control of the heater current. A 12-channel turret tuner is included to cover Bands I and III, but, as the coils in it are changeable, it can also be used for Bands IV and V if required. There are three cabinet styles; the T40 and T41 are table models without and with doors and the C42 is a console with doors.

A tuner unit (the "Rotomatic") enables Band-III reception to be obtained on existing Band I sets. It is a 12-position turret tuner like that in the "40" series sets and it replaces the early valves in English Electric one-band sets. The output is at i.f. and connection is by plugs to the valveholders.


EVER READY (64)
Layer-type batteries for portable receivers will be shown with minia-ture and sub-miniature layer types for hearing aids. There will also be a range of all-dry battery receivers, including portables and table models, and two tropicalized export receivers. The Ever Ready Co. (Great Britain) Ltd., Hercules Place, Holloway, London, N.7.

FERGUSON (14)
Television receivers with 12-in, 14-in and 17-in tubes will be shown. The T03T and T05T, using the larger tube sizes, have turret-switch tuners for Bands I and III; others are primarily Band I sets but have provision for the addition of a plug-in three-way tuner unit to cater for two Band III stations. Frame-flyback suppression is used on all sets and Halolight, an illuminated surround to the picture, is now fitted on four of the console models.

Among sound-broadcast receivers, there are three models which give f.m. reception on Band II as well as the normal long, medium and short wavebands. In addition to several radio-gramophones of console pattern, there is a new table model having a three-speed automatic record changer.

Thorn Electrical Industries Ltd., 105-109 Judd Street, London, W.C.1.

FERRANTI (58, 74)
An exhibit of considerable interest here will be a table projection tele-vision receiver giving a picture size of 16" x 12-in. The receiver is permeability-tuned over the five channels of Band I. The front end of the receiver is detachable so that it can be replaced by a Band I/Band III tuner unit. Beam current a.g.c. is applied to the final vision i.f. amplifier and this ensures minimum peak white defocusing and enables the set to be operated at a high average brightness level.

Among the valves and cathode-ray tubes on view will be a new 21-in rectangular tube with a 90° deflection angle.

Ferranti Ltd., Moston, Manchester.

G.E.C. (68)
A range of new sound and television receivers will be on view. New Osram valves notable for their very high slope of 15 mA/V are the Z759 and Z359, both B9A pentodes intended as video amplifiers. The first has a 6.2 V heater and the second a 0.3 A heater. For Band III television receivers there will be the B319 double triode and the LZ319 triode pentode, while a new addition to the audio range of valves will be the N709 output pentode with an anode dissipation of 12 watts.


GARRARD (71)
The record changers and gramophone turntable units shown by this firm will be seen in the new standard colour scheme of cream and brown. From a comprehensive range the retooled Model 301 "transcription" motor, the new compact RC110 and RC111 three-speed record changers and the Type GC2 and GCE3 piezo-electric pickups may be selected as worthy of closer inspection. The GC2 is a Rochelle salt crystal turn-over unit with a frequency range comparable with that of separate crystal heads, and the GCE3 employs a ceramic element for use under extreme conditions of heat and humidity.

Garrard Engineering and Manufacturing Co. Ltd., Newcastle Street, Swindon, Wilts.

GIBBS (20)
This firm will be showing a record cabinet with a capacity of 170 records, and a range of tables suitable for television sets.

Herbert E. Gibbs Ltd., First Avenue, Montague Road, Edmonton, London, N.18.

GOODMANS (63)
This stand will be virtually a sound-proof theatre for the demonstration of high-quality reproduction, and
visitors will be able to compare the results obtained with a variety of loudspeaker types and systems, including multiple units with crossover networks. A staff of specialists will be in attendance to answer questions.

A new 12-in, 12-watt reproducer, the “Orlin III,” will be shown in which the top response can be modified to give optimum performance on inputs of varying quality.

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

H.M.V. (10)
An important feature of this stand will be a new projection television receiver, Model 1823, with a projection tube of twice the screen area of more usual types. This gives a brighter picture than normally obtainable from such receivers. The current range of 14-in and 17-in direct-viewing sets on show will be available either as two-band versions or as Band I versions which can be modified for Band III reception when required. Three fringe-area sets incorporate A.G.C. on vision and sound, dark-scene contrast expansion, fly-back suppression and interference inversion.

Among the radiograms will be a portable and a transportable, both with a 3-speed record player on a pivoted counterbalanced desk which swings into the back of the cabinet when not in use.

Two new sound receivers will be shown. Model 1360 is a transportable in a plastic cabinet while model 1126 is a 5-value table receiver.

The Gramophone Co. Ltd., Hayes, Middlesex.

HUNT (90)
The Supermoldseal Type W96 is a new miniature metalized-paper capacitor having a tough cast resin case which is not easily damaged by accidental contact with a hot soldering iron. Working voltages are 200, 400 and 600 d.c. and capacitance values range from 50 pF to 100,000 pF. A new miniature single-hole fixing dry electrolytic known as the Type L136 will be shown, together with a range of low-voltage miniature electrolytics measuring 1 in long and ½ in diameter, with working voltages of from 12 to 150 V d.c. and capacitances of 1 to 50 µF.

A new development, described as the sprayed plate technique, is said to result in small bulk for a given capacitance.


INVICTA (95)
A 13-channel selector switch on the side of the cabinet will be a feature of three television sets to be displayed. These receivers, one 14-in and two 17-in, also incorporate automatic vision gain control (the black-level adjusting circuit), flywheel sync, a dark screen for daylight viewing and a built-in Band I aerial for areas of high signal strength.

A new console radiogram of small size is capable of playing L.P. records and has a receiver section covering the trawler waveband.

cast sound receivers is the KR20FM. This is a 6-valve set for a.c. operation which covers the usual medium and long wavebands and also the v.h.f. band. Some of the older models are still being retained, among them the FP151 a.c./d.c./battery portable.

Five radio-gramophones will be shown. Among the new types is the LG-40AM/FM in which the receiver covers the f.m. band and has a push-pull output stage. Kolster-Brandes Ltd., Footscray, Kent.

M.O.S. (212)
The main exhibit on this stand is a telemetering system for guided missiles. Ministry of Supply, Shell Mex House, Strand, London, W.C.2.

McMichael (72)
The new television receivers will be available with 14-in or 17-in rectangular flat-faced tubes and in table and console models, with or without sound radio receivers. One chassis is common to all the new sets. Special attention has been given to reliability and service accessibility. The entire chassis can be taken out of its cabinet in 1 min and the tube in 11 min. These new sets will be adequately supported by a comprehensive range of sound receivers including an a.c./d.c. mains/battery portable set with a self-contained ferrite rod aerial. McMichael Radio Ltd., 190 Strand, London, W.C.2.

MARCONIPHONE (13)
Another addition to the “Companion” range of sound receivers will be model T37DA, a 5-valve a.c./d.c. transportable covering two wavebands. There will also be a new mains/battery portable, model T36AB, in attache-case form and a new table receiver, model T38A, covering three wavebands. New radio-gramophones on show will be the model ARG40A, the ARG41A in a “contemporary” style cabinet and the TARG39A table model, all with 5-valve 3-waveband receivers. Television receivers will also be displayed. The Marconiphone Co. Ltd., Blyth Road, Hayes, Middlesex.

MASTERADIO (62)
To be shown for the first time at the exhibition will be a new table radio-gram in a distinctively designed walnut veneered cabinet. It incorporates a 3-speed automatic record changer and covers short, medium and long waves. Also entirely new will be a portable electric gramophone known as “The Harmony” which plays 12-in records.

Television receivers will include two 17-in models with built-in Band III converters; one is a multi-channel table model, the other a console type with full-length doors. Some car radio sets will conclude an interesting display. Masteradio Ltd., Fitzroy Place London, N.W.1.

Mullard (56)
For the amateur constructor this firm have produced a new design for a high-quality ten-watt amplifier, built around five Mullard audio valves—EF86 input, ECC83 phase-splitter, two EL84 output pentodes in push-pull and GZ30 rectifier. The response is almost flat from 10c/s to 20kc/s and harmonic distortion is below 0.4%. A booklet giving details will be available on the stand and the amplifier itself will be demonstrated in an associated room. Mullard Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

MULTICORE (100)
Designed to increase soldering speed, a 5-cored wire solder will be shown publicly for the first time. This contains a new flux (362) which in some applications permits the use of cheaper solder alloys containing less tin.

Murphy V250 two-band receiver with 17-in. tube.

Masteradio “Harmony” portable record player.

Philco 14-in. tunable television set, Model A1467.
To demonstrate the large-scale use of Multicore solder in industry, the assembly and wiring of Ferguson television tuning units will be carried out.

Special soldering alloys to be shown include TLC, with a melting point of 145°C and "Consol" containing silver and having a melting point of 296°C. Multicore Solders Ltd., Hemel Hempstead, Herts.

MURPHY (40)
This year's receivers are based on a chassis which is substantially the same for all models, the chassis differences between the 14-in V240 and the 17-in V250 being mainly the provision of higher voltages for the tube of the latter. Fringe-area models have flywheel sync, a gated a.g.c. circuit and a special noise limiter.

Provision is made in all models for Band-I and Band-III reception by means of a 12-channel turret tuner, the r.f. stage being of the cascode type. A direct-drive line-scan circuit is used.

Among sound-broadcast receivers, the new V198 and A212 will be shown. The V198 is an a.c./d.c. set with a built-in ferrite-cored aerial covering medium and long wavebands. The A212 is a larger table model for a.c. mains only and including one s.w. band. It has an internal plate aerial and provision for an external aerial. Murphy Radio Ltd., Welwyn Garden City, Herts.

NAVY (204)
Operational conditions for underwater television are simulated by the provision of a large glass-sided tank on the ground floor, in which the camera is suspended, while the remote control and monitoring gear is in the gallery. Training exhibits are being provided by the two Naval electrical schools—H.M.S. Collingwood and H.M.S. Ariel—and the R.N.V.(W)R. Examples of radio communication equipment, electronic control and navigational gear and facsimile apparatus used in the Navy are being provided by Marconi's, Pye, Redifon, Muirhead, Decca, Murphy and G.E.C. for display and demonstration on this stand. Admiralty, Whitehall, London, S.W.1.

NERA (208)
This firm will be showing projection equipment for picture sizes ranging from 30in to 84in. A projector for ceiling mounting is designed to give a picture 4ft by 3ft.

A 12-channel converter for Nera receivers will also be shown. Nera of England Ltd., Jeffries Passage, High Street, Guildford, Surrey.

PAM (4, 84)
Five television models will be shown, all for a.c./d.c. operation and with 13-channel tuners. A form of a.g.c. is provided in all but the cheapest 12-in Model T954.

Two table model sound receivers (955a and 965) employ basically the same 4-waveband chassis, which is also used in the Model 966RG radio-gramophone.

The Model 610 wide-range record player has a push-pull output driving an 8-in loudspeaker. The cabinet is designed to reinforce the bass response when the lid is closed and the loudspeaker aperture is designed to give wide-angle diffusion of high frequencies. Pom (Radio and Television) Ltd., 295, Regent Street, London, W.1.

PETO SCOTT (40)
The television receivers shown by this firm are designed primarily as Band-I sets with a switch change-over to an alternative tuner, which is physically a separate unit, for Band III. The tuner has a cascode r.f. stage and tuning is continuous by the adjustment of ganged cores to the coils. The circuit arrangement

Left: Pam Model 966/RG radio-gramophone.
Right: Marconiphone table radio-gramophone, Model TARG39A.

PHILCO (34)
Among the new television sets to be shown is a 14-in table model incorporating a turret tuner for reception of Band-III programmes. It has a.g.c. and noise suppression on both vision and sound channels. Similar facilities are offered by a 17-in model, with the additional feature of a removable front to the cabinet which allows the tube and mask to be cleaned.

Three sound receivers on view are notable for having all metal parts and components fully tropicalized so that they can be operated in kitchens, etc., without fear of deterioration from steam and damp. Philco (Great Britain) Ltd., Romford Road, Chigwell, Essex.

PHILIPS (96, 97)
Of most topical interest on these stands will be an a.m./f.m. table receiver, Model 543A. It uses 7 valves and is designed for a.c. mains only. Another new exhibit will be a 5-valve receiver which also acts as

Right: Mullard range of valves for a.m./f.m. receivers.
an alarm clock and will switch itself on and off at pre-set times. It is pre-set tuned for four stations, three medium-wave and one long-wave.

Amongst radio-gramophones and record players will be a new portable record player, Model AG2121, incorporating a 3-valve amplifier and, in the lid, a 7-in loudspeaker.

Two new table television receivers, one 14-in and the other 17-in, will incorporate a turret tuner for reception of B.B.C. and Band-III programmes.

*Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2.*

**PILOT (59)**

Five television sets to be shown by this firm will all have provision for plugging in a tuner for reception of alternative programmes. Two are 14-in models and three are 17-in models. The 12-position tuner is a turret type covering 13 channels and costs 6 guineas. It has a dual control knob, with a numbered inner section for selecting the channel and an outer rim for fine oscillator tuning.

Among the sound broadcast receivers will be a new battery/mains portable (a.c./d.c.) in attaché-case form. It has a Ferroxcube built-in rod aerial and a 6in x 4in elliptical speaker.

*Pilot Radio Ltd., Park Royal Road, London, N.W.10.*

**PLESSEY (38)**

This firm manufactures an extensive range of components, accessories and complete radio assemblies for the trade; their exhibit will consist of some of the newer and more interesting items now in production. A novel development is some special clips for sub-miniature valves, one is for chassis mounting like a valveholder, the other holds two valves and can be fixed in any position. A strip switch for a.m./f.m. sets will also be shown.

*Plessey Co. Ltd., Vicarage Lane, Ilford, Essex.*

**PYE (94)**

One of the latest television receivers to be shown by this firm will be the 13-channel Model VT4. This is a 14-in table receiver with a tilted-forward screen, and the 12-position channel selection switch covers the five B.B.C. channels in Band I and channels 7 to 13 in Band III (channel 6 being brought in by oscillator trimmer tuning when required). The receiver also incorporates vision a.g.c., flywheel sync, vision interference inversion and frame fly-back suppression. High-quality sound reproduction equipment will also be on view.

*Pye Ltd., Radio Works, Cambridge.*

**R.A.F. (203)**

Inspection and repair of v.h.f. airborne equipment as undertaken in the workshops of the Maintenance Command of the R.A.F. is to be demonstrated. Radio's part in weather forecasting will be illustrated in a typical Meteorological Forecasting Office set-up on the stand. Visitors will also see the complex assembly of radio and electronic equipment now carried in modern jet aircraft.

*Air Ministry, Whitehall Gardens, London, S.W.1.*

**R.G.D. (93)**

Four table-model and two console receivers comprise the R.G.D. television programme together with a combined television and radio-gramophone (Model C55). An improved synchronizing circuit ("Synchrolock") is a feature of the 17-valve circuit.

Twin 6J-in loudspeakers and a push-pull output stage are used in the "Two-Ten" table model radio-gramophone which takes its place with the R.G.D. console models. The "One-Ten" sound receiver is a 6-valve, 3-waveband model with push-pull output.

*Radio Gramophone Development Company Ltd., Eastern Avenue West, Mawneys, Romford, Essex.*

**R.S.G.B. (209)**

A wide variety of modern amateur constructed sound and vision transmitting and receiving equipment will be seen on the R.S.G.B. stand. The emphasis is on equipment for use in the recently formed Radio Amateur
Emergency Network. V.H.F. and u.h.f. gear, some transmitter transmitters and s.s.b. transmitting and receiving equipment will also be displayed. Historic amateur equipment and a clandestine receiver constructed in a prisoner-of-war camp will be seen.


REFLECTOGRAPH (287)
An ingenious continuously variable drive mechanism forms the basis of the magnetic tape recorders made by this firm. In addition to standard portable domestic recorders, a number of scientific and industrial machines will be shown. For some of these (Series P) a frequency response of 80 c/s to 15 kc/s ± 3 db is claimed at 7½ in/sec.

Two systems of recording very low frequencies have been developed, one of which (Model PLF2), employing a differential pulse-code system, is capable of recording down to zero frequency and is independent of tape speed.

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

REGENTONE (38)
Sound receivers and radio-gramophones include the “Multi 99” table radio-gramophone incorporating a B.S.R. “Monarch” record changer. This model is also available in console form.

Three portable gramophones in tough-fibre cases are designed for hard use. They are the RP2 record player for feeding the pickup terminals of any broadcast receiver, the HG2 “Handy-gram” with built-in amplifier and loudspeaker, and an automatic record changer version (AHG2).

Regentone television sets are being re-designed in detail and will be shown in new cabinets. Regentone Radio and Television Ltd., Eastern Avenue West, Mawneys, Romford, Essex.

ROBERTS (102)
Portable sound broadcast receivers are associated with the name of this firm and in the current range Model RP4 (battery) and RMB (a.c. mains/battery) are now available in “rexine” covered cabinets. Models CR (a.c. mains/battery), BR (battery) and MR (a.c. mains) can be obtained in a wide range of colours. Roberts Radio Company Ltd., Creek Road, East Molesey, Surrey.

ROLA CELESTION (3)
A loudspeaker designed to be operated under conditions of extremely high or low atmospheric pressure, and capable of surviving complete immersion in water is indicative of the wide field of activities of this firm. All sizes from 2½ in to 18 in diameter are available, including elliptical types and other special designs for receiver manufacturers. A wide range of output transformers, including hermetically sealed types for tropical climates will be shown.

Public address loudspeakers and line-matching transformers, under the Truvox marque, for powers from 3 to 120 watts also form part of this exhibit.

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

S.T.C. (83)
Asymmetric resistors (working on a rectifier principle) suitable for digital computers will be shown under construction and as used in an electronic accounting machine. Also on view will be metal rectifiers for h.t. and e.h.t. supplies; battery charging rectifiers; high voltage aluminium rectifiers for aircraft power supplies; germanium junction power rectifiers and a germanium junction photocell suitable for direct operation of relays. Standard Telephones and Cables Ltd., Connaught House, Aldwych, London. W.C.2.

SIMPSON (104)
Some fine examples of engineering construction will be seen in the professional and domestic magnetic tape recorders made by this firm. The long-duration tape monitors for recording air traffic control messages and the Model SP/1 portable recorder with 10-watt output are of great technical interest.


SKY-MASTS (30)
The design and erection of aerial masts and complete aerial installations constitute the main activities of this company and their exhibit will show in model and in actual form some of the more interesting types they produce.


SOBELL (12)
Sound-broadcast, television receivers and radio-gramophones will be displayed on this stand. Most of the last include automatic record changers and all have three-speed motors and employ crystal pickups. The sound receivers have provision for a pickup and an external loud-speaker.

Most television sets include turret tuners for Bands I and III; the 12-in model, which does not, has provision for a Band-III adaptor. A form of a.g.c. is included in the sets and fly-back suppression is fitted. The models include 12-in, 14-in and 17-in types and all are for a.c./d.c. operation.

Sobell Industries Ltd., Langley Park, Slough, Bucks.

STELLA (55)
Four new table television receivers will be shown with provision for re-

Vidor "Lady Margaret" handbag-size portable, but with 5-in. loudspeaker.

Whiteley concentric Duplex loudspeaker.

Taylor Model 67A signal generator.

Telequipment oscilloscope Type 520 with 4-in. flat-faced tube.

Waveforms type 405 television signal generator.

The exhibit will include a Band-III converter and an insulation test set covering 150 V to 10 kV Telemechanics Ltd., 3 Newman Yard, Newman Street, London, W.1.

TELEQUIPMENT (80)

Television test apparatus is the speciality of this firm, who this year will show a 625-line Monoscope equipment which provides a complete video signal and synchronizing pulses to C.C.I.R. standards. Models for 405 and 525 lines have been available for some time.

Specially designed for television work is the Type 520 oscilloscope embodying a 4-in flat-faced tube and a "X" amplifier of exceptional performance. The "X" amplifier gives an expansion up to 5 screen diameters.


TELERECTION (5)

Considerable thought has been given by Telerection to the problems involved in the design of multi-band television aerials and while final designs cannot very well be produced before all the facts of Band-III television are known, they will be showing some examples of how the problems can be tackled for both the semi-local and fringe area viewers.

Telerection Ltd., Antenna Works, St. Paul's, Cheltenham, Glos.

Wireless World, September 1954
TELEVISION SOCIETY (205)
The equipment to be displayed has been chosen to illustrate the various aspects of television engineering covered by the papers read at the society’s meetings. Reprints of some of the papers read during the past session will be available.

TRIX (65)
Amplifiers and auxiliary equipment for every class of sound reproduction from portable “crooner” outfits to rack-mounted large-scale p.a. installations are made by this firm. Designed for high-quality music reproduction in the home, the Model T41 amplifier, with a power output of 3-4 watts, is of special interest. A separate control unit is provided with independent bass and treble controls and there are two inputs for use with pickups of all types giving maximum output for 3 mV and 130 mV.
Trix Electrical Company Ltd., 1-5 Maple Place, Tottenham Court Road, London, W.1.

ULTRA (69)
Receivers embodying tubes of from 12-in to 4-Hz will be exhibited. Because of the particular mask shape adopted, a somewhat bigger picture is than usual for the tube size is claimed. The tuning system has a switch channel selector giving a choice of one Band-I and two Band-III stations, the Band-III tuner being a separate unit.
In addition to a range of sound-broadcast receivers, a radio-gramophone will be on view. This is the ARG891 which includes space for record storage. A model for f.m. reception is available.
Ultra Electric Ltd., Western Avenue, Acton, London, W.3.

VALRADIO (70)
Reception of f.m. transmissions in Band II, as well as television transmissions in Bands I and III, is possible with the new multi-channel tuner to be shown by this firm. It uses a PC84 cascode r.f. amplifier and a PCF80 frequency changer and covers 40-100 Mc/s in four steps and 170-225 Mc/s in two steps. Continuous tuning is provided over each step by ganged iron-dust cores and brass slugs in the coils.
Incorporating this tuner will be a new projection television set, giving a picture of 27in x 20in on a screen in the lid.
Valradio Ltd., New Chapel Road, High Street, Feltham, Middlesex.

VIDOR (87)
No fewer than five different portable sets will be shown this year; one, the “Lady Margaret,” is entirely new and although no larger than a lady’s handbag (8 x 8 x 4 in) it incorporates a 4-valve receiver, takes a 90-V battery and boasts a 5-in loudspeaker; the weight is 61 lb only.
Provision is made in the latest 14-in and 17-in television receivers for internally fitting a Band-III converter.
A special feature will be made of export type receivers, the batteries being protected against humidity and extremes of temperature.
Dry batteries of some 370 different types, ranging from those for torches to special models for nucleonic equipment, will be shown.
Vidor Ltd., West Street, Erith, Kent.

WAVEFORMS (75)
A new television signal generator will be on this stand. The Radar 405 provides an r.f. signal, tunable over Bands I and III, which is modulated by the correct sync pulses and a selection of test patterns. The sound and vision outputs are independently tunable and can be used together. The output is adjustable from 10 µV to 10 mV.
A more elaborate instrument, the type W90, will also be shown, together with a range of other test apparatus.
Waveforms Ltd., Radar Works, Truro, Road, N.22.

WEARITE (74)
Principal interest on this stand centres on the Ferrograph magnetic tape recorder, which is available in many forms for scientific and industrial research as well as for domestic and professional sound recording.
A special version (2A/NH) of the Model 2A recorder will be shown, with tape speeds of 73 and 15/2 in/sec instead of 33 and 73 in/sec. Another interesting version is the YDC with simultaneous dual-track recording for comparative analysis or stereophonic recording.
Wright and Wearite Ltd., 131 Sloan Street, London, S.W.1.

WESTINGHOUSE (72)
Tubular cut-out rectifiers will be prominent on this stand and the normal range will cover d.c. outputs of up to 15 kV in single units with current outputs of between 100 mA and 8 mA. Copper-oxide instrument rectifiers, “Westectors” and germanium diodes will also be on view.

WHITELEY ELECTRICAL (105)
The cambric cone, introduced last year, has now been applied to the 12-in concentric Duplex and other loudspeakers in the high-quality range. A new dismountable “bass reflex” cabinet, which can be easily assembled, has been introduced for use with the 10-in and 12-in high-quality loudspeakers. Extension loudspeaker units with volume controls and optional push-button remote control will also be shown.
Sound reproduction is by no means the only activity of this firm, and the exhibit will also provide examples of a wide variety of components, including amplifiers, wavemeters, a.m. and f.m. transmitters.
Whiteley Electrical Radio Company Ltd., Mansfield, Notts.

WOLSELEY (16)
To be shown this year will be a new “X” type television aerial with a “delta” matching section incor-
porated in one of the Vs formed by the crossed dipoles. Appropriately named the “Deltex” aerial it is said to give better matching between aerial and feeder. As neither dipole need be split and insulated at the centre it results in a far stronger construction. Like all other Wolsey aerials the “Deltex” is pre-assembled to simplify erection.
Wolsey Television Ltd., 43-45 Knight’s Hill, West Norwood, London. S.E.27.
NOW that the G.E.C. "F.R." metal-cone loudspeaker is in quantity production, the makers have decided to issue a design for an amplifier which will ensure that its full capabilities are realized. This design will be published as a booklet (price 3s 6d), which will also give details of a recommended cabinet for the loudspeaker.

The circuit type number "912" indicates that the frequency range is 9 octaves (30 c/s-16 kc/s) and that the power output is 12 watts. The first stage is a Z729 low-noise pentode, followed by a B309 double triode in which one triode acts as the second a.f. stage and the other as a phase splitter.

Two N709 pentodes in push-pull have the output load distributed between anodes and cathodes, thus giving a compromise between pentode and triode operation as far as efficiency and harmonic distortion are concerned.

Feedback is applied over the last three stages and can be modified by a switched RC network in the feedback loop to give a flat response or one with an approximately 5 db level lift or drop from about 3,000 c/s upwards. This is described as a "presence" control and when "in" has the effect of transporting the listener to the front seats of the concert hall where the ratio of high to low frequencies is higher than, say, at the back of the hall, where the increased proportion of reverberation and high-frequency absorption tend to depress this ratio. The device is admitted artificial but the effects are more realistic than those which would be obtained with normal sloping tone control characteristics. Normal tone control is, of course, provided (between the first and second stage) to cope with variations in recording and pickup characteristics.

The "F.R." metal-cone loudspeaker* in addition to its low non-linearity distortion is capable of a very uniform and extended frequency response when housed in a suitable enclosure. A very rigid cabinet of octagonal section has been developed in which unwanted panel resonances are suppressed, only the single Helmhotz resonance being applied at or near the fundamental cone resonance to control the impedance rise and extend the low-frequency response. The vent is situated in the centre of the cabinet, which is raised from the floor by four supports, the height of which tunes the acoustic resonance, since the air mass between the floor and base is in radial vibration. It is conceivable that, with this arrangement the resistive damping is increased. However this may be, the result is a remarkably smooth and full bass response down to 30 c/s which adds no trace of coloration to the reproduction of speech.

* See Wireless World Nov. and Dec. 1952.
Combination F.M./A.M. Receivers

Design Factors of Sets for the New B.B.C. Service

FREQUENCY modulation broadcasting is to commence in this country in the near future. Special combination receivers will have to be provided for the reception of both the f.m. transmissions in the v.h.f. Band II, and the a.m. transmissions which will continue to be radiated in the medium and long broadcast bands.

The standards of f.m. transmission will be similar to those prevailing in America and Germany; 100 per cent modulation will correspond to 75 kc/s deviation, maximum modulation frequency will be 15 kc/s, and pre-emphasis corresponding to a time constant of 50 µs will be used. The nominal channel separation will be 200 kc/s, and judging from a preliminary list of stations it would appear that stations serving the same area will be separated by 2.2 Mc/s. Generally, the minimum field strength in towns may be expected to be in the region of 800 µV/metre, and in country districts about 250 µV/metre.

Translating this information into receiver requirements, we arrive at the following design data. The receiver should be tuneable over the whole of Band II; that is, 87.5 to 100 Mc/s, although initially only 88-95 Mc/s will be available for the f.m. service. Regardless of the modulation frequencies involved, the bandwidth will have to be made considerably greater than that theoretically required, to allow for oscillator drift; a 3 db at ±100 kc/s should be regarded as a minimum. In this respect, it is safer to err on the liberal side as the distortion produced on a f.m. receiver by mis-tuning is at least as great as that obtained on selective a.m. receivers. Taking into account the “capture effect” and the distribution of stations, a selectivity characteristic of 3 db at ±150 kc/s would probably make a good compromise.

As the vast majority of these receivers will undoubtedly be used with the inevitable “piece of wire” acting as an aerial, a sensitivity of the order of 10 µV will almost certainly be required. Sensitivity in f.m. receivers means not only that the standard 50-mW output is obtained with a given r.f. input signal 30 per cent modulated, but also that the receiver limits satisfactorily with the same input. If satisfactory limiting requires a greater input than that required to produce standard output, it is this figure that expresses the true sensitivity of the receiver. Satisfactory limiting may be defined as that which produces an i.f. to a.m. ratio of not less than 30 db. For preference the figure should be in the region of 40 db. The f.m. to a.m. ratio expresses the difference in the output of a receiver produced by injecting consecutively (at the centre frequency) i.m. and a.m. signals both 30 per cent modulated. It is as well to point out here that the majority of f.m./a.m. signal generators available in this country to date show a distressing tendency to change frequency when the system of modulation is changed. As 100 per cent modulation corresponds to 75 kc/s deviation, it should be clear that 30 per cent modulation corresponds to 22.5 kc/s deviation.

General Considerations.—From the foregoing, the outline of the combination f.m./a.m. receiver becomes apparent. First, two tuners are required; one to tune the long- and medium-wave broadcast bands, and the other to tune the v.h.f. band. For obvious reasons these should be controlled by a single knob. Secondly, two separate intermediate frequency amplifier chains are required; one for the broadcast bands which will embody the usual selective amplifier operating at a frequency of about 470 kc/s, and the other a relatively wide-band amplifier operating at a considerably higher frequency. Thirdly, in all but a few cases, two detectors are required—one for a.m. and one for f.m. demodulation, the latter including, or being preceded by, some form of amplitude limiting.

Fourthly, a method of switching both the wavebands and the systems must be devised.

In all but the most expensive receivers, the short waveband, which has been a feature of the majority of our receivers since the mid-thirties, may now be expected to disappear. In Western Germany, where over 90 f.m. stations give almost complete coverage, even the long waveband has disappeared from what may be termed the standard receiver. This may eventually be expected to happen here when complete f.m. coverage is attained, but until then a long waveband will have to be provided in our receivers for the reception of Droitwich.

Due to the use of a higher value of intermediate frequency and the need for a considerably wider bandwidth, more stages of amplification are needed for f.m. than for broadcast reception. The usual method of obtaining this is to use the heptode section of the broadcast frequency changer as an extra i.f. amplifier, together with a second i.f. stage using a valve with a higher slope than is usual in broadcast receivers. A special series of valves has been made available for combination receivers. The Mullard range includes the ECH81 triode-heptode, the EF85 variable-mu pentode with a mutual conductance of 6 mA/V, and the EABC80 triple-diode triode. With the latter, two diodes are used for the f.m. demodulator and the third for detection and a.g.c. on the broadcast bands.

Delayed a.g.c. cannot be provided with this arrangement, but as a great deal more gain can be obtained from the i.f. amplifier than is usual in broadcast receivers, this should be of little consequence. Alternatively, a separate germanium diode could be fitted. A.G.C. is not generally used with f.m. receivers as minor variations in amplitude do not affect the receiver output, and the lack of a.g.c. provides extra limiting with large inputs. Both the ECH81 and EF85 are operated with relatively large screen resistors (22 kΩ and 56 kΩ respectively) which make it almost impossible to exceed the maximum permissible dissipation. With standard 470-750 kc/s i.f. transformers, the
EF85 stage gain will be far too high and instability will result unless this is reduced to manageable proportions. This can be achieved either by using i.f. transformers with a suitably low dynamic resistance or, possibly more simply, by switching in a supplementary cathode resistance. The conversion conductance of the ECH81 is 775 pA/V, and the mutual conductance of the heptode section is 2.4 mA/V when it is used as a straightforward amplifier.

V.H.F. Tuning Unit.—As the heptode section of the ECH81 is used as an i.f. amplifier for v.h.f. reception, it clearly cannot be used as a frequency changer at these frequencies. It is, furthermore, undesirable that it should be so used, as at v.h.f. it would give very poor gain in comparison with other methods. It would also require switching at v.h.f. which is something to be avoided as far as possible.

The v.h.f. mixer is therefore almost invariably a separate valve; triodes and pentodes being equally popular. Both types are usually employed as self-oscillating mixers; a circuit which gives a high conversion gain. In Germany, a triode self-oscillating mixer (EC92) is much favoured, but as the Germans tend to use this without a stage of r.f. amplification, oscillator radiation is a problem. To minimize this, the valve is used in a form of bridge circuit the function of which is to cancel out the oscillator voltages at the aerial. Its efficacy, however, seems somewhat limited, as one German receiver employing this circuit which the author tested showed 300 mV to be present across the correctly terminated aerial sockets. It is understood that this is by no means uncommon. As German receivers use an i.f. of 10.7 Mc/s and make use of the whole of Band II, it can be seen that the oscillator frequency actually falls within the band. It can only be assumed that this fact was taken into account when frequencies were allocated.

There can be no doubt that in this country such a practice would be frowned upon, and an r.f. stage should be regarded as a necessity. For the same reason, the use of a super-regenerative type of receiver is almost out of the question. Its high efficiency and apparent simplicity make it appear an attractive proposition, but as it makes use of a pulsed oscillator it could be placed under the heading of "small power transmitters." The power radiated by these oscillators is so high that it is doubtful whether an r.f. stage would provide adequate protection. To return to the r.f. stage, here again a choice between triodes and pentodes can be made; the triode being earthed-grid connected. As receiver noise is of little moment in f.m. receivers, the choice between triodes and pentodes for the mixer or r.f. amplifier is purely a matter of convenience. The choice is usually made by balancing amplification against cost.

Either permeability or capacitive tuning can be used; the latter being more convenient from a mechanical design standpoint. Tuning capacitors made specially for these receivers are now available. If permeability tuning is used, the r.f. stage can be pre-set tuned to the centre of the band to avoid alignment problems. Little is lost by so doing. One advantage of not having externally controlled signal frequency tuning is that the inter-valve circuit capacitance can be kept low, permitting a higher LC ratio to be obtained. A unit similar to that published in Wireless World recently, but designed for use on Band II, with an aerial step-up transformer and a 1:1 i.f. transformer, will give a gain from the aerial input to the secondary of the i.f. transformer considerably in excess of 100. One last word about the usefulness of the r.f. stage. Quite apart from the fact that it isolates the oscillator, it is well worth the extra cost because a well-designed stage will provide appreciable rejection of spurious responses as well as worthwhile gain.

I.F. Amplifier.—A typical i.f. amplifier for a combination a.m./f.m. receiver is shown in Fig. 1. As can be seen, system switching takes place at intermediate and audio frequency. Great care must be taken with the layout of the switch wiring, and particularly the relative positions of the grid and anode wires. German designers tend to use a slider switch which runs almost the whole length of the chassis in some cases. This enables the switching of each stage to be carried out as close to the valve as possible.
possible. This type of switching is facilitated in German receivers by the fact that only a two-position switch is necessary. British receivers will be complicated by the necessity for incorporating a long waveband. Nevertheless, a similar arrangement will probably be necessary for switching the ECH81 anode and the EF85 grid and cathode. Care must also be taken with the output lead of the v.h.f. unit. It may not always be possible to place the output connections of the unit close to the switch, and if the connecting lead is more than an inch or two long it must be screened. Low-capacitance screened lead should be used and the i.f. transformer secondary tuning capacitance reduced accordingly.

The necessity for switching the ECH81 anode and the EF85 grid may not at first be clear. The reason for switching the ECH81 anode is that many frequencies are present at the anode of a mixer, and the presence of two circuits tuned to different frequencies in the output could cause undesirable effects. One obvious one is the possibility of unwanted signals passing through the wrong channel and reaching the audio section through leakage across the switch. The switch in the EF85 grid circuit is intended primarily to short-circuit the a.g.c. line when using the higher i.f. in order to prevent stray coupling between the i.f. stages. It incidentally performs the additional function of short-circuiting the secondary of the first 470-kc/s i.f. transformer which results in slightly improved v.h.f. sensitivity.

The reason for $R_1$ may also appear obscure. It is included in order to comply with the valve manufacturer's requirements which do not tolerate operating high-slope valves with their heaters on but with no high tension. Nevertheless, it is desirable to stop the v.h.f. unit operating when the receiver is being used for broadcast reception, and $R_1$ covers both requirements by reducing the h.t. to some 20 volts.

The f.m. discriminator is a ratio detector of the unbalanced variety; $R_{15}$ is the load and $C_{15}$ the stabilizing capacitor. $R_{13}$ and $C_{13}$ form the de-emphasis circuit. It will be noticed that grid current biasing is used with the EAB80 triode. This is preferable because it enables the cathode to be taken directly to chassis potential. As this cathode is common to one of the ratio detector diodes, this circuit reduces the possibility of unbalance in the detector. It incidentally shows a slight saving in cost over the cathode biasing arrangement. The distortion introduced by this stage is remarkably low and no fears need be felt on this score.

F.M. Detector.—There are many forms of f.m. detector, most of which are only of academic interest to domestic receiver designers as they are either very inefficient, or they require additional valves to act as limiters. Information on these can be obtained from the literature and it is proposed to confine this section to a discussion of two types only.

Until 1947, limiting in f.m. receivers was nearly always provided by two saturated amplifiers preceding the discriminator. That tended to make these receivers rather expensive. It would not be far from the truth to state that if a simpler solution to the limiting problem had not been found, f.m. broadcasting on a large scale would have been made impossible through the lack of listeners. Combination receivers are expensive enough without the additional cost of two extra stages! In fact, two solutions were found; the nonode valve and the ratio detector.

The nonode valve, designated EQ80 in this country, is a "gating" valve. Two voltages having a phase angle between them of 90 deg are applied to the third and fifth grids. The voltages at the first and second grids are held constant and anode current can only flow when both the third and fifth grids are positive. As in a pentode, if the first and second grid voltages are held constant, the electron current is likewise constant. Therefore, in the nonode valve any change in anode current will be solely a function of the phase difference of the voltages at the third and fifth grids. If this phase difference is made to vary in accordance with an f.m. signal, the valve will convert changes in frequency to changes in amplitude, and the valve will become an f.m. demodulator. As the electron current is constant, the valve will not respond to changes in amplitude of the input signal and limiting is therefore automatic. There is, however, one serious
The are small sensitive, and the resultants are excellent. A typical circuit is shown in Fig. 2.

It is not proposed to go into any detailed description of the operation of the ratio detector, as this has been dealt with elsewhere. The circuit is shown in Fig. 3. As can be seen, it bears a resemblance to the conventional phase detector but with two major differences. The diodes here are connected in series and the resultant voltage developed across the load is stabilized by means of a large capacitor. This capacitor holds the amplitude constant and limiting is therefore automatic. Satisfactory limiting can be obtained with about 6 volts input. As the loading is heavy, a form of matching is used between the primary and secondary of the discriminator transformer. Possibly the most important factor in the design of the ratio detector is what the designers have termed the S/P ratio; that is, the ratio of secondary to primary voltage. On this depends whether the detector will limit satisfactorily, if at all. After all other parameters have been fixed, the S/P ratio becomes a function of the coupling between the primary and the secondary, and therefore between the primary and the tertiary.

An easy method of adjusting the coupling is during alignment. A d.c. meter (low loading) is placed across the stabilizing capacitor and an unmodulated signal is injected into the receiver. All i.f. circuits except the secondary of the discriminator transformer are adjusted for maximum d.c. output. The meter is then transferred to the audio take-off point (point X in Fig. 3) and the secondary of the discriminator transformer is adjusted to give a d.c. voltage half of that which was obtained across the stabilizing capacitor. The primary may then require a slight re-adjustment after which the secondary setting should be checked. This process should be repeated until no further adjustment is necessary. The signal is then amplitude modulated and the point of maximum limiting should occur with about 10 kc/s of the alignment frequency. If it does not, the position of the tertiary winding should be adjusted with relation to the primary. The alignment process must then be repeated. The whole process must be repeated as often as is necessary until the point of minimum a.m. response does fall within about 10 kc/s of the alignment frequency. If it does not occur anywhere within the permissible range of adjustment of the tertiary winding (that is, between the top and bottom of the primary winding) the transformer has been incorrectly designed. It will be noted that it is not absolutely necessary to use an i.f. signal generator to align this detector. The need for such a generator will only arise if some obscure fault develops, or for more involved tests.

The ratio detector has enjoyed great popularity both in America and in Germany, and will no doubt become just as popular here. It is simple, reasonably sensitive, and f.m./a.m. ratios of 40 db and more can be obtained in practice with quite low inputs. It has another advantage in that the sideband responses are small and it tends to limit even on random noise. The result of this is extraordinarily low interstation noise. This is a great advantage in domestic receivers as it is doubtful whether most people would appreciate the colossal din, common with receivers using other types of detector, that occurs when tuning from one station to another.

