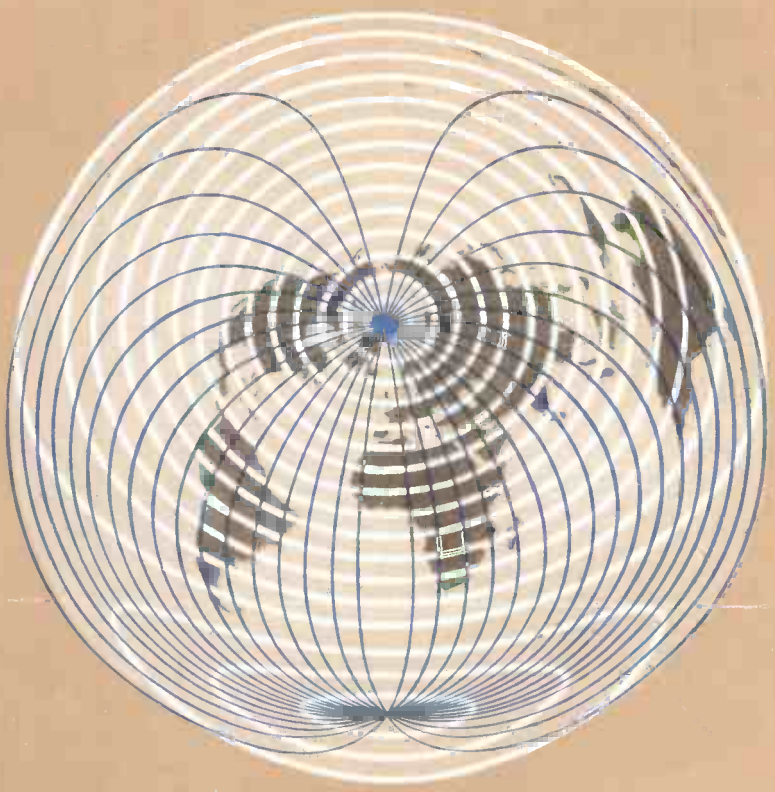
OCTOBER 1957 TWO SHILLINGS

Show Review

Wireless World

ELECTRONICS
Radio · Television



FORTY-SEVENTH YEAR OF PUBLICATION

Wireless World

ELECTRONICS, RADIO, TELEVISION

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OCTOBER 1957

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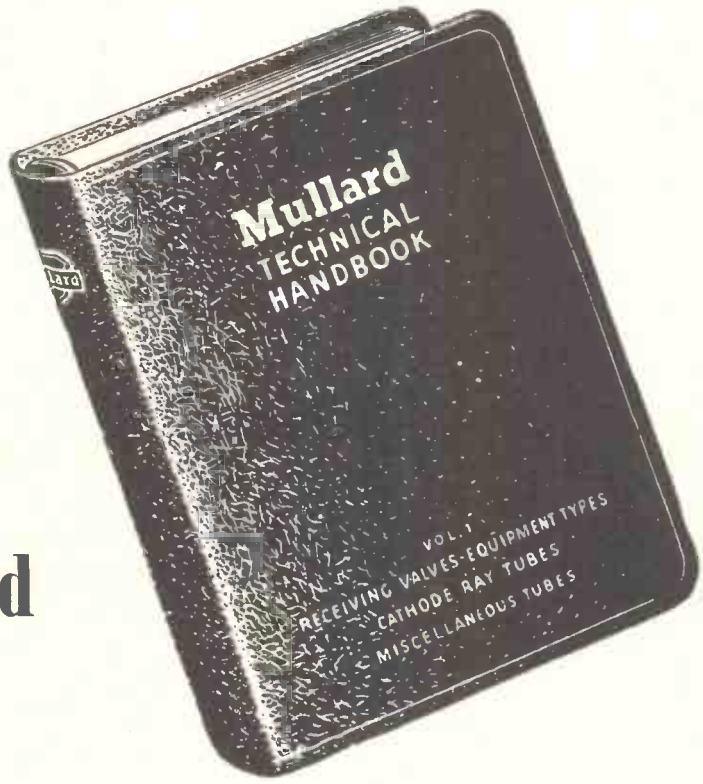
A service for all who need complete data on Mullard valves, tubes and semiconductor devices



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Mullard

OCTOBER 1957

Vol. 63 No. 10

Wireless World

The "Ideal" Receiver?

ARGUMENTS as to whether this year's Radio Show was better, as good as, or worse than last year's have subsided without leaving any conclusion which is not to some extent coloured by prejudice. Our own view would be that it was a better show, but by a margin too small to justify any claim for recognition as a landmark in any future history of the development of broadcast receivers. Although, as our review elsewhere in this issue points out, most of the changes seen this year are developments of trends already discernible a year or more ago, there has been ample food for thought in the rate at which some of these changes are taking place, and the reaction of the buying public to the new types of set which are offered to them.

Take, for example, the combined television and v.h.f./f.m. sound receiver. From the technical point of view this is a particularly neat and logical combination, since not only the audio-frequency amplifier but also the early intermediate-frequency stages can be made to fulfil dual functions. There is no more economical way, either in first cost or in the space taken up in the living room, of making provision for the reception of all the domestic broadcast services in this country. In spite of this, according to reports published in the trade Press, there has been no spectacular swing in popular favour towards this type of receiver, though there were more sets to choose from this year than last. According to some dealers, many of their customers still want medium and long waves if only for the reception of the popular Luxembourg programmes; others point to the fact that some members of the same family may wish to receive the sound programmes while others are viewing television—clearly a case for separate sets in different rooms. Even those for whom these objections do not carry any weight may still argue that the small power outputs and loudspeakers which are perfectly adequate for the sound accompaniment to television and, indeed, for many of the sound programmes themselves cannot do full justice to all the qualities of the B.B.C.'s v.h.f./f.m. service.

The truth is that no single receiving system can completely satisfy all the varying tastes and requirements of all sections of the community and, at the same time, fall within the price limits that most people can pay. Accordingly, manufacturers produce a range of sets giving permutations and combinations of those features which they judge will make the widest appeal. For economic reasons it is obvious that such a range cannot be expected to be complete, and that some potential customers must go without or put up with a set which to them is second best.

As a way out of this impasse there is, in our view, a case for a return to unit construction; but, before the indulgent smiles of the conservative body of the radio industry give place to ribald laughter, let us hasten to add that we do not visualize a return to the block system, which we in this journal are old enough to remember, in which every stage was built as a separate unit, but rather to an extension of the ideas which have found favour with the "hi-fi" enthusiasts. The basic unit would be a vision receiver with alternative input tuners and a plug-and-socket take-off point for sound which would go either to a small internal conventional rectifier/discriminator/amplifier and loudspeaker, or to an external high-quality sound-reproducing system. No system other than one based on units could hope to satisfy the individuality expressed by those with strong ideas of what constitutes good sound reproduction, and to any who may think that a unit system must look like a laboratory test bench we commend the many fine examples of "custom built" sectional furniture which have recently been introduced. There is no need for the "electronics" to be any more apparent than they are in a conventional receiver, and for those who are prepared to pay the cost, even knobs and dials can be discreetly tucked away behind panels or concentrated in neat remote-control units.

By these means it should be feasible to give the man who wants, say, television with high-quality sound all that he wants without forcing him to buy also an automatic record changer and a cocktail cabinet.

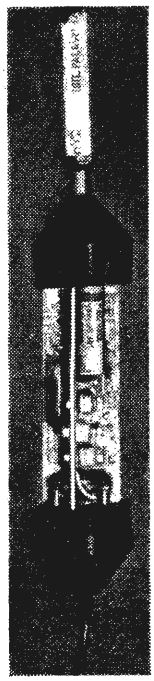
We know only too well that there will always be those who want to combine X's amplifier with Y's tone-equalizer and Z's loudspeaker, but we have every reason to believe that an experienced dealer will have either the technical knowledge to help the customer to do this or the arguments to persuade him to stick to one make.

Farnborough Air Show

DEVELOPMENTS IN RADIO AND ELECTRONICS

As in most technological industries and services, electronics plays a significant and, in some cases, a dominant part in all branches of aviation. Manufacturers make use of computers for design, vibration generators and strain gauges for testing, and computers again for the more advanced flight data instruments. None but the smallest light aeroplanes may fly without v.h.f. communications equipment and long distance radio communication and radar are essential aids to the flight controller.

Developments in ground-to-air communications equipment are toward the provision of a wider selection of channels and greater flexibility in selection. In the new Murphy MR370 transmitter a decade switching system tunes to any of 622 channels at 90kc/s separation (56 at 100kc/s) in the 100-156Mc/s band. In the Murphy airborne v.h.f. receiver (MR300) 44 channels (100kc/s) are available and with the Standard Telephones STR9X conversion kit to give 44 channels with automatic tuning instead of the former 10, is now in full production.



Ultra SARAH transistorized rescue beacon with cover removed.

Redifon have brought out a new medium-frequency (200-525kc/s) beacon, the layout of which is designed to reduce routine maintenance time. It is available as a dual installation where continuity of service is essential together with an automatic change-over and alarm unit.

Two developments in air rescue beacons were noted. Burndept have introduced a crystal-controlled u.h.f. beacon transmitter ("SARBE") in two forms with or without two-way speech facilities, and Ultra are making an inexpensive version of "SARAH," with built-in transistor h.t. supply, for use on small fishing vessels.

With the growing density of traffic, the work of the air traffic controller is becoming increasingly onerous. Much thought has been given to ways and means of simplifying his task and in a new Decca display system now under development the controller is presented only with the essential information required to make decisions. All radar and flight report material is sifted by a team of operators before appearing on his screen. The basis of the display is a 405-line projection television plan of the airport and its approaches, derived from a transparency in the outer control office by the "Deccafax" system (described on p. 470 of this issue).

Superimposed on this "static" display are moving symbols indicating all aircraft in the area. Small numbered squares represent aircraft under radar observation, while circles indicate movements, based on reports, of aircraft not yet in radar range.

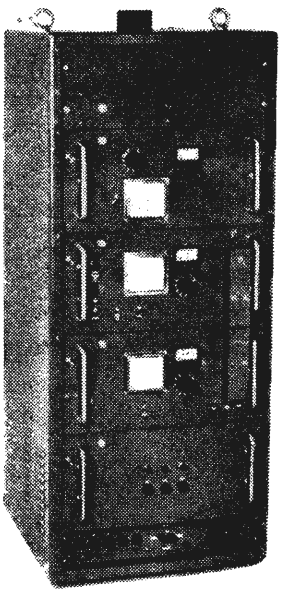
The method of generating, controlling and displaying the flight symbols is ingenious. The symbols and numbers are first selected from a monoscope tube with a store of 100 digits by a 20-line spiral scan and are fed into the main radar display tube during the flyback period between each radial sweep. Their position is determined by "gated" currents in auxiliary horizontal and vertical deflection coils and normally the symbols are stored in a row at the top of the tube. When a target is identified it is "boxed" by one of the symbols, first using manual control of deflection, and is then followed by putting on a traverse with the right speed and direction. Adjustment of the rate may be required from time to time to keep the target "boxed"; but it is hoped later to incorporate auto-following. The video signals corresponding to the symbols and their position coordinates are repeated on a separate c.r. tube which is scanned at 405 lines, synchronized and mixed with the "static" Deccafax information and applied to the controller's projection display tube.

Unwanted permanent echoes in a radar screen are reduced in the Cossor CR21 surveillance radar by a cancellation technique and rain echoes by the use of circular polarization in conjunction with a quarter-wave filter plate in the radar beam. This equipment, which was shown in prototype form last year, has recently undergone extensive official trials and in its mobile form has been widely demonstrated abroad.

Marconi's have introduced a high-power (3MW peak), 10-cm radar (Type SR1000) for long-range civil and military requirements which breaks new ground in combining transmitter, receiver and all power supplies in a single compact cabinet measuring only 87 in × 81 in × 40 in.

Doppler Navigation

Where navigational assistance from ground stations is either impracticable or inexpedient the Doppler system of independent course tracking by the change of apparent frequency of radio reflections from the ground is without a serious rival. The general principles were described in our May issue (p. 225) and since then more details have been disclosed of the equipment developed by the Ministry of Supply and the Marconi Company for use by the R.A.F. This employs a four-element slotted waveguide aerial system switched to direct downward-pointing beams, forward to port and aft to starboard or alternately forward to starboard and aft to port. The use of simultaneous fore and aft beams gives an increase in the Doppler frequency shift and compensates for small changes in the transmitted frequency. The Doppler

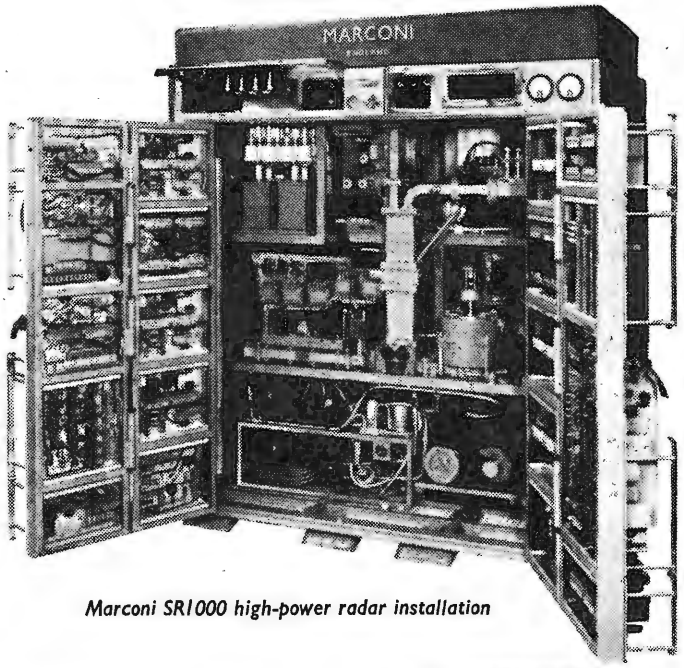


Murphy MR370 v.h.f. transmitter/receiver.