**Intermediate Frequency.**—The choice of an intermediate frequency is, as usual, a difficult one. The designers of the ratio detector chose 10.7 Mc/s as being the highest frequency that would give a reasonably high gain per stage. Unfortunately, this frequency has the drawback of causing the fundamental oscillator frequency to fall in Band II, and the second harmonic to fall in the middle of Band III. In spite of this, 10.7 Mc/s has virtually become standard in both America and Germany.

The same considerations hold good for this country. Although initially an i.f. of 10.7 Mc/s may not cause the oscillator to interfere with broadcast reception in Band II, it will almost certainly affect the public services operating in Band II and to the commercial television services in Band III. It is highly debatable whether radiation in mass-production receivers can be kept within the limits laid down by B.R.E.M.A. The radiation problem is further complicated in f.m. receivers by the fact that the majority will not be used with a matched aerial. The piece of wire that will probably stand proxy for an aerial will almost certainly increase the nuisance value of the receiver. For this reason it is suggested that the oscillator voltage at the aerial socket should be measured without the usual terminating resistance.

Any frequency above 12.5 Mc/s will keep the oscillator out of Band II, but to keep its second harmonic out of Band III requires an i.f. above 20 Mc/s. For the same stability margin this frequency will only give half the gain per stage that can be obtained with 10.7 Mc/s. Even so, the sensitivity of the receiver should be adequate, and the higher frequency has advantages to offer. It will give increased protection from spurious responses; an important point when it is remembered that television stations in Band III could cause interference due to the oscillator second harmonic. Another advantage is that the farther removed the signal frequency is from the oscillator, the greater will be the protection against radiation given by the signal-tuned circuits. A minor advantage is that it makes the design of a receiver with a pre-set tuned i.f. stage easier by keeping the oscillator frequency well away from the centre of the band.

**The Pseudo F.M. Receiver.**—It will have become quite clear by now that combination f.m./a.m. receivers are going to be somewhat more expensive than the standard 4 + 1 domestic receiver we have been used to. In the circumstances, it was only to be expected that attempts would be made to produce something considerably cheaper—if only for use in high signal strength areas. It is well known that f.m. signals can be received on an a.m. receiver by the simple expedient of tuning down the slope of the selectivity characteristic. This is often referred to as slope-detection. This form of detection has many drawbacks. It is very inefficient, it provides no limiting, and it gives two tuning points for each station. The use of it is only justified by its simplicity and cheapness.

A receiver using a slope-detector for f.m. reception has been produced in Germany; the circuit is shown in Fig. 4. It can be seen that the receiver consists of three valves plus rectifier. The first valve is a v.h.f. triode (EC92) used as a self-oscillating mixer...
on v.h.f. only. It incidentally illustrates the typical way in which this valve is used. The second valve (EF41) does service as an i.f. amplifier on v.h.f. and an r.f. amplifier on medium waves. The final valve (ECL113) is a triode-pentode, the triode section acting as a leaky-grid detector on both bands, the pentode being the audio output valve. Volume is controlled by a variable resistance in the cathode of the EF41, and a potentiometer in the anode circuit of the detector provides a reaction control on medium waves and a tone control on f.m. Whether for f.m. or a.m. reception, this receiver is only suitable for use in high field strength areas, and it is not known what success it has had.

This receiver has no r.f. stage, nor does it provide any form of limiting. As far as this country is concerned, such a circuit might conceivably fill a temporary need as a converter, but as a receiver it should surely be rejected. Quite apart from the ethics of the case, it is doubtful whether such a receiver would be capable of any better performance on f.m. than the standard broadcast receiver gives on medium and long waves.

Audio Amplifier.—The B.B.C. has stated that it is introducing v.h.f. broadcasting, "not as a complete substitute for long and medium wavelengths but as a powerful reinforcement of the sound services." We may therefore take it that fidelity will only be a secondary consideration. Taking into account the high-frequency attenuation of land-lines and the frequency response of studio equipment, it will only be on rare occasions that full advantage will be taken of the upper modulation frequency limit of 15 kc/s. This, however, need not make us downcast, as reception in many places will be considerably better than that which is obtainable on medium and long waves. It is suggested that in combination receivers the distortion level should not be higher than 2 per cent at the maximum rated output, and should preferably be of the order of 1 per cent. To attain these figures will require a substantial amount of negative feedback with a consequent reduction in amplification. The amount of feedback that has to be used may be so great as to reduce the sensitivity of the receiver to a level which is below that required. In this case, it may be thought worth while to use the otherwise idle triode in the ECH81 as an extra audio amplifier on v.h.f. The method by which this may be done is shown in Fig. 5. Hum is the greatest problem here, and extra smoothing must be used in the anode supply. Even then, full use of the valve cannot be made, and it will be noticed that only one-quarter of the anode load is used. This keeps the hum level low and enables the stage to give a useful power gain of over six times.

Results.—Three receivers comprising an EF80 preset tuned r.f. stage, EF80 self-oscillating mixer, ECH81 i.f. and a.f. amplifiers, EF85 i.f. amplifier, EABC80 ratio detector and a.f. amplifier, EL85 power
amplifier and EZ80 mains rectifier, used in a similar manner to that described in this article, had sensitivities of 3, 4 and 9 nV respectively, and f.m./a.m. ratios of between 36 and 40 db at these signal levels. The intermediate frequency was 19.5 Mc/s. Bass boost at 80 c/s was between 4 and 5 db with reference to 400 c/s, and the frequency response with pre-emphasis was level up to 8 kc/s. Overall distortion at 1.5 watts output was in the region of 2 per cent.

Conclusions.—It was mentioned in the “Second Report of the Television Advisory Committee, 1952,” that the additional cost of incorporating v.h.f. in new receivers will be of the order of 30 per cent. It was also stated that the additional cost would be greater unless the receivers were mass-produced. Whether these receivers can be produced on anything like the scale of the 4+1 receiver will depend on two factors. The first is the speed with which the B.B.C. are able to erect the stations, and the second is whether the ordinary man-in-the-street is going to think it worth while to spend that extra 30 per cent on his receiver. If demand is great enough, we may be well on the way to building up a thriving industry in a.m./f.m. receivers. In this case, it may be possible to reduce the 30 per cent substantially, and that will justify all the arguments that have been made in favour of f.m. broadcasting.

References

Colour Television Tests

By J. Franklin

If any television experimenters in London happened to have their sets running after programme hours during July they may have been lucky enough to see some strange things on the screen. The things in question, which I saw quite by chance on my receiver, were orderly patterns of white dots on a synchronized, but otherwise blank, raster. Sometimes the patterns had a bar or several bars across them and at other times they were quite plain.

Having been following developments in colour television pretty closely, I realized immediately that the B.B.C. were transmitting a sub-carrier frequency on the main 45-Mc/s carrier wave from Alexandra Palace—a sub-carrier such as would be used for conveying colour information in a compatible colour television system of the N.T.S.C. type. As is generally known, this sub-carrier in the N.T.S.C. system enables the colour information to be transmitted within the same video band as the monochrome signal, and its frequency is chosen so that the colour sidebands are interleaved between the monochrome sidebands.

The great problem which British television people seem to be faced with at the moment is whether or not we can adapt the N.T.S.C. type of colour system to our existing 405-line standards. And this depends to some extent on whether the system is compatible enough. In short, is the presence of a sub-carrier and its resultant pattern on the screen going to cause too much deterioration of our pictures? I imagine that the B.B.C. were attempting to answer this question by arranging a series of test transmissions of a sub-carrier signal so that observations could be made on typical receivers. An interesting problem here is: what is the best frequency for the sub-carrier?

In the June issue of Wireless World a report was given of a British version of the N.T.S.C. colour television system developed by Marconi's, and in this the sub-carrier used was approximately 2.66 Mc/s. I therefore assumed that the B.B.C. were transmitting something comparable with this. Tests with an absorption wavemeter, however, showed the frequency to be more like 2.8 Mc/s, or perhaps slightly under. This higher frequency, of course, would give a finer and less visible dot pattern on the screen than in the Marconi system, and I personally found that I could not see the dots when I moved to a distance of about 4-5 feet from the screen.

On the other hand, the higher the sub-carrier frequency the more likely is the colour signal to interfere with the sound channel of the system. I presume that the bars I saw on the screen were a form of modulation on the sub-carrier to test for this effect (probably square-wave modulation). There was, in fact, a perceptible low-frequency noise in the loudspeaker when these bars appeared, but it did not strike me as being particularly obtrusive. No doubt the amount of this interference would vary with different receivers.

Presumably some organized observations were made on these test transmissions, apart from the clandestine ones such as my own, and it will be interesting to see the results when they are eventually published.
"Why Lines?"

THE "Lissajous" scanning system proposed by F. P. Hughes (your August issue), if it earns full marks for originality surely merits none for practicability.

If one inscribes three similar and symmetrical rectangles within the screen so that the smallest is one quarter of the whole screen area, and the area between each rectangle and the next larger is also one quarter of screen area, it is clear that with B.B.C. standards the spot will be in each of the four equal areas for approximately 22 per cent of total transmission time, the remainder being lost to synchronizing pulses, etc. With "Lissajous" scanning the spot will be 11 per cent of transmission time in the central area, 14 per cent in the next area as one moves outward, 19 per cent in the next and 56 per cent in the outermost fringe. Moreover the spot will take as long in total to scan the four small rectangles in the corners (comprising together 1.8 per cent of screen area) as it does to scan the important centre area. In fact the transmission time wasted on the edges and corners of the picture will be very much greater than that "wasted" in sync. pulses in conventional systems and definition in the important central area will be equivalent to a 30 per cent cut in line number and 50 per cent in bandwidth as compared with the conventional.

Even more serious would be the consequences of the timebase waveform departing in the slightest degree from purity. As the screen is being scanned equally from left to right and from right to left any phase drift will shift half the picture elements one way and the other half in the opposite direction. At screen centre a drift of 0.001 c/s will cause the picture elements to separate by approximately 0.006 of the total picture width, giving a "defocus" effect equivalent to complete loss of the one-megacycle bands on the test card. Similar loss of definition, but varying in complex fashion from place to place on the screen, would result from 0.6 per cent of total harmonic distortion. As these results would be additive on some parts of the screen, it would probably be necessary to specify tolerances of not more than 0.0002 c/s max. phase drift and 0.1 per cent total harmonic distortion for the timebase oscillators. Such a specification is probably not unattainable, but the cost and complication would obviously be prohibitive.

Teddington, Middx.

S. HOSKING TAYLER.

Why A.G.C.?

I SEE from p. 40 of the August issue that "Diallist" proposes to build a modified version of my midget sensitive i.f. receiver (described in the April issue) without a.g.c. A.G.C., he maintains, is unnecessary because the receiver is intended only for reception of local stations which in his locality are free from fading. Surely "Diallist" isn't under the impression that a.g.c. is used only to combat fading? It has another merit, equally important; namely, that it ensures equal volume from all signals. This fully justifies its inclusion in a local-station receiver. "Diallist" is indeed fortunate if all his local transmissions are of equal strength and, if they are not, he will need to reset the volume control after each tuning adjustment.

The inclusion of a.g.c. avoids this, making operation easier and prolonging the life of the volume control potentiometer.

Although it may not apply in this particular case, a.g.c. is sometimes used to avoid the application of large signals to the detector. Such protection may be necessary if the detector overloads easily (as anode bend detectors do) or if the detector may be damaged by large signals (as some crystals are).

J. L. OSBOURNE.

Ionic or Iontic?

PEOPLE speaking languages of Anglo-Saxon or Latin origin employ, generally successfully, a great number of technical and scientific terms derived from the Greek. Occasionally, though, in the process of adaptation, there is a regrettable loss of clarity and precision.

An example of successful use is the word ion, which is the neuter present participle of a Greek verb meaning "to go." But non-Greek technologists, in coining derivatives and compounds of this useful word, have introduced error and confusion. Ionic order (architectural), Ionic school (philosophic), etc., refer to the ancient Greek land Ionia. Ionic is a synonym of Ionian; therefore, ionic bombardment might (and should, by the rules of language) refer, say, to a naval action off the Ionian Islands! The mythological Greek priestess Io (Io), sweetheart of Zeus, who gave her name to these islands, bore no relation whatever to the electrically charged atoms, molecules or radicals in which the radio engineer is interested. She also had nothing to do with the new radio-active isotope ionium.

To avoid confusion, derivatives of ion should be formed from the genitive ions (iota) which gives us the root ions-, or sometimes, for the sake of euphony, ionto-.

The correct practice has already been adopted by the medical profession in the word iontophoresis (introduction of ions into human tissues). Radio technologists and physicists should, I suggest, follow suit by changing, for example, ionize into iontize, ionosphere into iontosphere, ionium into iontium, etc.

DIONYSIUS J. BATAIMIS. Hellenic National Broadcasting Institute, Athens.

Electronics and Automation

IN your report on a debate at the Brit. I.R.E. Convention ("Industrial Electronics," Wireless World, August, 1954, p. 358) you mention a discussion on the possibilities of flexible machines which could be programmed for different tasks as required: these would in fact be something like the original concept of a Robot; i.e., a mechanical substitute for a human being. One attempt to mechanize a production process in terms of "replacing human labour" has convinced me that this is a wrong approach. Human labour is very flexible and fairly cheap (especially if female) and a machine to carry out precisely an adjustment such as tuning a circuit to resonance, which at present is done by hand, is prohibitively complex. Not least of the difficulties is that of making the robot connect automatically with the appropriate part of different models of equipment.

The future of "automation" (factory production with the minimum of labour) lies mainly in the development of appropriate manufacturing techniques, such as printed-circuitry in radio and electronics, and the pressed-steel body in place of the coach-built body in the automobile.
industry. The future of industrial electronics lies in doing things which the average human operator cannot do successfully. This applies particularly to fast-moving flow production; e.g., colour printing, textile manufacture, continuous steel strip mills, but it is also beginning to find application in precision machine tools. Whenever the quickness of the machine deceives the eye, or the potential accuracy of the machine is greater than that of human hand and eye, there may be an essential job for electronics.

Birmingham. D. A. BELL.

Feedback Circuits

THE well-known feedback circuit (diagram (a)) is fully discussed in "Radio Designer's Handbook," p. 334. However, one soon finds out when trying to apply the circuit that either the anode load of \( V_2 \) becomes inordinately low or that the cathode load of \( V_1 \) becomes inordinately high with anything more than a small feed-back ratio. These snags disappear when the feedback is applied to the grid of a cathode follower which is direct coupled to \( V_1 \), (diagram (b)). It is possible to vary the feedback between wide limits without upsetting the working characteristics of either \( V_1 \) or \( V_2 \).

I am using this circuit in a pre-amplifier with a parallel-T whistle filter between \( V_1 \) and \( V_2 \). Coupled to a Baxandall tone control (Wireless World, Oct. 1952) the whole arrangement works very well, is silent, stable and, judged by ear, of high fidelity.

It is possible that this circuit may be discussed somewhere in the literature and if one of your readers could enlighten me I would be grateful.

Burgess Hill, Sussex. A. V. SLATER.

Vector Diagram Conventions

IN his July article, "Cathode Ray" has advocated that certain conventions should be adopted to ensure that there should be only one correct voltage vector diagram to correspond to any given circuit diagram. The suggested conventions involve the addition and placing of vectors in an order uniquely determined by the circuit configuration. The conventions thus imply a slight restriction on the commutative law of addition of vectors, and also on the usual understanding of a graphical vector as having length and direction but no defined position.

In my view, although it is desirable in every problem to establish a defined relationship between the sign convention for the circuit diagram and the sign convention for the vector diagram, it is undesirable to extend this to a perfect tie-up between circuit and vector diagrams in the rigid one-to-one manner that has been advocated by "Cathode Ray."

"Cathode Ray" has invited his readers to point out any flaw in the system which might account for its lack of general acceptance since it was first proposed in 1951. It is possible that this may reside in the restriction to which the diagrams are subject when an attempt is made to develop them into vector loci. For example, with reference to Fig. 14 of the July article, and considering a constant current condition, diagram (a) would provide the most convenient basis for a locus to illustrate the variation of \( V \) and \( V_2 \) with variation of \( \mu L \), \( R_1 \) and \( R_2 \) being constant. On the other hand, diagram (b) would be more convenient if \( R_1 \) were to be varied with \( R \), and \( \mu L \) held constant, while diagram (c) would be more convenient if \( R_1 \) and \( R_2 \) were to be varied with \( R_1 \) and \( \mu L \) held constant. To justify these alternative forms of vector diagram, "Cathode Ray" would have to redraw his circuit diagram to match each case, thus attributing undue importance to the cyclic order of the components in a circuit in which the only really significant fact is that the components are connected in series.

Bangor, N. Wales. DAVID MORRIS.

FURTHER EDUCATION

Radio Courses Available

IF the proposal put forward by the Parliamentary and Scientific Committee in a memorandum on higher technological education is adopted, some twenty of the existing technical colleges will be granted charters and become Royal Chartered Colleges of Technology, with the right to award degrees in technology. They would provide for advanced full-time "sandwich" and part-time day and evening courses, part-time courses and full-time and part-time research.

These are, of course, purely recommendations. Facilities for further technological education do already exist even if some of them are inadequate. We have secured from the Ministry of Education a list of further education establishments providing classes in radio and allied subjects. The term "further education," by the way, is used for establishments providing classes for those whose whole-time formal education has ended.

On the opposite page is tabulated some 150 further education establishments in England (grouped under counties) providing courses in telecommunications (col. A), radio theory, transmission and marine wireless (B), radio servicing (C), and television servicing (D). The letters used in these columns indicate full-time courses (F), part-time day courses (P) and evening courses (E).

† It is hoped to give similar details for Scotland and Wales next month.

Wireless World, September 1954
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C.T. College of Technology; T.C. Technical College; T.I. Technical Institute; E.I. Evening Institute; C.F.E. College of Further Education
With the introduction of the nickel-zinc grades of Ferroxcube with their high material permeabilities and low losses many new fields of application have been opened up. Not the least important of these is the replacement of bulky frame aerials by relatively small rods and coils. All aerial rod designs in this article are based on Ferroxcube rods in grade B2, which has an initial permeability of approximately 200 and a resistivity of 10 Ohm-cm. Its loss factor tanδ/μ at 0.5 Mc/s being 90 x 10^-6.

It should not be assumed that rod aerials, as they have come to be known, can only replace frames or indoor systems; with a rod of larger proportions than those discussed in this article, a signal voltage comparable with that of an outdoor aerial in combination with a normal input circuit can be approached. Interference which is now so prevalent all over the long and medium wavebands can often be reduced by the directional effect inherent in these assemblies.

Although the advantages of such a system are immediately evident, the design of a suitable assembly is rather complex, due mainly to the lack of practical design data on open-ended coils. An attempt will be made in this article to combine all necessary data on this form of aerial into workable formulae, and to present examples of the manner in which ferrites can be used in practical aerial systems.

Before analysing the physical properties of rod aerials it may be worth while to discuss the relative merits of inductive and capacitive aerials, as the basis of comparison may not be immediately obvious.

Inductive and Capacitive Aerials

The efficiency of any type of aerial is usually judged from the voltage delivered to the grid of the first valve. With an average domestic aerial of dimensions under a half wavelength, used in conjunction with a matching transformer, the voltage is proportional to the product of the field intensity (vectorially) in volts per metre, the effective height (h) in metres and the transformer ratio (N).

With inductive aerials, including rod aerials, the voltage at the first grid is mainly determined by the product of the effective height (h) and the aerial circuit quality factor (Q). No direct comparison should be made between these two types of aerial. However, a comparison can be made between the products of effective height (h) and transformer ratio (N) of the capacitive aerial against the effective height and quality factor Q of the latter.

* Mullard Ltd. (Components Division).
Basic Design Data

Frame Aerials.—At the input to any aerial the field concentration and frequency of the transmitter signal are usually known. A loop of \( n \) turns enclosing a part of the radiated field will then have induced in it an e.m.f. of

\[
\varepsilon_1 = \frac{\Phi \omega}{10^{-8}} \quad \ldots \ldots \ldots (1)
\]

where the cross-sectional area of the loop is \( a \) sq. cm., the flux \( \Phi \) is at a and the flux density \( B \) is in gauss.

If \( Q \) is the input circuit quality factor, then the voltage becomes \( \varepsilon_Q \), denoted \( \varepsilon_0 \), and is applied to the grid of the first valve. Therefore

\[
\varepsilon_0 = Q \Phi a \omega 10^{-8} \varepsilon \quad \ldots \ldots \ldots (3)
\]

Rod Aerials.—The main purpose of a high-permeability ferromagnetic core is to increase the flux density \( B \) within the closed loop. For satisfactory operation this should take the form of a rod so that the flux may be concentrated within the turns of the coil (Fig. 1(a)).

By redesigning the aerial coil and inserting a ferromagnetic core, the effective permeability of the enclosed medium to an external field is increased. This effective permeability \( \mu' \) is much lower and should not be confused with the initial permeability \( \mu_0 \) of the core material as measured in a closed magnetic circuit. The output voltage now becomes:

\[
\varepsilon_0 = \mu' Q \Phi a \omega 10^{-8} \varepsilon \quad \ldots \ldots \ldots (4)
\]

The calculations of \( \mu' \) will not be dealt with here, as it is fully covered in the literature; it is only necessary to say that \( \mu' \) can never exceed \( \mu_0 \) and depends mainly upon the physical dimensions of the core. This can be seen from Fig. 5.

It has often been argued that a flat plate of ferromagnetic material would be more suitable for this application than a small-diameter rod, but experiments leading to the computing of Fig. 5 have shown that the flux density inside a plate at right angles to the magnetizing field differs very little from that of the magnetizing field. This can be shown if we take a plate of Ferroxcube with an initial permeability of 200 and dimensions \( l = 114 \text{ mm}, d = 6.3 \text{ mm} \). The \( l/d \) ratio then becomes 0.055 and from Fig. 5 we obtain an effective permeability \( \mu' \), which is for practical purposes unity.

With the introduction of a ferromagnetic core, the aerial system becomes considerably modified. So far we have been considering it primarily in relation to the external field, but it is also part of a tuned circuit and must have a specific value of inductance \( L \). From this it should be evident that the increased permeability necessarily involves a reduction in both \( a \) and \( n \), and therefore equation (4) must be developed, to contain \( L \) as a parameter. It is thus obvious that the physical size of the coil may be reduced to one not very much larger than that of the core. With the introduction of any ferromagnetic core, the inductance \( L \) increases by a factor \( L_{s} / L_{m} \), where \( L_{s} \) is the inductance with ferromagnetic core and \( L_{m} \) is the inductance with an air core. This is often termed the coil permeability \( \mu' \) and differs considerably from \( \mu' \) (see Fig. 1).

At this stage all coils will be shown diagrammatically as being short pile-wound coils. The designing of the most efficient coil will be dealt with later. The inductance of an air-cored coil of the form shown in Fig. 2 is given by the following formulae:

\[
L = n^2 \phi 10^{-8} \text{ henrys} \quad \ldots \ldots \ldots (5)
\]

where \( \phi \) is a constant which depends on the dimensional ratios \( a/d \) and \( b/d \) of the coil.

The ratio of the external and internal reluctance paths of an air-cored coil mainly determines this value of inductance. It can be assumed that this ratio of reluctance within the coil to that outside the coil is \( 10:1 \). Thus approximately \( 1/11 \)th of the circuit reluctance is outside the coil. For a coil where a ferromagnetic core is introduced the reluctance of the magnetic path inside the coil can be neglected compared with the external path.

If we now continue the assumption given above it is evident that the inductance ratio of a coil with a

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ferromagnetic core to that of an air-cored coil will be approximately 11:1.

It can be shown that for a short-section coil of the type shown in Fig. 2 the effective coil permeability \( \mu_e \) is usually between 5 and 15. With a ferromagnetic core the inductance will be:

\[
L = n^2d\phi_{mu_e} \times 10^{-8} \text{ henrys} \quad \ldots \ldots \quad (6)
\]

By substituting in equations (4) and (6) we obtain:

\[
e_0 = QBa \omega \mu' \sqrt{\frac{L}{d\phi_{mu_e}}} \times 10^{-4} \text{ volts} \quad \ldots \ldots \quad (7)
\]

Equation (7) thus shows that a high value of output volts \( e_0 \) can be obtained by the optimum choice of the effective values \( \mu' \) and \( \mu_e \). These factors can be controlled during the design stage.

**Control of Rod Permeability.**—If a ferromagnetic rod is placed in a uniform magnetic field \( B \), the field is distorted towards the centre of the rod. The maximum flux density is at the centre and decreases towards the two ends. The rod permeability \( \mu' \) is of the ratio of maximum flux density with the rod in position, to that of the original field flux density \( B \). For rods with large \( l/d \) ratios having reasonably high material permeabilities the flux distribution along the rod is almost parabolic. The curve of Fig. 3 shows this effect in terms of the ratio of induced e.m.f.'s for a grade B2 Ferroxcube rod 200 mm long and 8 mm diameter. From this curve it can be seen that equation (4) only holds when the coil is placed at the centre of the rod, where the flux density is maximum. The ratio of the mean to maximum flux density has been termed the averaging factor \( f_a \) and a curve, derived from Fig. 3 by integration, showing the dependence of \( f_a \) on the relative length of coil and rod for a symmetrical arrangement is given in Fig. 4. For a very short coil, \( f_a = 1 \) and for a coil surrounding the entire length of the rod it is 0.7.

Fig. 5 shows \( \mu' \) plotted as a function of the initial permeability \( \mu_0 \) and the ratio \( l/d \). To obtain a high value of effective permeability \( \mu' \) the ratio \( l/d \) and the initial permeability \( \mu_0 \) must be high. As a first approximation, \( \mu' \) may be assumed proportional to the ratio \( l/d \), say

\[
\mu' = \alpha \frac{l}{d} \quad \ldots \ldots \quad (8)
\]

From equations (7) and (8), and substituting \( \alpha = \frac{\pi d^2}{4} \) we get

\[
e_0 = QBa \omega \mu' \sqrt{\frac{L}{4\phi_{mu_e}}} \times 10^{-4} \text{ volts} \quad \ldots \ldots \quad (9)
\]

**Circuit Quality Factor (Q).**—The circuit quality factor Q is, of course, one of the main considerations. The reason for this is that an optimum Q value not only determines the output voltage \( e_0 \) but also the circuit selectivity. It would seem that as high a Q as possible would be an advantage, but tests have shown that if a Q value greatly in excess of 200 at 1 Mc/s is used, severe sideband cutting is experienced.

**Influence of Q on Signal/Noise Ratio.**—When calculating the effective Q of the circuit the effect of valve input impedance must not be overlooked. To account for this, our quality factor will now be denoted as Q'. The circuit quality factor Q' also has an influence upon the signal/noise ratio \( e_0/V_n \).

It can be proved that a given noise voltage \( V_n \) does not in any way depend on the value of Q' but is directly proportional to the frequency. By looking at either equation (3) or (4) it can be seen that \( e_0 \) is proportional to the frequency and quality factor, therefore \( e_0/V_n \) will not be subject to the frequency but will be proportional to the quality factor.

From this statement it can be seen that a high value of Q would be an advantage in respect of signal/noise ratio.

**Temperature Coefficient.**—The temperature coefficient of open-ended coils using Ferroxcube cores is a subject by itself and is extensively dealt with elsewhere. It should suffice to say that at normal ambient temperature the permeability of Ferroxcube has a small positive temperature coefficient which, in this type of application, produces a positive temperature coefficient of inductance of approximately \( 0.4 \times 10^{-4} \degree C \). This variation of inductance can in turn influence the shape of the tracking curve.

**Mechanical Mounting.**—Wherever possible the rod should be mounted above or to one side of the chassis so that the additional losses introduced due to the proximity of any metal-cased components are reduced to a minimum. In order to ensure optimum performance it is also advantageous to keep the length of the rod almost the same as that of the chassis, otherwise the latter will have a screening effect, thus lowering the obtainable grid voltage.

A general method of mounting is to extend small plastic brackets from the end of the chassis and insert the rod between rubber grommets so that any vibration or torsion that may be set up during transportation is absorbed. Tag boards and soldering lugs should be mounted away from the actual coil, otherwise a reduction of Q of as much as 20% at 1 Mc/s (299.8 metres) may result. This loss and any other which may be set up due to metal objects, is proportional to the square of the frequency.

**Adjustment of Inductance.**—Two methods of adjustment are now in general use, the more popular being to slide the coil along the rod until the required value of inductance is obtained. This will be found to be most critical as the centre line of rod is approached. The second method is that of removing or spacing of end turns, and is used where the coil is wound directly on the core.

**Material Tolerances.**—Mechanical tolerances on...
the dimensions of Ferroxcube B2 are ± 3% on diameter and ± 4% on length, and the value of initial permeability \( \mu_0 \) is generally quoted on ring specimens as being > 200. The combined effect of these tolerances can cause a spread in \( \mu_0 \) of ± 5%, when measured with a given coil in a fixed position, e.g., in the middle of the rod. For most rods and an average coil the required inductance should be designed at a point where \( 2 \pi l = 0.45 \). Fig. 6 shows that for starting value \( 2x - 0.45 \) a displacement of the coil to a position where \( 2x l = 0.2 \) or 0.6 will be sufficient to compensate for a spread in \( \mu_0 \) of ± 5\%.

**Effective Height.**—The factor known as the effective height has already been discussed in so far as it affects the comparative merits of inductive and capacitive aerials. As already explained it is common to express the field intensity in volts metre and the performance of an aerial as the effective height.

The effective height of a loop aerial is usually expressed as:

\[
h = \frac{2\pi A n}{\lambda} \times 10^{-4} \text{(metres)} \quad \ldots \quad (10)
\]

where \( A \) is the mean area of the loop in \( \text{cm}^2 \) and \( \lambda \) is the wavelength in metres. If a ferromagnetic rod is now introduced having a permeability \( \mu' \) equation (10) becomes:

\[
h = \frac{2\pi A n f_a \mu'}{\lambda} \times 10^{-4} \text{(metres)} \quad \ldots \quad (11)
\]

where \( f_a \) is derived from Fig. 4, \( A \) is the mean area of the coil in \( \text{cm}^2 \) and \( \lambda \) is the wavelength in metres.

**Coil Design.**—First let us decide what is going to be the main design parameter, i.e., maximum output voltage or a high value of \( Q \). If a high value of \( e_0 \) is aimed at, the \( Q \) value will more often than not be poor, and if a high \( Q \) value is the main requirement then the grid voltage may well be below average. Because most radio engineers are continually striving to achieve better selectivity we will consider first a design with a predetermined \( Q \) value.

Most of the information which has so far been published on this subject has treated the problem on the basis of a fixed frequency of 1 Mc/s. Experiments have shown us that the value of \( Q \) increases with the rod diameter, but from an economic standpoint the optimum value occurs at about 200-210 on a 5/16in diameter rod 8in long in Ferroxcube grade B2.

If we take this value of \( Q \) as a general figure and design our coil around a rod 5/16in dia. \( \times \) 8in long this will form a basis for all further designs. A coil whose length is relatively small has been chosen so that the value of temperature coefficient can be kept within reasonable limits. It will be found that due to the manufacturing tolerances essential with most ferrite materials, the coil will have to be moved toward one end of the rod to obtain the required value of \( Q \). Assuming an inductance of 197 \( \mu \)H for the medium-wave coil and a coil permeability of 13, the theoretical position of the coil from the centre line of the rod can be obtained from Fig. 6.

If we now take the reciprocal of our quality factor, i.e., \( Q = \tan \delta = 50 \times 10^{-4} \) we see from Fig. 7 that this value of \( Q \) can be obtained with a coil permeability of 11. If this value of permeability is accepted the new position of the coil, with reference to the centre line of the rod can be found by referring to Fig. 6 to be \( 2x l = 0.6 \).

The decrease in coil permeability must now be compensated for by an increase in the number of turns, in this particular case by multiplying by the ratio of 1:1.1 where it will be found that the required number of turns will increase from 27 to 30.

Due to the displacement of the coil, the flux distribution will decrease as shown in Fig. 3, for \( 2x l = 0.6 \) the decrease of \( e'c_{max} = 0.68 \).

Converting physical dimensions into cm and taking \( n = 50 \), \( f_a = 1 \) and \( \mu' = 117 \), the effective height is

\[
h = \frac{2\pi \times 0.5 \times 30 \times 1 \times 117 \times 0.68}{299.8} \times 10^{-4} = 0.0025 \text{ metre}
\]

The overall performance, \( hQ \) = 0.0025 \times 200 = 0.5.

If this value is compared with that of the second design it will be found that the increase of \( Q \) was obtained at the expense of overall performance.

From laboratory tests it has been determined that short thick rods should be employed where exceptionally high values of \( Q \) are required, i.e. say 9.16in \( \times \) 4in long. A typical design for a medium- and long-wave aerial coil utilizing the core stated above would be 50 turns of 9.40 litz wound approximately 3in from one end, this forming the medium wave section with 120 turns of 9.40 litz wound on the opposite end and used in conjunction with the medium wave coil for the long wave reception. A multi-turn coupling coil is sometimes found to be necessary between the two windings, when coupling to an external aerial.

With an assembly of these dimensions, and taking \( n = 50 \), \( f_a = 1 \), \( \mu' = 40 \) and \( e_{c_{max}} = 0.75 \), the effective height is

\[
h = \frac{2\pi \times 1.54 \times 50 \times 1 \times 40 \times 0.75}{299.8} \times 10^{-4} = 0.00484 \text{ metre}
\]

and the overall performance \( hQ \) = 0.00484 \times 250 = 1.21 where a Q of 250 is applicable for this type of rod.

Let us now consider a design where the voltage applied to the grid of the first valve becomes a main consideration. This design is again based on the same Ferroxcube rod as the first example, i.e. 5 16in dia. \( \times \) 8in long.

The initial or toroidal permeability of Ferroxcube grade B2 is given as 200; knowing this and the \( l/d \) ratio we can find \( \mu' \) from Fig. 5, i.e. 117. The coil effective permeability factor \( \phi_{\mu'} \), on the other hand, can be determined from Fig. 8, which is a curve of measured values of \( \phi_{\mu'} \), plotted as a function of \( a/l \). The quality factor will be \( Q = 10^{3} \times 62 = 161 \).

---

**Wireless World, September 1954**
With this information it is now possible to calculate the effective height, inductance, etc., of the aerial. As already explained, the value of $f_a$ for the short type of coil used is practically unity.

Therefore the effective height is

$$h = \frac{2 \pi \times 0.5 \times 27 \times 117}{299.8} \times 10^{-4} = 0.0033 \text{ metre}$$

and the overall performance of the aerial system will be

$$hQ = 0.0033 \times 161 = 0.532.$$  

For proof that a higher overall performance can be obtained by increasing the value of the $l/d$ ratio the above example has only to be re-calculated with an $l/d$ ratio of say 40. The objection here being that the rod would be difficult to manufacture by normal processing and hence not an economical proposition.

From Fig. 8 the effect of increasing the length of the coil can be seen, the slope between unity and $a/l = 0.5$ is reasonably flat and between 0.5 and zero extremely sharp. Therefore there is little benefit to be gained in increasing the ratio of $a/l$ above 0.5 as the price of a decrease of $\phi \mu$ would be considerable increase in both losses and temperature coefficient.

**Variation in Coil Performance.**—Recent tests on the size, shape and wire diameter of which medium wave coils are wound have proven rather interesting and will be summarized as follows. For reasons already explained, short-length single-layer coils have, up to now, been used, positioned towards one end of the ferrite rod. If we now spread-wind, or progressively wave-wind over approximately 2–3in of the rod length, keeping the ratio $a/l$ less than 0.5, it will be found that the quality factor will drop by approximately 25%, i.e. from 200–210 to 150–160. The pick-up voltage will, however, increase. Therefore, before finally deciding upon the type of coil necessary for a particular circuit, the main parameter of selectivity or sensitivity should be decided upon. If a long loosely wound coil is used then the value of $\phi \mu$ will increase, which in turn will decrease the value of inductance, so that the number of turns must be increased to compensate for this loss.

The effects of temperature coefficient on the type of coil described influence the overall performance of the aerial by very little and can be more or less neglected.

**Effect of Winding Wire.**—For close wound coils the Q values vary greatly both with wire diameter and type. For instance, with solid wire 25 s.w.g. the Q value is approximately 100, whereas with the same coil wound from 9.40 litz the quality factor increases to 270. It is worth noting that the input voltage increases with a decreasing wire gauge and is a maximum with litz. On the other hand, with long spread windings the quality factor remains almost constant with the type and wire gauge, the circuit voltage following the same trend.

Up to now we have only considered the effects of various types of coil on the quality factor, but it is of importance to take into account the effects of variations in the coil upon the inductance.

1. The maximum variation of inductance as a function of frequency is $ + 1^\circ \alpha$, and does not depend upon the coil dimensions.

2. As already pointed out, by increasing the length of the coil we also increase the value of $\mu$, and decrease the true value of inductance. Therefore for a constant inductance, the number of turns must be increased, but this in turn decreases the value of Q.

3. The type of wire used does not influence the value of inductance but can greatly effect the quality factor.

All coils so far described have a diameter which only exceeds the diameter of the rod by the thickness of the coil former which is usually of brown paper or very thin presspahn. To find what influence this increase in diameter has upon the circuit quality factor a series of measurements were taken with an increasing diameter of coil former and keeping the length of the coil and number of turns the same.

<table>
<thead>
<tr>
<th>Coil Diameter (mm)</th>
<th>Quality Factor (Q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>203</td>
</tr>
<tr>
<td>9.5</td>
<td>227</td>
</tr>
<tr>
<td>12</td>
<td>233</td>
</tr>
<tr>
<td>14</td>
<td>224</td>
</tr>
<tr>
<td>20</td>
<td>216</td>
</tr>
<tr>
<td>28</td>
<td>205</td>
</tr>
</tbody>
</table>

All measurements were taken at 1 Mc/s.

**Miniature Radio-Gramophone**

WEIGHING only 10 lb, the "Babyphon" portable radio-gramophone is operated entirely from batteries—90-V h.t. and two 1.5-V cells being required for the valves and four 1.5-V cells for the special turntable motor. This is designed for 45 r.p.m. 7-in records and a speed control is provided to compensate for battery voltage variation. The miniature pickup is fitted with a sapphire stylus.

In the receiver, which covers medium waves only, four low-consumption (0.025-A) valves are used, in conjunction with a ferrite rod aerial. The circular tuning dial is concentric with the record turntable. Storage is provided for five records in the lid.

The price of this instrument, which is of German manufacture, is £32 9s 11d (including tax, but without batteries) and the distributors in the United Kingdom are G.A. Distributors (Whitehall), Ltd., 29, Whitehall, London, S.W.1. A mains feeder unit is available and costs £4 4s.
Filters Without Fears

2.—Tchebycheff: a Name to Conjure With

By THOMAS RODDAM

LAST month I embarked on the task of persuading the reader that if he kept his nerve when confronted by a cumbersome algebraic expression there was no reason why he should not plunge into the exact theory of filter design without any fear of finding himself embroiled with the higher mathematics. As we shall see later, there are many problems where the classical theory is virtually useless. This is not because there is anything wrong with the classical theory itself, but is simply because the classical theory assumes that you have a lot of filter between the two ends, so that the end effects are relatively small correction terms. Where the filter is nearly all end, the direct approach is both easier and better. Moreover, the algebraic approach is balanced in regard to effort: a simple filter is easy to design, a complicated filter is extremely tedious.

The first stage of the process, which is always based on the low-pass filter, is to calculate the ratio of generator voltage to load assuming that we have a resistive generator, a resistive load, and \( n \) reactances in between. The \( n \) reactances, consisting of alternate shunt capacitances and serial inductances, form a low-pass filter of the \( n \)th order, and the standard way of calculating the currents and voltages is by means of Maxwell's circulating currents. Although I worked in terms of voltage, the whole treatment can be carried out in terms of current; often, indeed, it is desirable to work with current at one end and voltage at the other. For example, a pentode working into a valve grid suggests that we consider the input current/output voltage ratio; a triode working into a transistor emitter would best be treated by considering the input voltage/output current ratio: all we need to consider really is the ratio of input quantity/output quantity with and without the filter network. The ratio of those two ratios is the insertion loss.

The first article expressed this ratio of ratios in the form \( |N|^2 \), where the insertion loss in decibels is 10 \( \log |N|^2 \). We found that for the class of network we are considering, \( |N|^2 \) took the general form:

\[
a_0 + a_1 \omega^2 + a_2 \omega^4 + \ldots + a_n \omega^{2n}
\]

where \( n \) is the order of the network. The coefficients \( a_0, a_1, \ldots, a_n \) depend on the resistances, capacitances and inductances and some of the results are displayed in Table I. Since a low-pass filter has no insertion loss at zero frequency, the term \( a_0 \) is actually unity as you will see by looking at the table.