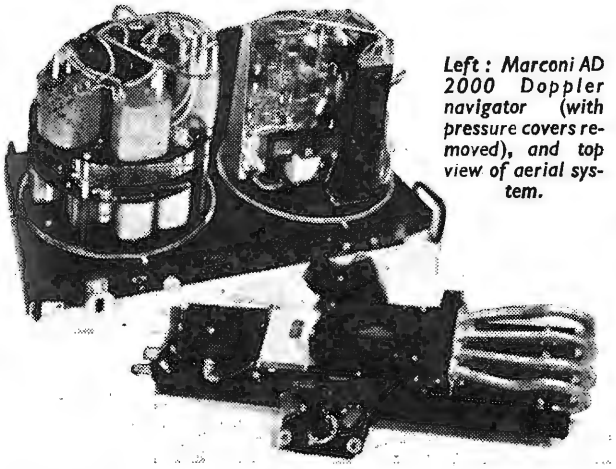
shifts given by the alternating beam positions are the same only when the axis of the aerial system is in line with the aircraft's track over the ground; any frequency difference can be used as an error signal to turn the aerial system automatically into the line of flight, and so indicate the drift angle.

Since the beam widths are finite there are multiple reflections from the ground, each with a slightly different frequency shift and this gives a whole spectrum with a Gaussian distribution about a centre frequency of maximum amplitude. In the Marconi AD2000 (military) and AD2300 (civil) Doppler Navigators phonic wheels are synchronized with and follow the Doppler centre frequency and are used to drive a computer which gives the pilot accurate information of course and distance flown, or his instantaneous position in latitude and longitude.

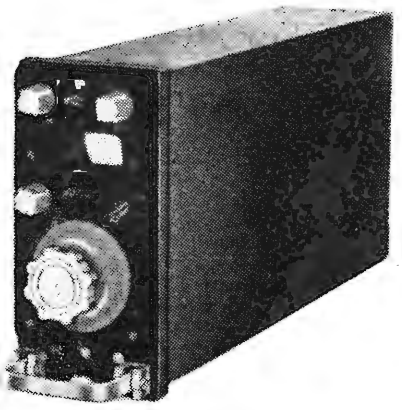
Ekco have introduced a drift unit (Type 153) for use with their E-120 airborne search radar which is relatively simple. It makes use of the single forward beam of the search radar (with the scan stopped in the forward and downward position)



Marconi SR1000 high-power radar installation



Left: Marconi AD 2000 Doppler navigator (with pressure covers removed), and top view of aerial system.

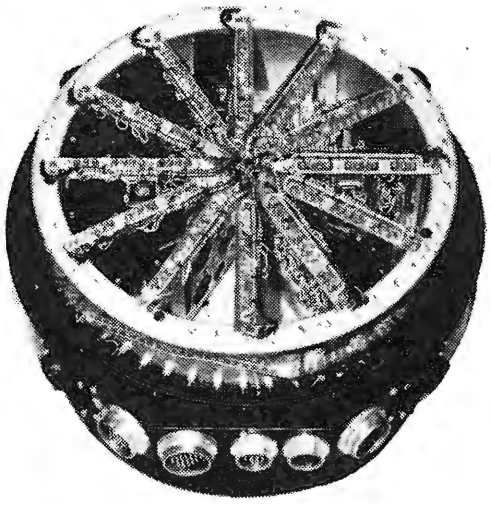


Ekco Type 153 Doppler drift indicator.

and displays the ground responses on a small c.r. tube with a single horizontal time base ("A" scope). Beating between component frequencies of the Doppler response spectrum causes amplitude modulation and "fuzziness" of the trace. The beam can be deflected through a servo system from a dial on the display unit calibrated in degrees of drift and is adjusted until the "flutter rate" of the display is a minimum (when the beam is pointing along the ground track). The angle between the aircraft heading and the track is then read off the scale. Accuracy depends on the operator's skill in estimating the null, but is stated to be generally of the order of $\pm 1°$.

The four-beam method has been adopted by Decca for their Doppler radar unit, since it lends itself to integration with the Decca Navigator and Dectra hyperbolic systems. A complete navigation system incorporating all the necessary computers and known as "DIAN" (Decca Integrated Airborne Navigation system) is now under development.

Electro-mechanical computers of small size are being used to simplify the preparation and presentation of flight data such as air speed, Mach number, vertical speed, altitude, etc. Hitherto these quantities have been measured and displayed by separate instruments, but



Elliott air data computer.

can now be derived from a two-capsule pressure transducer giving electrical analogues of static and dynamic pilot tube pressures. The calculations made by the computer take into account temperature and are based on the characteristics of a "standard atmosphere." Development has been initiated by the Ministry of Supply and practical interpretations were shown by Elliott Brothers and Kelvin-Hughes. An interesting feature of the displays used in these instruments is the fixed-pointer, moving-band type scale giving greatly increased length. In the Elliott computer there are 12 transistor amplifiers and these are arranged radially in the cylindrical pressurized container.

Many other interesting items were noted including an intercomm. system with long trailing leads and special headphones for use by ground servicing crews under severe ambient noise conditions (Ultra); a capacitance bridge sensitive enough to measure the dilation of rotors under centrifugal force (Wayne Kerr); a "breadboard" system for assembling and testing prototype servomechanisms (Vactric); new types of aircraft wiring cables for continuous operating temperatures up to 240°C (B.I.C.C.); a magnetic tape data recording system for analogue, PDM or FM signals (Solartron); and a vibration generator, Model VG109, developing a thrust of 8,000lb (Goodmans).

WORLD OF WIRELESS

Valves and C.R. Tube Restrictions

REGISTERED agreements relating to the supply of valves and c.r. tubes are among those recently referred by the Board of Trade to the Restrictive Practices Court, which has to decide "whether the restrictions which have made an agreement registrable are contrary to the public interest or not." Anyone who can furnish information from his own experience of the effects of these agreements covering exclusive dealing arrangements between manufacturers, dealers and users, the fixing of maximum discounts and restrictions on imports, is invited to communicate with the Solicitor to the Registrar of Restrictive Trading Agreements, Chancery House, Chancery Lane, London, W.C.2. (Tel.: Chancery 2858.)

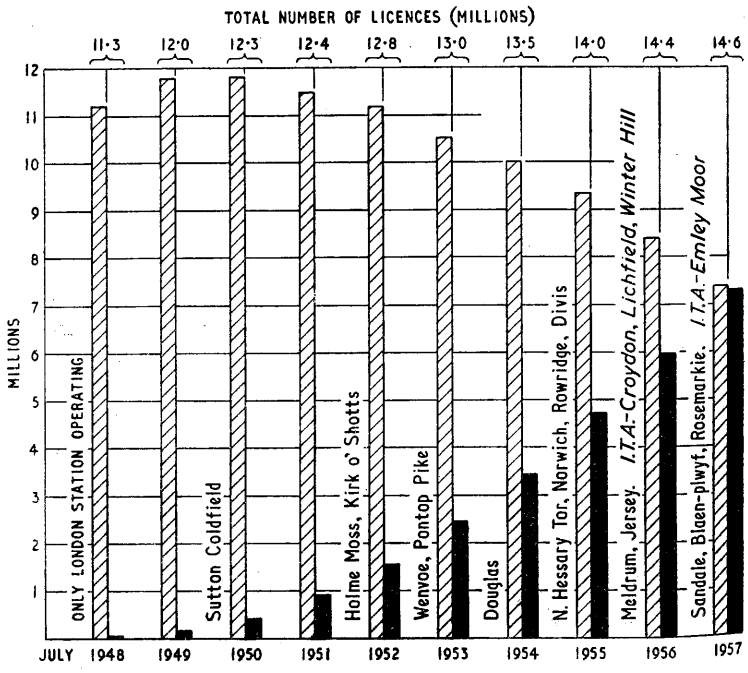
Cabinet Styling

ABOUT 60 manufacturers of cabinet materials, accessories and "embellishments" are exhibiting at a three-day trade show organized by the British Radio Equipment Manufacturers' Association. The exhibition, which is to be international, will be held at the Royal Hotel, Woburn Place, London, W.C.1, from October 1st to 3rd. Admission to the show, which is open from 2.0 to 6.0, is limited to *bona fide* trade visitors, who can obtain invitation tickets from B.R.E.M.A., 59, Russell Square, London, W.C.1.

Receiving Licences

ALTHOUGH the figures for August are not available at the time of going to press it is pretty certain that television licences in the U.K. now exceed the number of sound-only licences. The July figures are, sound-only 7,374,865, television 7,269,748. If, however, the 319,163 licences for car radio current in July are deducted from the sound-only figure the resulting total of 7,055,702 for *domestic* sound licences was already some 200,000 below the television figure.

The thermometers in this chart show the gradual rise and fall of the two groups of licences during the past ten years. The figures given are those at July each year. The additions to the number of television stations for each twelve months are also indicated on the chart.



What is a Technician?

THE confusion caused in the minds of laymen by the indiscriminate use of the words engineer and technician must have been still further confounded by the recent announcement in the lay press that pay increases averaging £125 were to be given to all "television technicians from the top existing rate of £1,600 a year downwards." The announcement concerned the agreement signed by the I.T.A. programme contractors and the Association of Cinematograph, Television and Allied Technicians on behalf of its members who include supervisory engineers, maintenance and control engineers, camera operators, technical assistants, etc. It is understood the Association will be negotiating for a similar agreement, which covers not only pay increases but overtime rates and conditions of employment, with the B.B.C.

Schools Television

IT has been estimated that scholars in about 1,000 schools will be viewing when the B.B.C.'s schools television service opens to-day, September 24th. All B.B.C. transmitters will radiate the programmes (designed for the 11s to 15s) from 2.5 to 2.30 on school days.

Television transmissions for schools are also being radiated from two I.T.A. stations, Croydon and Lichfield, from September 23rd. They are being organized by Associated-Rediffusion, the programme contractors, and will be transmitted on Mondays to Fridays from 2.45 to 3.10 and repeated from 3.25 to 3.50.

As we mentioned some months ago, the Association of Education Committees (10, Queen Anne Street, London, W.1) has issued a report on television equipment for schools which lists a number of "approved" receivers

Brit.I.R.E. Awards

THE Clerk Maxwell premium, the senior award of the Brit.I.R.E., is to be presented to Dr. K. D. Froome of the N.P.L. Metrology Division. The 20-gn. award is made for his paper "Microwave determinations of the velocity of light."

The Institution's 20-gn. Heinrich Hertz premium, awarded for the most outstanding paper dealing with the mathematical or physical aspect of radio, goes to Dr. A. G. Edwards (A.E.I. Research Laboratories) for his paper "The effects of atmospherics on tuned circuits." K. E. Harris, Cossor Radar's research director, receives the Brabazon 15-gn. premium (awarded for a contribution on radio and electronic devices for aircraft safety) for his paper "Some problems of secondary surveillance radar systems."

Both the Louis Sterling (15gns.) and the Marconi (10gns.) premiums go to overseas engineers. The first to Dr. A. van Weel (Philips, Eindhoven) for "Some remarks on the radio-frequency phase and amplitude characteristics of television receivers," and the second to Professor P. M. Honnell (Washington University, St. Louis) for "Prescribed-function vibration generator."

H. J. Leak receives the 5-gn. Norman Partidge Memorial Award for "High fidelity loudspeakers: the performance of moving-coil and electrostatic transducers."

"Sandwich" and Special Courses

NEARLY 70 colleges in all parts of the country are now offering sandwich courses—consisting of alternate periods of work in industry and college—leading to advanced-level awards such as the Higher National Diploma or Certificate or the recently introduced Diploma in Technology. A list of sandwich courses was published early in September by the Ministry of Education (H.M.S.O., 1s 4d).

In addition to the regular full-time and part-time courses for recognized awards provided by technical colleges and polytechnics, a large number of them are conducting short-term specialized courses. Among those beginning this term are the following:

Transistors and Allied Devices.—Twenty lectures (Tuesday afternoons or evenings beginning October 8th) at Borough Polytechnic, Borough Road, London, S.E.1. (Fee 50s.)

Pulse Techniques.—Twenty-two lectures on the fundamental principles (Monday evenings, beginning October 7th) and a 12-week laboratory course (Monday afternoons or Thursday evenings, beginning October 28th) at Borough Polytechnic. (Fees 50s and 20s respectively.)

Transistor Physics and Applications.—Eight lectures on successive Wednesday evenings from October 23rd at South East London Technical College, Lewisham Way, London, S.E.4. (Fee 20s.)