We then went on to the problem of choosing the element values. For a low-pass filter the insertion loss should be small if \( \omega \) is less than some particular value \( \omega_1 \) and large if \( \omega \) is greater than some other value \( \omega_2 \) (\( \omega_2 > \omega_1 \) of course). If \( \omega \) is less than unity, \( \omega \) is smaller than \( \omega_1^2 \), \( \omega_2^2 \), \( \omega_3^2 \), and so on. Near \( \omega = 0 \), therefore, the general form of

**Table I**

<table>
<thead>
<tr>
<th>ORDER</th>
<th>NETWORK</th>
<th>( N )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ST</td>
<td>![Image]</td>
<td>( 1+j/\omega CR + R/(R_1+R) )</td>
</tr>
<tr>
<td>2ND</td>
<td>![Image]</td>
<td>( 1+j/\omega CR + \frac{R}{(R_1+R)} )</td>
</tr>
<tr>
<td>3RD</td>
<td>![Image]</td>
<td>( 1+j/\omega CR + \frac{R}{(R_1+R)} )</td>
</tr>
</tbody>
</table>

**Summary of insertion coefficients for basic low-loss filter structures**

Wireless World, September 1954
\[|N|^2 \text{ is very close to } a_0 + a_1 \omega, \text{ so that we can keep } |N|^2 \text{ small by taking } a_1 = 0.\] 

Then we transfer our attention to \(a_0 + a_2 \omega^2\), and by similar reasoning we can arrive at the Butterworth function \((a_0 + a_2 \omega^2)\) which keeps very close to \(a_0\) for small values of \(\omega\) and then tips up sharply and smoothly. This gives us a maximal flatness, critically coupled, transitionally coupled response: there may even be some more names for it. Even more attractive, it gives a form which is fairly easy to work with.

The only problem is whether the Butterworth response is the most efficient one. There are three regions in a filter characteristic: the pass band, the transition region and the stop band. The transition region is that range of frequencies where there is too much attenuation for the signal to be useful, and too little attenuation to prevent it being a nuisance. Fig. 1, which shows the Butterworth function of the second order \((1 + x^2)\), indicates that if we regard the pass band as the region in which we can satisfy a \(\pm \frac{1}{2} \text{ db}\) condition, and the stop band as the region in which we have more than \(20 \text{ db}\) attenuation, the ratio of \(a_2/\omega\) is about 4.7.

It is very tempting to see whether we cannot do something to improve this state of affairs. Tchebycheff, in St. Petersburg in 1875, published a paper discussing what are now known as the Tchebycheff polynomials, which are exactly what we need. There is, by the way, the usual difference of opinion about the correct way to spell this name, which in some post-war writing appears as Chebychev, which conforms with the post-revolutionary alphabet. But the polynomials are always written as \(T_n(x)\) and I see no reason for allowing foreign politics to confuse us.

I do not propose to delve into the mathematics of the Tchebycheff polynomials because we shall have all the mathematics we can stand before we reach the end. All we need to know is that these polynomials oscillate up and down within prescribed limits for values of \(x\) between \(-1\) and \(+1\), and then increase steadily. Curves showing this pass-band behaviour are given in Fig. 2, which shows the first five Tchebycheff polynomials. You will perhaps recognize the shape in the region \(-1 < x < 1\) as that of the Lissajous figures of the same order and the appropriate phase conditions. It is not surprising, therefore, to find that the even polynomials, which are the only ones which concern us, are given by the equations:

\[
\omega = \omega \sin \phi \Rightarrow T_n = \cos \phi
\]

These two equations are given by Darlington, but other writers prefer:

\[
\omega = \omega \cos \phi \Rightarrow T_n = \cos \phi
\]

For our purposes there is yet a third form, which is much more convenient. The even polynomials are:

\[
T_0(x) = 2x^2 - 1
\]

\[
T_2(x) = 8x^4 - 8x^2 + 1
\]

\[
T_4(x) = 32x^6 - 48x^4 + 18x^2 - 1
\]

\[
T_6(x) = 128x^8 - 256x^6 + 160x^4 - 32x^2 + 1
\]

In the region we are considering as the pass band, \(0 < x < 1\), these functions oscillate between a maximum value of \(+1\) and a minimum value of \(-1\). For \(x > 1\) the highest order term takes control, and off they go, getting larger as \(x^2\) so that the asymptote has a slope of \(10 \text{ ln } x\) decade or \(30 \text{ db}/\text{ octave.}\) A third order filter, for example, which we shall see is associated with \(T_3(x)\), cuts off at the rate of 18 db/decade.

How can we make use of these polynomials? We have an insertion loss function \(|N| = a_0 + a_1 x^2 + a_2 x^4 \ldots a_n x^{2n}\) where \(x\), of course, is either \(\omega\) or \(\omega/\omega_0\), whatever \(\omega_0\) might be. We want this function to be within the limits \(1 \leq |N|^2 \leq 1 + t\) or \(1 - t \leq |N|^2 \leq 1\) over a range of frequencies, the pass band. To fix our ideas, let us work with the second order filter. We have to consider the Tchebycheff polynomial \(T_n(x) = 8x^4 - 8x^2 + 1\). At \(x = 0\) \(T_n(0) = 1\). At \(x = 1\), \(T_n(1) = 1\). At \(x = 0.71\), \(T_n(0.71) = -1\). For values of \(x > 1\), \(T_n(x)\) increases rapidly. We therefore take a function

\[
1 - t + t T_n(x)
\]

which lies between 1 and 1–2t for all positive values of \(x\) less than unity. The response is then \(\pm \frac{1}{2} \text{ log } (1-2t)\) decibels. Let us take our permitted tolerance \(0.625 \text{ db}\), for which we find \(t = 0.25\). I have chosen this rather odd tolerance to make the arithmetic easier. Now we have the function

\[
1 - 0.125 + 0.125(8x^4 - 8x^2 + 1) = 1 - x^2 + x^4
\]

The response of the second order filter is:

\[
|N|^2 = 1 - \omega^2 \left[ \left( \frac{CR}{R_1 + R_2} \right)^2 - 2LCk \right] + \omega^4LC^2k^2
\]

In this expression,

\[
R_p = R_1 + R_2
\]

\[
R_s = R_1 + R_2
\]

\[
k = R_1(R_1 + R_2)
\]

Last month I worked out in detail the conditions for a

![Fig. 1. Butterworth response of second order. The pass band is defined as the region in which the response is within \(-0.5 \text{ db}\), the stop band as the region in which the insertion loss exceeds \(20 \text{ db}\).](image1)

![Fig. 2. Form of the first five Tchebycheff polynomials.](image2)
Butterworth response with $k = \frac{1}{2}$, corresponding to $R_1 = R_2$. If you try to get a Tchebycheff response under these conditions, you find that you need a negative resistance somewhere in the circuit. We can, however, take $R_2 = \infty$, so that $k = 1$. Then

$$|N|^2 = 1 + \omega^2 [\frac{(CR_2)^2}{2LC} + \omega^2 L^2 C^2]
$$

We now compare this with the form

$$1 - x^2 + x^4
$$

For identity we must have

$$x^4 = \omega^2 L^2 C^2
$$

$$x^2 = (2LC - C'R_2^2) \omega^2
$$

It is not very hard to reach the equation

$$\omega^2 LC = (2LC - C'R_2^2) \omega^2
$$

so that

$$C'R_2^2 = LC
$$

$$L = CR_2^2
$$

which we must compare with the condition for a Butterworth response,

$$L = \frac{1}{2} CR_1^2
$$

To see what we have gained by this change, let us look at Fig. 3 and compare it with Fig. 1. The small bump, less than 1.2 db, at a normalized frequency of 0.7, has reduced the ratio $\omega_0/\omega_1$, from about 4.7 to about 3.3. Another way of expressing this result is that for the same stop-band response the +0.6 db pass band is increased from 0.7 to 1.

Most important of all, we have made full use of one piece of information, the permitted tolerance in the pass band. There is nearly always some inefficiency in a circuit which can be designed without using one of the vital parameters.

We should, I suppose, complete our calculations for the example. At $\omega_0^2 LC = x^2 = 1$, the edge of the pass band is reached. This, of course, means that

$$\omega_0^2 LC = 1
$$

Then as $L = CR_1^2$

$$L = R_1 \omega_0
$$

$$C = \frac{1}{\omega_0} R_1
$$

The other case of $k = 1$, with $R_1 = 0$, leads us to

$$L = CR_2^2
$$

instead of $L_C = \frac{1}{2} CR_2^2$, with

$$L = R_2 \omega_0
$$

$$C = \frac{1}{\omega_0} R_2
$$

This particular example is, I must confess, deceptively simple. The reason is that the choice of $t = 0.125$ got rid of all the awkward numbers. If we had decided to adopt 0.5 db, as our design criterion we should have been working with the function

$$1 - 0.8x^2 + 0.8x^4
$$

which although theoretically no harder, leads us to

$$0.8x^4 = \omega^2 L^2 C^2
$$

giving

$$0.894 x^2 = \omega^2 L C
$$

and

$$0.8 x^2 = (2LC - C'R_2^2) \omega^2
$$

or

$$1.12 \omega^2 L C = (2LC - C'R_2^2) \omega^2
$$

$$C'R_2^2 = 0.88 LC
$$

$$L = 1.137 CR_1^2
$$

Of course there is no more mathematics, really, but the actual arithmetic is more tedious. It is interesting to notice here that the new value of $\omega_0$ is 0.945 (LC), so that by tightening the tolerance from ±0.625 db to ±0.5 db we have cut the pass band down by just over 5%.

We may, perhaps, come back to this matter later.

The third order filter is related to the Tchebycheff polynomial of the sixth order, $T_6(x)$. For $x = 0$, $T_6(x) = -1$, so that we consider

$$1 + t + t^2. T_6(x)
$$

which oscillates between 1 and 1 + 2t. The expression we arrive at is therefore

$$1 + 18t x^2 - 48x^4 + 32t^2 x^6
$$

Any value of $t$ going to make this look pretty alarming, and it is this sort of arithmetic which gives network design a bad name. A little investigation shows, however, that if we take $t = 1.16$, so that the response is to be within ±0.25 db, and then take as our function $1 + x^2 - 3x^4 + 2x^6$, we shall not be too much in error. In the special case when $R_2 = \infty$, we can pick up the expression quoted in the previous article and simplify it to:

$$|N|^2 = 1 + \omega^2 [(C_1 - C_2)R_1]^2 + \omega^2 (2LC_1 C_2 (C_1 + C_2)R_1)
$$

and the conditions for this Tchebycheff response become

$$\omega^2 L^2 C_1 C_2 R_1^2 = 2 x^4
$$

$$2 \omega^2 L C_1 C_2^2 (C_1 + C_2) R_1 = x^6
$$

$$\omega^2 (C_1 + C_2)^2 R_2^2 = x^4
$$

I am not going to solve these equations for $L_1$, $C_1$, and $C_2$, though they do not present insuperable difficulties. You will realize, however, that if we had not cheated in our writing of the polynomial, if we had taken $t$ as, say, 0.1, and if we had chosen $R_3 = 3R_1$, the equations might have been rather grim.

Fortunately, there is a much more advanced approach to this problem, and this leads, as is not unusual, to a rather simpler arithmetical process. If you want to know the amount of $\£100$ at 5% after 17 years, you do not write down a long table:

$$\£100
$$

$$\£110.5 \text{ and so on}
$$

You know that the answer is $100 (1.05)^{10} = 100$ anlolog (16 log 1.05). If you deal a lot with money you will not even do this: you will look the answer up in tables.

There are tables which give the values of the elements in second and third order Tchebycheff low-pass filter, for response tolerances up to ±0.5 db. They are given in chapter 12 of "Filter Design Data," by J. H. Mole (E. & F.N. Spon, 1952). With the aid of these tables the use of the Tchebycheff response becomes a matter of no greater complexity than the use of the Butterworth response. The only trouble is that you must be satisfied, in the third order case, to work with either equal resistances at both ends, or with one end open-circuited.

Perhaps we should just look back. The ordinary processes of the application of Maxwell’s circulating...
currents have led us to an expression for the insertion loss of a network

\[
20 \log \left( \frac{V \text{ or } I \text{ in}}{V \text{ or } I \text{ out}} \right)_{\text{network}} = 10 \log |N|^2
\]

where

\[|N|^2 = 1 + a_1 \omega^2 + a_2 \omega^4 + \ldots + a_n \omega^{2n}\]

We have then sought a function of the same form which represents the frequency characteristic of a low-pass filter. Such a function, which we can call a filter function, is

\[F(x) = 1 + a_1 \omega^2 + a_2 \omega^4 + \ldots + a_n \omega^{2n}\]

If our network is to have this characteristic, obviously

\[a_1 \omega^2 = a_1 \omega^2\]

\[a_2 \omega^4 = a_2 \omega^4\]

and so on.

Two basic kinds of filter function, the Butterworth and the Tchebycheff, have been discussed, and we have seen how we can solve this set of simultaneous equations to find the reactances required. We have also seen that in the simple form we have used, the Tchebycheff equations become very cumbersome. It's a good thing we can dodge the hard work by looking up the answers in tables. We have not yet decided whether the Tchebycheff response is always worth while, or what price we must pay for a flatter response. These are matters of very great interest, but they will occupy more space than I can demand here.

The phase characteristics of filters are often of interest, and it must be noted that we have all the information for plotting these characteristics. From the results in part I we can see that the insertion phase shift is:

1st order \[\theta = \frac{\omega}{CR}\]

2nd order \[\theta = \frac{\omega(CR_p - L/R_s)}{1 - \omega^2LCK}\]

3rd order \[\theta = \frac{\omega \left( LR_p + L \right) - \omega^2 LC + R_p}{1 - \omega^2 L \left( CR_p + C R_s \right)}\]

Into these expressions we can now substitute the values we have found for the responses we consider. This may become one of the factors which settles our final choice of response.

**Correction:** In the first part of this article it is regretted that the curves of Figs. 4 and 6 on pages 369 and 370 of the August issue became transposed.

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**Ultrasonic Developments**

*Techniques Revealed at Oxford and Manchester*

PROBABLY the most familiar ultrasonic device to radio technical people is the ultrasonic flaw detector, which works on an echo-sounding principle and uses electronic circuitry somewhat akin to radar. While this idea has become well established it has not been allowed to stagnate, any more than has radar, and recently some interesting variants and developments of the original theme have come to light. One or two were described in papers read at the recent Brit. I.R.E. Convention on industrial electronics at Oxford, while others were on show as actual apparatus at the Ninth Annual Exhibition of Electronic Devices organized by the Institution of Electronics (North-West Branch) at the Manchester College of Technology.

A fairly straightforward application of the flaw-detector principle was an equipment for obtaining echo patterns from the living human brain, the idea being to detect abnormal structures such as cerebral tumours. This was shown at Manchester by the Department of Physics of the Royal Cancer Hospital (see Fig. 1). The ultrasonic waves are generated by a quartz crystal which is pulsed by a thyratron discharge at a repetition rate of 50 c/s and produces a series of damped wave trains at a frequency of 1.25 Mc/s. When the crystal transducer is applied to the patient's cranium a beam of ultrasonic energy about ±4° wide passes through the brain until it encounters an internal surface differing in elasticity or density, and then some of the energy is reflected back. The crystal also acts as a pick-up device, in between the times it is being pulsed by the thyratron, and it receives the burst of reflected energy and converts it back into an electrical signal. This is then amplified and applied to the Y plates of a cathode-ray oscillograph, which has a time-base locked to the 50-c/s thyratron pulse generator. The original transmitted pulse appears at the left-hand edge of the time-base sweep (since it is fed back into the receiver amplifier) while the returned pulse appears farther along to the right, the actual distance between them indicating the distance of the internal reflecting surface from the cranium.

The time-base of the oscillograph will show echoes from surfaces up to 20cm away, and it has been possible to calibrate it in centimetres by using a water tank and immersed reflecting surface in place of the patient's head, for the velocity of the ultrasonic waves in water is very little different from their velocity in brain tissue (a depressing thought!). Since the transmitted pulse is applied straight back to the receiving amplifier, however, this amplifier is paralysed for a short while and as a result echoes from less than 3-4cm away do not appear on the oscillograph.

With an amplifier gain of something like 100 db the equipment is extremely sensitive, and an echo with a

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Wireless World, September 1954

www.americanradiohistory.com
A high signal-to-noise ratio can be obtained in a tank of water from a glass fibre of less than 0.001 in diameter. Particles and bubbles in the water, too small to be seen, can also be shown up clearly. As for the accuracy of location, a resolution of 20 microns is claimed for the equipment.

When the Wireless World reporter was invited to try the apparatus on his own head he was somewhat reluctant, having heard of the emulsifying and cavitation effects produced by ultrasonic waves. It appears, however, that there is no danger of the brain becoming addled, as the average power used is only about 10 microwatts.

One problem in ultrasonic flaw detection which is providing a great deal of food for thought is that of launching the ultrasonic wave into the material at an oblique angle—or more particularly at a variable angle so that the material may be scanned for flaws. Normally, of course, the beam simply travels in at right angles to the surface from the point where the transducer is applied. One approach to the problem has been the use of suitably shaped blocks of glass or Perspex between the transducer and the work. The lower surface of the block, in contact with the work, is made flat, while the upper surface is curved so that the transducer (also suitably curved to fit) may be slid round it in an arc. In this way a steerable beam is obtained, but the method is still rather slow and cumbersome.

A rather ingenious system of beam steering and scanning which the National Physical Laboratory has tried out was described by G. Bradfield at the Brit. I.R.E. Convention. This works on the principle of causing the ultrasonic wave to be launched from one side of the transducer slightly before or after it starts from the other side. The result is an inclined wave front (the actual inclination depending on the time lag) and the beam travels obliquely from the crystal instead of at right angles to its surface. A comparable situation in Nature is that of sea waves coming in at an oblique angle to a beach, so that they break at one end of the beach somewhat later than at the other end—though here, of course, the waves are arriving instead of departing.

To achieve this effect a barium titanate transducer is used and is divided into a number of sections by grooves (Fig. 2). Each section is then fed from a corresponding section of an LC delay line into which a short 2½-Mc/s electrical wave-train is injected. (Actually the barium titanate sections themselves form part of the capacitive elements of the line.) As a result the ultrasonic wave is launched from the "injection" end straight away and from the other end a fraction of a microsecond later. Using a 0.235-μsec delay line the wave-front is given an inclination of 4° from normal and with a 0.47-μsec line it has an inclination of 8°. This gives two beam angles in, say, an "easterly" direction, and by injecting the 2½-Mc/s signal into the other end of the line the same angles of inclination can be obtained in a "westerly" direction. Thus, with the normal propagation of the beam straight into the material, there are five beam angles available altogether.

A rotating switch enables any one of these five beam angles to be selected, but in practice it is arranged to sweep through them in rapid succession so that the returning echoes along the beams can be displayed almost simultaneously on a cathode-ray tube. In this way the material is scanned in a similar fashion to radar and the range and bearing of the echoes can be presented either in B-scope form (Cartesian co-ordinates) or as a p.p.i. display.

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**Fig. 1. Ultrasonic echo-sounding equipment for locating abnormal structures in the brain. The crystal transducer is applied to the head by a clamp device which indicates the orientation of the ultrasonic beam.**

**Fig. 2. Simplified schematic of beam-steering system enabling the material to be scanned through five different angles. The flaw-detection equipment can be connected to either end of the transducer delay line.**
Another ultrasonic examining device with cathode-ray tube presentation was mentioned by F. Gutman at Oxford. This is an ultrasonic microscope developed by the Russian scientist Sokolov for detecting and studying objects in opaque media. Here, a beam of ultrasonic waves is reflected from the object under examination and is focused and collected on a plate of piezoelectric material which is mounted in a cathode-ray tube. Secondary electrons are produced from the plate by the action of the electron beam and their path is modified by the piezoelectric charges caused by the ultrasonic waves. An image is then obtained by the usual television method. A magnification of several thousand is claimed for this instrument.

**Thickness Measurement**

Ultrasonic techniques are also being used a great deal nowadays for gauging the thickness of materials, and, as they generally utilize reflection of the waves, they are particularly valuable when only one surface of the material is accessible. The reflection, however, is not used in the same direct way as in the flaw detector. An ultrasonic generator is applied to one surface of the material and the reflected waves returning from the far side intersect with the outgoing beam to produce standing waves. At a certain frequency (determined by the thickness of the material and the velocity of the waves in it) a resonance condition occurs, and from this frequency the thickness can be calculated. The mechanical resonance also occurs at harmonics of this fundamental frequency.

To put the principle into practice it is therefore necessary to be able to vary the frequency of the ultrasonic generator and to obtain an indication of the mechanical resonance. The first is easily done with a variable frequency oscillator, while the resonance indication is obtained from the fact that the internal damping of the material at resonance puts a load on the oscillator; this can be detected by an increase of anode current in the oscillator valve.

Unfortunately, this increase of anode current is not always enough to give a good indication. One way of overcoming the trouble was described by F. M. Savage at Oxford, and the improved technique has been used in a commercial instrument which was exhibited at Manchester (see Fig. 3). The oscillator is frequency-modulated over a small deviation range by a motor-driven capacitor. Then, when the oscillator is tuned (by a permeability control) to the mechanical resonance frequency of the material, pulses of anode current are produced as the oscillator frequency is swung back and forth through this point. These pulses are at an audio frequency rate (determined by the motor-driven capacitor) and they are amplified, rectified and applied to a meter and to a pair of headphones. Resonance is then indicated by an increase in the meter reading or by an audible note.

Padding capacitors are placed in series with the motor-driven capacitor so that modulated bands of various widths can be chosen. Narrow bands provide maximum selectivity and accuracy while the wider bands are used when the material has a rough surface or is of variable thickness. The oscillator covers a range of 0.75 Mc/s to 2 Mc/s and this enables the same crystal transducer to be used for all frequencies with very little loss of sensitivity. If only the fundamental resonance indications were used the thickness measurement range would be of the same order as the frequency range (just over 2 to 1), but by using harmonic resonance indications as well this range can be extended to about 1,000 to 1.

**MERCUtY SWITCHES**

THE Tiltray mercury switch is operated by a built-in relay, but the design is a little unusual in that the mercury elements are carried by a tilting tray pivoted in such a way that it ensures a smooth surgeless flow of mercury from one contact to the other. In certain operating sequences this could be important.

How this is achieved is shown in the schematic diagram reproduced here. The armature A moves the tilting tray C carrying the mercury capsules by what is called a variable ratio one-tooth gearing, consisting of an extension of the armature A and a curved finger B. This slows down the movement of the tray as the armature accelerates towards the coil. Acceleration of the tray is further retarded by the action of the pneumatic damper D and the return spring E.

Mercury switches find many applications in circuits where heavy currents flow, and they are especially useful where inductive loads are involved as quite high inductive surges can be handled safely since the energy is released in a mercury-vapour arc and there is no high-voltage build-up.

Tiltray mercury switches are made by Besson and Robinson, Ltd., 6, Government Buildings, Kidbrook Park Road, London, S.E.3, and can be arranged for switching three circuits of up to 60 A each in a single compact unit; the operating power is ½ to 2 W d.c. or 5-15 VA a.c.
Measuring Small Voltage Changes

Simplified Method Using Polystyrene Film Capacitors and Electrometer Valves

A problem that arises quite frequently in development work is the accurate measurement of small changes in the d.c. level of relatively high voltages. The change of level may be produced deliberately by an adjustment made elsewhere in the circuit, or it may develop over a matter of minutes as a result of slow changes in circuit constants.

A change of, say, 0.1 V at a 300-V level would be imperceptible on a voltmeter; the rate of change would be too slow for normal a.c. techniques to be employed; and the application of manually adjusted backing-off voltages is fraught with danger to the meter on which the change is to be read.

The development of the polystyrene film capacitor and the low grid conductance of modern electrometer valves enables this problem to be solved very simply. Fig 1 shows the basic circuit where C₁ and V₁ are the capacitor and the electrometer valve respectively, and S₁ is a polystyrene-insulated switch. So long as the switch is closed the valve and the difference meter are protected from any changes of d.c. level at the input. When a measurement is required the switch is opened and, as the capacitor is already charged to the correct backing-off voltage, only difference voltages are transferred to the metering system. The potential across the capacitor can change only as a result of internal leakage, of leakage across the switch, of leakage or grid current in the valve, or of electrification effects in the dielectric.

![Fig. 1. Basic circuit used for measuring very small voltage changes.](image)

The insulation resistance of good types of polystyrene film capacitor is so high that their time constants are measurable in terms of years, and in this application both internal leakage and electrification effects can be ignored entirely. On most types of relay the supporting insulant of one of the contacts can be replaced by polystyrene without difficulty. The grid conductance of the valve can be kept acceptably small by choice of valve and operating potentials.

The system has many advantages. Backing off is automatic, is independent of polarity, and is independent of input level within the operating range of the capacitor. Since leakage in the capacitor can be ignored, a direct calibration check against any voltage standard of suitable range can be carried out at zero-voltage level, and drift in the instrument itself over any desired period can be checked simply by shorting the input and opening the switch.

Polystyrene film capacitors are now generally available in values up to 0.2 µF with quite a modest ratio of volume to capacitance. A single 0.2-µF capacitor is sufficient for most applications, but there are occasions when, in order to be able to use a more familiar type of valve such as the EF37A or the MEI400, it may be worth while using a number in parallel to provide, say, 1 µF. Various voltage ratings are available, and capacitors rated at 350 V working at 65°C (1,000-V d.c. test) have operated very satisfactorily at a 500- to 600-V level when mounted in such a position that they remain substantially at room temperature.

Practical Circuit

In considering the layout of the instrument, there is only one lead whose insulation is vital; that connecting the grid, the capacitor, and one contact of the switch. The use of a length of polythene-insulated coaxial cable for this lead and the adoption of a simple "guard" system(1) will reduce leakage to negligible proportions. For the guard system, the mounting clip for the capacitor, the outer conductor of the cable, the framework of the switch (preferably relay-operated), and the metalizing of the electrometer valve, should all be connected to the earthy input lead.

The characteristics of electrometer valves and of general purpose valves which can be pressed into use in this role have been the subject of a number of articles of recent years(2), and little need be added here. The electrode potentials are so chosen that normal grid current is almost completely suppressed, and the "reverse" grid current which flows is predominantly the result of ionisation of free gas molecules by the electrons flowing to the other electrodes. The gas pressure varies somewhat from one type of valve to another, and from valve to valve within any one type, but there is little the user can do about it other than to avoid any careless maltreatment which might result in the release of further gas from the electrodes.

The choice of a valve for this application depends mainly on the range of difference voltages to be measured, on the time interval over which the measurement is to extend, and on the accuracy demanded. By reducing the anode voltage to some 5-10 V, and by adjusting one's methods to deal with

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* Ministry of Supply.
values of $g_m$ and $\mu$ as low as 15 $\mu$A/V and unity respectively, grid currents of 10$^{-13}$ A and below can be achieved without much difficulty, but the range of input and output voltage tends to become somewhat limited. It is advisable, therefore, to be content to achieve a grid current no lower than is really necessary for the particular application in mind. The arithmetic is quite simple; one assumes a constant charging rate for the capacitor and employs $VC = Q = \frac{vi}{t}$ (volts, farads, amps and seconds) to calculate the grid current that would result in the development of an acceptably

![Fig. 2. Simple form of measuring set using battery operation.](image)

small error voltage across the chosen capacitor during the time needed to complete the measurement.

As an example of what can be achieved using quite conventional circuitry, we can take the case of the ME1400. Strapped as a triode, the electrode potentials recommended by the makers are 4.5 V on the heater, 45 V on the anode, and -2 V bias on the grid. Under these conditions the valve has a $\mu$ of 20 and a $g_m$ of 300 $\mu$A/V, whilst the anode current is about 100 $\mu$A and the grid current is around 6 $\mu$A. The grid can be swung about half a volt each side of the recommended operating point without approaching too close to anode current cut-off on the one hand or the commencement of normal grid current on the other. The grid current is reduced by a factor of three, or thereabouts, at the peak of the negative swing, and is increased by a similar factor at the peak of the positive swing.

With such a limited grid base there are obvious advantages in adopting the cathode follower technique. The required conditions will be met by the use of 90 V h.t. and a 470-k$\Omega$ cathode load. Using such a value of cathode load, the gain of the system will approximate to $\mu/(\mu + 1)$ and only $1/\mu$ of the input voltage will appear between grid and cathode. A change of level at the input not exceeding 10 V, of either polarity, could therefore be handled satisfactorily.

If we use a 1-$\mu$F capacitor and take 6 $\mu$A as being a representative value of grid current for small excursions, we obtain a leakage rate ($V/t = i/C$) of 6 $\mu$V per second or 22 mV per hour. If the error due to this leakage is not to exceed say 1 per cent, we should have about three minutes in which to complete a difference measurement of 0.1 V, or about half an hour for one of 1 V. For a 10-volt measurement
(taking the positive-going input as being the worst case) the leakage rate would increase to about 70 mV per hour, giving us an hour and a half for the same percentage error.

Periods such as these are quite long enough for the completion of most tests in which the change to be measured is the result of a change in the effective value of a component (e.g., a thermal change), and it is only in the more specialized applications that it is worth employing one of the more esoteric types of electrometer valve. In fact, for applications where the change of voltage level develops more or less conveniently with the making of some adjustment elsewhere in the circuit, as, for example, when one is examining the response of a stabilized power pack to changes of load or of input voltage, we could safely use a single 0.2-µF capacitor and still have a large margin in hand for stray leakages. In the same way, there are occasions when it would be in the nature of an extravagance to employ an electrometer valve at all and when the average EF37A would do the job quite satisfactorily if used in the circuit described.

The design of the metering portion of the instrument is largely a matter of personal choice. Although the valve is operating as a cathode follower in the arrangement described, the output impedance is not particularly low and it is not really satisfactory to feed even a 25-µA meter movement direct from the cathode. The simplest form of practical circuit is probably that shown in Fig. 2, in which V₃ is any convenient valve of reasonable slope. An unbalanced circuit such as this is very vulnerable to both i.t. and h.t. variations, and is best suited to battery operation, particularly as the current requirements are small.

**Mains Operation**

For mains operation, the use of a Bridge circuit such as that shown in Fig. 3 makes the provision of stabilized h.t. and l.t. unnecessary for most applications. Pentode loading of the cathode followers V₃ and V₄ provides them with high impedance cathode loads through which they can be fed with 8 or 9 mA a piece at the expense of a very modest voltage drop. This keeps up their gₑ and permits the use of a robust meter. With correct adjustment of the preset variable resistor which provides the bias for V₄, the bridge will remain balanced over quite a wide variation of mains voltage.

Since the change to be measured may be of either polarity, a centre-zero meter or a change-over switch for the meter should be provided, and voltage ranges of 0.25, 1.0, 2.5, and 10 volts f.s.d. can be provided by the use of a range switch and series resistors suitable to the meter employed. The use of a relay-operated switch for S₁ simplifies the control of surface leakages and permits the linking of other events to the opening of the switch. Where the power supplies are unstabilized and the relay is a.c.-operated, it is advisable to feed the relay coil from a separate transformer. For general use it is desirable to include in the instrument a suitable resistor in series with the input terminal; this will limit the charging current when the instrument is first attached to a high voltage point.

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**Infra-red Analysis**

Mervyn-NPL infra-red spectrometer for chemical analysis and process control.

THE selective absorption of electromagnetic waves by organic and other liquids and gases is becoming increasingly important as a rapid method of analysis in the petroleum, chemical and many other industries. Wavelengths of the order of 3µ (3 x 10⁻⁶ mm) in the infra-red region of the spectrum are generally used, and a curve is plotted showing how the absorption varies with wavelength. From this and a knowledge of the absorption characteristics of pure substances, an analysis of mixtures can be made.

The first essential is the production of a "monochromatic" source of radiation of variable frequency, and in the past this was provided by a refracting prism and an expensive auxiliary optical system. Recently the National Physical Laboratory have developed an efficient method of making diffraction gratings, based on a method originated by Sir Thomas Merton, which produces comparable resolution at a fraction of the cost.

Mervyn Instruments, Copse Road, St. John's, Woking, Surrey, have undertaken the commercial production of an infra-red spectrometer using the Merton-NPL grating. The source of radiation is a Nernst filament lamp and the beam is interrupted 800 times per second. After absorption in the specimen under test, the beam passes to a lead selenide photocell, the output of which is amplified and recorded on a chart.

To achieve accuracy comparable with a balanced double-beam null method of measurement, a high degree of overall stability is required. In the Mervyn instrument this is achieved by continuously monitoring the source of radiation and the sensitivity of the detector and applying any variations to the amplifier in the form of gain control. Compensation for the wavelength-dependent characteristics of the source, the grating filter and the detector is effected continuously, as the spectrum is transversed, by an adjustable shaped cam.

**Magnetic Tape Spools**

DIMENSIONS of spools for nominal tape lengths of 300, 600, 1,200 and 1,750ft are given (with tolerances) in a new specification (B.S.2478 : 1954) obtainable from the British Standards Institution, 2, Park Street, London, W.I., price 2s. These spools are for domestic and commercial recording, as distinct from those used in broadcasting studios.

Other matters touched on by this specification include the width of safety lane and the direction of recording in dual track tapes. It is recommended that if the tape moves from left to right with the active side away from the observer, the upper track should be in use.
TRANSFORMERS for Low and High Frequencies

Demonstrating Their Differences by “General” Vector Diagrams

Now that we have spent two issues studying vector diagrams—and I hope the time has not been wasted—we should be better equipped to tackle problems like the one an Australian reader put to me some while ago. He asked for an explanation of the fact that in critically-coupled r.f. transformers, such as those often used in i.f. amplifiers and f.m. discriminators, the voltage across the secondary is 90° out of phase with the voltage across the primary. He says that the textbooks (and “Cathode Ray”!) gloss over this part of the story.

Well, I can’t easily forget that when dealing with the discriminator stage in f.m. receivers a few years ago I tripped up over this very thing, so it is some comfort to be told that it is a difficult point. One catch, perhaps, is that in ordinary low frequency transformers the secondary voltage is in phase with the primary voltage, or very nearly so, and it is easy to assume the same thing holds for transformers in general.

A clue can be given quickly by saying that the r.f. transformer is very loose-coupled and normally works in the condition of resonance, whereas the ordinary power transformer is very close-coupled and non-resonant. To get a complete picture, however, there is nothing for it but to pull out our small but trusty kit of basic principles and get to work.

Probably the best approach is to start with a theoretically perfect 100% coupled transformer and see what happens as the coupling is loosened. If you like we can start with something simpler still—a single winding on an iron core, as in Fig. 1. When this is connected to an a.c. generator, as in Fig. 2(a), the alternating current that flows through the coil produces an alternating magnetic flux in the core. Because the current is the direct cause of the flux, the flux is in phase with the current.

The alternations of flux generate an e.m.f. (“the e.m.f. of self-induction”) in the coil, proportional to the rate of flux variation, and always tending to oppose its cause—the variation of current. According to the current notation explained last month, $I_{K}$ means the current whose positive direction in Fig. 2(a) is clockwise around the circuit. At the start of the current cycle, as shown in Fig. 2(b), the current is increasing at its greatest rate, so this induces the maximum e.m.f. tending to oppose the increase of current, and therefore anticlockwise at this moment.

To keep the current increasing, notwithstanding this opposition, it is necessary for the generator to be exerting an equal e.m.f. clockwise (we are neglecting the resistance of the coil). Whether one looks at it from the point of view of the coil or the generator, $b$ must be maximum positive with respect to $a$. So $V_{ab}$ (which, using the “potential-rise” convention, means the voltage change on moving from $a$ to $b$) is peak positive, as shown. In the familiar words of the textbooks, the current lags the applied e.m.f. by 90°. The information given in Fig. 2(b) is much more conveniently portrayed in Fig. 2(c), which is the general vector diagram for Fig. 2(a). (The whole point of going over this very elementary stuff is really to remind ourselves of the conventions explained in detail in the last two issues.)

It would make no difference in principle if the wire we used for this coil happened to be composed of two strands. Nor would it make any appreciable difference whether the strands were insulated...
or not. The flux causing the e.m.f. would link both strands equally, and if one strand happened to become disconnected from the generator, the same voltage, in the same phase, would exist between the ends of the disconnected strand as before. Fig. 3 shows an enlarged view of the separated strands, with the disconnected one dotted to distinguish it. What we have is now a virtually 100% coupled transformer, and there can be no doubt that the secondary e.m.f. $V_{cd}$ (Fig. 4) is in phase with the primary e.m.f. $V_{ab}$.

Now consider what happens when a resistance load is connected across the secondary. Being a resistance, it passes current $(I_{II})$ in phase with $V_{cd}$. This current of course has to flow through the secondary winding, and in doing so it creates an alternating magnetic flux—a quite unchangeable result, like the law of the Medes and Persians, only more so. Yet it can’t be allowed! The generator is still applying the same e.m.f. as before (we assume) and this must be exactly balanced by the e.m.f. generated in the primary by the alternating magnetic flux. That flux was just right before $I_{II}$ started to flow, so it can’t still be right when another lot of flux is being caused. There is only one way out of this deadlock; the way of the Persian monarch Ahaseurus when his wife convinced him that a law he had made under the influence of a sinister courtier was wrong. He couldn’t rescind it, but he could issue another that would neutralize it. Nothing can be done to prevent $I_{II}$ exerting its magnetizing influence, but this influence can be exactly neutralized and the status quo restored if the generator supplies a primary current that creates an equal and opposite flux. This current is of course in addition to the original magnetizing current needed to induce the back e.m.f.

100% Coupling

It is time we brought our vector diagram up to date. Because it is induced by the same flux as the primary e.m.f., the secondary e.m.f. is represented in Fig. 5 by $cd$, an exact duplicate of $ab$. The current diagram at (a) applies before the secondary was loaded; the fact that $I_{II}$ was then zero is shown by the distance $J$ to $L$ being zero. After connecting the resistance load the current $I_{II}$ is represented at (b) by $JL$ in phase with $cd$. The current effective for causing magnetic flux is the total current crossed on moving from $L$ to $K$ ($I_{JK} = I_{II} + I_{LK}$), and this can only be kept the same as in (a) by raising $K$ to the new position shown at (b); that is to say, by adding the vertical dotted portion (equal to $JL$) to the original horizontal portion.

The fact that there is no actual connection between meshes $K$ and $L$ is appropriately represented by leaving $K$ and $L$ without a direct connecting line in Fig. 5(b), but the distance from $K$ to $L$ does nevertheless correctly represent the total current in the two windings lying between meshes $K$ and $L$. This logical interpretation of vector diagrams constructed on this plan is particularly helpful in transformers, for it shows the net magnetizing current, irrespective of the individual currents flowing through the windings.

The sign of the currents is automatically taken care of, provided that the circuit diagram is drawn so that the coils are wound in the same direction—see Fig. 4—and have equal numbers of turns. (This is covered by the normal practice with transformer vector diagrams, of working in volts per turn and amperes-turns, rather than total volts and amps, so as to avoid vectors of absurdly different lengths.) It is easy enough to take separate account of unequal turns, by multiplying or dividing by the turns ratio as required.

In Fig. 5(b) the primary current $I_{IK}$ lags the applied e.m.f. $V_{ab}$ much less than the original 90°. Power transformers are usually designed so as to make the magnetizing current $(I_{IK}$ here) small compared with the other part of the primary current needed on account of full load. That other part has the same phase relative to the e.m.f. applied to the primary as the secondary current has to the e.m.f. given by the secondary. For instance, if the secondary is loaded by a capacitor, a leading current is added to the magnetizing current in the primary.

On the equal-turns-ratio assumption, if $a$ in Fig. 4 is joined to $c$, $d$ is at the same potential as $b$ and can be joined to it without making any difference. We have, in effect, reverted to our single-winding two-strand coil, and the load current can be regarded as going straight from generator to load, only the magnetizing current flowing via the coil, which is no more than an inductive shunt (Fig. 6). This “distinction without a difference” would be represented in Fig. 5 by making $cd$ coincide with $ab$, and joining $L$ directly to $K$.

The next step is to take account of the resistances of the windings. These can be shown separately from
the coils, as if they were resistors in series with the primary and secondary coils. In the Fig. 6 representation they are also in series with one another, so the magnetizing current were small enough to neglect they could be lumped together as one resistance; but as we don’t know whether we shall always be justified in neglecting the magnetizing current we shall keep them separate. Fig. 7 shows the modified diagrams. Since R_s and R_p form a simple potential divider, the potential of d is part of the way down from e to a, and on the assumption that R_s is small compared with R_p it is shown only a little way below e in the voltage diagram. The voltage V_{eb} across R_p must be in phase with the current flowing through it, however, so eb must be drawn parallel to JK. The result is that the phase angle between primary current and generator voltage is slightly reduced. But the more important practical effect of these resistances is to make the secondary terminal voltage V_{ad} less than the primary terminal voltage V_{eb}.

Leakage Inductance

And now we come to the point of this inquiry: to see what happens when the coupling between the two windings is not 100\%. It never quite is, of course, in any actual transformer. If the windings are separate they cannot coincide, so at least a small amount of the flux caused by the primary current fails to link with the secondary winding. One of the objects of using a closed iron core is to make the magnetic path around both coils so easy that very little flux will take short cuts. With care, the leakage flux (as it is called) can be reduced to less than 1\% of the whole, so a very good approximation can be made to the theoretical fully-coupled transformer—at least at low frequencies. At high frequencies it is much more difficult, for several reasons: the iron core loses much of its permeability, and very close coupling of the windings tends to cause excessive stray capacitance and loss. Fortunately, very close coupling is seldom wanted in r.f. transformers.

The effect of the magnetic leakage in a transformer is the same as if the inductance of each winding were divided into two parts: one part common to both windings as in Fig. 7 to represent the flux that links both; and the other completely uncoupled, to represent the leakage flux. Putting two and two together we get—three, as in Fig. 8 (since one inductance in each winding is common to both).

Let us remember that inductance is the name given to the flux-making ability of any part of the circuit. This ability is reckoned as the number of volts the flux would generate if the current in that part of the circuit were made to change at the rate of 1 amp. per sec. When an alternating current of 1 amp. (r.m.s. value) is made to flow, the r.m.s. value of its rate of change is 2\pi f amps per sec, so the back voltage generated by an inductance L is 2\pi fL. To drive the 1 amp against the back voltage, an equal e.m.f. must be applied. The number of volts needed to drive 1 amp. through a resistance equals the resistance in ohms; by analogy, 2\pi fL is the reactance in ohms of the inductance L.

So the effect of leakage flux L_p' in the primary winding is similar to that of the resistance R_p, except for the usual 90\% difference in phase. And the same for L_p''  The inductance common to both windings is the mutual inductance, M. And the coefficient of coupling, usually denoted by k, is equal to M / (L_p + L_s), where L_p and L_s are the total primary and secondary inductances. This formula applies whatever the ratio of the transformer, but if the ratio is 1:1, so that L_p = L_s, then k = M / (L_p + L_s) and L_p = L_p' + M and L_s = L_s' + M. When L_p = M, then L_p' = 0 and k = 1, which means that the coupling is 100\%.

Before we go on to loose-coupled transformers, shall we just draw the general vector diagram for a loaded power transformer with appreciable leakage, on the basis of Fig. 8. Although this case is a “must” in every book and course on electrical engineering, so that one would have thought that by now a standard technique would have been arrived at, there is still the utmost chaos. Some teachers draw an upward arrow alongside the generator and another upward arrow alongside the primary (to represent the back e.m.f. opposing it); some show the primary arrow pointing downward, in the same circuitual direction: some show both arrows pointing both ways; some draw two primary voltage vectors pointing in opposite directions; some in the same direction; and so on. No wonder that when a certain teacher tested a class by asking what, in Fig. 3, would be the polarity of the voltage from c to d relative to that from a to b, 11 said the same and 12 said the opposite!  

It is usually easiest to work backward from the load to the generator. So the first vector to draw in Fig. 9 is ad, representing the output terminal voltage V_{ad}. The nature of the load Z_L is unspecified, but a mixed power load is generally somewhat inductive, so we draw the load current vector JL slightly lagging on ad. (If we take the e.m.f. applied to Z_L in the direction ad, that is to say clockwise, the corresponding direction of current is downwards, that is to say in the direction JL.) Now that we have the phase of I_L, we can draw dg in phase with it to represent the drop in the secondary resistance, and ge leading 90\°, for the drop in the secondary leakage inductance. That gives us ae, representing the e.m.f. induced in the
transformer. The current needed to create the flux to induce it is \( I_{KL} \), which (since it passes wholly through inductance, \( M \)) lags \( V_{op} \) by 90°, and \( LK \) is therefore drawn accordingly. (To be quite correct it should be slightly less than 90°, to allow for core losses.) If we like we may mark this vector “\( \Phi \)”, to show that it also represents \( \phi_{KL} \), the primary current, is of course \( I_{1l} \), \( I_{1k} \) so we join \( J \) straight to \( K \) to represent it. This shows its phase, enabling us to draw \( ef \) and \( jf \), and so finally to arrive at \( V_{ab} \), the generator voltage needed to maintain the assumed load conditions.

If you have a book on electrical engineering handy, look up its vector diagram for the equivalent transformer circuit, Fig. 8, and compare it with Fig. 9 for clarity and ease of construction.

Just to exercise this new simplicity you might care to redraw Fig. 9 for a highly capacitive load, making \( JL \) turn well to anticlockwise of \( ad \). Then you will demonstrate the untruth of the axiom that the part cannot be greater than the whole. But, of course, being radio men, familiar with the workings of tuned circuits, we see nothing new or surprising in this. It is quite normal for the current in one branch of a parallel tuned circuit to be very much greater than the whole current fed in.

**Tuned Transformers**

This thought makes a convenient bridge to the loose-coupled tuned r.f. transformer. Its equivalent circuit, Fig. 10, is almost the same as Fig. 8, except for the capacitance in series with the primary, and the explicitly capacitive load. But the proportions of \( L \) and \( M \) are vastly different. In the power transformer, nearly all the inductance is mutual, \( L' \), and \( L'' \), being just minor leakage. In the r.f. transformer, nearly all the inductance is \( L' \), \( M \) being relatively tiny. The condition for “critical” coupling—the coupling between two resonant circuits giving the greatest secondary voltage—is that the reactance of \( M = 2\pi f/M \) = \( R \). (So that we don’t become involved in complications right at the start, we are assuming that the two tuned circuits are identical.) Now since the reactance of the whole primary or secondary, \( 2\pi f(L' + M) \), is \( Q \) times \( R \), \( M \) is \( 1/Q \) of the whole inductance (if either coil—and a typical value for \( Q \) is 100). It may seem queer that the biggest output voltage is obtained with something like 1% coupling; it might be expected that it would be with 100%. But close coupling throws the two circuits out of tune and largely destroys their magnification. Any closer than critical coupling makes the single resonant peak divide into two, and it is the deepening hollow between them that makes the output at the original resonant frequency drop.

Just before drawing the complete vector diagram for Fig. 10 it may be a good thing to take note of the characteristic shape of the diagram for a single tuned circuit, as shown in Fig. 11(a). The current in a series tuned circuit is a maximum at resonance, so we make \( JL \) fairly long. But \( R \) in a good tuned circuit is relatively small, so notwithstanding the maximum current we draw a short line \( dg \) in phase with \( JL \). The voltages across \( C \) and \( L \) are \( Q \) times as great however; \( V_{op} \), leading and \( V_{out} \), lagging the current by 90°. (Even if we had made \( dg \) quite small, a \( Q \) of 100 or more would put \( a \) and \( e \) well off the paper—and probably off the desk as well!—so a somewhat lower \( Q \) will have to do.) The result is a long thin rectangle, with \( a \) and \( e \) so placed as to show that \( V_{op} \), the injected e.m.f., is equal to and in phase with \( V_{out} \). This picture fits all that one knows about series resonant circuits—I needn’t go into all the details. The only point to note is that if \( R \) and \( L \) in the circuit changed places the voltage diagram would be as in Fig. 11(c). Seeing that in reality \( R \) and \( L \) are mixed up together, it is purely a matter of choice which order we show them in the equivalent circuit; personally I think (b) is a clearer and more recognizable picture than (c).

We already have a good start towards the vector diagram for the coupled circuits, of which Fig. 10 is the equivalent circuit. As you see, I cunningly lettered Fig. 11 so that it corresponds with the secondary, the “generator” being \( M \), which induces the necessary e.m.f. There is one other important difference however: the reactance of \( L' \) is not exactly equal and opposite to that of \( C \), for \( L' \) is less \( L \). Now we have made the reactance of \( M \) equal to \( R \), so the amount by which \( eg \) must be shortened is equal to \( dg \), representing the drop across \( R \) (Fig. 12). The vector \( ae \) is now the diagonal of a square instead of one of its sides, so is \( \sqrt{2} \) times as long as before;

![Fig. 9. Vector diagram corresponding to Fig. 8, for a transformer having comparatively little magnetic leakage.](image)

![Fig. 10. Modification of Fig. 8 equivalent to a loose-coupled tuned r.f. transformer with identical primary and secondary coils.](image)

![Fig. 11. (a) is a single tuned circuit; (b) the corresponding vector diagram; and (c) the modified form of the voltage diagram if L and R in (a) changed places.](image)

*Wireless World, September 1954*
and its phase is 45° behind. The current through M is therefore \( \sqrt{2} \) times \( I_{J} \), (it includes \( I_{JK} \) as well), and of course 90° behind \( V_{ef} \). So we know the length and direction of KL, which we draw accordingly, Fig. 13. This gives us \( I_{MK} \), the primary current, and we can now proceed to complete the diagram by drawing first \( ef \), 90° ahead of \( JK \), and equal to \( eg \) (for \( JK = JL \)); then \( fh \) in phase; then finally \( hb \) 90° behind \( JK \), and equal to \( ad \).

This complete picture has been arrived at without any deep thought, just by following exactly the same rules as for previous examples—the three fundamental phase relationships (for \( R \), \( L \), and \( C \)) and the two prescribed rotations for voltage and current. Apart from following these rules correctly, there has been no need to worry about which way arrows should point, or whether we have the vectors in the right directions. And the diagram is simplicity itself to interpret. We see at once the two slim rectangles representing the two tuned circuits, and that they are at right angles to one another, showing that the voltages across them are 90° out of phase—which was what we set out to do. We see that the primary current is in phase with the injected e.m.f., which therefore sees a resistance load (as of course it should, at resonance). Since \( fh \) and \( dg \) are only half as long as \( ab \), we see that the primary and secondary currents and the voltages across the circuits are half what the same input e.m.f. would produce across a single tuned circuit with the same characteristics. (If you are not quite sure about this, take away the secondary L, R and C from Fig. 10 and draw the voltage diagram for what is left. It should be a rectangle standing on \( ab \), twice as tall as \( bb \)).

If you have become intrigued by all this you probably won’t be kept from going on with it, drawing diagrams for less and more coupling than critical, and in doing so will learn (or confirm) quite a lot about coupled circuits. So far, I haven’t come across a conventional vector diagram for critically-coupled tuned circuits. Perhaps it is such an unintelligible mess that no one dared publish it!

**BOOKS RECEIVED**


**Short-wave Conditions**

*Predictions for September*

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during September.

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

*Simple Circuits Based on CR Time Constants*

By B. T. GILLING

In radio work neon tubes are used mainly as voltage stabilizers and occasionally as saw-tooth generators, but they also have a very useful field of application as interval timers. Two different types of timers have recently been built by the writer and they are described below as examples of what can be done and also as exercises in simple relay switching. A very good article on relays by T. Dawson appeared in the January, 1953, issue of *Wireless World* and this should be consulted.

The basic neon timer circuit is shown in Fig. 1(a). A large capacitor is charged slowly from a high voltage through a high-value resistor. The voltage across the capacitor will rise until it reaches the striking voltage of the neon, which will fire and discharge the capacitor until the extinguishing voltage of the neon is reached. The relay in series with the neon will operate and close its contacts and this will complete the discharge of the capacitor. The relay will then drop off, opening its contacts, and the whole operation will recommence. This cycle of events will continue as long as the high voltage is applied. A small resistor of a hundred ohms or so is connected in series with the contacts to prevent a too rapid discharge of the capacitor with consequent sparking.

A disadvantage of this circuit is that only the small portion of the charge of the capacitor between the striking and extinguishing voltages of the neon flows through the relay coil, the rest being dissipated in the series resistor. The circuit can be rearranged as Fig. 1(b) to overcome this. When the neon strikes the relay operates and its contacts short-circuit the neon; the capacitor then discharges through the relay and a more positive action is achieved. This latter method in a slightly modified form is used in both of the instruments to be described.

The first one is an interval indicator, shown in Fig. 2. The object of this instrument is to give an audible indication at the end of any half minute from one to two-and-a-half minutes. It was developed to time the operations of a cleaning machine used by watch repairers in which the parts to be cleaned are immersed in different fluids for set times. It is push-button operated for simplicity of working and uses one relay. This relay has windings of 50 and 1,500 ohms and three sets of contacts, two being change-overs and the third a single make which is arranged to close at low spring pressure before the others start to move. The operation is as follows. Assume that push-button 1 is pressed. C₁ will charge through R₁. When the neon strikes...
of cuit, pressed in and three contact other change-over contact. A will change over, locking up the relay through its 1,500-ohm coil and $R_3$. $A_3$ will change over, transferring the neon to the oscillator circuit $R_1 C_1$ and a note will be heard in the telephone earpiece. This note is adjusted by the variable portion of $R_2$, and will continue until any one of the projecting buttons is pressed, releasing the operated button. The supply voltage is thus removed, the relay drops off and the instrument is ready to be operated again.

The values of the resistors in the high voltage circuit, $R_n$, $R_y$, $R_y$, are chosen to give an operating value of 150 volts at the push buttons, $R_n$ being chosen to pass the same current as the holding and tone generating circuits combined. In this instrument, close accuracy of timing was not essential and so no attempt was made to stabilize the high voltage. The values of the capacitor and resistors in the charging circuit give times of 1, 1½, 2 and 2½ minutes. This depends on the value of the high voltage and it may be necessary to alter the value of $R_n$ to obtain exact timing on an individual instrument.

A Post Office type 3000 relay is used and the values of the windings are not critical. The first coil will work at any value up to 1,000 ohms, and provided appropriate alterations are made to $R_n$, any high resistance value will suit the second coil. A point to bear in mind is that the second coil has only to hold the armature after it has been operated, therefore a very much lower value of current is called for than would be needed had the relay to be operated by this winding.

The method of generating the indicating signal is a simple one calling for the minimum of additional components but the circuit can be rearranged as shown in Fig. 2(b) to switch in an external indicator, either sound or light.

The second instrument (Fig. 3) was designed to switch on the lamp of a photographic enlarger for any predetermined time with close accuracy. It is operated by a telephone key-switch having a central off, one locking and one non-locking position. Two relays are used, one having a 50-ohm coil and a change-over contact. The other has a 2,000-ohm coil and three contact sets, two make contacts and a change-over. It is a two-step relay, the first step being controlled by $B_2$, which closes at light spring pressure before the other two sets move.

The operation is as follows. The key-switch is pressed in its non-locking position, closing its contacts $K_2$, $K_3$, the contacts $K_2$ being adjusted to close a fraction before $K_3$. Relay $B$ will operate, but as $K_2$

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**TABLE I**

The resistance values are selected to give an increase of approximately one half per step in a ratio series familiar to photographers as $f$ numbers.

<table>
<thead>
<tr>
<th>Seconds</th>
<th>1</th>
<th>1.4</th>
<th>2</th>
<th>2.8</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>8</th>
<th>11</th>
<th>16</th>
<th>22</th>
<th>32</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kilohms</td>
<td>62.5</td>
<td>25</td>
<td>37.5</td>
<td>50</td>
<td>75</td>
<td>100</td>
<td>150</td>
<td>190</td>
<td>310</td>
<td>400</td>
<td>600</td>
<td>800</td>
<td></td>
</tr>
</tbody>
</table>

---

Fig. 3. Timer for switching on a mains circuit for any predetermined time with close accuracy.

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value is wired in circuit and a variable resistor connected in place of $R_i$. A value for this is found which will allow the relay to operate only to close $B_i$ when the key-switch is operated. Finding the value of these resistors in this way also permits the use of relay coils having a resistance other than 2,000 ohms. Relay $A_i$ is a Post Office type 600 and its resistance is not critical; values of up to 1,000 ohms can be made to work.

In the examples shown the high voltage supply is obtained directly from the mains. This is a simple and efficient method but it must be very strongly emphasized that either the instrument must be in a case made entirely of insulating materials with no metallic controls exposed, or, if a metal case is used, no wiring must be allowed to come into contact with it and it must be securely earthed. Rectification is by a small 24-section selenium unit and smoothing is of the simplest, consisting of resistor and a single 16-$\mu$F capacitor in each case. The maximum current drawn in either is less than 20mA.

A point of importance to be observed in all timers is that the charging capacitor must be of high-grade paper construction with very low leakage and, in fact, all parts associated with the charging part of the circuit must be of the highest insulation.

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**Training in Television Servicing**

By G. N. PATCHETT,*
Ph.D., B.Sc., A.M.I.E.E., M.Brit.I.R.E.

*Bradford Technical College.

**Special Apparatus for Practical Demonstrations**

In the training of television service technicians there are a number of problems which do not occur in most other subjects. The course is essentially a craft type and the people normally attending such courses have a limited academic background, so that the subject must be dealt with in as simple and as practical a manner as possible. Unfortunately, a modern television set is a complicated piece of equipment and is tending to become more so with the introduction of efficiency diodes, Band III, etc. It is extremely difficult to explain the operation of many television circuits without going into mathematics and complicated circuit theory. Although a television servicing technician is only required to repair sets and not design them, the author finds it difficult to understand how a satisfactory repair can be made without at least an elementary knowledge of how the circuit operates and, what is equally important, what will happen under various fault conditions. It is, of course, possible to cure many faults by a trial and error method, but this may be very time-consuming and expensive. Experience of typical faults on particular models is, of course, most valuable but is something which cannot be easily taught.

In view of the difficulties of explaining many circuits the author considers that practical demonstrations are the ideal way and essential to the teaching of this subject. This idea is used to a great extent at Bradford Technical College, where the course consists of two nights per week for a period of two years. One night is devoted to lectures and demonstrations and the other night to practical work by the students themselves. Turning to the practical work, this is divided into two types, (a) experiments on simple circuits, (b) actual fault finding on commercial television receivers. The work done during the first year of the course consists of type (a). For this purpose a number of experiment boards have been constructed, each board consisting of a simple circuit of a section of a television receiver, e.g., a time base or a synchronizing separator. These boards are designed so that they may be used for three purposes:

1. Experiments on the general operation of the circuit. Voltages, waveforms, etc.
2. The effect of faults on the general operation of the circuit and on the voltage readings and waveforms.
3. The actual location of faults on these circuits.

A typical board is shown in Fig. 1. The "board" consists of hardboard covered with drawing paper on one side. The circuit is drawn on this paper which is then covered with celluloid or, rather better but more expensive, Perspex. More recently a transparent plastic covering has been used which can be secured to the paper by heat. The components of the circuit are fastened to the back of the board and are con-
nected to small terminals which are located in the correct positions on the circuit diagram. In series with most components are connected two terminals which are normally joined together by a link. By removing the link the component is effectively open circuited. The board is most useful to show the operation of the circuit, and voltage readings and oscillograph waveforms may be taken at various points. Since these are taken at points on an actual circuit diagram it is easy to see just what voltage is being measured. By removing the links, one at a time, the effect of open-circuited components can be seen on both voltage readings and oscillograph waveforms. The effect of short circuits may be seen by connecting appropriate terminals together.

Fault Finding Scheme

In order that the same board may be used for actual fault finding the links are of special construction. They are made of a sandwich of Leatheroid and copper foil (cemented with Bostik) and are used with the Leatheroid upwards. For fault finding, a number of dummy links are available which are constructed in a similar manner but a slot is cut in the copper foil so that, although the circuit is not completed, the link appears the same as normal. Short circuits may be placed on the circuit by shorting links fitted with crocodile clips on the underside of the board, the students being instructed not to turn the board over. From the point of view of fault finding these boards have the advantage that they can be used repeatedly, whereas when soldered connections are broken and remade to place faults on circuits the apparatus soon becomes useless, owing to damage to components, soldering tags, etc.

In order to operate these boards a coaxial cable is fed to each position in the room. Each position may be supplied with any of the following:—

1. B.B.C. signal from aerial.
2. R.F., modulated with test pattern.
3. Video signal of test pattern.
5. Line pulses.
6. Frame pulses.

The last four are fed through an amplifier and cathode follower unit on each position so that the output may be varied in amplitude and either polarity may be obtained by means of a switch. These supplies and boards have been found invaluable for demonstrations and save much time in connecting up circuits when wishing to give demonstrations. If much connecting up is required in order to give a demonstration the general result is that the demonstration does not get shown.

At present 33 such boards are available and it is hoped to make more in the near future. For the second part of the practical work a number of commercial television receivers are available and also two sets constructed at the college. One is a normal circuit (largely Wireless World design) arranged with separate chassis for the various sections while the other is a projection set. Faults of various types are placed on these sets and the students get experience in locating them.

Apart from the normal equipment of cathode-ray oscillographs, valve voltmeters, signal generators, etc., a number of special pieces of equipment are available which are most useful. The first is a commercial oscillograph with d.c. amplifiers and an X trace which can be expanded to approximately five times the screen diameter. This is invaluable for showing the operation of d.c. restorers and of circuits where the d.c. component is important.

The second is a television waveform display apparatus which was constructed at the College and is described in more detail elsewhere. The apparatus is essentially a special cathode ray oscillograph arranged so that the waveform of 2 to 250 lines of a television picture may be shown. The lines can be varied so that any selected ones may be shown and a pulse is available for brightening the corresponding lines on a picture on a normal receiver. This is particularly useful for showing the operation of synchronizing separators, which are almost impossible to demonstrate on a normal cathode-ray oscillograph. Fig. 2(a) shows the frame synchronizing period on even frames taken on the signal from the pattern generator, while (b) shows the effect of integration of the frame pulses. In this the build-up of voltage can easily be seen but it is quite impossible to show anything of this nature on an ordinary oscillograph since the frame synchronizing pulses occupy only a small fraction of the total frame time. The apparatus can, of course, be used with advantage for fault finding.

Camera Equipment

Recently a complete television camera has been constructed to help in clarifying some of the mysteries of the camera side of television, which cannot normally be seen by students outside the London area. The camera itself consists of a Pye Staticon miniature pick-up tube with a two-valve pre-amplifier, a cathode follower and a pulse amplifier. It also contains an electronic view-finder with corresponding time bases and video amplifier. The camera is fed from a control unit which is mounted on two racks. These contain the power supplies, video amplifiers, time bases, pulse generator and monitor tube. The signal from the pre-amplifier is fed by coaxial cable to the video amplifier on this control unit. After amplification and frequency-response correction, the signal is fed to a clamp circuit to set the black level, and then to a blanking amplifier which suppresses the signal for the required periods. The synchronizing signal is then added to give a complete video waveform. The control unit also contains a small r.f. oscillator and amplifier which is modulated

[Fig. 2. (a) Video signal of pattern generator during even frame synchronizing period. Negative picture signal. (b) The effect of integrating the synchronizing pulses during the frame synchronizing period. Positive pulses.]

with this video signal so that the camera may be used to operate a normal commercial set.

The camera is most useful for showing effects of d.c. component, definition, etc., which are difficult to show on a normal pattern-generator signal. It is designed to give a correct B.B.C. synchronizing signal and will resolve at least the 2-Mc/s bars on Test Card C. Built into the same control unit is a monoscope which enables a Test Card C pattern to be produced when required. Some further work is required on this section to give complete satisfaction but it will be a most useful addition as this signal is not available (apart from a few minutes) during normal class time.

Fig. 3 is a general view of part of the laboratory with the television camera control unit and other apparatus. Although much time and effort have been devoted to this work it is felt that it is well worth while if it enables students to obtain a better understanding of the working of a television receiver. With the introduction of more channels and, at some later date, colour, the complexity of the television receiver will increase and it will be even more difficult to give satisfactory training. The servicing trade is already short of technicians and it will become more important to have highly skilled people available as more sets are installed and as their complexity increases.

MODERN AIRFIELD RADIO

A NEW civil airport near Dungeness, known as Ferryfield, opened recently by Silver City Airways, is said to be the first airfield in the world planned especially to deal with the transport of vehicles, as distinct from passengers or freight. It will eventually replace the cross-channel car ferry now operating from Lympne.

Its interest from our standpoint is that, being a new airport, it has no legacy of existing radio facilities that must be integrated with new services and the whole radio and radar installation has been planned from the ground up, so to speak.

First and foremost is the air-to-ground communication; this is carried out primarily on two v.h.f. channels in the 118- to 132-Mc/s aircraft band by means of modified T1131 crystal-controlled transmitters of 50 watts telephony rating and four Marconi HR82 receivers. Two transmitters and receivers are in service and two on stand-by. There are also two h.f. transmitters (one operational and one stand-by) for single spot-frequency operation in the 2- to 25-Mc/s band. They are rated at 250 watts telephony and 350 watts c.w. telegraphy and have been installed to handle long-distance communications in connection with charter work. There are two h.f. receivers of Racal design.

Two aids to navigation are provided; one is a v.h.f. direction finder operating on the null-signal aural...
principle and employing a pair of rotatable dipoles with switched reflectors to give "sense." Bearings are taken on the normal R/T transmissions from the aircraft. The other navaid is a Decca 424 radar with the scanner and radio-frequency head located about 400 to 500 yds from the control tower. The i.f. signal is "piped" to the tower where, in a room fitted with tinted glass windows, are two c.r. tube display units, with separate i.f. receivers to allow for independent operation. Thus one can cover the distant approaches out to 25 miles or so, while the other can give an expanded picture of aircraft movement within a mile or two of the airfield.

Radio-telephone facilities are provided in this room to enable aircraft to be "talked down" to within visual distance of the runways under conditions of poor visibility. Here is located also the v.h.f. direction finder so that all the radio navigational aids are conveniently to hand.

Not yet installed, but planned, is a v.h.f. radio-telephone system for keeping in touch with all airport vehicles. It, and all the other radio services, will be operated from the controller's console as is now customary practice at all airfields, large and small.

The radio and other airport equipment at Ferry- field was planned and installed by Racal, Ltd., and, of course, is approved by the Ministry of Transport and Civil Aviation.

International Technical Questions

PROFESSOR BALTH. VAN DER POL, director of the International Radio Consultative Committee (C.C.I.R.), has sent us a copy of Volume I of the Proceedings of the VIIth Plenary Assembly of the Commit- tee which was held in London last September. Engineers and technicians interested in the international aspects of technical radio questions will find the book (which is available in English and French) of considerable interest.

Volume I contains the full text of 90 recommendations, reports and resolutions adopted by the assembly. It also gives full details of the study programmes and questions which will be investigated during the three years before the next assembly, to be held in Warsaw in 1956. These investigations are carried out by the study groups of each of the member countries of the International Telecommunication Union of which the C.C.I.R. is a permanent organ. It is as a result of the papers submitted by these national study groups that the recommendations and further study programmes are arranged.

As the book also contains the texts of those reports, etc., adopted at the previous two plenary assemblies which are still valid, it forms a complete collection of the current C.C.I.R. documents.

Some idea of the diversity of subjects covered in this 406-page book may be gained from the following summary of some of the entries in the 20-page index:

Propagation: Ionospheric, tropospheric and ground-wave.

Receivers: Noise and sensitivity; selectivity; frequency stability; choice of i.f.

Recording: Standards for sound on discs, film and tape.

Television: Recording, polarization, standards conversion, picture and sound modulation, combining monochrome and colour.

Two further volumes covering the reports of the study group chairmen and the director (Vol. II), and the minutes of the plenary assembly (Vol. III) will be published later.

Volume I is obtainable from the Publications Depart- ment, International Telecommunication Union, Palais Wilson, Geneva, Switzerland, price 23.10 Swiss francs.

ELECTROSTATIC RADIOPHANY

THIS picture shows an x-ray image of a valve and a potted circuit obtained by a new process called xeroradiography which dispenses with ordinary photographic techniques. The method is cheap because the plates can be used over and over again and is very quick—the radiograph being ready in less than a minute from the time of exposure.

In place of the ordinary photographic plate a thin film of selenium on a conductive backing plate is used, and this is charged electrostatically. On exposure to the x-rays the charge is modified according to the pattern of the object being radiographed, so that an electrostatic image is obtained. This image is then made visible by spraying on to the plate a very thin film of charged powder, which adheres in accordance with the charge distribution. For re-use it is only necessary to wipe the plate clean and recharge.

The method has been developed by Ferranti, who say that it is possible to obtain pictures with an even finer grain than in conventional x-ray photographs.
COMPACT GRID-DIP OSCILLATOR

By G. P. ANDERSON
(Amateur Radio Station G2QY)

A Useful Method of Finding the Resonance Frequency of Coils and Circuits

DURING recent years the increasing appreciation of the value of the grid-dip oscillator as an item of test gear has been reflected in the number of articles published describing different varieties of the species. The only excuse the present writer has for offering yet another contribution on the subject lies in the use of a triode-diode v.h.f. mixer valve as an oscillator and mains h.t. rectifier.

Basically the GDO comprises an oscillating valve tunable over the desired frequency range, and including a meter to show the rectified current flowing in the grid circuit. The oscillator coil is usually placed on the outside of the unit in order to permit it to be brought near to the circuit under test. When the test circuit and the GDO are tuned to the same frequency, power is absorbed from the oscillator causing the grid current to fall; hence its name.

An examination of the makers' characteristics for the diode part of the Mullard EAC91 shows that it is designed with limiting values of 50 volts between heater and cathode, and a cathode current of 5 mA. Using the triode section as an oscillator with approximately 50 volts h.t., the current taken is well within this limit, and the valve may be made to oscillate easily up to frequencies of the order of 220 Mc/s, using components suitable for operation at lower frequencies as well. The particular model shown in the photographs is designed to cover the range from 5 to 160 Mc/s with seven coils, which are arranged to plug in to the end of the unit.

The mains transformer may be quite small as it supplies about 2 watts only, and the smoothing shown in the circuit diagram, comprising $C_5$ (32µF) and $R_2$ (10 kΩ), is adequate for the purpose. The

![Circuit diagram of the grid-dip oscillator described in the text.](image)

**LIST OF COMPONENTS**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1$</td>
<td>20 + 20 pF variable</td>
</tr>
<tr>
<td>$C_2$</td>
<td>32 µF 50 V wkg.</td>
</tr>
<tr>
<td>$C_3$</td>
<td>100 pF silvered mica</td>
</tr>
<tr>
<td>$C_4$</td>
<td>30 pF 50 V wkg.</td>
</tr>
<tr>
<td>$C_5$</td>
<td>250 µA meter</td>
</tr>
<tr>
<td>$R_1$</td>
<td>22 kΩ 1/2 W</td>
</tr>
<tr>
<td>$R_2$</td>
<td>10 kΩ 1/2 W</td>
</tr>
<tr>
<td>$V$</td>
<td>EAC91 (Mullard)</td>
</tr>
<tr>
<td>$A$</td>
<td>See table</td>
</tr>
<tr>
<td>$L$</td>
<td>Mains transformer; secondaries 50 V at 5 mA, 6.3 V at 0.3 A.</td>
</tr>
</tbody>
</table>

On the right the layout of the parts inside the box is shown with the top and one side removed.

WIRELESS WORLD, SEPTEMBER 1954
signal produced, if listened to in a receiver, is modulated very deeply with 50 c/s, but this is no disadvantage in using the instrument; it is in fact very useful for identifying the signal when accurate frequency checking is desired.

The model shown is built into a box measuring $7 \times 3\frac{1}{2} \times 3\frac{1}{2}$ in, which is a convenient size for holding in the hand. It could be made smaller, but was originally built as a companion to a self-contained battery model, which used one triode of a 3AS in a similar oscillator circuit, driven by hearing aid batteries. The only external difference was in the replacement of the mains toggle switch by a spring-loaded push button, conveniently placed for thumb operation. This switch was fitted in the heater circuit in order to prevent the batteries being run down unnecessarily.

Details of the coils, and the approximate ranges covered, are shown in the table. If use at the upper end of the range only is contemplated a smaller capacitor at $C_1$ permitting a different layout to secure shorter leads in the oscillator circuit would probably enable the GDO to be used at even higher frequencies. In passing it may be mentioned that tests have been carried out with 120 volts applied to the rectifier without any signs of distress; with the heater left unearthed, this voltage does not appear across the heater and cathode, but only between the two cathodes, and, of course, the cathode and anode of the diode.

For completeness, a few notes on the use of the GDO may be added. Each range should be calibrated, conveniently by comparison with a suitable receiver, but it should be kept in mind that such calibration is only approximate, since coupling to a tuned circuit tends to "pull" the oscillator. In use the coil of the GDO should be brought near to the circuit under test, and the tuning condenser varied until a decrease in grid current is indicated. The coupling should then be reduced, by moving the GDO away, until the smallest observable "dip" is obtained; in this way, the "pulling" of the oscillator frequency is reduced to a minimum. If more accurate knowledge of the frequency than is given by the GDO calibration is required, the oscillator frequency may be checked on a receiver, maintaining meanwhile the coupling to the circuit under test.

Apart from the obvious uses in adjusting tuned circuits in receivers, transmitters and such like, the GDO may also be used to find the resonant frequencies of aerials, guy-wires, etc.

### COIL TABLE

<table>
<thead>
<tr>
<th>Coil</th>
<th>Approx. Freq. Range</th>
<th>Turns</th>
<th>Winding Length</th>
<th>Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5-9 Mcs</td>
<td>68½</td>
<td>¹⁄₈ in</td>
<td>36 s.w.g. enamel</td>
</tr>
<tr>
<td>B</td>
<td>9-15</td>
<td>39½</td>
<td>¹⁄₈ in</td>
<td>28</td>
</tr>
<tr>
<td>C</td>
<td>14-24</td>
<td>24½</td>
<td>¹⁄₂ in</td>
<td>24</td>
</tr>
<tr>
<td>D</td>
<td>25-40</td>
<td>15½</td>
<td>¹⁄₄ in</td>
<td>22</td>
</tr>
<tr>
<td>E</td>
<td>37-63</td>
<td>8½</td>
<td>¹⁄₈ in</td>
<td>20</td>
</tr>
<tr>
<td>F</td>
<td>60-110</td>
<td>5½</td>
<td>¹⁄₈ in</td>
<td>20</td>
</tr>
<tr>
<td>G</td>
<td>100-160</td>
<td>1½</td>
<td>¹⁄₈ in</td>
<td>20</td>
</tr>
</tbody>
</table>

The coils are each wound on 1-in lengths of ¹⁄₈-in diameter Paxolin rod, and are terminated on two 20 s.w.g. tinned copper wires inserted in the ends, spaced to suit the socket on the grid-dip oscillator. In the original model, the socket is a diode valveholder (Base Type B3G).

**FITTING CAR RADIO**

In order to encourage radio dealers not having facilities for handling motor cars to take a more lively interest in car radio, Pye Telecommunications are organizing fitting depots throughout the country to which dealers can send their customers for skilled and prompt fitting of the latest Pye car radio receiver. At the time of writing depots are functioning in Birmingham, Cambridge and Manchester.

To facilitate speedy installation in the widest possible range of cars the new set is made in three separate parts; radio tuner, combined output and power unit and loudspeaker respectively. The first and last only need be in the body of the car and space can generally be found somewhere under the bonnet for the power unit, where, incidentally, it will be within easy reach of the battery in most cases.

The tuner is a complete three-valve, two-waveband superhet less output stage, and is designed to have a reasonably small frontal area so that it can be accommodated conveniently in the space provided on the dash board, or immediately below without obstructing either the driver or passenger.

Tuning and the combined volume/on-off controls are fitted with normal type knobs and disposed on either side of a rectangular dial, while the tone control and wave-change switch have disc-shaped "dollys" for finger or thumb operation and are let into the lower part of the dial. There are separate scales for medium and long waves with illumination for night-time operation. The price of the new set, including aerial, purchase tax and fitting fee is £28.

*Right: To facilitate installation the new Pye car radio receiver is broken down into the three units shown here.*

_Wireless World, September 1954_
**Manufacturers' Products**

**NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS**

**Strip Connectors**

THE plug and socket connector illustrated is one of a new range introduced by Bulgin for the electrical interconnection of individual items of a larger equipment. A typical application would be where several chassis are mounted in a rack or a cabinet and slide in and out on guide rails for maintenance and servicing. The socket part can be fixed to the back of the chassis and the plug part (or vice versa) on the back of the rack or cabinet. When the chassis are pushed fully home the two parts mate together and the electrical interconnections are automatically made. To ensure correct alignment of the pins and sockets, individual sockets are allowed a free lateral movement of ±5 deg.

Plugs and sockets are mounted on strips of good-quality bakelite material, the pin spacing being 7/8 in. Pins are hollow and the leads are secured by tip soldering as in the older-type valve pins. Sockets are fabricated from resilient metal strips, bent to shape, and have integral soldering tags.

These new connectors are available in 3- to 6-, 8-, 10- and 12-way types and prices range from 1s 11d for a 3-way plug and socket to 3s 6d for a 12-way.

The makers are A. F. Bulgin and Co., Ltd., Bye Pass Road, Barking, Essex.

**Auto-alarm Receiver**

THE “Seaguard” auto-alarm receiver is intended to take the place of the ship’s radio officer when he goes off duty. It maintains a constant watch on the marine distress frequency of 500 kc/s, and, in the event of a distress signal conforming to the international standard of 12 four-second dashes at one-second intervals being received, operates an alarm. In order to allow for slight mis-tuning of the caller’s transmitter the Seaguard receiver is pre-tuned for reception over the band 490 to 510 kc/s.

A receiver of high sensitivity is employed and elaborate precautions are taken to ensure that only a genuine distress signal of the agreed form will actuate the alarm mechanism, which comes into operation after the fourth dash of correct duration and spacing.

The Seaguard consists of two main units, receiver and power supply, both housed in a single cabinet with draw-out chassis for servicing. A built-in meter provides means for checking all valve feed currents and failure of either unit is indicated by one of two lamps lighting up; also the alarm bells ring.

The equipment is supplied by the Marconi International Marine Communication Co., Ltd., Marconi House, Chelmsford, Essex.

**Wireless World, September 1954**
Sporadic E

YOU'VE probably had your whack of television interference by sporadic E reflections at one time or another in the course of the present summer (sic) "Clouds" of intense ionization, forming sporadically in the E-layer and capable of propagating long-distance interference with our TV services were forecast as most likely to occur in the daytime between May and August by T. W. Bennington,* whose work is well known to Wireless World readers. His forecast has been amply borne out by what happened this year. At one time or another from early May onwards severe modulated r.f. interference during daylight has been reported from many parts of the country. Unless there's some interesting event, sporting or otherwise, on tap, I don't often use my receiver during the afternoon. Hence it wasn't until early in July that I saw sporadic E interference in full swing. It began more or less mildly with the appearance of a number of faint whitish lines on the screen. They were not stationary, but jittered about, sloping now from left to right and now from right to left between the top and bottom of the screen. The lines grew rapidly more obvious and "greys" appeared between the "whites." Meantime, they became steadier and less inclined this way or that. Watching them was very trying to the eyes, but I was too fascinated to switch off. So far as I remember, the next development was sudden: the lines became alternate black and white vertical bars of equal width, covering the entire screen. They were at one time so steady that I could count them: 24 black bars, with jagged edges indicating modulation.

Long-Range TV

TELEVISION is full of surprises. If you were asked what were the chances of obtaining consistently good pictures at a seaside town, 70 odd miles from the nearest transmitter and with huge hilly areas inland, you'd probably reply without hesitation that they were not very bright. That's certainly what I should have said about Torquay—if I hadn't just returned from a visit to friends who live there and seen for myself the quite excellent pictures that they regularly have on their screen. Good reception is rare in the more low-lying parts of the town; but, given an efficient receiver and a high 3- or 4-element Yagi array, pictures in the higher parts are very nearly up to the standard of those obtainable in a normal town.

A.G.C.

Almost the only fly in the ointment in this part of South Devon is slow, and sometimes not so slow, fading. My host had done a good deal towards minimizing the effects of this by rigging up a remote-control arrangement for the contrast. With this he could keep the picture-level more or less steady; but I couldn't help feeling that this job of work should have been done in the receiver itself by means of effective a.g.c. It is not only in places far from a transmitter that receivers have to cope with signal variations big enough to be a nuisance to the viewer. I am glad to see that an increasing number of manufacturers are including a form of a.g.c. in their sets. What a boon it will be if it is really effective against aeroplane flutter; for this form of interference is becoming more and more frequent with the increasing number of planes in the air.

The F.M. Scheme

THOUGH the first stage of the B.B.C.'s plan for v.h.f. broadcasting provides for only nine stations, it will cover a good 75 per cent of the homes of this country. The idea is to turn every TV station eventually into a combined television and sound broadcaster. This means that the provision of interference-free sound broadcasting will go forward hand in hand with steadily improving television coverage. Since it should be possible to share much of the building, maintenance and running costs between the "whites.'
between the two services this should make for a considerable saving in expense. A saving in manpower, too; for the number of engineers and technicians needed to run a "combined" transmitting station should be quite a bit smaller than that called for by two completely separate outfits. Although we may not be the first country to have a nationwide high-fidelity sound service we shall, I believe, be the first to demonstrate the economies of combined sound broadcasting and television stations.

AWARDS TO AUTHORS

AUTHORS of a dozen or more papers on radio and allied subjects read before the Institution of Electrical Engineers last session, or accepted for publication during the session, are to be awarded premiums by the Institution.


Premiums valued at £5 will be given to the following authors for the papers quoted:

- E. D. Daniel and Dr. P. E. Axon (R.A.E.), for "The Influence of Some Head and Tape Constants on the Signal Recorded on a Magnetic Tape." and "The Reproduction of Signals Recorded on Magnetic Tape;" Dr. E. A. O'Donnell Roberts (Mullard), for "A Study of Some of the Properties of Materials Affecting Valve Reliability;" Dr. J. A. Saxon and B. N. Harden (Radio Research Station, Slough), for "Basic Ground-Wave Propagation Characteristics in the 50-800 Mc/s Band" and "Ground-Wave Field Strength Surveys at 100 and 600 Mc/s;" J. Brown (Imperial College), for "Artificial Dielectrics Having Relative Indices less than Unity;" A. Talbot (Imperial College), for "A New Method of Synthesis of Reactance Networks;" and E. Green (Marconi's), for "Synthesis of Ladder Networks to give Butterworth, or Chebyshev Response in the Pass Band."

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WIRELESS WORLD, SEPTEMBER 1954
Teleoptics

I HAVE been reading with very great interest an article in the June issue of the French journal Television in which the author, Gaston Muller, puts forward some very original ideas. He is, like myself, afflicted with a divine discontent, as, indeed, is F. P. Hughes, who wrote "Why Lines?" in last month's Wireless World.

Muller criticizes the use of scanning in television; the picture is transmitted piecemeal and not in one complete whole as in the long-range TV system employed by the moon and other heavenly bodies.