Operational Calculus.—A course of 20 evening lectures on applications to electric circuit theory begins at South East London Technical College on October 22nd (Fee 26s.)

Control Engineering.—A series of courses covering industrial instrumentation, mathematics of feedback systems and automatic process control are being given at Battersea College of Technology, Battersea Park Road, London, S.W.11, during the Autumn and Spring terms. They begin in the week commencing September 30th.

Linear Servomechanisms.—A one-year evening course (Mondays) begins at Battersea College of Technology on September 30th. (Fee 20s.)

Pulse Circuit Design.—Twenty-two evening lectures begin on Thursday, October 10th, at Twickenham Technical College, Egerton Road, Twickenham. (Fee 40s.)

Higher technology courses at Southall Technical College, Beaconsfield Road, Southall, Middlesex, include radio telemetry (12 lectures, beginning September 30th), digital computers (12 lectures, October 1st), transistors (12 lectures, October 2nd), and pulse techniques (18 lectures, October 10th).

Essentially for Layman.—A course on elementary theory of electrical and electronic engineering, including some radio and television servicing, on Mondays and Wednesdays at the Wesley Evening Institute, Wesley Road, London, N.W.10. (Fee 30s.)

2,600 miles on 2 metres is the record set up by two amateurs in California and Hawaii in July, according to a note in the *R.S.G.B. Bulletin*. The Californian station, W6NLZ, near Los Angeles, used a 13-element, 24-ft Yagi and the Hawaiian station, KH6UK, at Kahuku, Oahu, employed an array consisting of four 24-ft Yagis in a box formation. Both transmitters had an output of 1kW. With such arrays what were the e.r.p.s?

A fourth channel in Band III has now been cleared. The first station to operate in it will be the I.T.A. Chilterton Down, Isle of Wight, transmitter, which, when opened next summer, will serve central Southern England. The carriers in channel II will be 201.25 Mc/s (sound), and 204.75 Mc/s (vision).

Radio Hobbies Exhibition is the new title given to the annual amateur radio show organized by the Radio Society of Great Britain. The emphasis at the show, which opens at the Royal Horticultural Old Hall, Vincent Square, London, S.W.1, on October 23rd for four days, will be on home construction. Admission to the exhibition, open daily from 11.0 to 9.0, costs 2s.

B.S.I.R.A.—The series of "open days" at the headquarters of the British Scientific Instrument Research Association at Southill, Elmstead Woods, Chislehurst, Kent, originally arranged for October 7th to 11th, has been extended to include the 14th also. Enquiries for invitation tickets should be addressed to the director.

Isle of Man is to have a v.h.f. transmitter on the same site as the permanent Douglas television station now being completed at Carnane. Initially it will transmit only the Home Service.

For R.E.T.M.A. read E.I.A.—The American Radio-Electronics-Television Manufacturers' Association, which through the years has grown from R.M.A. through R.T.M.A. to R.E.T.M.A., has now changed its name to the all-embracing Electronic Industries Association.

Air Communications.—A five-week meeting of the communications division of the International Civil Aviation Organization opened in Montreal on September 10th. It will be concerned primarily with radio-telephone facilities and procedure (especially in relation to the introduction of the selective calling system). It will also consider the formulation of international technical standards for air traffic control radar equipment.

Canada's fourth Decca Navigator chain, covering the Quebec area, will be opened in October. The third chain, centred at Nova Scotia, was opened in August, and two other chains (Newfoundland West and Newfoundland East) are under test by the Canadian Department of Transport. Two of the stations in the Western Newfoundland chain are also used for the North Atlantic Dectra long-range navigational system.

Personalities

Lord Brabazon, president of the Radio Industry Council in succession to **Sir Edward Appleton,** is a director of Electric & Musical Industries, Ltd. For some time before the war he was president of the now defunct Radio Manufacturers' Association. Unfortunately sickness prevented him from performing his first public function as R.I.C. president—the opening of the Earls Court Radio Show.

Sir Thomas Spencer, M.I.E.E., on September 9th completed 50 years' service with Standard Telephones and Cables, of which he is chairman and managing director. Sir Thomas, who is also chairman of Standard Telecommunication Laboratories, Kolster-Brandes, and International Marine Radio Company, was founder and first chairman of the Telecommunication Engineering and Manufacturing Association.

Sir Leonard Owen, C.B.E., has been appointed managing director of the Industrial Group of the Atomic Energy Authority in succession to **Sir Christopher Hinton,** K.B.E., F.R.S., who has become chairman of the Central Electricity Generating Board. Sir Leonard, who obtained his degree of Master of Engineering at Liverpool University, has been engaged in the development of Britain's atomic energy programme since 1946 and for the past three years has been director of engineering and deputy managing director of the Industrial Group.

Rear Admiral P. Dawnay, M.V.O., D.S.C., who in January takes up the appointment of Flag Officer Yachts, is a signals specialist and was at one time captain of the naval signal school H.M.S. *Mercury*. From 1941-43 he was signal officer to the Admiralty Delegation in Washington and the combined chiefs of staffs, and in 1945 was signal officer at the Yalta conference of heads of States. In 1946 he was promoted captain and for two years, 1948-50, was deputy director of the Signal Division at the Admiralty.

H. E. Cornish, O.B.E., M.C., B.Sc.(Eng.), A.C.G.I., M.I.E.E., succeeds **Sir Archibald Gill,** K.B., B.Sc.(Eng.), M.I.E.E., as general manager of British Telecommunications Research, Ltd., the research establishment jointly set up by Automatic Telephone & Electric Company and B.I. Callender's Cables, at Taplow, Bucks, some ten years ago. Sir Archibald, who now becomes chairman of B.T.R., which he joined last year, was engineer-in-chief of the Post Office until his retirement in 1951. Mr. Cornish has been Postmaster General of Sarawak since 1951 and previously held telecommunications engineering and administrative posts in Nigeria and Malaya.

C. G. Mayer, M.I.E.E., has relinquished the post of managing director of R.C.A. Great Britain, Ltd., to which he was appointed in July last year, and has become special representative for Europe of the parent company, Radio Corporation of America. His office is in Eagle House, 109, Jermyn Street, London, S.W.1. **P. A. Turnor** resumes the position of managing director, which he relinquished last year.

R. S. Roberts, M.Brit.I.R.E., until recently senior lecturer in the department of radio and musical instrument technology at the Northern Polytechnic, Holloway, London, N.7, which he joined in 1937, has been appointed executive technical director of Wolsey Electronics, Ltd. Prior to entering the teaching profession he was for 14 years with Wright & Weaire, where he was in charge of the technical department. For three years during the war Mr. Roberts, who is 51, was seconded to the Ministry of Aircraft Production for work on the development of radar equipment. During his career as a lecturer he has also worked as a consultant and was for some years an examiner in advanced radio engineering for the Brit.I.R.E. graduate examination.

W. E. Miller, M.A.(Cantab.), becomes assistant managing director of the Trader Publishing Co., publishers of *Wireless & Electrical Trader*, of which he is managing editor. **H. E. Craddock** becomes managing director of the company. Mr. Miller started his journalistic career in 1925 when he joined the staff of *Experimental Wireless*, now *Electronic & Radio Engineer*, and a year later joined the *Trader* as technical editor. He was president of the British Institution of Radio Engineers from 1952-54 and is honorary secretary of the Radio Industries Club.

J. M. Dodds, O.B.E., M.A., B.Sc.(Eng.), Dr. Ing., has succeeded **B. G. Churcher,** M.Sc., as manager of the research department of Metropolitan-Vickers. Dr. Dodds, who joined the company in 1928 and after two years as a college apprentice went into the research department, was one of the first two industrial engineers to be taken fully into the confidence of the Government on radar—the other was **L. H. Bedford.** Dr. Dodds has been assistant manager of the research department since 1953.

L. Roullier, A.M.I.E.E., is appointed head of the recently-formed Electrical Division of Aluminium Laboratories, Ltd., of Banbury, Oxon. He has been transferred from Aluminium Union, Ltd., London, where he was engaged on development engineering associated with the use of aluminium in electrical apparatus. He joined the Aluminium Group of Companies in 1954 after six years with Johnson & Phillips, Ltd., with whom he served a post-graduate apprenticeship course.

R. W. Fane, M.Sc., A.Inst.P., author of the article on thermionic cathodes, graduated from University College, Exeter (now the University of Exeter). Following National Service he returned to Exeter where, after taking a Diploma in Education, he carried out research on thermionic emission and was awarded an M.Sc. by London University in 1951. He joined Marconi's as a lecturer on post-graduate courses at Marconi College, transferring to the Research Laboratories in 1954 to work on problems relating to high current density electron beams.

Thomas W. G. Calvert, B.Sc., who, on page 505, writes on the use of ferrites for f.m., is a graduate of University College, London. For two years prior to coming to London in 1954 he was a student at Portsmouth Municipal College. He is 21 and has now joined the metals division of I.C.I.

R. A. Burberry, of the radio division of Standard Telephones & Cables, was recently awarded a prize by the Royal Aeronautical Society for his paper "Aerial systems for aircraft" published by the Society. He joined S.T.C. in 1947, after five years at the T.R.E. (now R.R.E.), Malvern, and is now head of a group working on aircraft aerials.

John G. Elting, formerly with Ultra Electric as production engineer, has joined Simon Equipment, Ltd., as works manager.

OBITUARY

Dr. Irving Langmuir, who in 1950 retired from the associate directorship of the physical chemical research laboratories of the American General Electric Company in Schenectady, died on August 16th at the age of 76. Dr. Langmuir, who was awarded the Nobel chemistry prize in 1932, is perhaps best known in our field for his researches on surface chemistry and the emission from hot filaments in gases which led to the invention of the gas-filled lamp and rectifier. He received numerous awards, among them the Hughes Medal of the Royal Society.

Radio Show Review

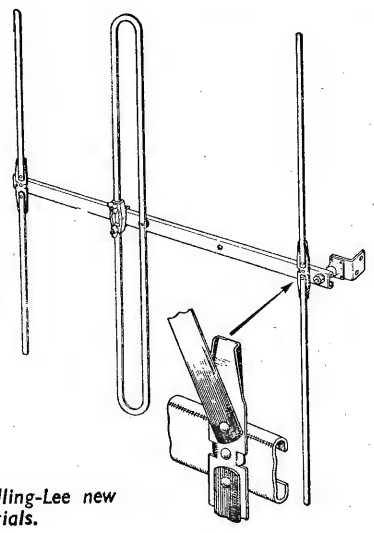
Trends as Seen by *Wireless World* Technical Staff

AERIALS

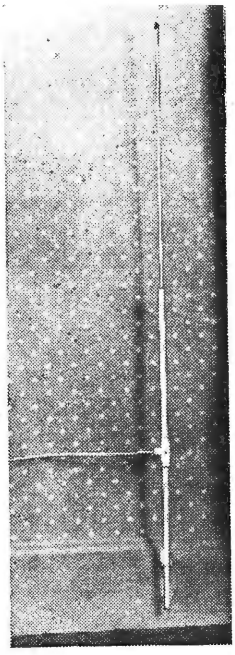
A NEW development with interesting possibilities is the idea of standardizing a limited number of aerial units or "aerial bricks" and using them as the occasion demands to assemble aerials for any location or for any service or combination of services it is possible to envisage. If well planned the "aerial bricks" will enable either single-band or multi-band aerials to be assembled with very little difficulty and the dealer benefits by having fewer parts to stock; the listener benefits as his particular requirements can easily and cheaply be met and the manufacturer benefits as he has to concentrate only on production of a limited number of standard parts. Prices and installation costs should be reduced all round.

Belling-Lee call this a "Unit Plan" and say it offers the choice of over 200 different outdoor aerial combinations and many more indoor varieties. A similar arrangement is adopted by Burwell for a new range described as "View-Well" aerials. In this case there is a basic unit consisting of a three-element Band-III aerial with a folded dipole adjustable for length, one reflector and one director. The elements are mounted on a cross-arm with swivel fittings at each end for attachment of additional units. These can be either extra Band-III directors or Band-I or Band-II systems, or a combination of all three can be assembled as a unified aerial system.

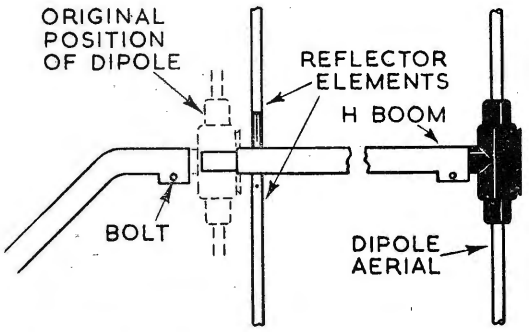
Provision for adding extra director elements to a basic aerial unit forms part of the J-Beam Aerial's policy. The main unit is a slot-beam Band-III aerial having a skeleton slot with four directors and two reflectors forming the equivalent of a double four-element broadside aerial. It is supported by a "Y"-shaped fitting attached to the twin cross-arms supporting each end of the slot and the side arrays of parasitic elements. Additional units, in the form of directors, are added when it is necessary to increase the gain and/or directivity of the system and with



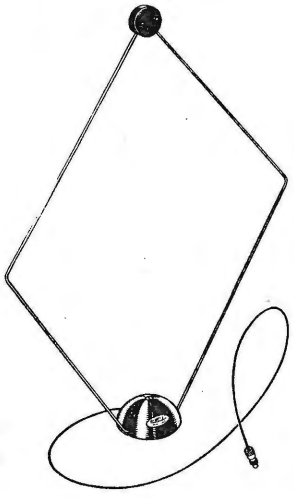
One of the Belling-Lee new Band-III loft aerials.