Although the viewer thinks he sees a complete picture it is in reality a mere illusion—like marriage, where one gets to know the real personality of ones partner bit by bit instead of all at once. As things are at present the marriage between electronics and optics, which produces as its offspring the television picture on our screens, is rather an unsatisfactory one from Muller's point of view. The offspring, by means of the scanning process, grows up gradually into a fully fledged adult over a period of time in the same way as an infant in the biological world. M. Muller wants the offspring to arrive in the world like Venus as a ready-made adult with none of this time-wasting growing business.

He describes his proposed remedy for this unsatisfactory state of affairs at considerable length, but admits that practical details are likely to prove very formidable. It is these tiresome practical details that are holding up a teleoptical scheme of my own as I want to provide every room in my house with television, using one set only. As you cannot just couple up an extension c.r.t. as you can a loudspeaker I propose to mount my set on the roof next to my mastshead pre-amplifier and to distribute the picture optically. I intend to use a small projector-type c.r.t. in the set and by an elaboration of the optical arrangement used in a binocular microscope, coupled with the necessary number of periscopes, I shall be able to beam the picture down each chimney of my house. It doesn't look as if we are going to get any coal next winter and I don't like to think of the chimneys as being entirely useless.

In the empty grate of each room, there will be a prism or inclined mirror to throw the image forward on to the back of a translucent screen standing in the position occupied by the normal fire screen. In this way television will be available in each room and the occupants will be able to gather in a half-circle round the fireplace as has been the habit of families for generations past.

The Etch and the Itch

ONE sometimes comes up against the problem of replacing a defunct valve, on which the etched type number is indecipherable, in a receiver about which no technical information is available.

In a recent issue of the American journal Radio-Electronics a gallant attempt is made to solve this problem by suggesting various things which may be done to enable the faint and elusive type number to be read. All depend on the fact that the etching process causes a slight roughening of the glass over the actual etched area. Among other things suggested is that the valve be rubbed on your hair; the rough etched area of the glass collects more of the natural scalp oil than the rest and so shows up. But those of us who have dry scalps need not despair. All we need do is to stick the valve in the refrigerator and when it is really cool take it out and breathe on it; and we shall find that the resultant condensation has collected more readily on the rough etch than elsewhere.

These suggested remedies are all very well in their way, but I am surprised at a technical journal like Radio-Electronics having any truck with such non-electronic methods. I must confess, however, that I only discovered the correct method myself by chance.

One day I had on my laboratory table the chassis of a set which I had picked up cheaply in the Petticoat Lane of radio. I was having trouble in deciphering the valve numbers and had left the room for a few moments in search of a valve data book and when I returned I noticed the cat rubbing itself against the valves and other components of the up-ended chassis.

There was nothing abnormal about all this, of course, but when I reached the chassis I noticed that the etching stood out boldly amid the dust which had gathered on the rest of each valve. The explanation is simple. When glass is rubbed with a piece of catskin it becomes electrified and readily attracts particles of dust. But there had been a much greater degree of friction between the itching skin of the cat and the rough area of the etching, and, therefore, a greater electrical charge with the result that the dust had been attracted there to a much greater extent than elsewhere on the glass envelope of each valve.

Mobile Phone Boxes

EACH YEAR there is an outcry from punters at the shortage of 'phone boxes at Newmarket, Epsom and other racing centres, to give people a chance of getting on to their London bookmakers for the later events in the programme after they have lost all their hard cash to the ready-money course bookmakers in the earlier races.

The usual excuse of the G.P.O. is that the capital outlay in building dozens of telephone kiosks which would be used for only a few days in the year would not be justified. Have they never heard of such things as radio waves, or are the officials in charge of the telephone department totally lacking in imagination?

I see no reason at all why temporary 'phone boxes made of wood and canvas should not be dumped down where needed, each containing a battery-powered radio unit, for linking with a similar installation on the roof of the local telephone exchange. Such temporary boxes, with their complete freedom from connecting cables, could be readily moved by a suitably equipped pan-technicon from course to course as required.

Wireless World, September 1954

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The anode connection of the QV06-20 is brought out to a top cap, and this feature, together with a short metal base screen which is connected to a base pin, ensures excellent separation between input and output.

The QV06-20 is directly equivalent to the popular American 6146. Further details of the QV06-20 and other valves in the comprehensive Mullard range are readily obtainable from the address below.
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FERROGRAPH MODEL YD A triple-speed instrument designed mainly for use in the scientific and industrial fields. Principally intended for operation from and into 600 ohm lines, a high gain stage has been provided, however, to allow for recording direct from normal microphones.

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A vibration generator depends for its accuracy largely upon the suitability of its driving equipment. Goodmans—who pioneered vibration generators in this country—have now produced a self-contained drive unit consisting of oscillator, amplifier and power pack. Although primarily intended for use with Goodmans Model V.47 Generator, it will also find wide application in the laboratory and in industrial processes where a high quality source of audio frequency is required. A brief specification of this latest Goodmans product is given below, and full circuitry details are available on request to "Vibration Dept. W".

**Brief Specification**

- Frequency range—10-10,000 c/s in 3 ranges.
- Power output—5 watts into 3 ohms.
- Output Level Stability—±0.05 db 10-10,000 c/s.
- Distortion—less than 0.2%.
- Hum level—72 db down on 5 watts.
- Power supply—100/115 v, 200/225 v, 225/250 v
  50-60 c/s, 75 watts.
- Weight—45 lb.
- Dimensions—16½in. x 13in. x 11in.
THE TIMES
and special supplements

THE TIMES has gained a special reputation for its supplements, for the great thing about a supplement is that it should be thorough.

That is why the supplement for the radio industry published separately by THE TIMES on August 23rd will be so well worth reading. The articles, on varied subjects ranging from the radio show and current trends in set design to detailed news of the latest developments in components, will be informative and authoritative to a high degree. Reports on the B.B.C.'s plans for sound and television, a special article on the use of navigational aids in the air and on the sea, communications equipment, electronics as an aid to production, and many other articles of general interest are included.

This supplement of 32 pages published by THE TIMES reviews the radio industry fully and lucidly. Those who serve that industry, and the public in general, will find it stimulating and valuable reading.

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AUTOMATIC FREQUENCY MONITOR (20 Mc/s)

Designed for the measurement of any frequency in the range 10 c/s to 20 Mc/s with a basic accuracy of ± 1 part in 10⁶ ± 0.1, 1.0, or 10 c/s. Higher accuracies available if required. The unknown frequency is determined by counting the number of cycles that pass through a 'gate' open for a selectable time interval of 0.1, 1.0, or 10 seconds. The result is presented on eight panel mounted meters each scaled 0 to 9 and is in decimal notation. Full information available on request.

CINEMA-TELEVISION LIMITED

A Company within the J. Arthur Rank Organisation

WORSLEY BRIDGE ROAD · LONDON · SE26

Telephone HITher Green 4600

SALES AND SERVICING AGENTS

F. C. Robinson & Partners Ltd.,
287 Deansgate, Manchester, 3

Hawnt & Co., Ltd.,
59 Moor St, Birmingham, 4

Atkins, Robertson & Whiteford Ltd.
100 Torridale Street, Glasgow, 32
SUFXLEX POLYSTYRENE CAPACITORS

because of their LOW DIELECTRIC LOSS
and SMALL SIZE are admirably suited for
use in I.F. transformers and padded circuits.
Their uniquely high insulation resistance
and low dielectric absorption make them
indispensable in computers, nucleonic and
medical equipment.

IN 1881 J. C. MAXWELL
derived this relationship
between dielectric constant
and refractive index.
That this holds true for
Polystyrene implies that
polarization is almost
entirely due to elastic
displacement of electrons only.
This means LOW DIELECTRIC
LOSS and dielectric
constant independent
of temperature, frequency
and voltage.

* The capacitors shown here are actual size.

CAPACITIES: 5 pf. to 0.5 mfd.
TOLERANCE: 20% to 1%.
VOLTAGES: 250v. to 750v. D.C.
HS Type: for general use.
HSA Type: with additional sealing
for use in exceptional
humidity conditions.

SUFXLEX
Limited

PRECISION TELEVISION RELAY CABLES

... to meet increasingly severe system requirements.

AUDIO FREQUENCY CABLES

... of quad, double quad and figure "8" construction.

POLYTHENE INSULATED & SHEATHED CABLES

for the highest standards of television and radio relay engineering.

BRITISH INSULATED CALLENDER'S CABLES LIMITED, 21 BLOOMSBURY STREET, LONDON, W.C.1
STABILISED POWER SUPPLIES

provide all the necessary power supplies for electronic equipment in the LABORATORY and WORKSHOP.

THE Airmec Stabilised Power Supplies which operate from 100-130 and 200-250 volts 50 c/s mains are designed for either bench use or for forward mounting on a standard 19in. rack. Both current and voltage meters are incorporated, and in the Type 776, a meter switch enables any of the four separate direct outputs to be monitored. Separate switches and fuses controlling all D.C. outputs are fitted to each unit for convenience of operation.

**Type 705**
- Stabilised output continuously variable from 200-350 volts at maximum currents of 200-100 mA.
- May be employed with positive or negative lines earthed or with output floating.
- Output change is less than $\pm 0.5$ per cent. for $\pm 10$ per cent. input change.
- Output change from no load to full load is $+0, -0.5$ per cent.
- Source Impedance 5 ohms.
- A.C. output 6.3 volts at 5 amps, centre tapped, unstabilised.
- Price £55—Immediate delivery.

**Type 776**
- Stabilised positive output continuously variable from 200-350 volts at maximum currents of 200-100 mA.
- Positive output change is less than $\pm 0.5$ per cent. for $\pm 10$ per cent. input change.
- Stabilised negative output of 85 volts at 5 mA.
- Unstabilised positive output of 500 volts at 200 mA.
- Unstabilised negative output of 500 volts at 3 mA.
- A.C. output 6.3 volts at 5 amps, unstabilised.
- Price £60—Immediate delivery.

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

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HIGHP WYCOMBE - BUCKINGHAMSHIRE - ENGLAND

Telephone: High Wycombe 2060

Cables: Airmec, High Wycombe
Implementing the policies of N.A.T.O. has brought its own problems, not the least of which are the varying electrical properties of the actual raw materials selected for electronic and radio equipment and components. The news that Gresham Transformers have completely and successfully met the requirements of American Specification MIL-T27 is yet another achievement and is another testament to the quality of Gresham's products. The news that Gresham Transformers have completely and successfully met the requirements of American Specification MIL-T27 is yet another achievement which goes to prove that—

To Every Transformer Problem
There is a GRESHAM Answer

---

GRESHAM TRANSFORMERS LTD
TWICKENHAM ROAD, HANWORTH, MIDDX.
FELTHAM 2271-4
Dubilier Precision Wire Wound Resistors are manufactured under very close supervision to exacting standards in order to ensure that the finished resistors will maintain stability over long periods. Specially insulated wire is used which combined with subsequent impregnation in similar insulating material eliminates the possibility of shorted turns. These resistors can be made over a wide range of values and to very close tolerance. For full technical information send for Catalogue Brochure R.9.
The best which present techniques can devise...

Like its predecessor, the QUAD II embodies outstanding features anticipating trends in both amplifier and associated equipment design. The importance of these features will be apparent to all who have followed the growth of high quality reproduction in recent years.

The criterion, as always, is that the reproduced sound shall be the closest approach to the original—that the enjoyment and appreciation of music may be unimpeded. This is reflected throughout the electrical and mechanical design. It is reflected, too, in the straightforward and logical system of control, achieved without the sacrifice of a single refinement or adjustment capable of contributing to the final objective.

The QUAD II for convenience of installation, is constructed in two units—the main amplifier and the control unit. Each is complementary to the other, offering in complete form the best which present techniques can devise.
STRICTLY EXPORT ONLY


SOME OF THE TYPES CARRIED IN STOCK

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>LAC9</td>
<td>3C54</td>
<td>6S5</td>
</tr>
<tr>
<td>LACGOT</td>
<td>3C54</td>
<td>6S5</td>
</tr>
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<td>LAC8</td>
<td>3C54</td>
<td>6S5</td>
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<td>6S5</td>
</tr>
<tr>
<td>LAD1T</td>
<td>3C54</td>
<td>6S5</td>
</tr>
</tbody>
</table>

HALTRON HOUSE, 49-55 LISSON GROVE, LONDON N.W.1.

Tel.: Ambassador 1041 (5 lines) Cables: Hallmatic, London
The TAPE RECORDER for every Home.

Here at last is a Tape Recorder all can afford. The 'PLAYTIME' offers a new world of entertainment and interests at a price until now unimaginable.

A scientifically developed, precision engineered instrument, it weighs only 16 lb. and is built in a beautifully appointed, compact case, finished in attractive two-tone leathercloth.

The 'PLAYTIME' is the lowest priced Tape Recorder giving a full hour's playing time. Completely self-contained for recording. Plays back through normal radio or amplifier.

ACCESSORIES

The 'PLAYTIME' is supplied complete and ready for use, optional extras being a matched High Fidelity Crystal Microphone at 52/- and ONE HOUR Spool of special matched tape at 26/6.

This is the lightweight precision engineered chassis of the Playtime—scientifically developed and superbly presented.

Write for coloured leaflet.
Track Assembly

Moulded with

‘Araldite’

This selector unit (part of the Ultra Jet Pipe Temperature Control System) controls the temperature of the exhaust gases of a turbo-jet aero-engine.

The resistance elements and track segments are moulded in ‘Araldite’ Casting Resin B, simplifying assembly and sealing the elements against climatic changes and ensuring mechanical stability.

This is another example of the versatility of ‘Araldite’ epoxy casting resins which combine exceptionally low shrinkage on setting with resistance to high temperatures, humidity and corrosive agents. ‘Araldite’ epoxies are facilitating production in many industries—most notably in the potting and sealing of components for radio, electronics and electrical engineering generally.

THESE ARE THE NEW EPOXIES!

‘Araldite’ (regd.) epoxy resins are obtainable in the following forms:

- Hot and cold setting adhesives for metals and most other materials in common use
- Casting resins for the electrical, mechanical and chemical engineering industries
- Surface coating resins for the paint industry and for the protection of metal surfaces

Full details will be sent gladly on request.

‘Araldite’ epoxy casting resins

Aero Research Limited

DUXFORD, CAMBRIDGE. Telephone: Sawston 187 A Ciba Company

© 204-75 A
Powerful 40 kilowatt D.S.13's were used to transmit Her Majesty the Queen's Speech direct from Auckland, New Zealand, to the United Kingdom on Christmas Day, 1953.

More than 180 of these transmitters are in use throughout the World

* Available for early delivery

D.S. series of transmitters

<table>
<thead>
<tr>
<th>D.S.</th>
<th>Power kW</th>
<th>Band</th>
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<tbody>
<tr>
<td>D.S.10</td>
<td>3/5</td>
<td>Double Sideband</td>
</tr>
<tr>
<td>D.S.12</td>
<td>4</td>
<td>Independent or Single Sideband</td>
</tr>
<tr>
<td>D.S.13</td>
<td>40</td>
<td>Independent or Single Sideband</td>
</tr>
</tbody>
</table>

Write for Radio leaflets:
- Type D.S.10 No. 179/25
- Type D.S.12 No. 129/25
- Type D.S.13 No. 130/25

Standard Radio

Standard Telephones and Cables Limited


RADIO DIVISION - OAKLEIGH ROAD - NEW SOUTHGATE - LONDON, N.11
RELAYS

A compact design for close stacking

SERIES 595
D. C. OPERATED

This extremely compact relay has its connections to both contacts and coil brought conveniently to one end, and is designed without projections to facilitate close stacking where banks of Relays are in use. The contact current handling capacity is exceptionally high in relation to the overall dimensions of the Relay. Good armature design has reduced the effects of shock, vibration and acceleration, and the spring type hinge eliminates backlash friction and risks of displacement.

For further details of our range please write.

TELEPHONE: NEWMARKET 3181-2-3
TELEGRAMS: MAGNETIC NEWMARKET

MAGNETIC DEVICES LTD
NEWMARKET
Again Advance lead the way—this time with a V.H.F. Signal Generator covering 7.5 to 250 Mc/s, a range that embraces Bands 1 and 2 and also the impending Very High Frequency Television Transmissions on Band 3. Moreover, this instrument is available at a price well within the reach of every service man. In the traditional Advance manner, this instrument is designed for simple operation and with a versatility that not only fulfils present needs, but anticipates the even more exacting requirements to deal with the television test problems of tomorrow.

Below are some outstanding features:

- WIDE RANGE—7.5 to 250 Mc/s
- SINE AND SQUARE WAVE MODULATION
- RELIABLE ATTENUATION
- LOW LEAKAGE—less than 3 microvolts
- TRULY PORTABLE—weighs only 17 lbs
- COMPETITIVE PRICE

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

Full technical details available in Folder W23 on request.
### SOME SUGGESTED EQUIPMENT COMBINATIONS

<table>
<thead>
<tr>
<th>Equipment</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowther Amplifier A.1oF.</td>
<td>35</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lowther Master control unit</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lowther F.M. unit</td>
<td>22</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Lowther DT.4 radio unit</td>
<td>37</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Connoisseur motor</td>
<td>23</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Lowther pick-ups with diamond styli</td>
<td>43</td>
<td>19</td>
<td>8</td>
</tr>
<tr>
<td>Pick-up transformer</td>
<td>1</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>Extra power pack</td>
<td>5</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>£189</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

- **Rogers Baby-de-Luxe amplifier and control unit**  £ 23  0  0
- **Rogers Radio Feeder unit 3 wave-band**  £ 24  16  0
- **Garrard T/B unit with 2 Decca pick-ups**  £ 14  0  11

**Total**  £ 61  16  11

- **Goodsell amplifier and pre-amp. type M.A.5 can be substituted for the above if desired.**

- **Goodsell Williamson amplifier**  £ 33  10  0
- **Goodsell pre-amplifier**  £ 18  18  0
- **Goodsell F.M. unit**  £ 15  0  0
- **Connoisseur 3-speed motor**  £ 23  8  11
- **2 Leak pick-ups with diamond styli and transformer**  £ 21  19  9

**Total**  £ 112  16  8

- **Leak T.L.10 and Leak Point One pre-amp**  £ 28  7  0
- **Leak pick-up with 2 diamond styli and transformer**  £ 21  19  9
- **Collaro transcription motor**  £ 13  9  0
- **Goodsell F.M. unit**  £ 15  0  0

**Total**  £ 78  15  9

Loudspeakers and Cabinets to choice. Standard Radio Feeder units available, and special Export units with extra short wavebands if required.
It seems paradoxical to refer to variable standards. Yet even amongst Hi-Fi enthusiasts—whose critical perceptions none could question—there is no yardstick of performance. A “Standard” is that which wholly satisfies an individual requirement. And requirements are as diversified as the means to their attainment. To misquote—“Perfection lies in the ears of the listener.”

We are well aware of this at Classic, and we devote our service to matching individual requirements, backing it with specialised advice.

When you come* to Classic you can be sure of getting the precise combination of equipment you need. Any combination of equipment can be supplied to specification and will be specially packed for export orders. All equipment and cabinets are available on hire purchase or credit sale terms in Great Britain and Northern Ireland.

* and you get the same specialised attention if you write—wherever you may be. We can ship any equipment anywhere in the world.

<table>
<thead>
<tr>
<th>LOUDSPEAKERS</th>
<th>HI-FI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cash Price</strong></td>
<td><strong>Credit Sale</strong></td>
</tr>
<tr>
<td>s.</td>
<td>d.</td>
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<tr>
<td>Vitavox Klipschorn</td>
<td>145</td>
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<tr>
<td>Lowther Type PM3</td>
<td>96</td>
</tr>
<tr>
<td>Acoustical Corner Ribbon</td>
<td>95</td>
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<tr>
<td>Wharfedale “Triune”</td>
<td>90</td>
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<tr>
<td>Wharfedale Corner 3 Unit</td>
<td>72</td>
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<tr>
<td>Tannoy 15in. dual concentric</td>
<td>33</td>
</tr>
<tr>
<td>Tannoy 12in. dual concentric</td>
<td>27</td>
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<tr>
<td>Lowther PWT (walnut)</td>
<td>78</td>
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<tr>
<td>Goodmans Axiom 22 (in recommended reflex cabinet)</td>
<td>37</td>
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<tr>
<td>Goodmans 150 in Corner Baffle</td>
<td>22</td>
</tr>
<tr>
<td>Wharfedale Super 12/CS/AL in Classic Reflex cabinet</td>
<td>38</td>
</tr>
<tr>
<td>Wharfedale W/10 CSB Corner Baffle Assembly</td>
<td>24</td>
</tr>
</tbody>
</table>

**COMPLETE WHARFEDALE AND GOODMANS AND W.B. RANGE NORMALLY STOCKED.**

**Bass reflex cabinet of contemporary design and heavy construction finished in straight grained or burr walnut veneer, or oak veneer, lined with Celotex and fitted with a Wharfedale W12/CS/AL Loudspeaker. Dimensions 20in. x 21in. x 42in. high. £37 10 0**

**Radiogram Cabinet to match. Dimensions 20in. x 21in. x 36in. high. £36 0 0**

**Equipment Cabinet to match for Tape Recorder or Record storage. Dimensions 20in. x 21in. x 36in. high. £27 0 0**

**ELECTRICAL CO LTD**

**‘HI-FI’ SPECIALISTS**

**352-364 LOWER ADDISCOMBE ROAD · CROYDON · SURREY TEL. ADDISCOMBE 6061-2**
Magnetic Materials

Extensive research and manufacturing facilities have established Mullard as the leading producers of magnetic materials. They were the first, for example, to introduce Ferroxcube, the world's most efficient magnetic ferrite; 'Ticonal' anisotropic permanent magnets, renowned for their high stability and high energy output; and Magnadur, an entirely new type of permanent magnet with the insulating properties of a ceramic.

The wealth of experience gained from these developments is available to all users of magnetic materials through the Mullard advisory service. An enquiry to the address below will put a team of specialised engineers at your disposal.

Mullard

'Ticonal' Permanent Magnets • Magnadur (Formerly Ferroxdure)
Permanent Magnets • Ferroxcube Magnetic Core Material

Mullard Ltd., Component Division, Century House, Shaftesbury Avenue, London, W.1.2.
Junction TRANSISTORS

for hearing aids

The smallest glass-encapsulated transistor in the world; a result of the specialised valve manufacturing techniques pioneered by HIVAC.

Hermetically sealed against moisture.

All British manufacture throughout.

Contains a germanium junction element manufactured and supplied by HIVAC.

The new HIVAC junction transistor type XFT1, because of its extremely small size and high performance, is the perfect element for all stages of the most modern Hearing Aids.

Dimensions are only 5.3 x 3.8 x 15 mm.
DELIVERIES WILL COMMENCE IN SEPTEMBER

Samples are available now to Hearing Aid Manufacturers

Hivac Limited
STONEFIELD WAY, VICTORIA ROAD, SOUTH RUISLIP, MIDDX.

Telephone: Ruislip 3366
Cables: HIVAC, RUISLIP.
3-SPEED TRANSCRIPTION UNITS

MODEL 2000
Comprises Transcription Motor and Turntable complete with 3-speed gear and switch mounted on banjo-type unit plate

MOP'EL 2010
Same specification as Model 2000, but mounted on rectangular unit plate and equipped with a studio "P" High Fidelity pickup head

Absolutely uniform speed; reproduction free from rumble and frequency modulation. Available for A.C. voltages 100/125 and 200/250. Finished in cream scratchproof enamel. Also available for A.C./D.C. supply.

GRAMOPHONE UNITS Single- and 3-speed

New in design and supplied in two types:—A.C.554 for 78 r.p.m. records; A.C.3/554, a new unit for 3-speed operation.

Turntable is heavy duty steel, rubber covered; fitted with striker for operating automatic stop.

Spring Suspension and check springs eliminate acoustic feed-back.

Pickup Rest fitted with safety clip.

Motor—4 pole, dynamically balanced

The above units are also available for A.C./D.C. supplies.


COLLARO LTD., Ripple Works, By-Pass Road, Barking, Essex.
RECORD CHANGERS

"54" High Fidelity Changer. COLLARO'S latest complete mixing unit for 7in., 10in. and 12in. records. Suitable for A.C. voltages 100/125 and 200/250 and available for A.C./D.C. supplies.

RCS31. Non-Mixing Changer for single-speed operation at 78 r.p.m. with 10in. and 12in. records. Also 3RCS31, 3-speed version for operation at 33 1/3, 45 and 78 r.p.m. with 7in., 10in. and 12in. records.

RC532. Mixing Version of Model RC531 for single-speed operation at 78 r.p.m. with 10in. and 12in. records intermixed in any order. Also 3RC532, 3-speed version, for operation at 33 1/3, 45 or 78 r.p.m. with 7in. records, or 30in. and 12in. records intermixed in any order.

PICKUP HEADS

"Studio" High Fidelity crystal pickup Head. No special filters required. Non-hygroscopic; full tropical guarantee.

Orthodynamic head for 78 r.p.m. and long-play records. Change over effected by switch. Permanent twin point stylus of special durable alloy.

Magnetic Head for 78 r.p.m. records only. Standard type semi-permanent needles. Unsuitable for sapphire stylus.

Magnetic Low or High Impedance Heads for 78 r.p.m. records only. Interchangeable miniature steel needles or permanent sapphire stylus.


COLLARO LTD. Ripple Works, By-Pass Road, Barking, Essex.
We can deliver these from stock...

THE Tape recorder with SINGLE KNOB CONTROL

Scientifically developed and precision engineered, this new Tape Recorder is the most portable, compact and lightweight unit giving a FULL HOUR'S PLAYING TIME. At 26 gns. it represents unbelievable value. Completely self-contained for recording and only connecting to pick up terminals of any radio or input of any amplifier for play back.

26 GNS.

SUPPLIED ready for use with the following optional extras. Matched High Fidelity Crystal Microphone 26/1. Laboratory Matched special ONE HOUR spool of Tape 26/5.

M.O.S. PERSONAL CREDIT PLAN

SEND ONLY 10% DEPOSIT with balance spread over any period up to 24 months.

THE Tape Recorder with SINGLE KNOB CONTROL

THE ONLY TAPE RECORDER WITH SINGLE KNOB CONTROL FOR RECORD, PLAY-BACK, REWIND AND FAST FORWARD WITHOUT UNLACING TAPE.

PLAYTIME gives you ONE H OUR'S FULL PLAYING TIME.

PLAYTIME records and plays back with equal ease in any position, even upside down or on its side.

Because it is scientifically developed and precision engineered there is absolutely minimum wow and flutter.

Supplied ready for use with the following optional extras. Matched High Fidelity Crystal Microphone 26/1. Laboratory Matched special ONE HOUR spool of Tape 26/5.

TECHNICAL DATA

- The only Tape Recorder giving Full Playing Time in all positions.
- Built-in "Top-up" spool for additional spool length.
- Separate variable control ensures correct volume for all types of recording and playing back.
- Built-in "Top-up" spool for additional spool length.
- Frequency response 60/3.000 Hz.
- Instantaneous and positive braking.
- Automatic erase of unwanted recordings.
- Powered by specially designed motor.
- High fidelity twin track recording heads completely enclosed in heavy metal case to prevent contact and complete protection against static magnetic and electrostatic fields.
- For use on A.C. mains 200/250 v.
- Self-contained for recording and to play back just use any radio or amplifier.
- PLAYTIME is very portable and compact, finished in attractively lined hauteur finish and complete protection against stray magnetic and electrostatic fields.
- Overall size 12 in. x 10 in. x 4 in.
- Weight 16 lbs. only.
- Storage space for spare spool and tape.
- Size of tape table only 11 in. x 9 in.

M.O.S. PERSONAL CREDIT PLAN

SEND ONLY 10% DEPOSIT with balance spread over any period up to 24 months.

Fully Guaranteed

M.O.S. PERSONAL CREDIT PLAN

SEND ONLY 10% DEPOSIT with balance spread over any period up to 24 months.

Fully Guaranteed

TWO SPEED TAPE RECORDER

The Tape Recorder for the Connoisseur who wants the best in Tape Recording. At 45 Gns. there is no better value. The "EDITOR" is now available with two speeds giving 2 HOURS' PLAYING TIME.

With operating height of just over 5 in., this wonderfully compact unit is amazingly simple to use for a hundred and one different recording purposes. Superb true balanced recording and listening can be obtained. The "EDITOR" is the smallest mains operated Tape Recorder giving 2 HOURS' FULL PLAYING TIME.

TECHNICAL DATA

- Independent Fast and Forward Controls for Recording and Playback.
- Two speeds 31 in. and M/min. per sec.
- High quality Amplifier can be used quite independently for a microphone or phonograph record reproduction.
- Overall negative feed back.
- High fidelity twin track recording heads with trackable, automatic erase.
- Powered by three high grade recording motors.
- Fast forward and rewind without miniing tape.
- Precision engineering giving negligible wow and flutter.

See and hear them at the RADIO CENTRE

The relaxation of Hire Purchase Restrictions makes it possible to supply any equipment you require on Easy Terms up to 24 months repayment period with a VERY LOW initial deposit.

E. G. MADOLGE

Telephone: MUSEUM 6667. THE RADIO CENTRE.
£13.19.6
Carr. & Packing 7/6.

Here is the heart of your Tape Recorder! If you are building or modernising your own equipment—you must have the latest BURGOYNE Tape Deck giving 2 speeds, designed for building into complete recorders. Greatest value ever offered.

- For use on A/C Mains 200/250 v.
- Powered by 3 high grade motors.
- True forward and high speed rewind with automatic high frequency start-up.
- Twin track high impedence heads totally enclosed to offer complete protection from static magnetic and eletronic fields. No matching transformers required.
- Deck will take all standard plastic and paper tapes up to 1,200 ft. capacity.
- Washable top panel of very durable finish.

The M.O.S. PERSONAL CREDIT PLAN gives you a variety of methods of purchase. Here is a further selection of equipment:

**SUPPLY COMPANY**

33 Tottenham Court Rd., London, W.1
Telephone: MUSuem 6667
**Announcing the NEW Armstrong “TWIN”**

**True High Quality at an economical price**

- Beautifully veneered walnut cabinet, 27½ wide, 14½ deep, 31½ high.
- Unique style (registered design).
- 8 valve, all wave radio chassis.
- Very latest 3 speed record changer.
- Twin 10” P.M. loudspeakers.
- Bass and Treble lift and cut controls.
- Ample record storage space.
- ONLY 57 Gns. (inc. Purchase Tax)

Also in our Radiogram range:

The “STANDARD”—8 valve, all waveband with 10” loudspeaker—69 Gns.
The “SPECIAL”—8 valve, all waveband with 10” loudspeaker—79 Gns.
The “SUPER”—14 valve, five wavebands with 12” loudspeaker—125 Gns.
(all tax paid.)

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S.E.C.
BRT 400 D

For the full specification please send for a copy of publication BC2084.

**SHORT SPECIFICATION**

<table>
<thead>
<tr>
<th>BAND COVERAGE</th>
<th>OVERALL FIDELITY</th>
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<tbody>
<tr>
<td>0.150—0.385 Mc/s</td>
<td>Less than 2 db down at 50 c/s</td>
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<tr>
<td>0.510—30.0 Mc/s</td>
<td>Less than 6 db down at 5,500 c/s</td>
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<tr>
<th>SIGNAL/NOISE RATIO</th>
<th>A.G.C. CHARACTERISTICS</th>
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<tr>
<td>Standard input for 20 db:</td>
<td>Output constant within 3 dB for 100 db change in signal input.</td>
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<tr>
<td>1.3—30.0 Mc/s</td>
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<tr>
<td>0.150—1.3 Mc/s</td>
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<tr>
<th>SENSITIVITY</th>
<th>OUTPUT CIRCUITS</th>
</tr>
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<tbody>
<tr>
<td>Better than 1.0 μV for 1.5 watts output, over the whole band.</td>
<td>At 2.5 or 15 ohms: 2.5 watts</td>
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<td></td>
<td>At 120 ohms: 0.05 watts</td>
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<td></td>
<td>At 600 ohms: 0.2 watts</td>
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<tr>
<th>SELECTIVITY</th>
<th>POWER SUPPLY</th>
</tr>
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<tr>
<td>Six switched bandwidths:</td>
<td>95—130 and 195—250 volts, 40/80 c/s. Also from 12 volt battery, using BRT 401 auxiliary power unit.</td>
</tr>
<tr>
<td>0.5 kc/s</td>
<td>2.0 kc/s</td>
</tr>
<tr>
<td>5.5 kc/s</td>
<td>13.0 kc/s</td>
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In all cases:

* Transformer input tap changing by switch on front panel.
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<table>
<thead>
<tr>
<th>RATING</th>
<th></th>
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<tbody>
<tr>
<td>Heater Voltage (volts)</td>
<td>V_h 6.3</td>
</tr>
<tr>
<td>Heater Current (mA)</td>
<td>I_h 1.6</td>
</tr>
<tr>
<td>Maximum Anode Voltage (volts)</td>
<td>V_a(max) 800</td>
</tr>
<tr>
<td>Maximum Screen Voltage (volts)</td>
<td>V_g2(max) 300</td>
</tr>
<tr>
<td>Maximum Control Grid Voltage</td>
<td>V_g1(max) 100</td>
</tr>
<tr>
<td>Maximum Voltage between g1 and g2 (volts)</td>
<td>V_g1-g2 400</td>
</tr>
<tr>
<td>Mutual Conductance (mA/V)</td>
<td>g_m 14</td>
</tr>
<tr>
<td>Inner m</td>
<td>g_m 5.3</td>
</tr>
<tr>
<td>Maximum Anode Dissipation (watts)</td>
<td>P_a 5.0</td>
</tr>
<tr>
<td>Maximum Screen Dissipation (watts)</td>
<td>P_g2 5.0</td>
</tr>
<tr>
<td>Maximum Cathode Current (mA)</td>
<td>I_k(max) 300</td>
</tr>
<tr>
<td>Maximum Potential Heater/Cathode (volts DC)</td>
<td>V_h-k(max)t 300</td>
</tr>
</tbody>
</table>

- Taken at V_a = V_g2 = 150V at 200mA.
- Provided the cathode is positive

All maximum ratings are Absolute values not Design Centres.

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MAZDA

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These new Marconi equipments are for the quantitative measurement of both transmitter and interference field strengths in the range 0.15 to 30 Mc/s. Basically, the TF 1054 and TF 1055 each comprise a high-quality superheterodyne receiver with built-in noise-diode signal generator for gain standardization. The necessary loop and rod aerials, aerial coupling unit, aerial supporting tripod, and mains-operated power unit are supplied with each equipment.

**FREQUENCY RANGE**
TF 1054: 0.15 to 2.4 Mc/s
TF 1055: 2.4 to 30 Mc/s

**BANDWIDTH**
9 kc/s

**FIELD STRENGTH MEASUREMENT RANGE**
Minimum: TF 1054, 20 µV/metre at 150 kc/s and 6 µV/metre at 2.4 Mc/s.
TF 1055, 6 µV/metre at 2.4 Mc/s and 0.3 µV/metre at 30 Mc/s.
Maximum: +125 db relative to the appropriate minimum quoted above.
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a LIFT to your production

At every stage of production and despatch, mechanical handling is helping to save labour... cut costs... get the goods there on time.

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The Miniature Oscilloscope with the GIANT Specification!

TYPE 2300 (Industrial Electronics)
- Direct-coupled X and Y amplifiers.
- D.C. to 3Mc/s frequency response.
- 7c/s to 50Kc/s time-base with a trace expansion control from zero to 15in.
- Compact and portable.
- Weight: 6½lbs.
- Size: 7½in. x 4½in. x 7½in.
- 2½in. effective screen diameter.

SEND NOW FOR FULL DETAILS to Sole Distributor —

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SOLDERING—SAFE—SIMPLE—SPEEDY

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PRIMAX—
- BALANCED GRIP SOLDERING GUN
Specially designed for easy soldering on hard-to-reach jobs
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The PRIMAX-SOLDERER is the ideal tool for any RADIO-TV-TELEPHONE mechanic or amateur. Just the tool for service calls and small jobs on the bench. The Primax-Solderer works on a different principle from that of commonly known soldering irons. A current of high amperage produced in the transformer will heat the soldering tip within 6 seconds. Available 110, 200/220, 220/250v. 50 cycles, 60w.

ONE YEAR'S GUARANTEE

Sole Distributors:—

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Tel.: SLOANE 3586 - Through wholesalers & retailers
These loudspeakers have been designed to provide minimum magnetic interference together with high acoustic efficiency. ELAC Elliptical and round loudspeakers are used in most of the leading Television and Radio receivers.

**PRICES INCLUDING P.T FOR LOUDSPEAKERS LESS TRANSFORMER.**

<table>
<thead>
<tr>
<th>Size</th>
<th>Brand</th>
<th>Flux (Gauss)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>7&quot; x 4&quot; Elliptical</td>
<td>PM. 6G</td>
<td>6,500</td>
<td>19/10</td>
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<tr>
<td>3 1/2&quot; PM. 3G</td>
<td>PM. 6G</td>
<td>6,500</td>
<td>17/2</td>
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<tr>
<td>6 1/2&quot; PM. 6G</td>
<td>PM. 6G</td>
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<tr>
<td>8&quot; PM. 8D</td>
<td>PM. 6G</td>
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<td>10&quot; PM. 10D</td>
<td>PM. 6G</td>
<td>7,500</td>
<td>31/8</td>
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Stamford Works, Broad Lane, Tottenham, N.15.
MAGNETIC TAPE RECORDERS

This is one of the high performance Recorders from the Reflectograph range that you are invited to both see and hear on Stand No. 207 at the Radio Show, Earls Court. The Reflectograph range covers a wide field with many exclusive features. A representative selection will be there for your inspection.

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We can supply meters with NON-STANDARD CURRENT and VOLTAGE RANGES to any specification. DELIVERY 7-14 days.

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SEPTEMBER, 1954


Telephone: MUSton 2958

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PAINTON & CO. LTD. have entered into an exclusive arrangement with Eduard Winkler Apparatebau of Nuremberg, Germany, to manufacture and market the well-known Winkler Precision Multi-Way Switches.

Switching up to 30 positions per bank.
Adjustable stop to set number of positions.
Single, Double, Three-Pole or Four-Pole designs.
1 to 6 Banks operated from common shaft.
Distinctive design Knob, with adjustable skirt.

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High quality material and dimensional precision are attributes of Bullers die-pressed products. Prompt delivery at competitive prices.

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<thead>
<tr>
<th>Product</th>
<th>Description</th>
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<tbody>
<tr>
<td>PORCELAIN</td>
<td>for general insulation</td>
</tr>
<tr>
<td>FREQUELEX</td>
<td>for high-frequency insulation</td>
</tr>
<tr>
<td>REFRACTORIES</td>
<td>for high temperature insulation</td>
</tr>
<tr>
<td>PERMALEX &amp; TEMPLEX</td>
<td>for capacitors</td>
</tr>
</tbody>
</table>

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More than 100,000 Amplivox miniature E.M. earphones are already in use in the Radio and Deaf Aid Industries—more than enough to prove their value and reliability.

The largest of the series weighs 10 gms. and the smallest 6 gms. only; their maximum diameter is .835" and minimum .703"; all types are available in standard impedances of 15, 100, 600, and 2,000 ohms (E.4/5 types only 7,500 ohms) at 1,000 c.p.s. Other values to order.

Typical responses:

- 130
- 120
- 110
- 100
- 90
- 80
- 70 kcs

Amplivox miniature earphones are made for snap fitting to flexible ear attachments, moulded inserts, "Stethoscope", and Lightweight Headset units.

Manufacturers’ enquiries invited.

2, Bentinck Street, London, W.1. WELbeck 2591.
INDEPENDENT SIDEBAND RECEIVER

... developed to British Post Office Specification

This new Independent Sideband Receiver type GFR 552 is designed for operation on long-distance, point-to-point, short-wave radio links forming part of the international trunk network. On independent sideband working, the GFR 552 provides facilities for the reception of two single sideband signals, each 6 kc/s wide, one above and one below the frequency of a reduced-level pilot carrier. Each sideband will accommodate either two 3 kc/s wide telephony channels, or several voice frequency telegraph channels. The GFR 552 may also be used for reception of single sideband or double sideband transmission. In the case of the second application this receiver offers two advantages: firstly, the absence of non-linear distortion which occurs in normal d.s.b. receivers when signals are subjected to selective fading conditions; and, secondly, the ability to select upper or lower sideband for demodulation, dependent upon which is freer from adjacent channel interference.

The circuit and chassis layout of the GFR 552 closely follows that of the Mullard Receiver GFR 551, which was based on a British Post Office design (Receiver, Radio No. 22). Special features of the GFR 552 include a high order of oscillator stability and freedom from cross-modulation through which cross-talk between channels or inter-modulation between wanted and unwanted signals might occur. A brief technical summary is given below. More detailed information supplied on request.

**FREQUENCY RANGE** - 4-30 Mc/s.

**NOISE FACTOR** - better than 7 dB over the band.

**SIGNAL TO NOISE RATIO** - 25 dB for 4 microvolts peak sideband input over the band.

**SELECTIVITY** - The response is flat within 2 dB for sideband frequencies between 100 c/s and 6000 c/s. At 10 kc/s from the carrier frequency the response is -60 dB relative to the pass band.

**A.F.C.** - The a.f.c. system operates effectively with a pilot carrier level of -26 dB relative to 1 microvolt (which corresponds to a peak sideband level of 1 microvolt and a signal to noise ratio of 15 dB).

**NON-LINEAR DISTORTION** - Third order intermodulation products which might result in cross talk between sidebands do not exceed -60 dB relative to the sideband levels.

**OUTPUT** - Variable up to +14 dB relative to 1 mW into 600 ohms.

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Mullard

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

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EDDYSTONE
MODEL '770R'
V.H.F. COMMUNICATIONS RECEIVER

FREQUENCY RANGE 19 Mc/s. to 165 Mc/s. CONTINUOUS COVERAGE

- Highly efficient signal frequency circuits.
- Substantial diecast rotary coil turret.
- Excellent frequency stability and selectivity.
- Accurate re-setting and ease of handling.
- High sensitivity and excellent signal-to-noise ratio.
- High quality push-pull output.
- For AM, FM, NFM and CW Signals.
- Robust construction and outstanding reliability.
- Preferred type valves.
- Finest workmanship throughout.

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NEW!
The Manning-CarrMiniaturePolarised Relay

DATA—A Sensitivity of 25 milli-watts and capable of handling mains voltage on the contacts with alternating currents up to 0.25 amps. Being polarised it has the advantage that the Armature contact can be biased to lock in either direction by suitable adjustment of the contact screws, which provides a useful facility where pulse operation is required. Speed of operation is also high and the Relay will follow A.C. frequency of 50 c.p.s. Resistance up to 8,000 ohms, which is acceptable for Anode circuits. Alternatives to specification if required. Sole Concessionaires.

POST OFFICE TYPES 3,000 AND 600 RELAYS
to specification. Tropicalising, impregnating and Services jungle finish if required. Delivery 3-4 weeks.

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an inexpensive test set with 21 basic ranges

The Pullin Series 100 Multi-Range Test Set is an inexpensive piece of equipment invaluable to radio and electronic engineers. It is a compact, portable instrument with a total of 21 basic self-contained ranges which provide adequate facilities for the measurement of A.C. voltage, D.C. voltage and current, and resistance. All voltage measurements are at 10,000 Ohms per volt.

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LABORATORY INSTRUMENTS DYNAMOMETER TESTING SETS
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PORTABLE TESTING SETS

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Quartz Crystals of any shape and size cut and ground precisely to specification and coated, if required, with Gold, Silver, Aluminium or Rhodium, etc.

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Suppliers to Ministry of Supply, Home Office, B.B.C., etc.
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STEWART TRANSFORMERS Ltd.
75 KILBURN LANE, LONDON, W.10
Tel.: LADbroke 2296/7
A most versatile general purpose communication Receiver designed to rigid Admiralty specification. It operates as a single superheterodyne over part of its range and as a double superheterodyne over the remainder. Special features are overall frequency stability, re-set accuracy and low radiation. It will receive CW, MCW or RT signals.

"LISTEN THROUGH" FACILITY
A high speed relay circuit applies a pre-set blocking bias to certain valves of the receiver to "mute" it during actual transmission. This facilitates listening through during spacing periods.

FREQUENCY RANGE
Range 1. 60 - 125 kc/s
  2. 100 - 260 kc/s
  3. 260 - 660 kc/s
  4. 0.66 - 1.5 Mc/s
  5. 1.5 - 3.4 Mc
  6. 3.4 - 7.0 Mc/s
  7. 7 - 15 Mc/s
  8. 15 - 32 Mc/s

OUTPUT
Two simultaneous outputs are provided; 2 watts into 500 ohms for loudspeaker and 60 milliwatts into 100 ohm loads for headphones. Negative feedback is used in the final stages to ensure a constant voltage output under varying load conditions.

GAIN CONTROLS
Separate RF and AF gain controls are provided. The RF control is imperative when the AGC is in use.

The automatic gain control can be switched on and off as required. With an increase in output of 60 db the output will not increase by more than 8.0 db.

CRYSTAL CONTROL
Facilities are provided to Crystal control the receiver in the range 1.5-30 Mc/s when required.

TUNING SCALE
The calibrated tuning scale is 6½" long, and coarse and fine scales for logging purposes are provided.

All enquiries to

PYE LTD
11 Hinde Street, London, W.I. Telephone: WEL. 8175/6
Announcing the NEW
Armstrong
F.C. 48

OUTSTANDING FEATURES INCLUDE:

* 8 Valves including 2 double Triodes. 8 watts output from push-pull tetrodes. Heavy negative feed back is used resulting in negligible distortion and high damping factor.
* Provision for using F.M. adaptor to receive the present high quality transmissions from Wrotham and the new B.B.C. V.H.F. stations.
* An accessible socket at rear provides the power supply for this unit.

THE F.M. UNIT WILL BE AVAILABLE SHORTLY.

OTHER MODELS:


EXPORT MODELS:

EXP. 119. 10 valves, medium and two short wavebands plus six bandspread channels, 10 watts output. PRICE £55/19/4 (inc. P. Tax).


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ARMSTRONG WIRELESS & TELEVISION CO., LTD., WARLTERS ROAD, HOLLOWAY, N.7. Tel.: NORTH 3213

DC/AC CONVERTERS
Units Complete and ready for use

- for Electric Gramophones
  from £8 16s. 0d.
- for Radios, Radiograms, and Autochange Radiograms (inc. 3-speed motors) from £11 16s. 6d.
- for Television, Tape Recorders, and for operation of TV from Country House lighting plants, price according to instrument.
- Inputs, 6, 12, 24, 32, 50, 110 or 200/250V. D.C.
- Outputs, 110V. or 230V. 50 or 60 c/s.

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NEW CHAPEL ROAD, HIGH STREET
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THE NEW K6 UNIT
List Price 19 GNS.

SEE AND HEAR IT AT YOUR LOCAL DEALER

MODERN TECHNIQUES
138-144 Petherton Road, London, N.5
Tel.: Canonbury 5896
The PF 91 amplifier, with the PF 91A remote control unit, is a versatile and practical combination for those who demand realism in sound reproduction from record players, tape recorders, microphones or radio tuners.

- Built to proved mechanical and electrical engineering standards and suitable for continuous use even under tropical conditions.
- Frequency range substantially flat over entire audible range of 20-20,000 cycles per second, up to 12 watts output.
- Excellent oscillatory transient response because of balanced response characteristic from 2 cycles per second to 160,000 cycles per second.
- Low noise level.
- High damping factor.
- Very low harmonic and intermodulation distortion.

**MODEL PF91**

**28 GNS**

**MODEL PF91A**

**12 GNS**

4ft. extension cable available free of charge
Introducing

THE

GOLDRING

VARIABLE-RELUCTANCE PICK-UP CARTRIDGE
No. 500
with twin styli for standard and L.P. records
A new and spectacular advance in the realm of High Quality disc-record reproduction!

Featuring—

- Easily replaceable sapphire styli.
- Low playing weight—6 to 8 grams.
- Frequency response 15-20,000 cps.
- Very low dynamic mass and high compliance.
- Output 3mV per cm/sec.
- Suitability for use in all climates.

Designed specifically for applications requiring the highest attainable fidelity.

FOR FULL TECHNICAL DETAILS WRITE TO:

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MINIATURE

STANDARD INPUT
TRANSFORMER

Small, efficient, low priced, size 1in. x 1in. x 1in. overall as illustrated.
Uses: For coupling inputs of 3-150 ohms to normal type pentode valves.
Specification: Ratio 1-50, Primary 3.5 ohms. Secondary inductance 160 H.
at 1,000 c.p.s. Range 64 octaves ±2 db. Finish varnish dip, encapsulated block
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Two-piece slide TYPE B
We also make Castors with wheels up to 46 dia. and loads up to 30 TONS EACH

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THE COMPLETE TELEVISOR IS SAFE TO HANDLE, BEING COMPLETELY ISOLATED FROM THE MAINS BY A DOUBLEWOUND MAINS TRANSFORMER. ALL PRESET CONTROLS CAN BE ADJUSTED FROM THE FRONT, MAKING SETTING UP VERY SIMPLE.

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WILLIAMSON AMPLIFIER KIT 15 gns.
H.P. Terms £5.5.0 & 52 months. (This Kit is absolutely complete and all components are guaranteed ready for easy and rapid installation.)

WILLIAMSON OUTPUT TRANSFORMER
Author's Specification 2.6 ohms secoundaries £4.4.0

Mains Transformer SPA42A
This transformer has an additional 6.3v. 0.3A and is capable of supplying an extra 80mA for P.A. or Pre-amp. £12.12.6

WILLIAMSON CHOKES
12H 120mA Fully shrouded Feeder Unit 10 records.

This Transformer has an additional 6.3v. 0.3A and is capable of supplying an extra 80mA for P.A. or Pre-amp. £12.12.6

Build these NEW PREMIER DESIGNS
TRF RECEIVER

The circuit is the latest type TRF using 3 valves and 6 metal rectifiers for operation on 200/250 A.C. mains.

WILLIAMSON OUTPUT TRANSFORMER

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4 Miniature valves in a Superhet Circuit covering medium and long wave. Requires covered Cabinet 11x6.10x3.51, in two contrasting colours. With a grey panel, please state choice when ordering. The set may be used everywhere. £18.6.

Instruction Book 1/4 Post free. A detailed stock list of priced components.

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2 volt 10 amp. (by famous maker) £10.10.0

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An entirely new design, which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really transparent. The ideal Micro for tape, wire and sound projectors. Price £12.12.6 plus 6d. pkg. and carriage.

Decca Model 33A

A three-valve automatic Band Changer made by World-famous manufacturer offers a large choice of novel features. The Unit is designed to play 12in., 10in., and 78r.p.m. records in any order at 3, 5 or 7r.p.m. Capacity 35 records. £19.19.6.

New reversible dual pick-up Crystal Pick-up has extended frequency range to 10,000 c.p.s.--fully compensated for the A.C. lower frequencies with the Turnover frequency at the correct point. An essential feature is the simplicity of design. For use in 200/250/240 volts A.C. mains.

Limited Quantity Only

Plus 6d. p/kg. carriage 9/-.

Brand new, guaranteed and in List Price manufacturer's org. carton.

Special offer

A 12in. TRUVOX P.M. SPEAKER

(8-3 ohm Voice Coil.) The unit is supplied complete with wiring and instructions. £15.15.6.

There are also in Dave's Magazines

Plus 6d. p/kg. carriage 9/-.

Special offer

A 12in. TRUVOX P.M. SPEAKER (8-3 ohm Voice Coil.) For only £15.15.6

These are brand new in Maker's Cartons plus 7/6 p..1.p.

L.E.D. Meters

Large stocks available, a few of which are enumerated below:

Full Scale Scale External Deflection Length Dimensions

<table>
<thead>
<tr>
<th>Movement</th>
<th>in.</th>
<th></th>
<th>in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>35A</td>
<td>2 round</td>
<td>R.P. Thomson</td>
<td>7/6</td>
</tr>
<tr>
<td>3.5A</td>
<td>2.5 round</td>
<td>R.P. Thomson</td>
<td>7/6</td>
</tr>
<tr>
<td>4A</td>
<td>2.5 round</td>
<td>M.C.</td>
<td>6/6</td>
</tr>
<tr>
<td>5A</td>
<td>2.5 round</td>
<td>M.C.</td>
<td>6/6</td>
</tr>
<tr>
<td>15mA</td>
<td>2 round</td>
<td>M.C.</td>
<td>1/6</td>
</tr>
<tr>
<td>12mA</td>
<td>2 round</td>
<td>M.C.</td>
<td>1/6</td>
</tr>
<tr>
<td>10mA</td>
<td>2 round</td>
<td>M.C.</td>
<td>1/6</td>
</tr>
<tr>
<td>5mA</td>
<td>2 round</td>
<td>M.C.</td>
<td>1/6</td>
</tr>
<tr>
<td>3mA</td>
<td>2 round</td>
<td>M.C.</td>
<td>1/6</td>
</tr>
<tr>
<td>1mA</td>
<td>2 round</td>
<td>M.C.</td>
<td>1/6</td>
</tr>
</tbody>
</table>

+ 7/6 p..1.p.

Microphones

Loudspeakers

Pre-amp. Amplifier Complete, tested and ready for use, may be used. Overall size 9 x 7 x 5in. Price of £5.5.0 plus 6d. pkg. and carriage.

Instruction Book 1/4. A detailed stock list of priced components.

Accumulators

For 2 volt 10 amp. (by famous maker) £4.10.0

Moving Coil Amplifier

A super quality Moving Coil Motor base movement £2.12.6 and 4.4.0. Overall dimensions 3.5in. 3.5in. 3in. Price of £5.5.0 plus 6d. pkg. and carriage.

Microphones

Crystal Microphones

An entirely new design, which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really transparent. The ideal Mike for tape, wire and sound projectors, price 24/-.

DIODES

Germanium Diodes, G.E.C. wire ended, 2, 5, 15, 24/-.-oz.
The New
"PREMIER PORTABLE"

TAPE RECORDER

USING THE NEW LANE 2 SPEED TAPE UNIT MARK 6

COMPLETE 39 GNS CASH

Packing & Carriage 1 gn.

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

SPECIFICATION

- **TWICE SPEEDS** 7 in. and 31 in.  
- **LOW QUALITY HIGH AMPLIFIER**  
- **INDEPENDENT TREBLE AND BASS CONTROLS**  
- **MAGNETIC RECORD LEVEL INDICATOR**  
- **AMPLIFIER MAY BE USED FOR RECORD REPRODUCTION OF HIGH QUALITY**  
- **COMPARTMENT FOR HOUSING PAPER RECORD**  
- **SPECIAL DESIGN MICROPHONE BY LEADING MANUFACTURER**

LIMITED SUPPLIES OF 5-VALVE SUPERHET RADIO RECEIVER CHASSIS

Built to high standards emaning quality reception. Specifications:

- VALVE: L.E. Type 767, 787, 708, 7C3, 5U4, 2 WAVEBANDS.
- Long, medium, and short. CONTROLS: Tuning, volume, tone control (with Precision on Switch). Pick-up and Extension Speaker Socket incorporated. For use on 200/250 v. A.C. mains. Dimensions: Length 14in., height 111/2in., width 61/2in. Distance between controls, not to right from edge of chassis: 1in.  
- £19.6.0

STOP PRESS

Famous Manufacturer's Surplus of Anti-Interference Aerials offered at a fraction of original cost. The aerial is designed for reception of long, medium and short waves, with any ordinary or commercial receiver, having an input impedance greater than 1000 ohms long/medium waves and 150 ohms short waves. The installation discriminates against locally generated interference, especially on the short wave bands. The equipment enables the installation of an 8.3 Mc/s flatly-tuned dipole which operates as a T serial on medium and long waves. The aerial and receiver transformers are intended to be interconnected with a 70 ohms coaxial cable.

COMPONENT PARTS

- **Aluminium Aerial Transformer**, £1.01.0: 11 in. (including 70 ohms coaxial cable, 3/4 in. (including 1000 ohms coaxial cable).  
- **Component Aerial**, £1.01.0: 71/2 in. (including 70 ohms coaxial cable, 3/4 in. (including 1000 ohms coaxial cable).  
- **Aluminium Transformer**, £1.01.0: 11 in. (including 70 ohms coaxial cable, 3/4 in. (including 1000 ohms coaxial cable).  
- **Component Transformer**, £1.01.0: 11 in. (including 70 ohms coaxial cable, 3/4 in. (including 1000 ohms coaxial cable).  

SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW:

- **Amplifier**, £11.15.0, plus packaging and carriage 7/6.  
- **Hire purchase terms**, Deposit £11.15.0 and 12 monthly payments of £2.11.2

H.P. TERMS

Deposit £13.13.0 and 12 monthly payments of £2.11.2

Separate units can be supplied as listed below:

- **Amplifier** (built, wired and tested with Speaker), £14/15/-. plus packaging and carriage 7/6.  
- **Hire purchase terms**, Deposit £14/18/4 and 12 monthly payments of £1/4/7.

- **Amplifier Kit** (including speaker), £11/15/-. plus packing and carriage 5/-.  
- **New Lane 2 speed Tape Unit Mark 6, £18/10/-. plus packing and carriage 7/6.

- **Hire purchase terms**, Deposit £6/3/4 and 12 monthly payments of £1/10/10.

- **Portable Cabinet** (Rexine covered), £4/19/6, plus postage and carriage 5/-.

- **Microphone**, £2/19/6, plus postage and carriage 1/-.  

- **Reel Scotch Boy tape MC2-111 (1,200ft.), £1/15/-. plus packing and carriage 1/-.  

- **Instruction Booklet, 2/6. Post free.**
A radiogram manufacturer reports that the Monarch mechanism, using a special test disc, performed 500,000 changes without developing a fault.

This amounts to something like a lifetime of normal use.

Because the Monarch automatic record changer is a scientifically designed precision built instrument, leading radiogram and record player manufacturers install it as standard equipment. The excellent high fidelity performance makes this compact and streamlined unit famous for every modern gramophone use throughout the world.

The world’s finest and most wanted auto-changer.

Write for complete details.

BIRMINGHAM SOUND REPRODUCERS LIMITED, OLD HILL, STAFFS.
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For the detection of frequency modulated signals it is necessary to convert frequency changes into amplitude changes and to recover the intelligence contained in the original signals from the amplitude modulated carrier. The method most widely used for this purpose employs a form of phase discriminator known as the ratio detector. The particular advantage of the ratio detector is its excellent suppression of any amplitude modulation which may be present on the F.M. carrier as a result of noise or variations of gain in the earlier stages of the receiver. This type of circuit has good sensitivity and eliminates the expense of providing additional limiting stages.

A typical form of ratio detector circuit is shown in Fig. 1, and it will be noted that two diodes with independent cathode connections are necessary. The Mullard EABC80 is recommended for use in this type of circuit. This valve is a combined triple diode and voltage amplifying triode, with a heater rating of 6.3V, 0.45A, and it is mounted on the B9A (noval) base. One diod (a'd) is provided with a separate cathode (pin 3), the other two diodes and the triode sharing a second cathode (pin 7). The ratio detector circuit employs two of the diodes (a'd and a''d) which have low impedances (about 2000) whose ratio never exceeds 1.5. The other diode (a'd) is suitable for use in A.M. reception as a conventional detector and generator of A.G.C. voltage. The triode section is designed to be used as an audio amplifier following the detector during both F.M. and A.M. reception. Its electrical characteristics are similar to the triode section of the Mullard EBC41.

In the circuit illustrated, the primary winding L1 of the ratio filter is in the anode circuit of the final I.F. valve. The secondary coil, L2, is tuned to the intermediate frequency (10.7 Mc/s). The voltages in the two halves of L2 have a 180° phase difference, and their magnitudes depend upon the sweep frequency of the F.M. signal. The tertiary winding, L3, consisting of a few turns wound over the anode end of the primary, matches the anode circuit of the preceding I.F. stage into the diode circuit.

The ratio detector can take the form of a balanced circuit in which two equal capacitors are placed across the load resistor, R3, and their common connection taken to earth. In Fig. 1 the unbalanced type of circuit is given. Here only one capacitor, C1, has been retained, from which the audio output is taken. The 5µF electrolytic capacitor, C3, is then necessary to stabilise the voltage across R3.

The value of load resistance (56kΩ) is a compromise between that required for optimum gain and the necessary A.M. suppression. Good A.M. suppression is also achieved by using a relatively high resistance, 1.2kΩ, in series with the tertiary coil. Further increase in the value of load resistance (say, to 68kΩ), whilst resulting in larger output voltage, requires more satisfactory balancing in the preceding circuit in order to keep the rejection of A.M. to an acceptable value. Thus a trimmer capacitor could be connected from the centre-tap on the secondary to earth, and a small series resistance included in the lead from the centre-tap to the tertiary coil L3. These modifications will lead to a considerable improvement in suppression and some increase in sensitivity, but the preliminary adjustments to the trimmer are much more involved.

As a further refinement, some suppression can be sacrificed by connecting the stabilising capacitor across only a part of the total diode load (Fig. 2). With suitable values for R4 and R5 the suppression will depend to a much smaller extent on spreads in the forward resistance of the diodes and on variations in the amplitude.
We see to it...

are more reliable than EVER!

Rigid control of production processes, a ready acceptance of improved manufacturing techniques, and continual vigilance in the analysis and selection of raw materials ensure that every BRIMAR valve will do its job more efficiently... more reliably.

Modern manufacturing methods backed by an intensive research and development organisation enable BRIMAR to anticipate and meet the changing demands of the radio and electronic Industries. There is bound to be a BRIMAR valve to exactly meet YOUR specification.

now is the time
to BRIMARIZE!

<table>
<thead>
<tr>
<th>BRIMAR</th>
<th>MULLARD</th>
<th>MARCONI</th>
<th>COSSOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>12AT7</td>
<td>ECC81</td>
<td>OSRAM</td>
<td>EMITRON</td>
</tr>
<tr>
<td>B152 &amp; B309</td>
<td>12AT7</td>
<td></td>
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</tr>
</tbody>
</table>

The 12AT7 is a very reliable frequency changer and is widely used in modern TV receivers, VHF and UHF communications equipment. It is also frequently employed in industrial equipment, computer navigational aids and test equipment.

Use the BRIMAR
12AT7
with improved performance
at
NO EXTRA COST
Bring your equipment up to date with ACOs REPLACEMENT PICK-UP HEADS

If you already own a fine radiogram or record-player you now have the opportunity of rejuvenating it—of bringing it right up to date for a quite modest sum. Aco's Hi-g crystal pick-ups are now available in a range of specially designed "plug-in" models to suit most famous makes of record reproducing equipment. These Aco's Hi-g pick-ups, you will find, represent a truly phenomenal advance in pick-up design—with regard to both reproduction and tracking characteristics (so important with many of the new microgroove recordings). Ask your Dealer!

### MODEL

<table>
<thead>
<tr>
<th>HGP 33-I Collaro</th>
<th>HGP 37-I Collaro</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HGP 33-I</strong></td>
<td><strong>HGP 37-I</strong></td>
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</tbody>
</table>

HGP 33-I Collaro: A Hi-g pick-up head incorporating the HGP 33-I turnover cartridge for both standard and microgroove records. Will fit Collaro units RC 332; AC 334; AC3/534; 3/RC 532; and the Studio pick-up.

HGP 37-I Collaro: A Hi-g pick-up head incorporating the HGP 37-I turnover cartridge with cantilever sapphire styli. Designed for both standard and microgroove records. Will fit the above mentioned Collaro units.

Both models available in cream or walnut. Ask for Data Sheets No. 4700 and 4800.

<table>
<thead>
<tr>
<th>HGP 33-I Garrard</th>
<th>HGP 37-I Garrard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HGP 33-I</strong></td>
<td><strong>HGP 37-I</strong></td>
</tr>
</tbody>
</table>

HGP 33-I Garrard: A Hi-g pick-up head incorporating the HGP 33-I turnover cartridge for both standard and microgroove records. Will fit Garrard units RC 75M; RC 80M; RC 90; RC 111; Model TA.

HGP 37-I Garrard: A Hi-g pick-up head incorporating the HGP 37-I turnover cartridge with cantilever sapphire styli. Designed for both standard and microgroove records. Will fit the above mentioned Garrard units.

Both models available in cream or walnut. Ask for Data Sheets No. 4700 and 4800.

<table>
<thead>
<tr>
<th>HGP 39-I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HGP 39-I</strong></td>
</tr>
</tbody>
</table>

Hi-g pick-up heads incorporating cantilever sapphire styli. Separate heads for standard and microgroove records. Will fit the Aco's GP 20 pick-up arm and the Garrard C type adaptor. Used on the following Garrard units: RC 72A; RC 75A; RC 80; and the model M unit. Can be used on any units which at present use the GP 19 heads.

Ask for Data Sheet No. 4400.

<table>
<thead>
<tr>
<th>HGP 35-I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HGP 35-I</strong></td>
</tr>
</tbody>
</table>

Separate plug-in type Hi-g heads for standard and microgroove records; fitted with cantilever sapphire styli. The crystal unit is identical to that of the HGP 39-I above. Can be used on Garrard units RC 75M; RC 80M; RC 90; RC 111; and the TA player.

Ask for Data Sheet No. 4000.

<table>
<thead>
<tr>
<th>HGP 41-I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HGP 41-I</strong></td>
</tr>
</tbody>
</table>

Separate Hi-g plug-in heads for standard and microgroove records incorporating the crystal unit as used in the HGP 39 pick-up head. Will fit Collaro units RC 532; AC 534; AC3/534; 3RC 532. Available in cream or walnut.

Ask for Data Sheet No. 4500.

<table>
<thead>
<tr>
<th>HGP 45</th>
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<tr>
<td><strong>HGP 45</strong></td>
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</table>

Separate Hi-g pick-up heads for either standard or microgroove records. The crystal unit is identical to that used in the HGP 39-I head. Will fit Garrard units RC 80; RC 72A; RC 75A; and the Model M player. Can be used on any unit which at present uses the Garrard C adaptor with GP 19 heads.

Ask for Data Sheet No. 4600.

### PRICE

32/6 (plus 10/5 P.T.) for all types except HGP 39 models which are 32/- (plus 10/3 P.T.)

Always well ahead

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

COSMOCORD LIMITED ENFIELD MIDDLESEX

STAND No. 44
RADIO SHOW
EARLS COURT
"BELLING-LEE" NOTES

A New Multi-Element Array

On the "Belling-Lee" stand at Earls Court there will be seen for the first time, the broadside array illustrated below.

Recently we were asked to provide a good picture in a location surrounded by the hills of South Wales. There was a poor signal and several ghosts. We arranged for the erection of a double 3-element array, comprised of two "Junior Multirods" spaced a half-wave length apart. With this arrangement you can expect a theoretical gain of 3 dB over a single "Junior Multirod" or in micro-volts, about half as many again. As the erection was something of a problem the aerial was tried out on the ground, and right away the ghosts had gone. When properly installed, the customer wrote to say that they now enjoyed a marvellous picture, black and white instead of grey.

Aircraft Fuselink

This new fuselink L.1330 has been specially developed for use on 30 V circuits and is being manufactured in ratings from 35 amp. to 275 amp. It is very light in weight and is intended for direct bus-bar mounting, thus obviating the use of a holder with its cost and weight. It is expected to be explosion proof, and tests in this respect are still being carried out.

This type of fuse-link is already in service on considerable numbers of American aircraft and is expected to go into service very shortly on the Vicker's Viscount and other British-made aircraft. A.R.B. and Ministry of Supply approval is being sought. It is interchangeable with the American types and is, as far as we know, the only one of its kind manufactured on this side of the Atlantic, and therefore should be a dollar saver.

Advertisement of BELLING & LEE LTD.
Great Cambridge Rd., Enfield, Middx.
Written 20th July, 1954.

"Telesfilter"

This is the name given to a miniature flex lead suppressor designed to be fitted in the lead of a small domestic appliance for the abatement of interference to television. As it contains chokes, its application is limited to appliances taking not more than 2 amps. It does not suppress at broadcast frequencies unless used with a plug suppressor such as L.1308. The "Telefilter" is also available moulded into a lead with which an appliance could be wired.

ACHIEVEMENT

The unique internal soldering technique, employed in the manufacture of "Belling-Lee" standard fuse-links, bonds caps, element and glass into one unit. The risk of caps becoming loose is minimised, and a 100% fuse-link can only be rendered useless by breaking the glass, or by blowing in service. Improvement in electrical performance is achieved by setting the wire element on the diagonal, which enables it to be more accurately tensioned, thus ensuring that the fusing currents will be kept within "close limits". This new method of construction applies only to ratings from 300 mA up to 25 A. Lower ratings, down to 60 mA, are however, available.

Designed to blow within 10 sec. on a steady a.c. or d.c. 100% overload. List No. L1055/Rating. Size 1" x 1/".
• More consistent electrical and mechanical performance
• Caps, element and glass held as one—no cement to deteriorate, no solder blobs
• Caps permanently fixed
• Rating coded on caps

All "Belling-Lee" fuse-links undergo full inspection, and blowing tests are constantly carried out on sample batches.

Please write for catalogue P.34/WW.
Typical of the Ekcovision range is this 14" aluminised-tube table model incorporating Ekcovision Turret Tuning, Full Automatic Picture and Sound Control and Optical Filter. Handsome cabinet in walnut veneers. AC/DC mains.

GOOD LOOKING See for yourself the clear brilliant pictures on Ekcovision. And notice the many picture-improving refinements of this fine range of 14", 15" and 17" receivers. Choose for the future, too! Ekcovision 13-channel Turret Tuning is already incorporated in some models, and can be fitted at any time in others for easy, efficient reception of the Alternative Programmes as and when they become available in your locality.

GOOD LISTENING Hear and enjoy the wonderful fidelity and depth of sound of Ekco radio. You will find there are models of every size and price for your listening pleasure.

GOOD VALUE Every receiver, Vision and Radio, is backed by outstanding Ekco quality-engineering and utmost reliability. Distinctive in design and performance, these receivers offer you exceptional value-for-money! Your Registered Ekco Dealer can offer you expert Ekco 'Sales and Service' and will see that you get full and lasting satisfaction from the receiver you choose.

**Ekcovision**

**MODEL T221**

66 GNS.

Tax Paid.

**MODEL ARG233**

5-valve all-wave, floor standing auto-gram, Plays up to eight 12" or ten 10" or 7" records at three speeds, 5-position tonecontrol, Mahogany veneered cabinet. For A.C. mains.

66 gns. Tax Paid.

**MODEL A160**

All-wave superhet in handsome Walnut veneer cabinet. 8" speaker. Floodlit tuning scale. Sockets for gramophone pick-up and for tape recording. For A.C. mains.


**MODEL A222**

The Ekco 'New Radio-line' combines a 4-station switch-tuned radio and a Smiths mains-operated clock. It tells the time, acts as an alarm and switches itself 'on' and 'off'. Inbuilt aerials and sockets for extension speakers. For A.C. mains.

20 gns. Tax Paid.

**Ekco**

**Vision and radio**

**NATIONAL RADIO SHOW STAND 92**

E. K. COLE LTD., SOUTHEND-ON-SEA, ESSEX
Marconi's fitted the first ship with wireless and by 1907 200 ships and more than 100 shore stations had been equipped. Today practically every vessel that ventures on the high seas carries wireless. All radio approach and marker beacons around the British Isles have been designed and manufactured by Marconi. The mariner is warned of hazards and guided into safe channels by Marconi equipment in nearly every principal shipping lane of the world.
MANUFACTURERS OF EQUIPMENT, and DEVELOPMENT GROUPS are invited to send today for this NEW complete catalogue of Ediswan Clix Radio, Television and Electronic Components. Just write "Components Catalogue please" on your business letterhead and we will send you a copy.

EDISWAN CLIX RADIO COMPONENTS

THE EDISON SWAN ELECTRIC COMPANY LIMITED, Member of the A.E.I. Group of Companies

Radio Components Sales Office: 21 Bruton Street, London, W.1 Telephone: Mayfair 5543
The amplifier, speaker and case, with detachable lid, measures 8½ in. x 22½ in. x 15½ in. and weighs 30 lb.

**PRICE**, complete with WEARITE TAPE DECK ...................................................... £84 0 0

**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.

**Manufactured by**

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

Telephones: LiBerty 2814 and 6242-3

Telegram: "Vortexion, Wimble, London."
## MINIATURE HT RECTIFIERS

**FEATURES**
- Withstand overloads such as charging current of deformed electrolytic capacitors
- Instant starting — no warming-up period
- Unlimited instantaneous overload
- Practically indestructible in service.
- No limit to size of reservoir capacitor
- Simple wiring — two connectors only.
- Simple mounting — no valve holder
- Small size... low weight
- Low heat dissipation
- Low cost

### SELENIUM SentRercel RECTIFIERS

**Standard Telephones and Cables Limited**

**RECTIFIER DIVISION:** Warwick Road, Boreham Wood, Hertfordshire

---

**Table: Rectifier Specifications**

<table>
<thead>
<tr>
<th>TYPE</th>
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<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
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<tbody>
<tr>
<td>35°C</td>
<td>100mA</td>
<td>25mA</td>
<td>125V</td>
<td>350V</td>
<td>Unlimited</td>
<td>1 oz.</td>
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<tr>
<td>55°C</td>
<td>125mA</td>
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<td>Unlimited</td>
<td>1 oz.</td>
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<tr>
<td>40°C</td>
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<td>125mA</td>
<td>350V</td>
<td>Unlimited</td>
<td>1 oz.</td>
<td></td>
</tr>
<tr>
<td>55°C</td>
<td>200mA</td>
<td>150mA</td>
<td>350V</td>
<td>Unlimited</td>
<td>1 oz.</td>
<td></td>
</tr>
</tbody>
</table>

*For use in voltage divider circuits the peak inverse and maximum input voltages are stated, current output being as for half-wave operation.*
POST THE COUPON TODAY
FOR OUR BROCHURE ON THE
LATEST METHODS OF HOME
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Prices:

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Tax Paid.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1712</td>
<td>£174 0 0</td>
<td>Complete Radiogramophone chassis P139 and LF613...</td>
</tr>
<tr>
<td>R1712AA</td>
<td>£150 18 0</td>
<td>Tuner T139 with small Amplifier and Power Unit, panel mounted</td>
</tr>
<tr>
<td>R1712BB</td>
<td>£166 19 0</td>
<td>Tuner T139 with 500 ohm line output amplifier and Power Unit, panel mounted and arranged for working in conjunction with all types of existing high quality amplifiers K166 19 0</td>
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FS160. 350-0-350 v. 150 mA, 6.3 v. 4 amps., 3 v. at 3 amps. 31/6
FS10X. Output 350-0-350 v. at 150 mA, 6.3 v. 2 amps.
C.T. 6.3 v. 2 amps. 31/6
The above have inputs of 200/250 v.

OUTPUT TRANSFORMERS
MIDGET OP. 5,000 (1 to 32) 3/9
MIDGET (1000)te 313 3/9
MOP1. Ratios 26, 46, 56, 66, 90, 120-150 mA. maximum current, C.T. for O.P. Class B, etc. Secondaries 2/4 ohms. Top panel, and clamped, each 5/6
OP10. 10/15 watts output. 20 ratios on Full and Half Primary 17/9
OP10. 30 watts output, 20 ratios on Full and Half Primary 33/6
Williamson's O.P. Transformer to Author's specification 64/6
Chokes for Williamson's Amplifier, 30 H. at 20 mA. 16/4
10 H. at 150 mA. 32/-

FILAMENT TRANSFORMERS
All 200/250 v. Input.
P3. 6.3 v. @ 3 amps. 7/6
P4. 4 v. @ 2 amps., 7/6, F6. 6.3 v. @ 2 amps. 7/6
P6. 6.3 v. @ 0.3 amps., 9/6, F12X. 12 v. @ 1 amp. 6/6
PU6. 0-2-6.3 v. @ 2 amps, 10/-, F12. 12.6 v. tapped 6.3 v. @ 3 amps. 16/4
P24. 24 v. tapped 12 v. @ 3 amps. 23/6
P29. 0-2-6.3 v. @ 4 amps, 16/-, F12. 0-4.6 v. @ 3 amps. 27/6
FU12. 0-12.6 v. @ 1 amp. 27/6
P6. 6.3 v. @ 10 amps., or 5 v. @ 10 amps., or 12.6 v. @ 5 amps. 34/-
F6A. Four windings at 6.3 v., 4 tapped 5 v. @ 5 amps. each, giving suitable series and parallel connections up to 6.3 v. @ 20 amps. 51/6

Quotes etc.—stamped addressed envelope, please.
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Associated with Blick Time Recorders Ltd., Blick Engineering Ltd.

SEPTEMBER, 1954
"LITESOLD" SOLDERING INSTRUMENTS and ACCESSORIES

SPECIFICATION

<table>
<thead>
<tr>
<th>Size of Bit diameter</th>
<th>Weight (Less Flex)</th>
<th>Length</th>
<th>Loading</th>
<th>Fixed Bit</th>
<th>Replaceable Bit</th>
<th>Heat Guard</th>
<th>Safety Shield</th>
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<tr>
<td>Fixed or Replaceable</td>
<td>oz.</td>
<td>inch</td>
<td>watts</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>s. d.</td>
<td>s. d.</td>
</tr>
<tr>
<td>1/4</td>
<td>1</td>
<td>6</td>
<td>12</td>
<td>1 10</td>
<td>1 40</td>
<td>4 9</td>
<td>5 6</td>
</tr>
<tr>
<td>3/8</td>
<td>2</td>
<td>9½</td>
<td>27</td>
<td>1 2 6</td>
<td>1 5 6</td>
<td>4 9</td>
<td>5 6</td>
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<tr>
<td>5/16</td>
<td>3½</td>
<td>10½</td>
<td>40</td>
<td>1 5 6</td>
<td>1 8 6</td>
<td>5 0</td>
<td>6 6</td>
</tr>
</tbody>
</table>

PRICES

- Fixed or Replaceable
- Heat Guard
- Safety Shield

LIFE TEST

(See July issue)
The three "LITESOLD" mains models connected day and night since March were still working satisfactorily when this advertisement went to press.
(Over 3,800 hrs.)

Further details from the Sole Manufacturers and Distributors.

Illustration shows the 1/4" bit model in use with our HEAT GUARD.

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A mains operated instrument designed to a very stringent specification.
It measures d.c. and a.c. voltages from 0.2 to 250 V with an upper frequency of 200 megacycles.
It measures resistance from a few hundred ohms up to 500 megohms in four decades and it measures variations in power level over a wide range of decibels.

Accuracy conforms to B.S.89:1954 for industrial moving coil meters. Zero stability within 0.7% on d.c. and 1% a.c. in 24 hours.

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Ambassador VISCOUNT

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SEPTEMBER, 1954

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record changer. Record storage compartments
for 200 records. 10" speaker. £79. 10.0. in Gt.
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vessel in this elec-
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or speech.

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(I × \cos Θ)

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Expressly designed to correctly operate the TRUVOX Tape Deck Mk. III—for Recording and Playback through a 3 ohm speaker, also supplying power for erasure and biasing. Additional facilities are as (a) a pre-amplifier to feed a power amplifier for the playing of recordings at greater than normal volume for auditorium purposes etc.; (b) a pick-up amplifier to operate a loudspeaker direct from a gramophone pick-up; (c) a two-station radio receiver for direct listening or recording with a TRUVOX Radio Jack.

TECHNICAL SPECIFICATION

(a) Inputs: At Jack No. 1 (i) during recording 1-2 mV (crystal microphone) at 1 megohm impedance. (ii) for use as microphone amplifier 1-2 mV at 1 megohm. At Jack No 2 (i) during recording 0.5 v. at impedance of $\frac{1}{2}$ megohm suitable for pick-ups and radio connection. (ii) for replay 0.5 v. at $\frac{1}{2}$ megohm. At Jack No 3 for replay 0.5 v. suitable for pick-up connection at $\frac{1}{2}$ megohm.

(b) Output: 4 watts output at impedance of 3 ohms suitable for direct connection to moving coil speaker.

(c) Oscillator: Brought into circuit on record, fixed frequency at approximately 45 Kcs. at high impedance to suit Truvox Tape Deck. Erase voltage at least 150 v. Bias 80 v. approx.

(d) Level indication by Magic Eye Indicator: Taken out of circuit during replay.

(e) Hum level: 50 db down at 4 watts.

(f) Frequency Response: Fixed recording characteristic. Variable reply characteristics in accordance with setting of tone control. Fixed level response as pre-amplifier when switch in neutral position. Combined with characteristics of the Truvox heads and modern tapes, this gives a substantially level response from 70-10,000 cps.

(g) Valves: 1 EF.86 or Z.729, 1 ECC.83, 1 EL.84, 1 SY3GT, 1 EM.34, HT line voltage not in excess of 300 v.

The amplifier is designed to operate from AC supply mains 110-250 v. List price 16 gns.

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WHETHER the need is for a single unit or a supply running into thousands ... if it's a Selenium Rectifier that must fulfil critical requirements and maintain its characteristics over long periods ... the answer is to be found with Electrix.

- Electrix Rectifiers are characterised by their cool running and consistent long-life conformity to stated specification.
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- Your needs may possibly be met from 'standard' types, or
- 'To specification' models can be quickly prepared.
- Quotations by return ... and deliveries a matter of days only.
- We welcome export enquiries.

Here are some typical "standard" full-wave types each

<table>
<thead>
<tr>
<th>Output</th>
<th>List Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/15 Volts D.C. 1 Ampere.</td>
<td>9/-</td>
</tr>
<tr>
<td>12/15 Volts D.C. 2.5 Ampere.</td>
<td>13/6</td>
</tr>
<tr>
<td>12/15 Volts D.C. 4 Ampere.</td>
<td>22/6</td>
</tr>
<tr>
<td>12/15 Volts D.C. 6 Ampere.</td>
<td>35/-</td>
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</tbody>
</table>

Trade Supplied

- Heavy duty rectifiers with say 230/250 volts A.C. input and 220 volts D.C. output a speciality.
- We use only freshly manufactured selenium plates and components, no ex-W.D. materials whatsoever.