Wolsey "Twin-Super" indoor television aerial.



Meadow-Dale units for converting Band-I dipole to an "H."



Labgear indoor "Diamond" twin-band television aerial.

these the equivalent of a 16-element aerial can easily be built up. The basic aerial does not have to be disturbed other than for the assembly of the extra director units.

A step towards standardization has also been taken by Wolsey with their "Turret" wall bracket and universal aerial clamp. The latter allows the separate parts of a combined Band-I/Band-III aerial to be oriented through 360° and the wall bracket permits the whole system to be pointed in any direction relative to the wall or joist on which it is fixed. These two fittings were illustrated in our June issue as they made their appearance at this year's R.E.C.M.F. components show, but they are mentioned here in order to complete the picture of the latest trend in the design of v.h.f. aerials and accessories for television and f.m. sound broadcast reception.

Meadow-Dale aerials are designed with an eye to easy conversion from one type to another while utilizing all the parts of the original aerial. For example, if a plain dipole is found inadequate for any particular purpose, reflections causing ghosts for example, it can easily be changed into an "H" by means of the conversion parts. The insulator is removed from the supporting arm, it is replaced by a short boom having identical fittings carrying a reflector element and the insulator with its dipole fitted into the other end of the extension boom. All fittings are interchangeable.

Indoor television aerials have received quite a lot of attention lately and have emerged as two quite distinctive types. There is the "in-the-room" type and the loft or attic type and their principal differences are that the former must be reasonably small, pleasing to the eye and serve for both the high and the low television bands. These often stand on top of the set, like the Belling-Lee "Golden V," and the Labgear "Diamond," or alternatively they can be mounted inconspicuously like the Labgear "Spiral" or again be fixed, in one way or another, to the wall like the Wolsey "Twin-Super."

The Belling-Lee "Golden V" consists of two short telescopic rods with provision for swivelling in several directions and can be used as an ordinary dipole mounted on a picture rail if desired. It provides for reception on both television bands and also on the f.m. band, but should favour the 200-Mc/s band as the rods will not extend to a full-length Band-I or Band-II dipole, the total length being adjustable from 20 in to just over 32 in.

Labgear's new contribution, the "Diamond," is virtually a full-wavelength loop on Band III and a tuned loop on Band I, tuning on Band I being effected by a small pre-set capacitor housed in the top insulator, as shown in the drawing, and some loading inductance in the base. The capacitor enables the loop to be adjusted on any of the Band-I channels. It is directional and should be useful in suppressing ghosts due to multi-path reception. It is said to be effective up to about 20 miles from a station.

A novel twin-band aerial is the Wolsey "Twin-Super" designed for mounting on the wainscot or suspended from a picture rail. It consists of a half-wave Band-III dipole and an approximately three-quarter wavelength Band-III element telescoped into one end, as shown in the photographic illustration. These function as two collinear half-wave dipoles on Band III, the quarter-wave telescoped section serving to produce the necessary phasing to bring the currents in both dipole sections into phase for single-lobe response in the horizontal plane. The aerial is mounted vertically, of course, for vertical polarization. The result of this form of construction is that an appreciable gain, it is said to be about 2.7 dB, is obtained on Band III. The aerial is pleasing to the eye, being covered with a cream-coloured plastic material.

Loft, or attic, aerials need not be so tastefully finished as room aerials, also size is not so important, and full-length multi-element Yagis are permissible for Band III. Consequently for Bands II and III they take orthodox forms, but are made of light-weight materials and have simple types of insulators as they are not exposed to the weather. Belling-Lee have a new indoor range of this kind which includes 3-, 6- and 9- element types made of flat strip with channel-section light-alloy supporting arms. All are factory assembled and folded flat for transit, and this renders them very convenient for

passing through small trapdoors and into lofts. For erection the elements are opened out and snap into place. Only one wing nut has to be tightened and this is for fixing the aerial in position after it has been correctly oriented on its support. The short support is fixed to a joist, or rafter, by two screws.

Band-I loft aerials are invariably contracted in one way or another since few lofts will accommodate a 10 ft or more vertical aerial. No notable changes have been effected in this type, however, which, in general, are made the same as formerly. The Labgear "Bi-Square" is an exception, but it was introduced last year and so strictly speaking is not new.

The "Bi-Square" idea, however, has now been extended to Band II and as the aerial for this band measures about 2 ft 6 in cube, and is said to have a power gain of 10 dB relative to a plain half-wave dipole, it should make an excellent loft aerial. It goes together quite easily, all parts being secured by nuts and bolts.

With the exception of the Labgear "Bi-Square" f.m. aerials call for little comment as they are the familiar types, such as plain dipoles, horizontal "Hs" and 3-element models. Folded dipoles are used in some of the last mentioned models.

Combined aerials embracing the two TV bands and the f.m. band were somewhat more numerous this year, an understandable progress perhaps as provision is now made for f.m. sound reception in several of the new television receivers. The extra aerial at present adds very little to the technical problems involved in multi-band aerial design, as in most cases it takes the form of a simple dipole connected to the common feeder, or a simulation of this effected by adding horizontal quarter-wave elements to an existing Band-I dipole or "H" aerial.

One interesting example is the Telerection range of "Hi-Max" phase-corrected triple-band models. The simplest is a single Band-I dipole broken up into three phase-corrected collinear Band-III dipoles as described last year. To this is now added the Band-II horizontal dipole and this composite three-band unit is used with Bands-I and -III reflectors and directors to build up a variety of types to satisfy different conditions of reception.

Several firms now have adaptor elements which clip on to an existing Band-I television aerial and adapt it for f.m. sound broadcast reception in much the same way as provision was made for Band-III reception in the early days of I.T.A. Meadow-Dale call them "Convertorods." Antiference supply them for attachment to their range of "Hilo" twin-band television aerials and Belling-Lee supply rods easily attached by a wing-nut casting.

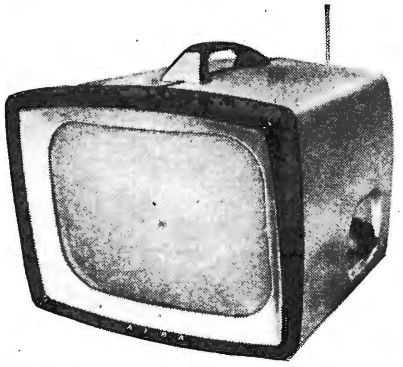
Outstanding among the Band-III only aerials was the "Dale Parabolic" model consisting of a single vertical dipole backed by eight vertical reflector elements arranged on a parabola. It provides a gain of 14 dB relative to a dipole, has a front-to-back ratio better than 36 dB and an acceptance angle of 22° measured from the centre-line of the aerial to the half-power points. Its impedance is 70 Ω so that a good match is achieved with a nominal 75-Ω cable.

TELEVISION

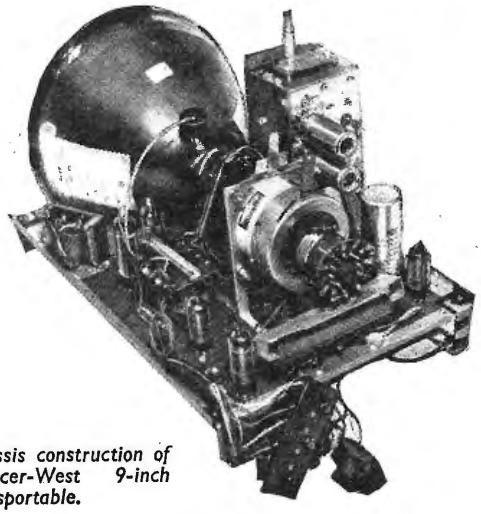
LAST year in our Show Review we gave a general description of a "standard" television receiver circuit which might well have applied to almost any set on view at the exhibition. This year the same circuit description was still valid. We would not like to suggest, however, that only the cabinet designers have been busy while circuit technicians have been taking a rest. The old gibe about the Radio Show being just a "furniture exhibition" has never been entirely justified. On this occasion, for example, one could see that the engineers had been actively engaged on problems arising from such recent techniques as 90° scanning and from the new forms of the television set—the transportable, the receiver incorporating v.h.f. sound, the combined radio-gram/television set. At the same time, there was evidence of quite a number of refinements to the basic circuit and to the overall mechanical design.

Although many more 21-inch sets were on view this year—practically all manufacturers have them now—the sales statistics still show the 17-inch screen to be the most popular size. In the past half year 67% of receivers sold had 17-inch screens, while only 7% had 21-inch screens (the remainder being largely 14-inch receivers). Does this mean that the 21-inch set is too expensive? Or perhaps too big for the average living room?

If one takes the theoretically correct viewing distance of ten times the picture height, one should sit at least 11 ft away from a 21-inch screen—but in how many living rooms is this really convenient or possible? At the more practical viewing distances, the gaps between our 405 lines become



Alba 14-inch transportable set with single rod aerial.



Chassis construction of Spencer-West 9-inch transportable.

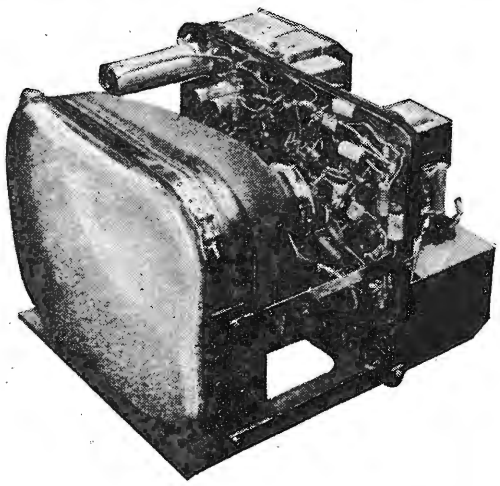
painfully obvious on a 21-inch screen. If this size of picture is correct for school classrooms (judging from the schools' models on show) then it is certainly too big for the home.

Nothing daunted, two firms were showing receivers with 24-inch screens this year. Even though there may be very little danger of implosion these days, the idea of sitting directly in front of one of these monsters is somewhat alarming—not to mention the possibility of X-rays generated by the use of 17kV on the final anode!

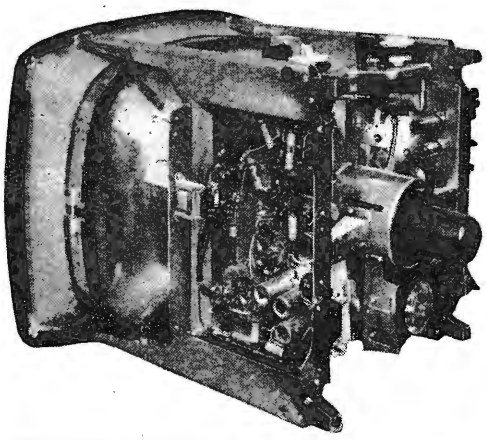
The 14-inch screen seems to have almost disappeared in the latest ranges of conventional table models, but is obviously coming back as a "standard" size for the new transportables, of which about ten makes were on show. This type of receiver, which is smaller, lighter and less expensive than the equivalent table model, is intended as a "second set" for carrying about to other parts of the home. It may, however, prove attractive as a "first set" to many people, in which case it could become a serious competitor to the conventional type of receiver.

The situation is not quite the same as in the U.S.A., however, where price competition is very fierce and the transportable has been introduced primarily to undercut all other models. To achieve such a low price the circuit performance has had to be reduced, in addition to the economies practised on the external design. In Britain, however, there has been no attempt to economize in size, weight or price, at the expense of the performance. The circuit, in fact, is practically the same as in conventional table models, only packed physically into a much smaller space.

Combined radiogram/v.h.f. sound/television set made by Ekco.



Vertical chassis in Sobell 14-inch transportable.



Two vertical chassis in Murphy 21-inch receiver.

Considerable ingenuity has been shown in chassis design in order to achieve this compression. A vertical type of chassis is common, arranged either as one complete section parallel with the tube face (the tube neck passing through its centre), or in two sections parallel with the sides of the cabinet. Printed circuits are used in some models. The problem of positioning chokes, transformers and loudspeakers to keep their magnetic fields away from the c.r. tube becomes acute, and in one case the loudspeaker has been specially designed from this point of view to allow it to be mounted close to the tube neck. High-permeability cores are used in line output transformers to reduce their size. The aerials are telescopic rod types, fixed at the back of the set. Some models have a pair of these elements to form the dipole, while others use only one and rely on the chassis to provide the lower element. Ball joints allow the rods to be adjusted for optimum pick-up in one receiver.

Vertically mounted chassis were seen also in some of the large 21-inch receivers. Here it is the geometry of the tube, with its sharp 90° flare, which makes this type of construction particularly convenient and allows plenty of room for servicing. A new Bush set had the chassis arranged parallel to the screen, while a Murphy receiver used two vertical chassis parallel with the sides. This style of construction is usually accompanied by a "wrap-around" type of cabinet of very simple design which either slides off, like a matchbox cover, or—notably in the transportables—comes apart in two halves.

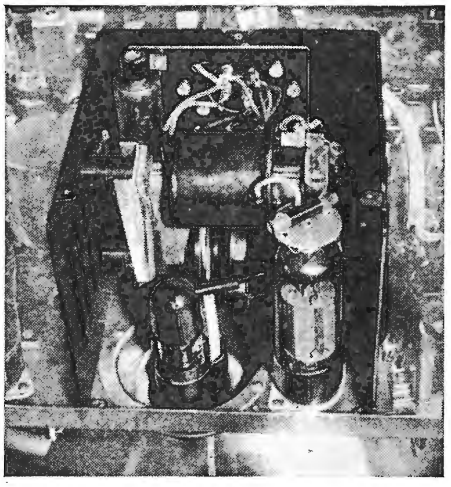
There were many more television receivers incorporating v.h.f. sound on show this year. Since the

Band-II tuning can easily be incorporated in the existing type of television multi-channel tuner, and only a discriminator and perhaps one other valve have to be added in the sound channel, the whole thing can be achieved very conveniently, at an extra cost of only a few guineas. In some models there is just one position on the multi-channel switch for Band II, and the Home, Light and Third programmes are selected by means of the fine-tuning control. This means that the fine tuning must cover a band of about 8 Mc/s instead of the usual 3 or 4 Mc/s required for television. Other models have three separate positions on the tuner for the Home, Light and Third programmes.

The sound take-off point is in the usual place after the common vision-sound i.f. amplifier. Then follow two sound i.f. stages and the f.m. discriminator, one diode of which may also serve as the a.m. sound detector for television. Owing to the loss of gain in the f.m. discriminator, the output of the television a.m. detector normally has to be attenuated to keep the two sound levels balanced when switching between television and v.h.f. programmes. For this reason, some models have to use an extra audio amplifier stage. One maker provides a magic-eye indicator to assist in f.m. tuning.

Having provided a reasonably high quality audio output for these television/f.m. sets, some makers have obviously argued that one might as well make further use of it by adding a gramophone turntable and pickup. Since no separate radio chassis is required, this has resulted in a v.h.f./radiogram/television set which, unlike the combined models of the past, is notable for its compactness and reasonable price. The examples on view were no bigger than an ordinary console television set or radiogram.

Vision a.g.c. circuits are still fairly equally divided between the mean-level system and the gated system (which maintains a constant black level). There have been various refinements, however. Peto Scott have introduced a mean-level system in which the a.g.c. bias voltage is applied to the common i.f. stage and also to the r.f. amplifier. The r.f. voltage, however, is delayed with respect to the i.f. voltage. This prevents an excessive voltage from being applied to the i.f. stage and so causing cross-modulation between vision and sound. Thus in fringe areas the a.g.c. operates only on the i.f. stage, leaving the full r.f. gain available for amplifying the weak signal, while in strong-signal areas any increase in signal above a certain level is taken care of by the delayed a.g.c. on the r.f. stage, to which it is possible to apply the larger bias voltage without encountering difficulties. Incidentally, the Peto Scott arrangement incorporates separate contrast controls for B.B.C. and I.T.A. which can be pre-set to give correct balance when switching from one programme to the other.

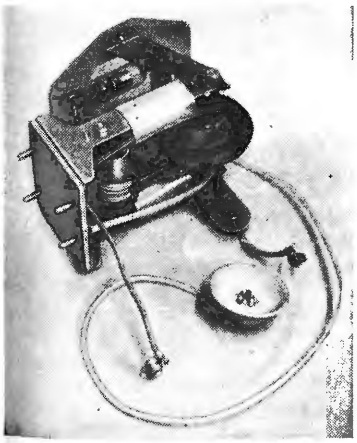


Line output transformer with Bakelite cups in Bush 21-inch receiver.

An experimental system of gated a.g.c. shown by Mullard was designed to avoid the situation when the receiver falls out of synchronization and the gating pulse (which is derived from the line timebase) consequently does not sample the black level but some other part of the video waveform. First of all the video waveform is inverted, so that the sync pulses appear on top, then the sync pulses themselves are inverted again. The resultant waveform is passed to a peak detector which gives a steady output voltage corresponding to the black level. Since this black-level voltage is continuous it can be sampled at any time by the gating pulse so that loss of synchronization will not affect the correct operation of the a.g.c. system.

As for synchronization methods themselves, the two principal systems are still the direct-locking technique and the flywheel sync system, which indirectly controls the frequency of the line timebase. There was, however, some evidence of a refinement to direct-locking circuits which the manufacturers describe as a simple form of flywheel sync. The line timebase oscillator incorporates an LC resonant circuit which produces a "flywheel" effect at the line frequency. Thus the timing of the individual line sweeps is not entirely dependent on the incoming sync pulses but is controlled partly by the natural period of the LC circuit. It is said that this considerably improves the performance on weak signals, when the sync pulses are distorted by noise, and generally reduces ragged edges on the picture. One receiver, incidentally, had a switch to allow the sync to be changed from direct-locking to flywheel according to circumstances.

The requirement of higher scanning power for the new 21-inch tubes with their 90° deflection angles has brought with it a number of incidental



Philco plug-in replaceable line output transformer.

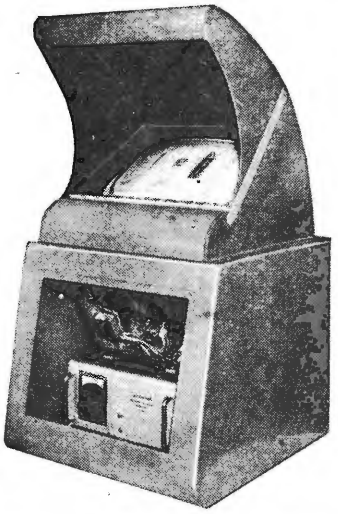
difficulties. For example, the geometry of these tubes does not allow the frame coils to be as large as would be desirable. Consequently they tend to run warm and the resulting change of resistance causes an alteration in frame amplitude and picture height. This has been overcome by means of thermistors in series with the frame coils.

Radiation from line deflection coils is a good deal worse, of course. Most receivers have shielded scannning assemblies to reduce this, but one maker (K-B) has gone further by arranging the line output transformer to drive the line coils in such a way that they are balanced about earth. This reduces the electrostatic field radiated to such an extent that no metal foil screening is required inside the cabinet. As a result it has been possible to build a plate type of internal aerial into the receiver—the chassis forming the lower element of the dipole.

Another safety measure, noted in the line scanning section of a Bush 21-inch set, was the use of Bakelite cups to enclose the windings of the line output transformer. The idea here is to retain the wax impregnation of the coils when they become warm, so that the risk of breakdown is avoided. Line output transformers being notoriously susceptible to breakdowns, it was interesting to see that at least one maker uses a plug-in type which can be very quickly replaced when a fault is suspected.

One of the most interesting television exhibits at the Show was basically nothing to do with domestic reception, though in fact it may eventually enter this sphere. Shown by Decca under the name of Deccafax, it was a facsimile transmission system utilizing the flying-spot principle, by which transparencies (diagrams, patterns, photographs, written messages, etc.) could be sent instantaneously over a video-frequency link. A standard unit is used for both transmitting and receiving, so that a two-way channel can be set up, and the outputs of several units can be mixed to form composite pictures. The system works on 405-line standards and an ordinary television set can, if desired, be used as a receiving unit.

For scanning the transparencies the flying-spot tube has to have a short-afterglow screen phosphor. This gives a bluish light, and a corresponding colour filter is used in front of the photocell mounted in the hood. Since the short-afterglow phosphor by itself produces an unpleasant flicker at the receiving end it is mixed with long-afterglow components giving red and yellow light outputs. These reduce the flicker in reception but do not enter the photocell during transmission because of the blue filter (which incidentally helps to filter out tungsten-lamp room lighting), so that the transmission scanning is done entirely by the short-afterglow component.



Deccafax equipment with Telequipment pattern generator for producing still test pictures.

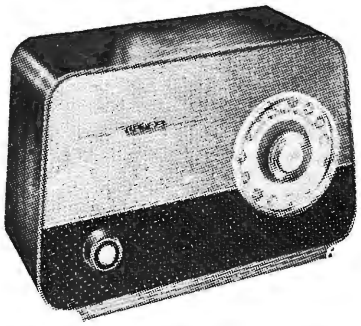
The possible connection with domestic television receivers lies in the fact that Telequipment were demonstrating the use of a single Deccafax unit, in conjunction with one of their own pattern generators, as a means of generating still television pictures for servicing and other purposes. The pattern generator supplies the sync and blanking waveforms to the flying-spot scanner and also accepts back the video signal from the photocell for modulating its own r.f. output. In this way, a complete television picture (which can be a test pattern or any other photographic transparency suitable for the Deccafax) can be generated locally on either Band I or Band III for feeding to the aerial socket of a receiver.

It has also been suggested that television relay companies could use the same equipment for transmitting their own test patterns, or even details of programmes and local advertisements. What the legal position is on this remains to be seen. At any rate, it would probably be quite legitimate for radio dealers to use the equipment to insert their own "commercials" between programmes displayed on receivers in their showrooms—even on Band I!

SOUND RECEIVERS AND REPRODUCERS

MOST of the differences from last year resolve themselves on closer examination as developments of trends already noted at previous shows, for example, the increase in the number of transistor battery portable receivers. The basic design of transistor sets, however, has not yet become stabilized, though to obtain adequate sensitivity a superheterodyne circuit with two i.f. stages is nearly always used. Self-oscillating mixer transistor circuits are generally adopted. As the usable upper frequency limit for commercially available transistors is still only of the order of 1 Mc/s, greater ease of operation and gain can sometimes be obtained by reducing the i.f., and thus reducing the generating frequencies. The i.f.s used this year range from 250 kc/s in the Peto Scott set to the standard 465 kc/s used by K-B and Vidor.

As regards the output, the choice lies between a single-ended stage giving only about 30mW, or a class-B push-pull stage giving about 300mW and corresponding to a small valve battery set. In general, single-ended stages were used in the smallest transistor sets, an exception being the use of a push-pull stage in the small (6in × 3in × 1¾in) Peto Scott model. The impedance of transistors being less than that of valves there are better possibilities of avoiding the use of an output transformer with, in this case, the important advantage of saving space and weight. Such an arrangement was seen in the Pam and Pye sets. Two examples of reflexing, with consequent saving in transistors, were noted in the Cossor and Peto Scott models. In the former, the second i.f. transistor also acts as the first l.f. amplifier; and in the latter, detection, l.f. amplification and



Ultra " Troubadour " f.m. only radio.

d.c. amplification (to provide amplified a.g.c.) are all carried out in the same transistor.

Transistor circuits easily lend themselves to extreme miniaturization. An experimental t.r.f. model built by Siemens-Ediswan was contained in an ordinary 20-cigarette box without difficulty. Besides the Peto Scott set already mentioned, very small commercial models were shown by Perdio ($5\frac{3}{4}$in × $3\frac{1}{4}$in × 1in) and Cossor (6in × $3\frac{1}{4}$in × $1\frac{1}{2}$in). A useful accessory supplied with the latter (particularly in view of its 30mW power output) is an insert earpiece to enable reception to be confined to the hearer.

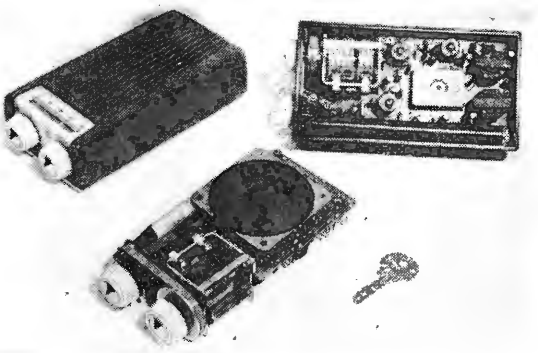
An interesting hybrid battery portable set shown by H.M.V., the 1410 "Mini-sette," uses transistors only in the push-pull output stage. The current consumption is normally greatest in this stage so that it is here that the low consumption of transistors offers the maximum advantage.

Though there were also few changes in a.m./f.m. sets the design of these is not so stabilized as the standard four valves plus rectifier arrangement in a.m. sets. This is due to the somewhat differing amounts of ingenuity thought worth while to enable valves to be used both for a.m. and f.m. reception; and to the occasional adoption of separate pentode r.f. amplification on f.m., instead of using a double-triode to provide both r.f. amplification and mixing. Sets for f.m. only, with which the Ultra "Troubadour" FM950 may now be included, remain rare, perhaps corresponding to the relative scarcity of push-button three-station a.m. sets.

Unlike table record players or radio-grams, not many table receivers offer improvements in the audio specification such as multiple speaker systems, improved speaker loading, or a push-pull output stage. This difference between receivers and record players is somewhat surprising as such improvements can be taken advantage of in v.h.f./f.m. reception as well as in the reproduction of modern gramophone records.

Record Players and Radio-grams.—Like sound receivers, the accentuation of previously noted trends provides most of the change. For example, almost every exhibitor now markets one or more record players. Transistor battery models are also now common, push-pull output stages being invariably used in this case. Multi-speed full-size transistor models were shown by Philco (A3755) and Pye, the latter using a Goldring variable-reluctance pickup. Although a transistor radio-gram is now an obvious possibility, only one, the Cossor 545 (45 r.p.m.) model, was seen.