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Pamphonic  £57 15 0
Goodmans Axiom  £57 15 0
Wharfedale Super 15/CS, each  £17 10 0
Lowther P.M.3  £96 0 0
Goodmans Axiom 150 Mk. II  £10 5 6
Corner Baffles (sand/filled) to take 10in. and 12in. units  £9 17 6

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Goodmans Axiom  £57 15 0
Wharfedale Super 15/CS, each  £17 10 0
Corner Baffles (sand/filled) to take 10in. and 12in. units  £9 17 6

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Chapman S.4  £16 0 0
Chapman S.5  £21 6 8
Lowther LES  £23 0 0
Lowther DT.4  £37 16 0
Leak V/S  £34 19 0

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Robers Senior  £28 0 0
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Retail Price of each unit:

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- Designed for use with Jackson Bros. Full Vision Drive or SL.8 Spin Wheel Drive.

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We have probably the largest variety of valves in the country. Let us know your requirements.

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<thead>
<tr>
<th>AVO METERS IN STOCK</th>
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</thead>
<tbody>
<tr>
<td>Avo Model 7</td>
</tr>
<tr>
<td>Avo Model 8</td>
</tr>
<tr>
<td>Signal Generator, Mains and Battery Models</td>
</tr>
<tr>
<td>Electronic Test Meter</td>
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<tr>
<td>Valve Characteristics Meter</td>
</tr>
</tbody>
</table>

Also full range TAYLOR METERS. List on request

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<tr>
<th>VALVE MANUALS</th>
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</thead>
<tbody>
<tr>
<td>Mullard</td>
</tr>
<tr>
<td>Osram</td>
</tr>
<tr>
<td>Brimar No. 5</td>
</tr>
<tr>
<td>Mazda, Post 4</td>
</tr>
<tr>
<td>Mullard Valve Replacement Guide</td>
</tr>
<tr>
<td>Art and Science in Sound Reproduction by F. H. Brittain, D.F.H., 2 6</td>
</tr>
<tr>
<td>Postage 6d. each extra.</td>
</tr>
</tbody>
</table>

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Grundig Tape Recorder £68 5 0
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- Acceptance Angle: 96°

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- Forward Gain: 3 dB
- Front/back Ratio: 25 dB
- Acceptance Angle: 176°

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- Forward Gain: 3.75 dB
- Max/min Ratio: 40 dB
- Acceptance Angle: 120°

Model 12
- Volts: 6, 12
- Watts: 50
- Br. Dia.: 3/16 (push-on), 1/16 (fixed)
- Nett Weight: 0.5 oz.

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Speeds production — heats up in 30 seconds.

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12in. 15 WATT 'DE LUXE'
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**SCALE LENGTH : 9"**
**RANGE FROM 0-500 μA**

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

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Garrard " T.A. " 3-speed Motor choice of MPM2 Heads ....... £10 16 0
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Goodmans Axiom 150 .............................................. £6 10 5
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W.B.HF10 Bin, Unit 3 ohm ...................................... £2 7 0
W.B.HF10/12 10in, Unit 3/15 ohm ............................. £3 13 6
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E.M.

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<th>E.M.I. 1,200ft.</th>
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<td>GARRARD UNITS</td>
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<td>RCT75M, RCT75 A/C.DC., RCROM, TA/AC, TA/B for Decca heads.</td>
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Finished: Hammered bronze with engraved Florentine bronze panel.

SEE PAGES 82-129 for our NEW Radiogram Chassis, Radiograms, and Television Models.

EARLS COURT VISITORS see Page 161 for details of how to get to our DEMONSTRATION ROOM at HOLLOWAY. We shall be open daily from 9 a.m. to 6 p.m. (Saturdays until 5 p.m.). Special High Fidelity Demonstrations on Thursday evenings 8 p.m. DEMONSTRATIONS also available at your local High Fidelity Specialists.

A·10 HIGH FIDELITY AMPLIFIER

AMPLIFIER


When comparing prices of High Fidelity Equipment THE A.10 INCORPORATES ALL NECESSARY FILTERS, and no additional filter units are required.

PRICE: AMPLIFIER £19.15.0

CONTROL UNIT £9.15.0

WRITE TO US FOR DESCRIPTIVE LITERATURE

ARMSTRONG WIRELESS & TELEVISION CO., LTD., WARLTERS ROAD, HOLLOWAY, LONDON N.7. Tel.: NOR 3213/4

TELCON and TELEVISION

Many years' experience in cable making enables Telcon to meet every television and VHF requirement, from BBC transmission lines to down-leads for domestic television receivers.

CAMERA LEADS

One of many specially manufactured multicore cables for trailing camera leads, capable of withstanding continuous flexing.

TRANSMITTER AERIAL FEEDERS

Thimble-type air-spaced coaxial, as used as feeder cables at all the B.B.C. Television Transmitters.

TELEVISION RECEIVER DOWNLEADS

Type BA.24, PSM. 80-ohm balanced twin for "fringe area" reception.
A CAREER AS A REGULAR ARMY OFFICER
FOR QUALIFIED ENGINEERS

MECHANICAL, ELECTRICAL AND ELECTRONIC ENGINEERS are required as officers in the Corps of Royal Electrical and Mechanical Engineers.

THERE ARE TWO METHODS OF ENTRY. These are either:
(1) On a short service commission (which offers a good opportunity of obtaining a permanent commission) with a gratuity of about £100 for each completed year of service on leaving.

or
(2) On a Permanent Regular Commission with a valuable pension and a terminal grant of £1,000 (tax free).

Candidates must be physically fit and not yet 29 years old, and have passed or be exempt from examinations of either the Institution of Mechanical Engineers or the Institution of Electrical Engineers as required for graduates, or have a University degree in Natural Science or Engineering. In addition 2½ years’ experience as an engineer (or 1½ years in the case of University graduates) is normally required.

The pay which Army officers may expect is according to the following table:—

<table>
<thead>
<tr>
<th>Rank</th>
<th>Normal age</th>
<th>If single</th>
<th>If married</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lieutenant</td>
<td>23</td>
<td>£686</td>
<td>£831</td>
</tr>
<tr>
<td>Lieutenant</td>
<td>25</td>
<td>£723</td>
<td>£860</td>
</tr>
<tr>
<td>Captain</td>
<td>27</td>
<td>£860</td>
<td>£997</td>
</tr>
<tr>
<td>Major</td>
<td>34</td>
<td>£1,188</td>
<td>£1,325</td>
</tr>
<tr>
<td>Lt. Colonel</td>
<td>42</td>
<td>£1,453</td>
<td>£1,581</td>
</tr>
<tr>
<td>Colonel</td>
<td>45</td>
<td>£1,791</td>
<td>£1,919</td>
</tr>
<tr>
<td>Brigadier</td>
<td>49</td>
<td>£2,065</td>
<td>£2,184</td>
</tr>
</tbody>
</table>

(Note:—This is the U.K. scale; there are various additions in certain overseas stations. In this table the figures of a single officer’s pay include an element for food and accommodation which are normally provided in kind. This has been done to provide a direct means of comparison with civilian scales of pay.)

For further details please write to:—
The WAR OFFICE (AGI (Officers) C), London, S.W.1. (And quote this publication)

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The Royal New Zealand Air Force has a limited number of vacancies for skilled radio mechanics and other good craftsmen. Free passages to New Zealand and excellent conditions of service.

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MAJOR TYPE 6 × 1½ × 1½ ins.
3 ohms operates on 3/6 Vo. D.C.
500 ohms operates on 18/24 Vo. D.C.
1000 ohms operates on 100/110 Vo. D.C.
2,300 ohms operates on 200/230 Vo. D.C.
17/6 Post & Pkg. 9d.

MAGNETIC RELAYS UNISELECTORS KEY SWITCHES

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Manufacturers of precision Quartz Crystals, for frequency control, in a wide variety of bases, covering all Aircraft, Shipping and Amateur frequencies. All are made to extremely fine tolerances, and have an activity pass figure as good or better than Government standard for the frequency. In addition we can undertake the calibration of your own crystals and supply certificates at nominal cost. Re grind service: Your redundant crystals can be reground to new frequencies at an average cost of 7/6 to 10/-, depending on tolerance, or taken in part exchange. Early deliveries can be given on all types. Re grind service 7 days approx.

H. Whitaker G3SJ. Contractors to the War Office, Air Ministry, Post Office and Government Departments the world over.

PARKER’S SHEET METAL FOLDING MACHINE


A. B. PARKER WHEATCROFT WORKS, WELLINGTON STREET, BATLEY, YORKSHIRE. Tel.: Batley 420
THE COMPLETE COMPONENT STOCKIST

A few lines we stock you might have difficulty in obtaining.

SPECIAL MINIATURE MAINS TRANSFORMERS. 30 m/a, 1 wave, 250 volts, 6.3 volts at 2 amps and 5 volts at 2 amps, 'ully shrouded, 22/6. 20 m/a type, 4 wave, 250 volts, 6.3 volts at 1 amp and 5 volts at 1/amp, 21/6. 40 m/a type, 150 volts and 6.3 or 1 amp, 21/6. All above transformers, standard tapped primary 200/250 volts.

HIGH STABILITY 2% f. w. RESISTORS. Range 100~ to 2 mega (these check better than 1%). Price 4/6 each. MORGANITE TYPE " T " f. w. MIDGET RESISTORS. 6d. 1 watt 8d. 10/2 to 10 mega.

WIREWOUND SMALL COATED RESISTORS. 25, 33, 40, 50, 68, 100, 125, 150, 200, 250, 330, 400, 450, 500, 600, 800, 1K, 1.5K, 2K, 2.5K, 3.3K, 4K, 4.5K, 5K, 6K, 6.8K, 8.2K, 10K. 7 watt max 2/3. 10 watt max 2/9 each.

LINEAR POTENTIOMETERS. Up to 100K, 5/6 each (Morganite), 1 meg, 1 mega, 1/2 each, 1/6 (Dubilier).

TAPPED POTENTIOMETERS. 1 meg, 1 meg, 2 meg, with centre tap, 7/6 (Dubilier).

0.003 mfd. 3 GANG CAPACITORS NEW JB 18/3.

Write now for CATALOGUE NO. 12 PRICE 1/-

70 PAGES 250 ILLUSTRATIONS

RADIO SERVICING CO.
82 SOUTH EALING ROAD, LONDON, W.5.
Next to Sth. Ealing Tube Station

CITY SALE & EXCHANGE LTD

Pye PF.91 Hi Fi Amplifier and its associated PF91A pre-amp. Frequency range 2 cps. to 160,000 cps., £42, or £11 deposit and the balance monthly.

Acousical QUAD II amplifier and pre-amp. A really first class unit, control unit having two switched radio inputs, £42 or £11 deposit and balance monthly.

Wearite Tape Deck £35 Truvox Tape Deck £23/2/-
Several shopsoiled Tape Decks from £9/9/0.

Leak TL/10 Amplifier and Point One pre-amp. 27 gns. cash, or 7 gns. deposit and the balance monthly. Available ex stock as illustrated.

Wharfedale Super 12/ CS/AL for single speaker supremacy, flux density 17,000 lines, total flux 190,000 lines, ex stock £17/10/-.
Also Super 8 CS/AL £6/13/3—W’10 CS/B £12/6/6—Golden 10 £7/13/1.
A ‘Clever Idea’ the Truvox radio jack—gets two radio stations plugged into any high gain amplifier, or tape recorder, post free, £3/19/11.
Also in stock the Editor, complete at 45 gns. The Impressario at 49½ gns. Radio unit 14 gns. extra. and the Herald, with detachable speaker and two mixed inputs at 48 gns. All available on Easy Payments.

Part Exchange Welcomed Easy Payments Arranged

Phone: CENtral 9391/2
YOU'RE SURE TO GET IT AT STERN'S

The "TELE-VIEWER"
5 CHANNEL TELEVISOR
DESIGN OF A COMPLETE 12" SUPERHET T.V. RECEIVER

PERFECT CONSTRUCTIONS MAKE
SIMPLE DIAGRAMS MAKE
CONSTRUCTION EASY

PERFECT FRINGE AREA RECEPTION
BETTER RECEPTION AT HALF COMMERCIAL COST

Here are some of the features which combine to make this such a fine receiver:

- The SUPERHET circuit, easily tuned to any of the five channels, i.e., LONDON, SUTTON COLDFIELD, HOLME MOSS, WENVOE and KIRK-O-SHOOTS.
- The extreme ease of tuning is accomplished by the provision of pre-aligned C.R.T.
- A life-like, almost stereoscopic, picture quality made possible by the following factors:
  a. Excellent band width of L.F. circuits.
  b. A really efficient video amplifier.
  c. C.R.T. grid modulated from low impedance source.
  d. High E.H.T. voltage (approx. 10 kV).

The picture brilliance is also much above the average and enables comfortable viewing with normal room lighting or daylight.

- FIRM picture " HOLD " circuits (Frame-Line) ensure a steady picture, free from hiccups and jerks even under most adverse conditions met with in " fringe " areas and excellent " interlace " ensures the absence of any " trace " effect.

- Negative feedback is used in the audio frequency circuits which provide 2/3 watts of High Quality Sound.

The receiver is built on two chassis units each measuring 14in. x 6in. x 3in.

Rigid C.R.T. mounting enables entire receiver to be safely handled with tube in position.

The "WIDE ANGLE" TELE-VIEWER

- A design that retains all the distinctive features of the 12in. Televisor but with increased Time Base efficiency, producing 16 to 18 kV. E.H.T., with ample scanning power for C.R. Tubes up to 17in.

- It can be completely built including supply of all valves for £33 (plus cost of C.R.T.) and is as simple to construct as the 12in. model.

- This is the most efficient "WIDE ANGLE" 12" large screen design yet offered to constructors, and yet it can be built for almost half the cost of similar designs.

- Complete assembly instructions, diagram, etc. available for £5.

A COMPLETE KIT OF PARTS TO BUILD A 3-4 WATT HIGH GAIN AMPLIFIER for operation on A.C. or D.C. Mains, 220-250 volts.

This amplifier will give 3 watts output for the small Input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the excellent magnetic types.

A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 3in. x 8in. x 7ln. and valve line-up is G12U-6FQ9-5TF6.

Price of complete kit, including drilled chassis, and valves £6 5/0, plus 1/- P.M. (which fits on 10in., 12in., or 15in. P.M.) £7 0/0.

Price of fully assembled chassis ready for use, £5 5/0. G.P. cost of speaker.

Copy of assembly instructions and components price list available for 1/-.

The Denco M.T.O. Modulated Test Oscillator £3/15/-

Crystal Rectifiers 6 or 12 volt 3 amp. rating... £1/7/6
6 or 22 volt 3 amp. rating... £1/5/0
6 or 12 volt 4 amp. rating... £1/17/6

SELENIUM RECTIFIERS

THE NEW Denco ULTRA MIDGET SUPERHET COIL PACKS

Model CP6VU. A 4-station " Pre-set " unit providing 4 on 10, 2 on 860, and one station on lower wave long, wave £1/10/6.

Model CP6OFU. A 6-channel " Pre-set " unit which provides any 4 stations on medium wave and any 2 stations on lower wave long, £1/13/6.

Model CP6UPF. A complete wired " Pre-set " unit for use with either 360PF or 800PF condensers. Overlap 360-500, and 120-500 metres. Price £1/6/6.

An attractive Desk and Drive Assembly is available for £5 0/0. Overall size of each unit 14in. x 6in. x 3in. deep.

Filament Transformer

30 v. 10 amp... £1/0/0
4 v. 1 amp... £0/7/6

HIGH FIDELITY PICK-UP

INCORPORATING THE FAMOUS CONNOISSEUR LIGHTWEIGHT MOVING IRON HEAD and including the CONNOISSEUR matching transformer (11/3-carr. a. l.) £39/6

The "Regent" Crystal Hand Microphone 25/6

Plus 1/- P.M. Complete with lead and cord. List price £2/0/6.

BATTERY CHARGER KITS
All kits are for A.C. Mains 220-250 volts. They comprise a Metal Rectifier and Transformer, and parallel to these low voltage charging, and a tapped Resistor, with Selector Switch, to enable the charging rate to be varied from 1 to 7 amp, max. £3/17/6.

For 6 or 12 volt batteries at max. 1 amp... £3/17/6
For 6 or 1 2 volt batteries at max. 5 amp... £5/2/6
For 6 or 12 volt batteries at max. 6 amp... £6/0/0
An easily followed Wiring Diagram is included with each kit.

WE CAN SUPPLY EX-STOCK

(a) The Hi-Fi Tape Recorder complete... £27/0/0
(b) The Tele-Voy Tape Decks... £25/0/0
(c) The "Regent" Model TK5 Tape Rec.

NEW C.R.T.s.

Unboxed 12in. C.R.T.s by one of the leading manufacturers. 6.6 volt heater, 7-9 kV. standard size. Supplied in maker's sealed cartons.

(Plus 1/- Carr. & Ins.) £12/19/6

BRAND NEW C.R.T. MASKS

Latest aspect ratio for 12in. "Round" tube, supplied every three (plus 1/- postage) 12/6

SPEAKER BARGAINS

PLESSEY 12in. 3 ohm Vcoil... £6 8/6
TREVOR 12in. 3 ohm Vcoil... £6 8/6
ROLA, 12in. 3 ohm Wcoil... £4 16/6
BASSEND, 12in. 15 ohm Wcoil... £4 13/0
GOODMANS, 12in. 3 ohm Vcoil... (Carriage and Ins. £0 6/6 extras) £5 5/0

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

Model H.F. 4-inch... £2/10/6
Model H.F. 6-inch... £3 7/6
Model H.F. 8-inch... £3 10/6
Model H.F. 10-inch... £3 13/0

These speakers are of the very latest design and provide quality reproduction for the lower-price range. 3 or 5 ohm models are available.

STERN RADIO LTD.

If you submit orders, please include postage and packing.
A Midget 4-valve Superhet portable covering medium and long wave-bands. Designed to operate on A.C. mains 200-240 volts or by an "Alldry" battery. The set is designed so that the main section can be supplied as a complete unit and can be added at any time. The set supplied as an "Alldry" battery Superhet can be accommodated in the case illustrated (size 9in. x 4in. x 7in.). This is attractively finished in finish, real wood, or blue resin. As a combined Mains/Battery Superhet Portable a polished cabinet is available to accommodate both Mains Unit and Batteries. Circuitry incorporates delayed A.V.C. and pre-selective Audio Feedback. The Set is completely self-contained and includes ready-wound frame aerials, fully aligned I.F. transistors, and drifted chassis etc. Overall size of assembled chassis 9in. x 4in. x 7in. This receiver as illustrated, can be completely built for £9/1/2 (plus Mains Unit if required). Send 1/2 for the fully descriptive Assembly Book which includes Practical Layouts and complete Price List of Components. Attach case available separately, 27/8.

"PERSONAL SET" BATTERY ELIMINATOR

A complete Kit of parts to build a Midget "Alldry" Battery Eliminator, giving approx. 60 volts and 14-24 volts. This unit is for use on an A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltage as above approx. to 60 volts. The Kit is quite easily and quickly assembled and is illustrated in a light-aluminium size case 4in. x 10in. x 10in. Price of complete Kit with easy-to-follow assembly instructions, 42/6.

In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and easy-to-follow assembly instructions, 42/6.

FOR HOME CONSTRUCTORS

A 5 VALVE 3 WAVEBAND SUPERHET RECEIVER

For use on A.C. Mains 200 to 250 volts. The following are outstanding features:

- A complete 5-valve set designed for high efficiency on all three wavebands.
- A 35mbelow P.M. speaker accurately reproduced.
- A choice of new 5-valve B.B.A. miniature valves.
- Built-in filter circuit with provision for external filter for distant stations.
- A white plastic cabinet of very attractive appearance, overall size 7in. x 5in. x 5in. (plus "T" 6V6).

Send 3/6 for the fully descriptive stage by stage assembly and wiring diagrams with which complete price details are given.

"MINI-TWIN" 1-VALVE BATTERY SET

A design of a simple 1-valve Stage Battery Receiver, giving excellent results on medium and long wave-bands and having exceptionally low battery consumption. Drilled chassis and practical diagrams make it the ideal set for the beginner to build. The complete chassis, including valve, can be built for 37/8, plus 6/11PTES, the attractive plastic case is 9/6, and suitable headphones, 1/6.

Send 3/6 for the fully descriptive stage by stage assembly and wiring diagrams with which complete price details are given.

"ITS STILL THE BEST MAINS OR BATTERY PORTABLE SET"

BATTERY PORTABLE

THE "MINI TWO-FOUR"

An "Alldry" Battery Portable of midsize, 9in. x 4in. x 7in. designed to cover medium wave-band 150-550 metres, with use of short trailer aerial. The simple design of this Receiver is so arranged that either a 2-valve set or a 2-valve (afterwards easily converted to the 5-valve) can be used. Consists of a T.R.F. circuit using a regenerative detector with H.F. stage and a high gain output transformer. Valve line up 1T4, 1T5, 42/6.

The 3-valve set can be completely built for 6/2/6 (less case) and the 5-valve for 6/5/6 (less case). Each price includes valves, speaker and drilled chassis.

Send 2/- for the assembly instructions: they include simple and complete practical component layout and diagrams which enable the most inexperienced constructor to successfully build either set. All components separate, a price list being supplied with assembly instructions.

A COMPLETE "CAR RADIO" FOR THE HOME CONSTRUCTOR

For use on A.C. Mains 200 to 250 volts. The following are outstanding features:

- A complete 4-valve Superhet Receiver employing a T.R.F. stage and incorporating a separate VIBRATOR PACK size 4in. x 3in. x 2in. for use on 6 or 12 volt D.C. supplies.
- We can supply all components to build this complete Receiver and Vibrator Pack including a Metal Case, Valves, Drilled Chassis and 6in. P.M. Speaker for £10/10/6. (Cheapest price available.) The Receiver Components for £2/6/8 and the Vibrator Components for £2/6/6.

This is NOT an EX-GOVT. Receiver, it is a new design employing new Components which are all available for separate purchase.

A COMPLETE ASSEMBLED SUPERHET PORTABLE

The complete chassis, including valve, can be built for 5/0/0, plus Mains Unit if required. Send 1/- for the fully descriptive Assembly Book which includes Practical Layouts and complete Price List of Components. Attach case available separately, 13/9.

ALL COMPONENTS ARE AVAILABLE FOR SEPARATE PURCHASE.

DUAL-CHANNEL PRE-AmplIFIER AND TONE CONTROL UNIT

This comprehensive PRE-Amplifier and TONE CONTROL UNIT provides a full control of bass and treble in conjunction with a main Volume/Attenuator.

It can be used with any amplifier and with any pick-up, and the range of frequency control provided by the unit is sufficient to correct any problems in all types of pick-up and all types of recording, i.e., English, American and long-playing, without recourse to pick-up correction. The extreme flexibility of the bass and treble control is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier. Response characteristics are given in 12-watt amplifier tests.

The unit measures only 3in. x 9in. x 3in., including self-contained power supply and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price including drilled chassis, valves (6BT7 and 6J5), £6/15/6. Complete assembly data are available separately for £1. Completely assembled and ready for use, £9/5/6.

AN AMAZING OFFER!

A COMPLETELY ASSEMBLED 4 VALVE T.R.F. CHASSIS

Including a 6in. P.M. SPEAKER and VALVES

Send 2/6 for the assembly instructions: they include simple and complete practical component layout and diagrams which enable the most inexperienced constructor to successfully build either set. All components separate, a price list being supplied with assembly instructions.

THE "SUPER THREE"

Designed for local station reception without the use of an external aerial. The complete chassis can be completely built for 5/15. This design provides for a 5-valve (plus Metal Röhren) Superhet Receiver incorporating a Frame Aerial for "room to room" use, provision is also made for a short external aerial, required for the reception of Commercial Programming.

Briefly the features are as follows:

- A complete set for A.C. mains 200-250 volts.
- This set includes a Main Transformer and Chassis is NOT live to mains (as many sets of this type are) and consequently the Receiver can safely be used in the Kitchen, etc.
- Each price includes valves, speaker, and the Vibrator Pack.
- For complete Receiver £2/10/6, £2/10/6 and the Vibrator Pack £2/6/6.

THE "MINI TWO-THREE"

Superhet Portable of midsize, 9in. x 4in. x 7in. designed to cover Medium Waveband and Long Waves for D.C. supplies. A.V.C. eliminates cross-talk. Provides very high fidelity, and can be completely built for 6/2/6 (less case) and the 5-valve for 6/5/6 (less case). Each price includes valves, speaker and drilled chassis.

Send 2/- for the assembly instructions: they include simple and complete practical component layout and diagrams which enable the most inexperienced constructor to successfully build either set. All components separate, a price list being supplied with assembly instructions.

THE "MINI FOUR-THREE"

Superhet Portable of midsize, 9in. x 4in. x 7in. designed to cover Medium Waveband and Long Waves for D.C. supplies. A.V.C. eliminates cross-talk. Provides very high fidelity, and can be completely built for 6/2/6 (less case) and the 5-valve for 6/5/6 (less case). Each price includes valves, speaker and drilled chassis.

Send 2/- for the assembly instructions: they include simple and complete practical component layout and diagrams which enable the most inexperienced constructor to successfully build either set. All components separate, a price list being supplied with assembly instructions.

THE "MINI TWO-FOUR"

Superhet Portable of midsize, 9in. x 4in. x 7in. designed to cover Medium Waveband and Long Waves for D.C. supplies. A.V.C. eliminates cross-talk. Provides very high fidelity, and can be completely built for 6/2/6 (less case) and the 5-valve for 6/5/6 (less case). Each price includes valves, speaker and drilled chassis.

Send 2/- for the assembly instructions: they include simple and complete practical component layout and diagrams which enable the most inexperienced constructor to successfully build either set. All components separate, a price list being supplied with assembly instructions.

THE "MINI THREE"

Superhet Portable of midsize, 9in. x 4in. x 7in. designed to cover Medium Waveband and Long Waves for D.C. supplies. A.V.C. eliminates cross-talk. Provides very high fidelity, and can be completely built for 6/2/6 (less case) and the 5-valve for 6/5/6 (less case). Each price includes valves, speaker and drilled chassis.

Send 2/- for the assembly instructions: they include simple and complete practical component layout and diagrams which enable the most inexperienced constructor to successfully build either set. All components separate, a price list being supplied with assembly instructions.
A 4 VALVE QUALITY "PUSH-PULL" 8-10 watt AMPLIFIER
for use on A.C. mains. Incorporating Negative Feedback. Filter Input Circuit and employing 6V6 in Push-Pull. A simple arrangement is provided to enable either a magnetophone, crystal or lightweight pick-up to be used, and is suitable for use with Standard or Long-playing records. A tone control is incorpor-
ated, and the 10 watt output transformer is designed to match 7 to 15 ohm speakers. The overall size of the assembly is 10 x 8 x 6 in. Price £3/12/0. Kit supplied ready for use, £1/17/0. Plus 5/- Carr. & Ins. Full descriptive leaflet are available separately for £1.

WE HAVE IN STOCK THE NEW COLLARO TRANSCRIPTION "RECORD PLAYERS"

Model 2000 comprises the Transcription Motor and Turntable with Speed Gear and Switch mounted on a single type unit plate. Price £3/12/6. H.P. Terms-Deposit £1/17/0 and 12 monthly payments £8/5/0.

Model 1000 has the same specification as the Model 2000 except that it is mounted on a rectangular unit plate and is equipped with the STUDIO "E" HIGH PICK-UP HEAD. Comprising a special low resonance arm and special bearings. Price £3/8/0. H.P. Terms—Deposit £8/14/0 and 12 monthly payments £1/5/4. An illustrated leaflet is available on request of R.J.E.

Stern Radio LTD.
RECEIVER
CHASSIS

Modernise your Old Radiogram

COMPLETE RADIOGRAM EQUIPMENT—QUALITY AT LOW COST

STERN'S DESIGN FOR HOME CONSTRUCTORS

THE "SUPER-SIX"

A compact and highly efficient superhet Radio-Radiogram chassis of outstanding quality.

YOU CAN BUILD IT FOR

£10/7/6

Including the OCTAL VALVE LINE-UP.

(£12/7/6 with the miniature valves)

We will supply it assembled and READY FOR USE for

£13/13/0

(Plus 7/- Carr. & Ins.)

H.P. Terms £3.10.6, deposit and 12 months at 17/6.

Incorporating the new B.V.A. Miniature Valve Line-up.

This receiver is designed to the very latest specification and provision is made to incorporate either the standard Octal Valve Line-up or the new B.V.A. range of miniature valves. Great attention has been paid to the quality of the reproduction of both Radio reception and Record playing, and excellent clarity of speech and music is obtained.

A few brief details:

- Octal's warehouses 18-50 metres, 150-550, and 800-2,000 metres.
- Employ 4 valves having PUSH-PULL for 5-6 watts output.
- Incorporates delayed A.V.C. on all wavebands and pre-selective feedback.
- A 4 position Tone Control operates on both Radio and Gram.

The ALL-WAVE SUPERHET CHASSIS

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

The three Receivers are for operation on A.C. mains 110/110 volts and 250/550 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention being given to the quality of reproduction which gives excellent clarity of speech and music on both gram and radio, making them the ideal replacement chassis for that "old Radiogram," etc.

Brief specifications: Model B.3.—Valve line-up, 6BQ5, 6B4, GAT5, 6B8W, 6X4—waveband coverage short 10-50, medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off, (2) tuning (3) waveband and (4) tone (3-position switch) which operates on gram, and radio, Negative feedback is employed over the entire audio stage. Chassis size: 11 x 7½ x 5½ in., dia 12 x 7 in. Price complete and READY FOR USE, employing a speaker of 15/6, with height above base 8 in. and 7/- extra.

B.P.P.—Valve line-up, 15/- deposit, 12 months at 17/6.

B.P.P./R.F.—Valve line-up, 2/- deposit, 12 months at 17/6.

A REPLACEMENT

RADIO-RADIOGRAM

CHASSIS

- Model AW3-5. A 5-valve SUPERHET Receiver covering the standard 3 wavebands, 16-50, 110-550, 900-2,000 metres. Price £15/6/6 (plus 7/- care. and ins.) or £2.14/- deposit, 12 months at £1.17/6.

- Model AW3-7. A 7-valve Superhet incorporating the most modern specification and provision is made to incorporate either the standard Octal Valve Line-up or the new B.V.A. range of miniature valves. Great attention has been paid to the quality of reproduction of both Radio reception and Record playing, and gives an exceptionally good range of station selection. Overall size 13½ x 7½ x 15 in., dia 13½ in., height above base 15 in. Price £17/15/6, with height above base 17½ in. Deposit £3.15/6, and 12 months at £1.17/6.

An outstanding offer!!

A BULK PURCHASE ENABLES US TO OFFER THIS "PUSH-PULL" 7 VALVE SUPERHET RECEIVER

For only

£12/19/6

(H.P. Terms £3/4/6 Dep.)

12 months at 18/4.

For complete equipment.

Special Reductions for Complete Equipment

For all Radiogram equipment.

H.P. Terms £2/12/0 Deposit and 12 Months at 15/-.

Normal price £4/17/6.

Complete which High Fidelity Crystal " Turnover " Head which incorporates separate stylus for L.P. and 78 r.p.m. Records.

- Will autochange on 7-in., 10-in. and 12-in. records not intermixed.


- Brand new in Maker's Cartons, complete with Mounting instructions.

This AUTOCHANGE UNIT by a famous Manufacturer is offered for £9/19/6 (Plus 7/- Carr. and Ins.)

Hire Purchase Terms £2/17/6 Dep. and 12 Months at 16/4.

Normal price £16/10/6.

- These units will autochange on all three speeds, 7-in., 10-in. and 12-in.

- They play MIXED 7-in., 10-in. and 12-in. records.

- They have separate sapphire units for L.P. and 78 r.p.m., which are moved into position by a simple switch.

- Minimum baseplate size required 15-in. x 13½-in., with height above 15½ in. and height below baseplate 3½-in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

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

£9/19/6

(Plus 7/- Carr. and Ins.)

H.P. Terms £2/10/0 Deposit and 11 months at 16/3.

FOR COMPLETE EQUIPMENT

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

- Model AW3-5. A 5-valve SUPERHET Receiver covering the standard 3 wavebands, 16-50, 110-550, 900-2,000 metres. Price COMPLETELY ASSEMBLED and READY FOR USE for 17/6, with 1½ months at 17½.

- Model AW3-7. A 7-valve Superhet Receiver for 15½ months at 17½.

- The COLLARO AUTOCHANGER MODEL 3RC/521 WITH A SPEAKER AND ...

![Special Reductions for Complete Equipment](Image-url)
Prices slashed at Clydesdale

PLEASE NOTE: Carryage and Postage charges refer to the U.K. only, Overseas freight, etc., extra.

INDICATOR UNIT "A.S.B." SERIES (U.S.A.)
Contains: 5 BPI C.R.T. with mu-metal screen, 3/4H6s, 6A7GT, 6AC7, plus H.T. 6V6s, etc. Metal case 18fin. x 8fin. x 8in. All controls brought to front panel beside viewing screen.
ASK FOR £13.19.6 each PAID X/H771

CARRYAGE X/H776 £3.19.6 each PAID

INDICATOR UNIT TYPE 62
With tubes: 3/VR54 (CRA54), 2/VR92 (EA50), etc. Dim.: 18in. x 18fin. x 11fin. Wgt.: 42 lb. In original wood case.
ASK FOR £3.19.6 each PAID X/H524

CARRYAGE X/E774 £2.9.6 each PAID

INDICATOR UNIT TYPE 305
As above, but in used, good condition, loose valves.
ASK FOR £2.9.6 each PAID X/E774

INDICATOR UNIT TYPE 6
With tubes: VCR524A, VCR525, and valves 7/V91 (EFSO), 2/VR54 (EB34), 6/VR92 (EA50). Dim.: 12in. x 7fin. x 18in.
ASK FOR £3.19.6 each PAID X/H493

CARRYAGE X/H497 £4.19.6 each PAID

POWER UNIT TYPE 285 Ready made for T.V.
A.C. mins., inputs 230 v. 50 cps. Outputs E.H.T. 2kV. 5 mA. H.T. 250 v. 150 mA. L.T. 6.3 v. 10a. and 6.3 v. 5 a. Fully smoothed and rectified with valves U120, SLUG, VR91 (EF30), plus cond. resistors, etc.
ASK FOR £54.2.6 each PAID X/E185

CARRYAGE X/H524 £2.9.6 each PAID

REPRINTS FROM "PRACTICAL TELEVISION"
Components Price List Free on Request.
The "Beginner's Receiver," modifying the R370A
The "Beginner's Transceiver," modifying Ind. Unit 64
The "Economy Transceiver" modifying the Ind. Unit 62
Argus Televisor, data and blueprints
BEGINNER'S T.V.
Mains Transformer 18fin. £1 12.6
Output Transformer 19.9
Crystal Diodes 5.3
Beginner's Transceiver 18fin. £1 0 0
BEGINNER'S TRANSCEIVER
Mains Transformer 18fin. £1 0 0
E.H.T. Transformer each £2 10/-. and £5 0 0

Ind. Unit 64 £4.9.6 each PAID X/H771

ION TRAP MAGNET ASSEMBLY
Mfg. Surplus.
Type 17½ by 1½ by 35 mm. tube neck.
ASK FOR 2/6 each 3d. EXTRA X/H919

IF/AF AMPLIFIER UNIT R133
With valves: 8/V955 (SF61), SLUG, U120A (5U10A), L.F 7 mc/s, etc. Dim.: 18in. x 8fin. x 7in. Wgt.: 22 lb. In original wood case.
ASK FOR £4.9.6 each PAID X/E195

CARRYAGE X/H919 £1 12.6 each PAID

R.F. UNIT TYPE 24.
In original carton. With valves 3/VR56 (SP61), etc. Range 20-30 mc/s. switched tuning. Dim.: 9fin. x 2fin. x 4fin. Wgt. 7 lb.
ASK FOR £12.6 each PAID X/H907

CARRYAGE X/H919 £24.9.6 each PAID

ASK FOR 19/6 each 1½ d. EXTRA X/H917

W.R. UNIT TYPE 27.
With broken detector Type 27, switchable tuning. Dim.: 9fin. x 2fin. x 4fin. Wgt. 7 lb.
ASK FOR £12.6 each PAID X/H907

CARRYAGE X/H919 £12.6 each PAID

Morse Practice Board Only
Comprises key, buzzer and "phone" terminals on board. 6fin. x 6fin. x 3fin. with battery clamps. ASK FOR £5/6 each. 9d. EXTRA X/E18

HALF MILE REELS (880 YARDS)
ASK FOR 5/- each CARRIER X/H860

MOTOR GENERATOR TYPE 29
ASK FOR £15/- each 9d. EXTRA X/H945

CARRYAGE X/H860 £15/- each 9d. EXTRA

MOTOR GENERATOR TYPE 30
ASK FOR £6/- each 3d. EXTRA X/H488

CARRYAGE X/H860 £6/- each 3d. EXTRA

COOLANT PUMP, by Packard, U.S.A. A type pump, direct driven by electric motor.
ASK FOR £3.19.6 each 3d. EXTRA X/H778

CARRYAGE X/H860 £2.6.6 each 3d. EXTRA

HAND OPERATED WOBBLE WHEEL, R98, BC-144
Redeproportioning wheel for suction and exhaust action to each stroke. Designed to pump hydraulic oil to a maximum reservoir pressure of 1,000 lb. per sq. inch. Direction of drawing water from approximately 5 feet below its own level, and exhausting same to a height of 4 feet above its own level, at a rate of 60 strokes per quart. Inlet and outlet threaded nozzles fitted at one end of the unit. Suspension arms and rams fitted at the other end.
Length of Pumping Handle 27fin. Length of pump overall 8fin. Height of pump overall 4fin.
ASK FOR £12/6 each 6d. EXTRA X/H860

CARRYAGE X/H860 £12/6 each 6d. EXTRA

FUEL PUMP (STANDARD) TYPE 36R/36Q/360
A Rotary unit with two pump chambers each having 4 blades, complete (less motor) with inlet and outlet valves, gear wheel, drive with 3fin. spindle. Diesel aluminium body, 6 hole mg. at 90°. Overall dim.: 11fin. x 4fin. x 4fin. Wgt.: 4lb. 4j.
ASK FOR £16/- each 6d. EXTRA X/H947

CARRYAGE X/H860 £16/- each 6d. EXTRA

ROTARY PUMP, 24 v. D.C. 2.5 AMP.S.
Ref. SU/4292. Jn. bore inlet, jn. bore outlet. 4fin. flange for connecting to tank. Ideal for pumping oil, petrol, water, etc. Diesel constructions with brass rotor blades. Dim.: 4fin. x 7fin. x 7fin. Wgt.: 15 lb.
ASK FOR £15/- each 9d. EXTRA X/H860

CARRYAGE X/H497 £15/- each 9d. EXTRA

DIRECT CURRENT GENERATOR TYPE 3DJG. Ref. 42U/506
Output 14/12 v. 9 amp. and 6v. 2fin. x 2fin. x 2fin. H.T. 6v. 2fin. x 2fin. x 2fin. L.T. 6v. 2fin. x 1fin. x 2fin. Wgt.: 10 lb. In original box.
ASK FOR £29.19.6 each 6d. EXTRA X/H9497

CARRYAGE X/H860 £29.19.6 each 6d. EXTRA

ENGINE DRIVEN GENERATOR TYPE KX. Ref. 41U/170. In Manufacturer's Cage. 24 volts, 1,500 watts (rotation clockwise), splined spindle. Jn. 1fin., projection 1fin., overall size 15fin. x 7fin. x 11fin. Wgt.: 27 lb. 4 hole fixed. Speeds: 3,500-5,000 r.p.m.
ASK FOR £33.15.0 each 6d. EXTRA X/H880

CARRYAGE X/H860 £33.15.0 each 6d. EXTRA

Order direct from--
CLYDESDALE SUPPLY CO., LTD., 2, BRIDGE STREET, GLASGOW · C.5

Phone: Sauch 2706/9.
**LASKY’S**

**BRAND NEW**

`£11/19/6`

**PRICE**

LASKY’S 7/6 extra.

**SOLDERS**

Medium walnut, finished in polished finish. 1-inch C.R. tubes.

**TABLE TELEVISION CABINETS**

With lin. spindle.

**NO. 1. L.M.S.G.**

Size: 41 x 5 x 21 in.

**PRICE**

Including carriage 2/6 extra.

**NO. 2. M.S.S.**

Size: 4 x 4 x 3 in.

**PRICE**

With lin. spindle, 16/-.

**Both for use with 465 Kc/s. I.F.**

**TABLE TELEVISION CABINETS**


**SOLON SOLDERING IRONS**

**LASKY’S PRICE** 7/6.

**HEARING AIDS**

By well-known manufacturer. 14 in. case, size: 2½ in. x 4½ in. x 1 in. Complete with batteries and 3 miniature tubes. Only two controls: volume and on/off. Fitted with internal crystal microphones. Used condition.

**LASKY’S PRICE** 36/6.

**Special Clearance Lines. Callers Only.**

**TABLE MICROPHONE STANDS.**

2 Section Chrome. Heavy base. 12/6.

**J/R/A3 AMPLIFIERS.**

As previously advertised, complete with all valves, but less output transformer. LASKY’S PRICE £7/10/0.

**P.M. LOUDSPEAKERS**

All with 3 ohm speech coil.

2½ in., 15/6. 5 in., £11/6. 8 in., 19/6.

**I.F. TRANSFORMERS**

445-520 Kc/s.

Miniature 1 x 2½ in. 9½ in. pair. Magnet 3½ in. with 0/T 600 ohm field 15/6.