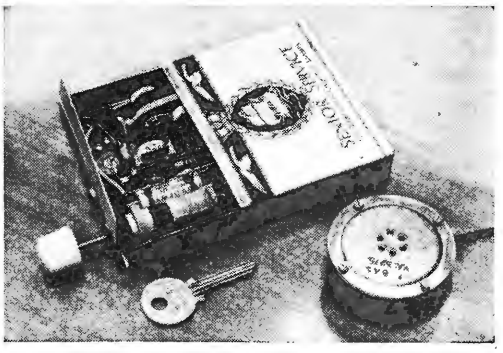
As we have already mentioned, table record players and radio-grams with improved audio specifications can readily be obtained. For example, in the Philco A3764 "Phonorama," when the heavy lid is closed over the record player an airtight seal is formed which completes a resistively loaded reflex cabinet for the 8-in speaker, to give a response down to 60 c/s. The a.m./f.m. tuner and 8-watt



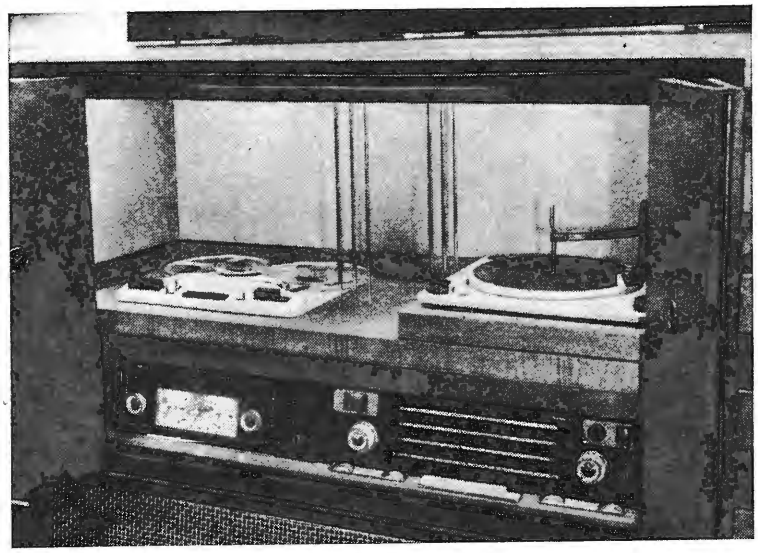
Peto Scott transistor receiver.

H.M.V. valve and transistor "Mini-sette."

Cossor transistor radio-gram.



Siemens-Ediswan prototype t.r.f. transistor set.



Ferguson radio-gram with tape recorder and clock switch.

"ultra-linear" push-pull amplifier are placed in the (large) port tunnel. A diffuser spreads the radiation from the 4-in tweeter. An economical circuit, noted in the Ferguson 393G "Fortune" record player, uses two triode-pentodes to provide amplification (sufficient to allow useful negative feedback) and phase-splitting from the triodes, and about 5 watts push-pull output from the pentodes.

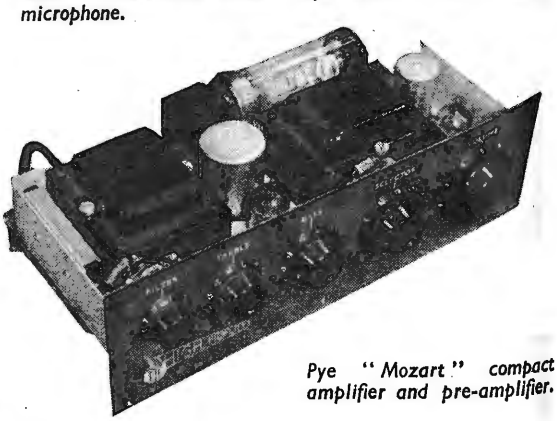
Multiple speaker systems giving a large apparent sound source (3D) and, it can be claimed, reducing intermodulation distortion, remain very popular. A simple, often used arrangement, is to capacitively couple one or more small (3- or 4-in diameter) moving-coil tweeters to the audio output. Five speakers (one 12-in Goodmans Audiom 60 bass unit, two 8-in × 5-in elliptical mid-frequency units and two 5-in tweeters) are used in the R.G.D. "Victoria" radio-gram, the Audiom 60 being fitted in a resistively loaded bass-reflex enclosure. In this set a 16-watt push-pull amplifier with separate bass and treble controls is also incorporated, and a variable reluctance pickup with diamond stylus is used.

In the loudspeaker used in the H.M.V. 1134 a.m./f.m. table receiver two cones are attached to the same voice-coil. Another way of improving reproduction is to operate two similar speakers in parallel, as in the Sobell RPS77 record player. Since each speaker then handles only half the output, the speaker distortion for a given output is reduced. In addition, if they are placed close together, their mutual interaction will produce a rise in efficiency at low frequencies, leading to a further reduction in distortion (see article "Loudspeakers in Parallel" by J. Moir, in this issue). Irregularities in response will also tend to be smoothed in the overall output. Alternatively, two dissimilar speakers may be operated in parallel to compensate for deficiencies in each other's response as, for example, in the Bush RG66 a.m./f.m. radio-gram (also fitted with a 4-in tweeter).

Tape Recorders and Reproducers.—A number of new models were seen. In the E.A.P. "Elizabethan Essex" (the new name for the "Triple Three" mentioned in our Show Guide) a push-pull bias oscillator offers a reduced d.c. component in the output with consequent decrease in the recording noise level. The 6-watt push-pull "ultra-linear" stage feeds a 9-in × 5-in bass speaker and two 3-in tweeters. A ribbon microphone is provided. In the Winston "Thoroughbred" volume controls on both the low (2mV) and high (200mV) level inputs allow full mixing facilities between these two sources. Two double-electrode small electrostatic tweeters are included (also noted in the Bush VHF64 a.m./f.m. table radio). The Baird recorder is unusual in having a single-ended "ultra-linear" output stage. As has been shown by Leakey (*Jnl. of the B.S.R.A., May,* 1957) such feeding of a pentode output valve's screen from a tapping on the output transformer has certain advantages even if the output is not push-pull. The above three recorders used the Collaro 3-speed tape deck.

R.C.A. showed a stereophonic tape reproducer whose external appearance matched that of their "Vice-President" record player, the amplifier and speaker in both units being intended to be used together in stereophonic reproduction. A 3-speed tape deck with two stereophonic heads is used, one for recording and one for monitoring. Single-channel recording and playback facilities are also provided.

E.A.P. "Elizabethan Essex" tape recorder with ribbon microphone.



Pye "Mozart" compact amplifier and pre-amplifier.

Stereophonic reproduction was also demonstrated using versions of the G.E.C. "Periphonic" system. Four "Presence Unit" tweeters in a horizontal line are used in each of the two systems, the input levels to the individual tweeters being differently graded in each case. This produces suitable high-frequency angular responses to give the differential intensity differences required for stereophonic reproduction (see Brittain and Leakey, *Wireless World*, Vol. 62, p. 208, May, 1956).

With increasing activity in tape recording some of the radio-grams shown, such as the Portogram TR100 (f.m.-only model), also included a tape recorder. In the Ferguson 403 tape radio-gram, a clock switch enables recordings from the a.m./f.m. receiver (which is automatically allowed 7 minutes' warming-up time) to be made at any preselected time within a minute, the apparatus being switched off when the tape unthreads from the emptied spool. The Ferguson 403 also includes a 10-watt push-pull amplifier with bass and treble controls, which can be switched out so that an immediate estimate of their effect is possible. The sound level from the three 4-in tweeters, relative to that from the 13-in × 8-in bass speaker, can be varied by a three-position control.

New Units for Sound Reproduction.—A somewhat unusual speaker mounting on a board placed across the corner of a room near the ceiling was seen in the T.S.L. "Concert Sound Corner." Back radiation downwards being blocked by an attached board at right angles, such radiation passes upwards to the corner, and is then reflected downwards into the room. This provides some approximation to horn loading.

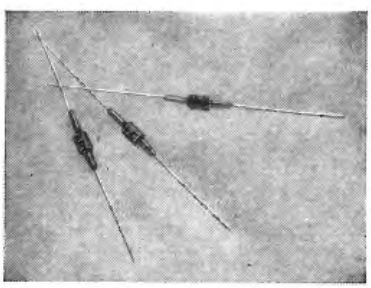
A compact ($10\frac{1}{2}$in × 5in × $3\frac{3}{8}$in) combined amplifier and pre-amplifier, the "Mozart" HF10, was shown by Pye. For an input of 10mV the output is 9 watts with 0.3% distortion. Bass and treble controls and four treble filter cut-off frequencies are provided. Simple compensation for different pickup sensitivities and impedances is also available. Another new 15-watt amplifier and pre-amplifier, the Lintronic "Wessely HF15," includes controls to give a continuously variable treble cut slope at two alternative frequencies, and to alter the relative levels of treble and lower frequencies (presence control).

The latter amplifier was also used in the "Wessely Symphonette Royale" record reproducer, which also incorporates a Garrard 301 transcription turntable, B.J. "Super 90" pickup arm with Tannoy variable reluctance cartridge and Thermionic Products "Microlift" pickup arm control, and also the "Dust Bug" anti-static dust remover.

A new ceramic pickup cartridge, the E.V. "Power Point," is designed to be very simply replaceable as a whole in the mechanism (turnover, turnunder or fixed alternatives are available). Response is within ±5dB of 250mV output from 50 c/s to 10 kc/s, the compliance being 10^{-6} cm/dyne. The needle is connected directly to the ceramic generating element.

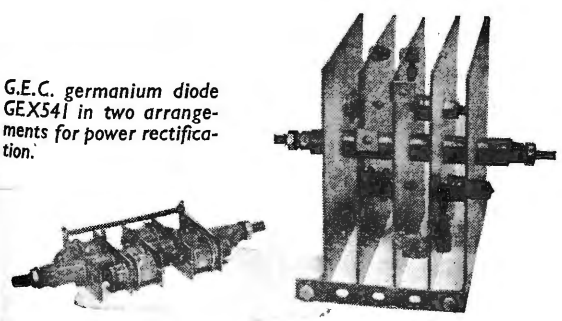
A prototype single-ended transistor audio amplifier using a new type of sliding bias to give almost doubled output was shown by Mullard. A rectified fraction of the output is fed back to shift the working point as the drive increases, this resulting in an increased output for a given dissipation or size of heat sink. If this fraction is fed back to the driver stage, rather than to the output as is usual, the increased gain allows much better d.c. gain stabilization. Moreover, the feedback time constant can be made so short that transient distortion due to this cause is virtually eliminated.

RECTIFIERS, VALVES AND C.R. TUBES



Group of S.T.C. silicon Zener diodes.

G.E.C. germanium diode GEX541 in two arrangements for power rectification.



SEMICONDUCTOR junction diodes, both silicon and germanium, are threatening very seriously the supremacy of the conventional metal rectifier in some power-supply applications. The reasons are their greatly superior rectification efficiency and extremely small size for a given power rating. As a striking example of what can be done, S.T.C. were showing a 17-inch television receiver in operation with its entire h.t. supply of 220mA derived from an experimental silicon diode about the size of a $\frac{1}{2}$-watt resistor. In the same receiver the efficiency diode was made up of four of these units, handling altogether 240mA mean at 4.5kV.

S.T.C. have, in fact, three ranges of these silicon diodes—a $\frac{1}{2}$-amp range, a 1-amp range and a 5-amp (development) range—all being available with peak inverse voltage ratings of 50, 100 and 150 volts. Being silicon, they will operate at ambient temperatures up to 100°C. The $\frac{1}{2}$-amp types do not require "heat sinks," but the larger ones do, and have threaded studs for mounting on to cooling fins.

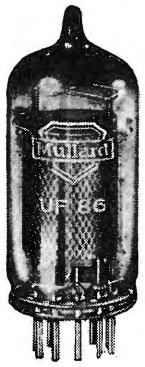
Germanium power rectifiers were represented by a new junction diode, GEX541, on the G.E.C. stand. This can be used in various series, parallel and series-parallel arrangements to provide d.c. supplies of anything up to about 30kVA, and will operate successfully at ambient temperatures up to 55°C. An example on show was a 3-phase bridge rectifier giving a d.c. output of 74 volts at 7.5 amps from

an a.c. input of 55 volts r.m.s. This firm also had a range of four silicon diodes and a new power transistor, the GET15, suitable for audio output stages. Two of these transistors operated in Class-B push-pull will give an output of 1 watt, using a 6-volt power supply.

Both S.T.C. and G.E.C. were also showing some special semiconductor junction diodes intended for voltage reference purposes. Known as Zener diodes, they have a low breakdown voltage in the reverse direction, with a fairly sudden turnover and a small slope resistance after the turnover point. If the Zener diode is biased in the reverse direction to just beyond the turnover point, any increase in reverse current will result in an almost constant voltage being developed across the device—the actual variation of voltage depending on the slope resistance. This reverse characteristic can therefore be used as a voltage reference or for voltage stabilization.

In receiving valves, the most notable exhibit this year was a new double triode from Mullard, the PCC89, intended for use as a cascode r.f. amplifier in television multi-channel tuners. The valve has a variable-mu frame grid construction to assist in the reduction of cross-modulation effects, and in the normal cascode series connection the mutual conductance is as high as 12.5mA/V for an anode current of 15mA. This permits a considerable increase in r.f. gain. Another new double triode was the Brimar type 5965, intended for use in two-state circuits in digital computers.