**ENERGISED SPEAKERS**

8 in. with T/O 600 ohm field 15/6.

**CAR RADIO AERIALS**

Two section, chromed 7½ inches. Side fitting. 15/-.

**CAR RADIO SPECIAL—PARTLY ASSEMBLED CAR RADIOS**

Small size case. 12 x 4 x 7 in. Will fit most cars. For either 6 or 12 volts, depending on vibrator. Chassis supplied with 5 octal valve holders, medium wave aerial and oscillator coils output transformers, volume control, sundry resistances and condensers, dial and knobs. Case finished in brown crinkle. Dial calibrated 150-550 metres. 5 valves divided. Either GT or metal. 6SA7, 6R7, 6Y7, 6K7, OZ4.

**LASKY’S PRICE** £5/6/6. Carriage 5/- extra.

Or less valves, 69/6. Carriage 5/- extra. Other chassis in various conditions of completion available for parts only. **CIRCUIT** for 5 valve car radio, using above chassis. **PRICE** 1/6.

**MAGNETIC RECORDING TAPE. SPECIAL OFFER**


**TANNY PRESSURE UNITS**

10 watts. 7.5 ohms impedance. Last few only.

**PRICE** 59/6

**AERIAL ROD SECTIONS**

Steel, heavily copper plated. 6½ in. long, 1 in. diameter. Any number may be fitted together. **PRICE** 2/6 per doz. **POST FREE**

**300 PF. FEED THROUGH CONDENSERS**

Ceramic. 6d. each. 4/6 per dozen.

**20 PF. AIR SPACED TRIMMERS**

9d. each. 7/6 per dozen.

**RADIO CABINETS**


**L. AND M. DUAL WAVE SUPERHET COILS**

Aerial and Oscillator. 5½ pair.

**INTERCOM. UNITS**

4-station operation. For use on A.C./D.C. mains 200-250 volts. Complete with 3 valves. Fitted in attractive plastic cabinet. **MASTER UNIT** £5/19/6. **Extension Units**. **PRICE** 2/- each complete. Carriage 2½/- each extra.

**THE UNIVERSAL A.C./D.C. TELEVISION AND RADIOGRAM**

A 30-page booklet giving full instructions for building a large 17 inch screen T.V. receiver, and a 3-speed auto change gram. as an extra.

**A.C./D.C. Mains.**

**Table T.V.**

**P.M. Focusing**

**Mullard valves and C.R.T.**

**5 Channel Superhet**

**Gram and T.V. entirely separate.**

**PRICE** 3d. **POST FREE**

**SPECIAL OFFER. BY FAMOUS MANUFACTURER. FRUSTRATED EXPORT ORDER.**

6 VOLT D.C. RADIO RECEIVER


**BRAND NEW AND UNUSED. COMPLETE WITH VALVES.**

**LASKY’S PRICE** £9/19/6. Carriage and packing 10/6 extra.

**TELESOPIC PORTABLE AERIAL MASTS**

Lightweight but extremely strong alloy. Extends to 15 feet. Gracefully at top and centre. Complete with all guys.

**L A S K Y’ S PRICE** 32/6

**PRICE** 2/6 extra.

**TRIMMERS**

Paxolins. Up to 100pf. 6d. each. Focusing 1½/- per doz. Ceramic. Up to 100pf. 9d. each. 7½/- per doz.
PORTABLE RECORD PLAYERS
Containing a new Plessey single speed automatic record changer (78 r.p.m.), Magnetic pick-up and 3-valve amplifier, with metal rectifier. For use on 200-250 v. A.C. mains. Amplifier uses EF.36 and EL.32 giving 3-watts output, tone and volume controls, 5in. speaker. In rexine-covered cabinet, size: 17 x 17 x 8in. With carrying handle. Though store sold, these players are new and every one is fully tested before dispatch. LIMITED QUANTITY.
LASKY'S PRICE £10.19.6

STAFF HOLIDAYS
All departments will be closed on Tuesday and Wednesday, September 28th and 29th. Re-open on Thursday, September 30th.

12 VOLT-4 WATT MOBILE AMPLIFIERS
BRAND NEW AND UNUSED. KT.61 output. Complete with power unit and synchronous vibrator (Weartite type QFA/12), and all valves. Fitted with rubber covered heavy duty battery lead. By famous manufacturer, in handsome metal cabinet, grey crackle finish. Size: 10in. x 6in. x 8in. Output impedance 3 ohms. With the addition of a suitable loudspeaker, this is ready for operation. Finest quality components throughout. Robustly constructed for rough handling. Complete with carbon hand-microphone with screened lead.
LASKY'S PRICE £7.19.6 OR LESS COMPLETE MICROPHONE £6.19.6 Carriage 5/- per unit extra.

DE LUXE T.V. CABINETS
Our new model. Mark II
This cabinet is now supplied complete with mask, glass, castors, shelf, bearers, c.r.t. neck end protector, back, speaker fret and baffle board. Finished in beautiful figured medium or dark walnut veneer, with high polish. Suitable for most home constructor T.V. receivers, including the "Viewmaster," "Practical Television," "Tel-King," "Magni-view," "Wireless World," etc. Can be supplied with cut-out for 14in., 16in. and 17in. c.r.t. tubes at no extra cost.
An allowance of 4s. 6d. will be made if the mask is not required. Inside Dimensions: Depth 16in.; width 17in.; height 28in. Overall height 32in. and width 18in.
WHY NOT CONVYERT YOUR TABLE RECEIVER TO A CONSOLE MODEL?
Adaptor frames for fitting 9in. or 10in. c.r.t. tubes can be supplied if required.
LASKY'S PRICE £8.10.0 Carriage 12/6 extra

ELECTROLYTIC CONDENsERS. ALL BRAND NEW.
8 mfd. 450 v.w. 1/9
8 + 8 mfd. 450 v.w. 2/6
16 mfd. 350 v.w. 2/6
16 mfd. 500 v.w. 3/6
20 mfd. 500 v.w. 3/6
30 mfd. 450 v.w. 3/6
30 mfd. 350 v.w. 3/6
60 mfd. 350 v.w. 3/6
60 mfd. 450 v.w. 3/6
120 mfd. 450 v.w. 4/6
150 mfd. 350 v.w. 3/6
200 mfd. 350 v.w. 4/6
6000 mfd. 6 v.w. 2/6
8000 mfd. 3 v.w. 2/6

MANY OTHER SINGLE AND MULTIPLE CONDENsERS IN STOCK.
THE TELE KING

IPTEMBER, 1954

TRIPLEX DARK SCREEN

10in.

LASKY'S PRICE 37/6. Post 2/6 extra.

The Tuner with Valves.

less valves.

output 9.5-14 Mc/s or 15.5-22 Mc/s. With full details and circuit diagram.

amp. and ECC81 (12AT7) as frequency

Uses two valves, EF80 (6BW7) as R.F.

C.R.T. MASKS. Brand New

PRICE 17/6.

uses two valves, EF80 (6BW7) as R.F.

Uses two valves, EF80 (6BW7) as R.F.

C.R.T. MASKS. Brand New

PRICE 17/6.

uses two valves, EF80 (6BW7) as R.F.

C.R.T. MASKS. Brand New

PRICE 17/6.

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PRICE 17/6.

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C.R.T. MASKS. Brand New

PRICE 17/6.

uses two valves, EF80 (6BW7) as R.F.

C.R.T. MASKS. Brand New

PRICE 17/6.
SELENIUM RECTIFIERS

L.T. Types
2/6 v. 4 a. h.w.
1/8
2/9
2/9

F.W. Bridge Types
2/6 v. 4 a. h.w.
1/8
2/9
2/9

12 v. 400 m. a.
5/8
5/9
5/9

140 field 700 ohms,
15-10-5-0-195-215-235 v. 200 watts
Double Wound 10-0-220-200-240

EX -GOVT. AUTO TRANSFORMERS 60
4 mfd. 400 v. plus 2 mfd. 250 v
2 mfd. 800 v...
or 3 in wood carrying case 9 x 7 x 5 in.,
Unused and guaranteed.

EX -GOVT. ACCUMULATORS with non -spill vents.
1.5 mfd. 4,000 v. blocks
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WIRE WOUND POTS:
5* x nins. high.
AMPLIFIER OR CHARGER CASES.
16mfd. 350 v.
32 mfd. 500 v.
32AF 350 v....3/9
16AF 500 v....3/9
16AF 450 v....3/9
16AF 350 v....3/9

DIAL BULBS,
(2,000 pfd.).
All complete with control knob.

CHARGED TRANSFORMERS
All 2-3 ohms. 24in. Celestion,
To charge 6 v or 12 v.

MICROPHONE TRANSFORMERS
1001
5/6
R.S.C. 25 WATT "PUSH-PULL" AMPLIFIER

Now firmly established and proving extremely popular, our H.F. Quality Amplifier we consider to be the best value in amplifiers offered to-day. The volume of its high fidelity reproduction is completely controllable, from the sound of a quiet violin in a concert hall to the full glorious volume of a great orchestra. Its sensitivity is so high that in areas of fair signal strength it can be operated straight from a crystal receiver. Entirely suitable for standard or long-playing records in small homes or in large auditoriums. For electronic organ or guitar or for garden parties or dance bands.

The kit is complete to the last detail, and includes easy to follow point-to-point wiring diagrams.

Twin volume controls with twin input sockets allow SIMULTANEOUS INPUTS for BOTH MICROPHONE and GRAM or TAPE and RADIO. SEPARATE BASS and TREBLE CONTROLS giving both LIFT and CUT. FOUR NEGATIVE FEEDBACK LOOPS with 15 db in the main loop from output transformer to voltage amplifier. Frequency response ± 3 db 50-20,000 c.p.s. Hum and distortion LESS THAN 0.5 per cent. Measured at 10 watts. This is comparable with some of the highest priced amplifiers. Six B.V.A. valves, Marconi-Osram KT series output valves. A.C. only, 200-230-250 v. 50 c/s. input. 420 v. H.T. LINE. Paper reservoir condenser. Compact chassis. Matched components. OVERALL SIZE 12 x 9 x 5.5 in. approx. Output impedances for 3 and 15 ohms speakers.

A PUSH-PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR £3/12/6

For mains input 200-250 v. 50 c/s. Complete kit of parts including point-to-point wiring diagrams and instructions. Amplifier can be used with any type of feeder unit or p.d. up. This is not A.C./D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 3-4 ohm speaker.


Price only £2/9/6. Complete kit for mains input 200-230-250 v. 50 c/s. Complete kit for D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 3-4 ohm speaker.

Price only £2/9/6. Complete kit for mains input 200-230-250 v. 50 c/s. Complete kit for D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 3-4 ohm speaker.

Price only £2/9/6. Complete kit for mains input 200-230-250 v. 50 c/s. Complete kit for D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 3-4 ohm speaker.

Price only £2/9/6. Complete kit for mains input 200-230-250 v. 50 c/s. Complete kit for D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 3-4 ohm speaker.

Price only £2/9/6. Complete kit for mains input 200-230-250 v. 50 c/s. Complete kit for D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 3-4 ohm speaker.

Price only £2/9/6. Complete kit for mains input 200-230-250 v. 50 c/s. Complete kit for D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 3-4 ohm speaker.

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### HUGUE CLEARANCE SALE

OF UNUSED RADIO COMPONENTS AVAILABLE TO MANUFACTURERS & EXPERIMENTERS

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Stock</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 Ceramic Variable Condensers, split stator, plated valves, spaced</td>
<td>1,000</td>
<td>2/-</td>
</tr>
<tr>
<td>2,500 Ceramic Variable Condensers, split stator, plated valves, spaced</td>
<td>2,500</td>
<td>5/-</td>
</tr>
<tr>
<td>2,000 Variable Condensers, 50 pF.</td>
<td>2,000</td>
<td>2/-</td>
</tr>
<tr>
<td>250 Transmitter tank Condensers, split stator, 500 pF. each section</td>
<td>250</td>
<td>10/-</td>
</tr>
<tr>
<td>500 Power Units: Type 300, 74 x 27 x 95 mm; Liquid pot 250V. and 15V</td>
<td>500</td>
<td>10/-</td>
</tr>
<tr>
<td>1,000 Stand-off Insulators only miniature 1 in.</td>
<td>1,000</td>
<td>2/-</td>
</tr>
<tr>
<td>1,000 Pots 100K, 1 spindle.</td>
<td>1,000</td>
<td>1/-</td>
</tr>
<tr>
<td>500 Pots, 1 meg.</td>
<td>500</td>
<td>1/-</td>
</tr>
<tr>
<td>1,000 Pots, 3 gang each, 75K.</td>
<td>1,000</td>
<td>1/-</td>
</tr>
<tr>
<td>1,000 Reedinger Pots, 100 ohm. Miniature wire wound.</td>
<td>1,000</td>
<td>2/-</td>
</tr>
<tr>
<td>1,000 Pots CoLumns, 700 ohms 5 watts. Wire wound. N.P. case.</td>
<td>1,000</td>
<td>1/-</td>
</tr>
<tr>
<td>1,000 Wire wound Pots, 0,000 ohm 3 watts.</td>
<td>1,000</td>
<td>1/-</td>
</tr>
<tr>
<td>250 100K Miniature Pots.</td>
<td>250</td>
<td>1/-</td>
</tr>
</tbody>
</table>

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6.3 v. 0.3 amp., 0.3 amp., 14/6.

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6.3 v. 0.3 amp., 0.3 amp., 14/6.

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6.3 v. 0.3 amp., 0.3 amp., 14/6.

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6.3 v. 0.3 amp., 0.3 amp., 14/6.

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RADIO TRADERS LTD.
23 WARDOUR STREET, LONDON, W.1. (Coventry Street end)
Phone No. GERnard 3977/G

PAXOXIN SHEET
18in. x 4ft. x 3in., 1/2 each
10in. x 9in. x 3in., 1/4 each
20in. x 10in. x 3in., 3/4 each

CONDENSERS
2 Mfd. 150 v. Tubular Paper (aluminum tubes), 1/2 each
8 Mfd. 450 v. Electrolytic, 1/p each
16 Mfd. 350 v. Electrolytic, 2/p each
32 Mfd. 450 v. Electrolytic, 2/p each
160 Mfd. 350 v. Electrolytic, 2/p each
20 x 2 Mfd. 250 v. Electrolytic, 2/p each
16 x 2 Mfd. 350 v. Electrolytic, 2/p each
16 x 4 Mfd. 350 v. Electrolytic, 2/p each
16 x 8 Mfd. Metal Cans Electrolytic, 350 v., 1/p each
32 Mfd. Metal Cans Electrolytic, 350 v., 1/p each
64 Mfd. Metal Cans Electrolytic, 350 v., 1/p each
Condenser clips for above, 3/4
d1 Mfd. 400 v. Metal Cans, 1/p each
50 Mfd. 12 v. 1/p each
12 Mfd. 50 v. Tubular Paper (aluminum tubes), 1/2 each
64 Mfd. 1000 v. Electrolytic, 1/4 each
0.0005 Tubular, 4l doom., 2/p each, 0.001, 350 v., 1/p per dozen
0.035, 350 v., 4/p per dozen
200 Assorted Mica Capacitors, 1/p each, 3/4
200 Assorted Mica Capacitors, 1/p each, 1/p each
CARBON RESISTORS
J 1/2 in. 3/4
1 J 1/2 in. 3/4
2 J 1/2 in. 1/4

HIGH STABILITY RESISTORS:
Tolerances: 1% 2% 5%
1 watt 1/2 1/2 1/2
2 watt 1/2 1/2 1/2
4 watt 1/2 1/2 1/2
8 watt 1/2 1/2 1/2
10 watt 1/8 1/4 1/4

WW AND VITREOUS RESISTORS. 5 watt, 1/8; 10 watt, 1/8, 15 watt, 1/8, 20/30 watt, 1/8, each
WW/CENTURY TRANSISTORS: C-205, C-206, 15V-8NSF, SK FUSE and other values, 2-3 watt, 1/2 each, 10/2 Isolated Spindle.

MAGNETIC COMPONENTS.
1000 Mics, 1/8, 25X, 50C, with trimmers, 1/4 each
1200 Assorted Carbon Resistors, 1/p each, 1/p each
1000 Carbon Resistors, 1/p each, 1/p each

TWIN MIDGET GANGS. 0.005, with trimmers, PERSPEX CAPS.

4-WAY PUSH BUTTON UNITS, 1/6 each
PUSH BUTTON KNOBS
30 Mics, 1/6, 30 Mics, 1/6

ASSOCIATED PLUGS LAMP HOLDERS
FUSES 11/2 watt each, 1 3/4 watt each, 2 1/2 watt each, 3 1/4 watt each, 4 1/2 watt each
POINTER KNOBS
Small black, with line, 1/2 in. hole
Medium black, with line, 3/4 in. hole
Large, 1/4 in. hole, 7/8 in. with spring clip, 1 in. hole
PLUGS BLACK 1/2 in. each
PHILIPS TRIMMER TOOLS
BELLING AIR SPACE TRIMMERS
WEARITE COILS: Types P4A, P0H, PAS, POS, P13 each.
VALVE HOLDERS: Moulded. BFA, 7/8, B7G, 1/8, B7F, 1/8, EF7, 1/8, BEC5, 1/8, 450V, 1/8, 500V, 1/8, 600V, 1/8
WEARITE SCREEN CANS
For BFA, B7G, 6-6 doz.; PAXOXIN-B7G, MAZADA 4-pin UX.
BULGIN, P4, Plug and Socket, 5/3; P200, Plug and Socket, 1/2 each.
BULGIN, 225, 2-1/2; Dolly Switches, 2-25, 1/4; Spokeless Switches, 2-25, 1/4.
Standard Switches, Ex-Govt. 1/2 each.
POST OFFICE LAMP JACKS, No. 10, 1/p each

L.F. CHOKES, 300 w., 60 mA, CHYS
OUTPUT TRANSFORMERS. Multi Ratio, 5/2: Pentode Power or Pentode O.C.T.

DUMO DRIVES, 4 in.
WESTECTORS: WX12, W12, W14, W16, W17, each.
ARCORECTORS (White Aluminum, mica or 1/2)

SIGNAL LAMP HOLDERS P/M, complete with adjsuting lamp holder, 1/p each
AIR SPACE TRIMMERS. Preset and spindle types, SPL, BPE, 1/2 each, 1/2 each, 1/2 each
JONES PLUG AND SOCKETS. 4-pin, 1/8; 8-pin, 1/8; 10-pin, 1/8; 12-pin, 1/8
SOLDER TAGS. 2 1/2 in.
SOLDER TAGS, Solderless, 4 in.
SOLDER SHOE, 48A, 1/4 each
CASH WITH ORDER OR C.O.D.
ALL ORDERS DEPT. W.1
ALL ORDERS LESS THAN £2 ADD POSTAGE
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Denco F.M. Feeder Unit Supplies finest quality audio obtainable today.

Complete Kit obtainable at £6-7/-

All parts obtainable singly as per Denco's. F.M. Catalogue (D.T.B. B.) Price 1/6.

Requires 230 v. at 50 m. a.

6.3 v. at 1.5 m. a.

Will work into P.U. sockets or amplifier.

TR116 Receiver

Receiver 25/3. This is a six-volt superhet receiver with 460-kca.l.p.p.s. Complete with all parts—2 EF68, 1 EF80, 2 EF86, 1 EL34. In brand new condition with full conversion data. £7/6, plus 2/6 post and pkg.

STROBE UNITS. Brand New. In sealed cartoons. Denco contains EF50, EA50, HP641, a host of condensers, relays, transformers, chokes, eleven tuning boxes, 7 pole and 8 smoothing condensers, size 18m. x 8m. x 7m. In new condition. 67/6.

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Dual scale 0-200 ohms and 100-200,000 ohms moving coil operated from 4-4 volt internal battery. Size 5 in. x 3 in. x 4 in.

Original price, 20/10.

Our price, brand new, £30/0.

T.C.C. = Thermo-Coupled.

61C. = G.E.C. 500 m.

300 mA.M.C.

200 mA.

30 mA.

500 uA.

3 A.

300 v.

150 v.

20 v.

15 v. (50 c.)

with minimum space.


Special Offer

Our Tape-Deck Amplifier and Power Unit (List £16/16/- and TRUVO Tape-Deck Mark III (List 23/21/-). £16. Call for demonstration or send for full details.

PYE 45 Mc/s. Strip.

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Size 11m. x 8m. x 2m. Complete with 45 Mc/s. Pre Amp, 15 valves 10 EF10, 5BQ4, 4 EL84 and 5AS6, volume controls and hosts of Resistors and Condensers. Sound and vision can be incorporated in this chassis with minimum space. New condition. Modification data supplied. Price £5. Carriage paid.

Vol. Meters

6 v. M.C. 2m. Projection 10/-

15 v. (150 c.) M.C. 2m. Projection 10/-

5 v. M.C. 2m. Square 7/-

10 v. M.C. 2m. Square 7/-

500 v. M.C. 2m. Square 15/-

500 v. M.C. Projection 3m. Dial 50/-

Dual meters

1 A. M.C. 2m. Projection 10/-

3 A. M.C. 2m. Square 7/-

5 A. M.C. Projection 6/-

20 A. M.C. 2m. Projection 15/-

30 A. M.C. 2m. Projection 15/-

Milliameters

500 m.A. M.C. 2m. Round 15/-

1 m.A. M.C. 2m. Square 17/-

1 m.A. Forecast 2m. Square 5/7

1 m.A. M.C. 2m. Square 15/-

10 m.A. M.C. 2m. Round 7/-

50 m.A. M.C. 2m. Square 10/-

500 m.A. M.C. 2m. Round 2/-

2 m.A. M.C. 2m. Round 10/-

200 m.A. M.C. 2m. Square 10/-

500 m.A. M.C. 2m. Round 10/-

30 A.G. 1 m.A. Meter Rect.

M.C. = Moving Coil. M.I. = Moving Iron.

T.C. = Thermo-Coupled.

All meters are Brand New and in original cartons.

No. 38 "Walkie-Talkie" Trans-Receiver, complete with throat Microphone. Junction Box and 4400 Buds in canvas bag. Frees ranges 1.5 to 9 m. Range approx. 6 miles. All units are as new and tested before dispatch. £8/10/-.

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Containing 4 EF50, 2 SP61, 2 EA50, 1 EB34, 1 single-tung. 5005 tuning condensers, W.W. volume/controls, switches, condensers and resistors. Size 12 in. x 9 in. x 5 in. New condition, 35/-, carry. 35/-.

Cryostat Microphone Inserts

8'6 x 8'6

8'6 x 8'6

Post Free

Post Free

Ideal for tape recording and amplifiers. No matching transformer required.

Please add postage. Articles up to 10/-, 1/-, £1, 1/6, £2, 2/-.

5 Watt Amplifier (Undistorted) Manufactured by Parmeko and Sound Rates for Admiralty. 40 watts. £5/0. M.M. ACH11, M104. Output Matching and 15,000. 200,000. a.c. COMPLETE IN STEEL GRAY AMPLIFIER CASE, £9/10/-.

Call for demonstration.

E3A 821 A Photo-Electric Cell and Multiplier.

For Polaroid and flying spot television transmission and research involving low light-levels. 9-stage multiplier. Brand new and guaranteed, only £21/10/-.

Special 11-pin base 21. Data sheets supplied.

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Complete with buzzer, Morse tap and battery compartment on hardwood, £1, post paid.

Crystals

200 c.k., 2 pin, U.S.A. 10/-

465 c.k., 2 pin, U.S.A. 10/-

500 c.k., 2 pin, British 15/-

EP50 (VR91A)

The selected EP50, Red type carbon, original base 10/- each, 2/- for ten.

Record Changers

Collaro RC3 531. Latest model 3-speed. Brand new maker's carton, cream finish, £10/10/-, carriage free.


Metro-Vic (Metrosil) Pencil Type EH.T. Regular EF72. Up to 10 k.v.


S.R. Oscillator Coil Unit

6-18 k., including EY51 valve, 37/-

American 12 V. Dynamotor

Output 200 volts, 60 m. Weight 4 lb. Suitable for Car radio or Electric Razor, 22/6.

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Type 24

50-65 m.E.

Variable Tuning.

24/5R, 1-VR137 ...

35/-

NEW

R.F. Units

Type 26

Brand New.

R.F.26's 15/-

R.F.25's 10/-

R.F.24's 10/-

Type 25

50-50 Mcs.

Switched Tuning.

With 3-SP61.

19/6 each.

Brand New.

Type 24

3-SP61...

23/6.

Type 25

10/-

Cathode Ray Tubes


VR137. Guaranteed full TV picture.

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VR987. £9/11/0.

VR987. 1/6, carriage 2/6.

VR987. 1/-, carriage 2/-.

Photo Cells G.S.18.

Limited stock...
COMMUNICATIONS RECEIVER R1155. The famous ex-Bomber Command Receiver. Known the world over to be supreme in its class. Covers 5 wave ranges 18.5-7.5 Mc/s, 7.5-3.0 Mc/s, 1,500-600 Mc/s, 600-200 Mc/s, 200-75 Mc/s, and is easily and simply adapted for normal mains use, full details being supplied. Aerial tested before despatch. These are IN EXCELLENT CONDITION IN MAKER'S CARTONS, ONLY £69/16/0.

A few of the R1155 model can also be supplied. This is the latest version which covers the Trawler receiver bands, and in addition is fitted with a 5 Mc/s oscillator. Used, but tested working before despatch. ONLY £17/19/6.

A factory made Power Pack, Output Stage and Speaker, contained in a black crackled cabinet to match the receiver, can be supplied at ONLY £5/10/- each, or £4 0 0 per pair.

F.S.D. SIZE AND TYPE PRICE

1 milliamp

R.C. 2 in. flush square

1

D.C. 2 in. flush circular

22/4

D.C. 2 in. desk type

25/-

D.C. 2 in. desk square

12/4

125 v. 2 in. flush circular

25/-

250 v. 2 in. flush circular

12/4

500 v. 2 in. flush circular

35/-

500 v. therino 2 in. flush square

5/-

therino 2 in. flush circular

5/-

20 amps

D.C. 2 in. Proj. circular

15 volt

D.C. 2 in. Proj. circular

4 volt

20-30-amps D.C. Car type moving iron

9/-

15 volts

A.C. 2 in. flush, circ. mov. iron

8/6

All meters BRAND NEW IN MAKER'S CARTONS.

100 MICROAMPS METER. 2 in. circular flush mounting. Widely calibrated scale of 15 divisions marked " yards " which can be rewritten to suit requirements. These movements are almost unobtainable to-day and being BRAND NEW IN MAKER'S CARTONS are a snap at ONLY 22 6.

POWER UNIT TYPE 3. This is a standard rack mounting job, and is for 500-250 v. 5-cycle mains with outputs of 250 v. D.C. 100 mA., and 6.3 v. 4 amp. Fitted with H.T. currents meter and voltmeter this is a first-class unit, and can be used for a variety of receivers. Used, but tested working before despatch. ONLY 99/6.

R.F. UNITS TYPES 26 and 27. For use with the R.1355 or any receiver with a 6.3 v. input. Twin variable tuning units which use 2 valves EP45 and 1 of EC52. Type 26 covers 65-50 Mc/s. (5-6 metres), and Type 27 covers 85-65 Mcts. (3.5-5.0 metres). Complete with valves and BRAND NEW IN MAKER'S CARTONS.

AMERICAN ROTARY TRANSFORMERS. 12 v. D.C. input. Output 255 v. at 60 A., ideal for car radio or running electric shaver from car battery. ONLY 22 6.

CRYSTALS. American. 100 kcs., 3-pin, 15/-, British Standard 2-pin 500 kcs., 15/- Miniature 200 kcs. and 465 kcs., 10/- each.

SPRAUGE CONDENSERS. .1 mfd. 600 v. w.kg., 9/-6 per dozen.

H.R.O. VIBRATOR. 6 v. D.C. input. Output 145 v. at 85 m.a., fully smoothed. Complete with vibrato and 6 x 5 rectifier in black crackle cabinet, size 7 x 7 x 6 in. Battery lead with croc clips supplied. ONLY 5/-.

TYPE 6 INDICATOR UNIT. The very popular display unit which contains all the circuitry of the 127 C.R.T. and mu-metal screen, 4 valves, 1 transistor EF30 and 2 of EF34. NEW CONDITION. ONLY 59/- (carriage, etc., 7/-6).

RECEIVER 25/73. Another purchase of these very popular receiving sections of the TR 1196. Makes an ideal basis for a mains operated All Wave Superhet, full modification data being supplied Complete with 6 valves, 2 ea. EF36 and EF37, and 1 ea. EK32 and EBC33. BRAND NEW. ONLY 17/6 (postage, etc., 2/-). Or a few less valves, but complete with the 465 kcs. I.F.s, etc., 8/- (post, etc., 2/-).

OSHOR H.O. COIL PACK. The 3 wave superhet pack recommended for the TR1196 Receiver conversion. ONLY 6/-.

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VACUUM TUBES. All Wave Superhet and Model Makers. E.R.S. Type B3-Mk. II. BRAND NEW IN MAKER'S CARTONS, ONLY 22 6 (post 2/-).

TRANSFORMERS. Manufactured to our specification and fully guaranteed. Output 255 v. at 60 m.a., 6.3 v. 4 a., 6.3 v. 4 a., 3 v. 3 a., 60/-

300 v.-0-350 v. 160 m.a., 6.3 v. 3 a., 3 v. 3 a., 5 v. 3 a., 43/-

350 v.-0-350 v. 150 m.a., 6.3 v. 5 a., 5 v. 3 a., taped at 4 v., 32/6

250 v.-0-350 v. 150 m.a., 6.3 v. 6 a., 5 v. 3 a., 32/6

Please add 2/- per transformer postage.

Cash with order please, and print name and address clearly. Amounts given for carriage refer to inland only.

U.E.I. CORPORATION
Radio Corner, 138, Gray's Inn Road, London, W.C.I.

(Open until 1 p.m. on Sundays. We are 2 min. from High Holborn (Chancery Lane Station) and 5 min. by bus from King's Cross.)

ARP12/VP32 VALUES, new, for 4/- each.


VALVES. Lists supplied.


NEW 9-100 MICRO-AMP. METERS. 4 in. Round flush mount. Made by Ernest Turners. £1/-7/6.


D.P.D.T. RELAYS. Operate at 200/300 volts D.C., 8/6. We can supply any type of voltage and contacts at varying prices.

NEW SELENIUM RECTIFIERS. F.W. 12/6 volt 3 amps., 14/6; 4 amp., 22/6; 6 amp., 30/-; 1 amp., 6/-, 12 v. 100 mA., 3/-; 24 v. 2 amp., 30/-; H.W., 250 v. at 100 mA., 9/-5; 250 v. at 275 mA., 17/-6; 250 v. at 60 mA., 4/-6.

GERMANIUM or SILICON CRYSTAL DIODES, 39/6-

MICRO-FUSE PACKS with matched Trans., 15/-.

FLS FILTER UNITS, 6/-6. Same as FLB but less switch.

TR196 TRANSMITTER SECTION. New and complete but less valves. 4-6-6-6 P.M. Radio. 8/-6. With valves, 2/-.

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R.C. ANTENNA MOUNTING STANDS, 3/6.

P.O. VEEDER COUNTERS 6-9999, 24/50 volts D.C., 15/-

19 in. x 10 in. x 10 in. RACK MOUNTING STEEL CASES, with 3 in. nil. wheels and two handles, 16/6.

All Carriage paid in the U.K., from Dept. W.W.

The only " walk-around " radio shop in Surrey

A large and varied stock of Radio Valves, Components, Receivers, Transmitters, Test Equipment, etc.,

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AMAZING OFFER! OFFICE INTER-COM SETS FAMOUS MANUFACTURER'S EXPORT SURPLUS

AMERICAN HEAVY DUTY L.T. TRANSFORMERS.

Pri. 200-250 v. to Sec. 100-175 v. 115 amps. at 500 w. 10" long, 1 1/2" wide, 1 3/4" high, 4½ lb. Weight 5 oz., 5/-, carr. 5/-.

HIGH SPEED L.T. TRANSFORMERS.

Pri. 115 v. Sec. 15 v. 40 amps. at 140 w. 5½" long, 1½" wide, 1 1/8" high, 2½ lb. Weight 1 oz., 2½/-, carr. 2½/-.

CABLE Single D3, one mile drums, 55/-, carr. 55/- each, £37.10/- per pair.

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30t. AERIAL MASTS TYPE 55. Comprising 9 1/2 wood sections and 1 metal mast top section with aerial clamp attachment, complete with base plate, guys and rings. Dia. of first section 1¾ in. Dia. of top section 1½ in. Supplied new in master's transit cases with instructions, £6/5/-, carr. 5/-.

COPPER PLATED AERIAL RODS. Push-in Neeve joint. 8½ lb per half gross, 1½/- P.P. SPECIAL PRICE of £2 per thousand in ten thousand lots, plus carr. 5/-.

LOOK! CO-AXIAL CABLE—LOWEST PRICE EVER. Super quality ex-Govt., 80 ohm. 50-yard coils, 27½/-, P.P. 1½/- 100-yard coils, 50/-, P.P. 2½/- 1,000 yards, £18/10/-, carr. 15/-.

CONSTANT VOLTAGE TRANSFORMERS BY SOLA U.S.A. Pri. 90-125 or 190-250 v. Sec. 150-220 v. Pri. 115 v. Sec. 17 v. 15 amps. and Sec. are completely isolated. For 50 or 60 cycle operation. Approx. weight 201 lb., £19/10/- each, £27/10/- per pair. Carr. according to distance.

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SPECIAL OFFER OF A.M. TRANSFORMERS. Pri. 220 v. Sec. 150 v. 1 1/4 kVA. 40 amp. 1½" x 1½" x 11¼ in. Transformer. Pri. 200-250 v. Sec. 1250-1300 v. 350 ma., 35/-, carr. 4½. HEAVY DUTY L.T. Transformers. Pri. 230 v. Sec. tapped 13, 13½, 14½, 15 volts. Very conservatively rated at 60 amps. £6/5/-, carr. 7/-.

ALL ORDERS & ENQUIRIES TO OUR DWIGHT ROAD BRANCH PLEASE. THIS IS OPEN ALL DAY SATURDAY.

HOURS 9-4 & 9-1 THURSDAY.

STORAGE BATTERIES. 12v. 75 A.H., built in box cases, £6/10/-, carr. 7/-; 6v. 320-175 A.H., as above £4/19/-, carr. 7/-.

AMERICAN 6 volt 90 A.H. 15 plate car battery, size 9 in. x 9 in. x 7½ in., £2/17/-, carr. 7½/-.


AMAZING OFFER! First time on surplus market. MANUFACTURE ACCUMULATORS made by Willard Co. 36 v. 0.2 A.H. size 3½ in. x 1½ in. x 1½ in. Weight 4½ oz., 7/6, P.P. 6d. Or set of three of 6 v and one 6 v sealed container, £1, P.P. 1½. Brand new and uncharged. Easily filled with hydrometer syringe.

EX. ARMY MEDICAL HYPODERMIC SYRINGES. Brand new, 1 c.c. with needle, 49/-, P.P. 6d. 10 c.c. with needle, 7/6, P.P. 6d. Extra needles, 5 for £2½, P.P. 6d.

PACKARD ROLL-ROYCE COOLANT PUMPS. A Turbine type pump driven directly from a splined splash. Brand new in maker's cartons, 3½/-, carr. 2½/-.

DOUBLE ANGLE SERVO UNIT ASSEMBLY for bomb sight computer T1. Comprising 27 volt double ended geared motor and reversing assembly, 32½/-, 9½/-.

FERRANTI 5 AMP., K.W. METERS, less case. Brand new, 13/6, P.P. 1½.

RECORD BOND TESTERS. Dial reading zero to 0.1 ohm. Movement built in strong bakelite case, 17½/-, carr. 1½. U.S.A. 30 AMP. OVERLOAD SWITCHES, 5/-, P.P. 6d. SUNVIC CONTROL Type 602A 4 pin hot wire replacement tubes, 6½, P.P. 9d.

INSTRUMENTS, ADMIRALTY INTEGRATORS, TYPE A 591. Incorporating very fine Galvano movement, coil 40 shots. Centrally zero to F.S.D. 1 microamp. Small mirror one metre radius. A very useful laboratory instrument, £2/6, P.P. 2½.

METER-VICKERS MASTER VOLTMETERS, 0-20 volts A.C. 50 cy. M.I. 6in. Centre zero to 0.1 volt, 20 ohm 7 to 1.5 amp. Motorola 1,725 r.p.m., £4/11½, carr. 7½.

CENTRAL MOTOR CARTS 1½ in. square bakelite case, 39½/-, P.P. 1½.

SLIDING RESISTORS. All by famous makers offered at a fraction of the original price, 3 ohm 12 amp, 22½/-, 1 ohm 12 amp, 12½/-, 50 ohm 1 amp, slow-motion control, 20½/-, 150 ohm, slow-motion control, 10½/-, with geared control, 32½/-, 20 ohms 7 to 1.5 amp, with geared drive 37½/-, £0.45 25 amp, with geared drive 3½ in. in steel case. P.P. on all types £2½.

CROYDON ENG. CO. GEARED CAPACITOR/INDUCTION MOTORS

A.C. 220-240 v. Motor shafts 1,400 r.p.m. Geared right angle shaft 360 r.p.m. Continuously rated. With Capacitor, £8/19/-, carr. 5/-.

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ORDERS ACCEPTED M/A FROM COLLEGES, SCHOOLS, LABORATORIES, ETC.
SELENIUM METAL RECTIFIERS (S.T.C. TYPE). Built to specification from milliamps to amps, H.V., F/B. or three-phase. All work fully tested and guaranteed. Your inquiries invited for large or small quantities.


CATHODE RAY TUBES. Type CV 1526, 21 in., 4 v. filament, 3,000 anode, complete with base and mu-metal screen. 20/-. p.p. 2/6.

CATHODE RAY TUBES. Type VCR 138 (ECR 35) with screen and base, in good condition. New, 20/-; used, 12/-; ex-equip., in good order. 20/-; p.p. 3/6.

HIGH-VOLTAGE TRANSMITTERS. Type CV 1526, 21 in., 4 v. filament, 3,000 anode, complete with base and mu-metal screen. 30/-. p.p. 2/6.

POT RUNNER UNITS. Type 3, made for use with the R.1132A, is a standard rack mounting job to match the receiver and is for 200/250 v. 21/2 cycle mains with a maximum of 100 ma. at 6.3 inputs, 5/6, p.p. 415/6, carriage 10/-.

CHROMIUM PLATED EXTENDIBLE AERIALS. Min. length 3 ft. Max. length 8 ft. Standable for car radio aerials. 8/6 each, p.p. 9d.

HANNEY of BATH offers:

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**COMMUNICATIONS RECEIVER**

**Admiralty Type B/28 (Marconi CR.100)**. Valve line up 2 RF, F.C., separate local Osc., 3 F.I.F., 2nd Osc., Output, B.F.O. and rectifier. Self contained power supply 200/250 volts A.C. 5 c.p.s. Variable Selectivity (crystal filter) 4500, 5000, 1000, 200, 300 and 100 cycles. Frequency coverage 60 kc/s to 30 Mc/s in six ranges, continuous tuning except for gap between 420 to 500 kc/s. Size 16in. x 13in. x 12in. Weight 32lb. The set for the serious operator. Thoroughly overhauled and in good condition, complete with new valves and air tested prior to despatch. A real bargain at only £27/10/- plus £1 carriage.

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Indicator contains 3 EF50, 1 5U4G, 4 5PE1 and a T.R.T. Type VCR 517, complete with Mu Metal-screen, 9 wire wound pots, with large assortment of resistors and condensers. Can be converted to Oscilloscope (as described in "Radio Constructor"). Circuit supplied. Tubes have no " Cut Off " and can be demonstrated to callers. Brand NEW (less relays). In original transit case, 67/- plus 7/6 carriage.

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12 volts DC input, 250 volts 60 mA. output, weight 2lb, size 4in. x 3in. diameter. Ideal for car radio, mobile amplifiers, small transmitters, etc. All tested prior to despatch. Only 32/- post paid.

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**PRICE 45 GNS.**

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NEW GRAMOPHONE AND SOUND EQUIPMENT

FERROGRAPH magnetic tape recorder, £125. [3218]


BUYING a new amplifier or rebuilding the old one? See Bernard J. Brown's advertisement for new receivers and amplifiers. Also repairs and service. [0029]

ALTERATORS, 230/1/50, 400v, self-tuned, £380, post paid. [0039]

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NEW MOUNTS, MACHINES, ETC.

WARD rotary converters for radio, television, broadcasting, etc. ALSO, rotary transformers, alternators, etc. WARD, 75, South St., Bishop's Stortford. WARRITE Tape recorder, £17/10. BATTERY chargers, 4 models, 2-6-12v, 1-2-4amp D.C. any mains voltage, also lighter transformers, variable duty, remote control car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [0012]

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Capacities from 4 to 70pF in vol-
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[Note: The document contains various advertisements and notices related to electronic equipment, transformers, cabinets, and other related products. It includes information about specific products, services, and contact details.]

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E6. Design and testing of high pressure hydraulic or pneumatic systems and components.
E7. Manufacturing and testing of missile components.
E8. Manufacture of prototype missile electronic equipment to M.O.S. specifications.
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L3. Design and manufacture of prototype electronic equipment.
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