The electrostatically focused cathode ray tube is now coming into much wider use in television receivers. It saves the extra weight and cost of magnetic focusing assemblies, and requires no adjustment once it is set because there is practically nothing to cause drift. The focusing is



Mullard low-noise pentode, UF86, for 100 mA a.c./d.c. operation.

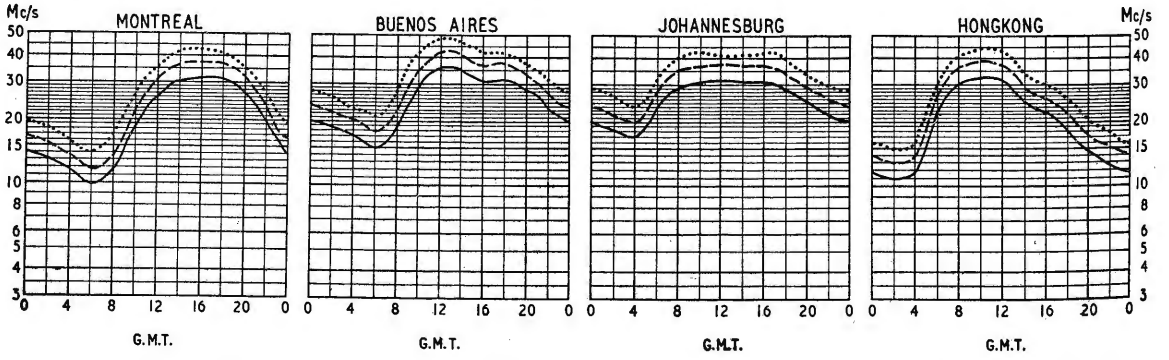
achieved by a short cylindrical electrode which surrounds a gap in the long final-anode cylinder. A fairly low potential is applied to this electrode (anything between 0 and 400 volts, according to the c.r. tube) which therefore produces an electrostatic lens action between itself and the two high-voltage ends of the final-anode cylinder. The configuration of equipotential lines is such as to bring the electron rays to a focus at the screen. New c.r. tubes of this kind were shown by both Siemens-Ediswan and Brimar.

The 24-inch tube mentioned earlier under the heading of "Television" is also a Brimar product. Known as the C24KM, it has a pentode electron gun with three anodes—a first anode, a pre-focus anode and a final anode. It does, however, require magnetic focusing as well. The final anode voltage is 17kV. Incidentally this firm has recently introduced a range of c.r. tubes in which a substantial increase in screen brightness is obtained by the use of a phosphor containing a new type of activator.

As an aid to the servicing technician, G.E.C. have produced a 6-inch "setting-up" c.r. tube which can be plugged into any popular television set using a 14-inch, 17-inch or 21-inch tube. Owing to its small size and weight, compared with the normal tubes, it is very convenient to handle, and when plugged in leaves a good deal of extra space, which is useful in gaining access to other components. It is available in two versions, one for magnetic focusing and the other for electrostatic focusing.

SHORT-WAVE CONDITIONS

Prediction for October



THE full 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 October.

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

•••••••••• FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

"Nearest Approach" Calculator

Rapid Interpretation of Marine Radar Screen Information

By A. L. P. MILWRIGHT*

IF a mariner wishes to determine the closest passing distance of his ship from any other ship by means of radar, it can be done quite simply by plotting the ranges and bearings of the other vessel's echo. The line joining the plotted positions indicates the relative course of the other vessel and by extending the relative course line the closest passing distance can be measured.

With the existing method of measuring bearing by means of a mechanical cursor, with its attendant possible inaccuracies, it is necessary to plot a number of positions and draw the relative course line as a mean through the plotted positions. The time taken to establish the nearest approach is therefore comparatively long (approximately 3 minutes if the "target" vessel is some distance away). If an electronic bearing cursor were to be used the time to determine the nearest approach could be reduced since the accuracy of the measured bearings would be higher, and fewer measurements would be required.

It may however be inconvenient to move from the radar screen to the plotting table and if plotting is done on the face of the p.p.i. or a reflection plotter the accuracy may be poor, particularly if the nearest approach is determined by extending a relative course line formed by two plotted positions close together, using a blunt wax pencil.

In the case of a true motion radar the nearest approach is not so readily available as with the relative display, and the operator will have either to construct a relative plot from his true plot or change the picture to a relative picture and from that construct a relative plot.

A Direct Answer

Various methods have been suggested notably by Topley[1] and Wylie[2] of determining the nearest approach without having to plot by using two radar ranges and a change of bearing, but both these methods present the information as a percentage of the initial pick-up range of the target. This may require the mariner to do an annoying little sum, e.g., 18% of 4.9 miles. To provide a simple method of determining nearest approach when using a true motion display the Ministry of Transport and Civil Aviation's Research group at the Admiralty Signal and Radar Establishment have developed a simple calculator.

The principle of the calculator is as follows. Suppose an incoming vessel is first observed at range R_1 (Fig. 1) and that after a short period of time the range has changed to R_2 and its bearing has changed by an angle α. Let the nearest approach distance be d and let θ be the angle BAO.

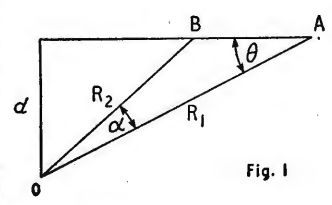


Fig. 1

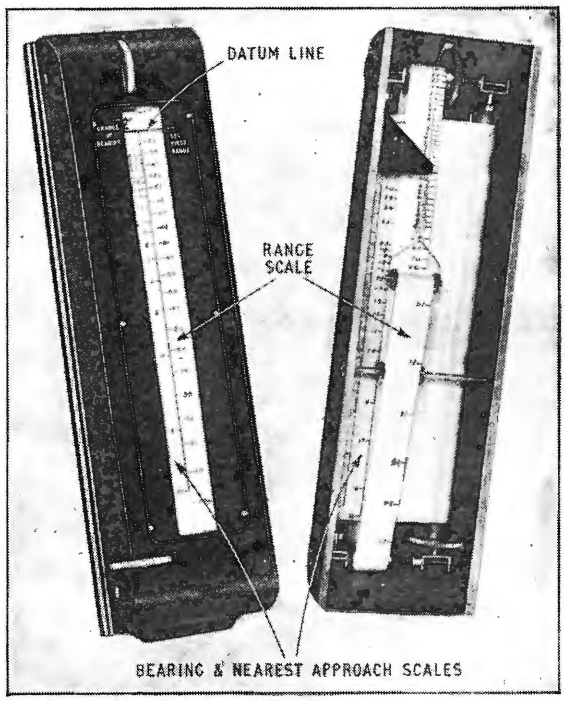


Fig. 2. Front and rear views of the A.S.R.E. "nearest approach" calculator.

Then $d = R_1 \sin\theta$ and $\dfrac{\sin\theta}{R_2} = \dfrac{\sin\alpha}{AB}$

also $\cos\theta = \dfrac{R_1 - R_2\cos\alpha}{AB}$

$$\therefore \sin\theta = \frac{R_2\sin\alpha}{AB} = \frac{(R_2\sin\alpha)}{(R_1 - R_2\cos\alpha)}\cos\theta$$

$$\therefore d = \frac{(R_1R_2\sin\alpha)}{(R_1 - R_2\cos\alpha)}\cos\theta$$

For small values of α, $\cos\alpha$ can be taken as unity, and if d is much smaller than R_1, $\cos\theta$ can be taken as unity since $\cos\theta = \sqrt{1 - \dfrac{d^2}{R_1^2}}$

$$\therefore d \approx \frac{R_1R_2\sin\alpha}{R_1 - R_2}$$

$$= \frac{\sin\alpha}{\dfrac{1}{R_2} - \dfrac{1}{R_1}}$$

Suppose we plot a scale (A) where the lengths

*Admiralty Signal and Radar Equipment.

(denoted by R_1R_2) from some fixed point (datum) are proportional to $\frac{1}{R_2}$, $\frac{1}{R_1}$ then the length between R_1 and R_2 will be proportional to $\frac{1}{R_2} - \frac{1}{R_1}$. If this length is now measured from the datum the scale reading obtained would be $\frac{1}{\frac{1}{R_2} - \frac{1}{R_1}}$.

By having a second scale B placed alongside A and calibrated such that the lengths denoted by R_1R_2, etc., on scale " A " are denoted by $R_1 \sin \alpha$, $R_2 \sin \alpha$, etc., then the operation $\frac{\sin \alpha}{\frac{1}{R_2} - \frac{1}{R_1}}$ can be carried out as follows:—

1. Set the first range R_1 on scale A, opposite the datum of scale B.
2. Note the reading on scale B opposite the reading R_2 on scale A.

The reading so obtained is equal to $\frac{\sin \alpha}{\frac{1}{R_2} - \frac{1}{R_1}}$ which as has been shown is a very close approximation to the nearest approach distance. A series of " B " scales would be required for each value of α.

Since the answer provided by the calculator is only an approximation, let us examine the error involved.

Let the actual distance of nearest approach be d and that obtained using the calculator be $d_{calc.}$

$$\text{Then } d = \frac{R_1R_2 \sin \alpha}{R_1 - R_2 \cos \alpha} \cos \theta$$

$$d_{calc.} = \frac{R_1R_2 \sin \alpha}{R_1 - R_2}$$

$$\therefore \frac{d}{d_{calc.}} = \frac{R_1 - R_2}{R_1 - R_2 \cos \alpha} \cos \theta$$

$$= \frac{1 - R_2/R_1}{1 - R_2/R_1 \cos \alpha} \cos \theta$$

$$= \frac{1 - \frac{\sin \theta}{\sin (\theta + \alpha)}}{1 - \frac{\sin \theta \cos \alpha}{(\sin \theta + \alpha)}} \cos \theta$$

$$= \frac{\sin \theta \cos \alpha + \cos \theta \sin \alpha - \sin \theta}{\cos \theta \sin \alpha} \cos \theta$$

$$= \left[1 - \tan \theta \left(\frac{1 - \cos \alpha}{\sin \alpha}\right)\right] \cos \theta$$

Assuming a limiting case when $\alpha = 5°$ then

$$\frac{1 - \cos \alpha}{\sin \alpha} < 0.044.$$

$$\therefore \text{ in the limiting case}$$

$$\frac{d}{d_{calc.}} = (1 - 0.044 \tan \theta) \cos \theta$$

$$= \cos \theta - 0.044 \sin \theta$$

Since $\sin \theta = \frac{d}{R_1}$ we have a relation between d, $d_{calc.}$ and R_1. Giving R_1 the values 12, 8 and 4 miles the values of d corresponding to chosen values of $d_{calc.}$ have been calculated and are shown in the table.

R_1 = 12 miles		R_1 = 8 miles		R_1 = 4 miles	
$d_{calc.}$	d	$d_{calc.}$	d	$d_{calc.}$	d
3.0	2.872	2.0	1.914	1.5	1.366
2.0	1.957	1.5	1.461	1.0	0.957
1.0	0.993	1.0	0.987	0.5	0.493
0.5	0.499	0.5	0.498	0.25	0.249

As can be seen from the table the accuracy of the calculator is high, particularly when the nearest approach is small.

The calculator can be constructed in a number of forms and a preferred type is shown in Fig. 2. This consists of two endless belts moving at right angles to each other and operated by the knurled knobs at each end. The range scale on the right (in the front view) is calibrated from 2 to 15 miles. The scale on the left is the nearest approach scale and ten such scales are provided at half-degree intervals for bearing changes of between 1 degree and 5 degrees. The bearing change is shown in the upper left-hand corner of the window.

In order to use the calculator all that is necessary is to proceed as follows:

1. When an echo is seen on the radar screen set the bearing cursor over the echo and measures its range.
2. Rotate the upper knurled knob of the Calculator until this measured range is coincident with the datum line (marked " set first range ").
3. Wait until the bearing has changed and then measure the *change* of bearing and the new range.
4. Rotate the lower knurled knob until the bearing change appears in the upper corner of the window.
5. Read off nearest approach distance on the left-hand scale opposite the second range of the target on the right-hand scale.

Provided both ships do not alter course the nearest approach distance can be checked for various bearing changes without having to reset the range scale.

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Wylie, F. J. " The Region of Collision." *Journal of Inst. of Navigation.* Vol. IX, p. 161 (1956).

Precision Plug-in Wirewound Resistors

AN unusual type of precision wirewound resistor has been introduced by Alma Components, Ltd., 165, Ossulston Street, London, N.W.1. It has a standard octal-valve plug-in base and can be supplied with up to six tappings which, by suitable external switching or interconnection, provides a wide choice of values with any one component. The plug-in feature enables this whole family of values to be instantly changed.

Alma plug-in, tapped, precision wirewound resistor.

The resistance wire is non-inductively wound on an eight-slot, ceramic former securely fixed to the base and finally " potted " in a non-hygroscopic resinous compound. Resistors are wound to specific requirements and in values up to 5 MΩ, with tolerances of from ±5% down to ±0.1% as required, normally at 25°C. The rating is $\frac{1}{8}$ W per section.

New Radio Telescope

OPENING OF THE MULLARD OBSERVATORY AT CAMBRIDGE

THE new Mullard Radio Astronomy observatory outside Cambridge was opened on July 25th by Sir Edward Appleton. The project has been financed jointly by Mullard, Ltd., the Department of Scientific and Industrial Research, and Cambridge University itself. The Mullard contribution of £100,000 provided more than half of the total sum required.

The methods used for measuring very low-level signals[1] (even below receiver noise) after they have been collected by the aerial remain relatively unchanged. For this reason and also more obviously because of their size and expense, the aerials usually excite the main interest at such observatories. In addition the two aerial systems at this observatory use a new technique known as "aperture synthesis"[2] to provide the maximum resolving and collecting power for a given structure size and weight.

The output voltage from a normal aerial such as a mirror may be regarded as being obtained by the appropriate combination of the voltages from a number of elementary aerial subdivisions of the mirror. The new technique is to use small movable aerials to take up in turn the positions of the various elements of a much larger aerial. Then, from the measured voltages given by the small aerials, the voltage which would be received by the large aerial can be calculated. The large aerial is then said to have been "synthesized." Since the combined output voltage involves vector products of the elementary voltages, it becomes necessary to use two elementary aerials.

Two additional factors give a considerable reduction in the total number of observations necessary. In the first place, in many of the element pairs the aerial elements are in the same relative position (have the same spacing and orientation), and all such similar pairs will give identical voltages. Thus

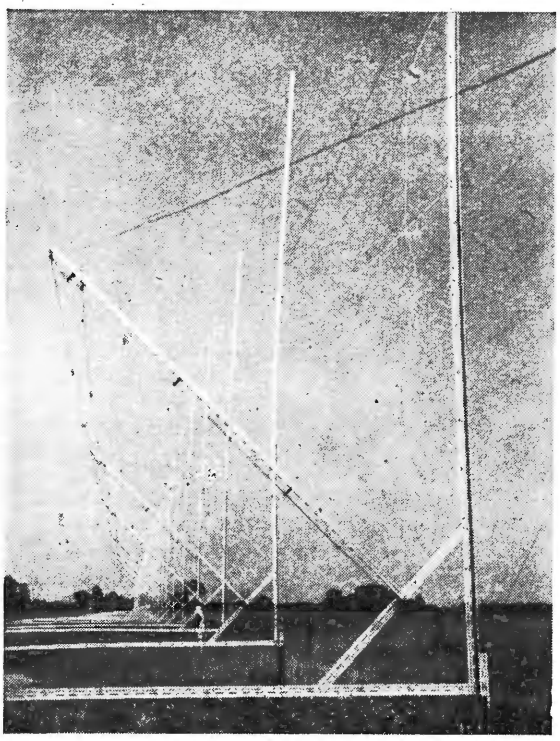

Fig 2. Part of the fixed aerial for use on 7.9m in synthesizing a single aperture.

the voltages need only be measured for each different relative position of the two elements, provided that we multiply the voltages for each different relative position by a factor proportional to the number of times that relative position occurs in all the possible element position pairs. Secondly, by suitably altering the phases of the voltages from the elementary aerials the synthesized aerial lobe may be rotated to give a maximum response anywhere within the lobe of one of the elementary aerials. Thus, once the elementary aerial voltages have been measured, it is possible to compute the voltage which would be given by the synthesized aerial in a number of different orientations. A similar technique for rotating the lobe of an aerial without physically moving any of its elements is often used in radar communication systems.

There is no need for the two elementary aerials to be the same size. In

[1] See for example *Wireless World*, July 1951, Vol. 47, p. 275.
[2] Described in "The Mullard Radio Astronomy Observatory, Cambridge," by M. Ryle, F.R.S., *Nature*, July 20, 1957, Vol. 180, p. 110.

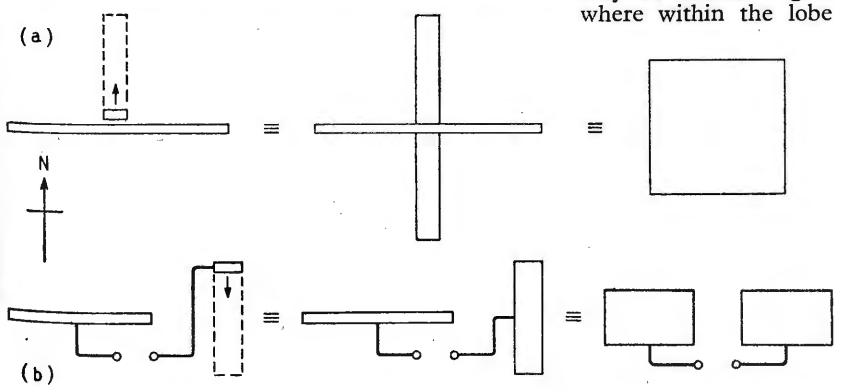

Fig. 1. The synthesis of (a) a single aperture, and (b) an interferometer; using one long fixed and one moving aerial. (Adapted from Fig. 2 of Reference 2).

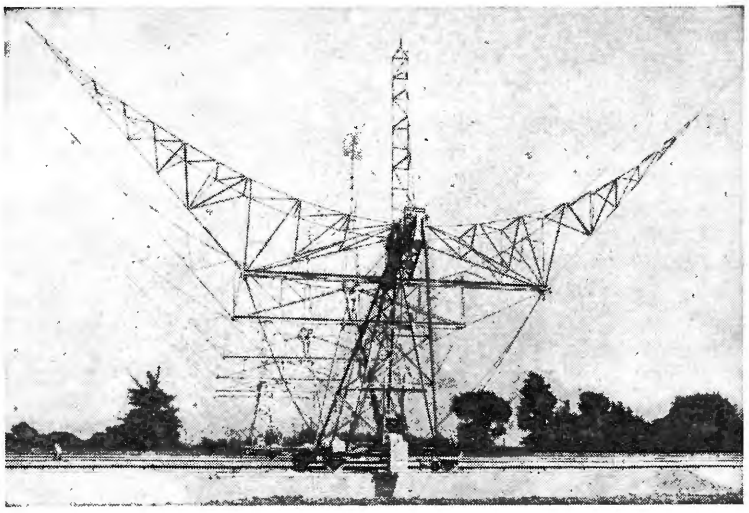

Fig. 3. Moving aerial of the radio star interferometer for 1.7 metres

the new systems one of the aerials is made comparable in size with the synthesized aerial so that it need not be moved at all. This also simplifies the measurement and computation process. A large aerial can be most economically built as a long line, since rotation about the long axis can be achieved without the need for a high or sturdy structure. If this aerial is arranged to run east to west, then, as the earth rotates, it also rotates in a plane at right angles to its long axis. All the different relative spacings of the elementary aerials can then be obtained if the small aerial moves at right angles to the long fixed one. According as to whether the path of the moving aerial cuts the long fixed aerial or not, the resulting effective synthesized aerial is a single aperture, or two apertures separated by a fixed distance forming an interferometer. These alternatives are shown schematically in Figs. 1a or 1b respectively. The lobe width in the equatorial plane and the earth's rotation rate fix the total time available for observation of any one source, or for "integration" of its signal. This imposes some restriction on the relative size and shapes of the two aerials in an optimum design.

Both of these two types of synthesis will be used in the new observatory. The arrangement for synthesizing a single aperture (Fig. 1a) will be used at a wavelength of 7.9 m to measure the galactic background radiation, and thus study galactic structure. The fixed east-west aerial is 3,200 ft long; the other is 110 ft long and can be moved over a distance of 1,700 ft. Each aerial is in the form of a corner reflector with an aperture of 40 ft. Part of the fixed aerial is shown in Fig. 2. For readers who are more used to reflecting surfaces, such as ordinary astronomical mirrors, which "look like" reflectors, it should perhaps be pointed out that the reflecting surfaces for both these aerial systems are formed by conducting wires spaced out on suitable frames. If this spacing is a small fraction of the wavelength used, then, at this wavelength, the wires will give nearly perfect reflection. The synthesized reception lobe on the 7.9 m aerial will be about 1 degree square, and the equivalent collecting area about 2×10^5 sq ft. The number of elementary positions of the movable aerial is about 75, so that a complete set of observations in a given rotation position will take at least this number of days. In a plane at right angles to the long axis the lobe width of the individual aerials is about 60° so that only three (or perhaps four to allow some overlap) rotation positions about this axis are necessary. The angle of rotation about the long axis is determined simply by the length of guy wires supporting the corner reflectors.

The arrangement for synthesizing an interferometer (Fig. 1b) will be used at a wavelength of 1.7 m to study sources of small angular diameter (radio "stars"). This wavelength was chosen as a compromise between the requirements of sensitivity (both the flux from the source, and the sensitivity of the receivers used, increase with increasing wavelength), allowable constructional errors (these are proportional to the wavelength), and gain and resolving power (both of which increase with decreasing wavelength for a given aerial). The fixed east-west aerial for 1.7 m is 1,450 ft long: the other is 190 ft long and can move up to 1,000 ft on railway lines. Both aerials are cylindrical parabolas with an aperture of 65 ft. The movable aerial is shown in Fig. 3. The synthesized reception lobe will be about 25 by 35 minutes of arc and this will contain an interference pattern in the plane of the equator with a lobe width of about 8 minutes. The equivalent collecting area will be about the same as the other aerial system—1.9×10^5 sq. ft. The number of elementary positions of the movable aerial is about 20. The lobe width of the individual aerials in a plane at right angles to the long axis is only about 4 degrees. Thus many rotation positions about this axis are necessary, and more precise mechanical methods of rotation have been adopted than those used for the other aerial system.

Although the operational wavelengths of the two aerial systems are not essentially fixed, altering these will involve changing the considerable number of full-wave receiving dipoles along the long axes of the aerials.

The large amount of computation involved in the synthesis method will be handled on EDSAC.

National Lending Library

WITH the ever-growing volume of scientific and technological journals published throughout the world the task of maintaining a really comprehensive library in an industrial organization is a major problem, and a considerable amount of material is therefore destroyed from time to time. The Department of Scientific and Industrial Research will be glad to receive such material for the recently formed National Lending Library. Offers of journals (not U.K. publications), which should cover at least six years and, if unbound, be 80 per cent complete, should be sent to the D.S.I.R. Lending Library Unit (20 Chester Terrace, London, N.W.1), of which the Technical Information and Documents Unit, which issues the "unpublished reports" referred to in "Technical Notebook," is now a part.

Loudspeakers in Parallel

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

INCREASE OF APPARENT SOURCE SIZE NOT ONE OF THEIR ADVANTAGES

MANY of the advantages of a stereophonic sound reproducer are due to the impression of source size that is transmitted, and it is natural (though quite wrong) to believe that the use of multiple speakers on a single channel will increase the apparent size of the source and thus have the same advantages. Two loudspeakers are clearly twice the size of a single speaker, and it is easy to fall into the error of thinking that our ears take the same "view" as our eyes. However, this is one of the few instances where plain common sense is quite wrong, for two loudspeakers with their voice coils in parallel (or series) convey the same impression of size as a single speaker, however they are mounted or spaced.

This is not to suggest that two loudspeakers in parallel have no advantages over a single speaker, it is just that the advantage of an increase in the apparent size of the source is not obtained. The merits of paralleled speakers will be discussed after considering this source size anomaly.

If two similar loudspeakers are spaced 8-10 ft apart (as they might be in a domestic stereophonic system, but with their voice cells in parallel), the apparent position of the sound source will depend on the listener's position with respect to the speakers, and on the relative polarity of the voice coil connections. With the voice coils in phase (both cones moving in the same direction) a listener seated on the median line, as in Fig. 1 (a), will always locate the sound source on the same line somewhere behind the loudspeakers. With a single artiste the lateral position is quite sharply defined, and, though the definition is less sharp with a large source such as an orchestra, it is important to note that the apparent size of the orchestra is the same as is given by a single speaker. The reproduced orchestra appears to occupy about two cubic feet of space about the centre line, giving the subjective impression that one is listening to a very small reproduction of a large-sized orchestra.

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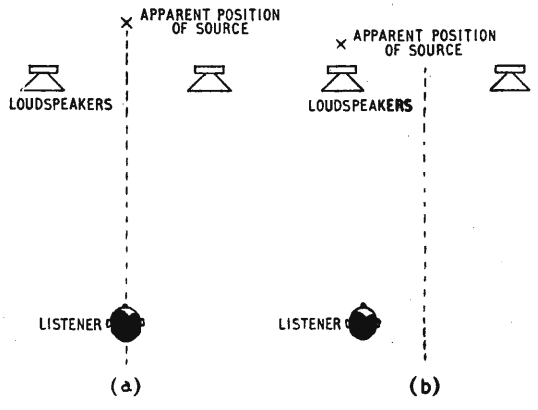

Fig. 1. (a) To a listener on the axis, the source of sound appears to be on this axis, but behind the speakers. (b) To a listener off the axis, the source of sound appears to be slightly behind the nearer speaker.

Effect of Moving Off Centre

If the listener moves off the median line, as shown in Fig. 1 (b), the virtual artiste starts to move with him in the same direction, but after a movement of only a few inches the source moves fairly sharply to just behind the nearer loudspeaker, and the remote loudspeaker apparently ceases to sound.

If the listener moves some way to the right, all the sound appears to come from the right-hand speaker, and the left-hand speaker seems to contribute nothing to the acoustic picture.

Though there is a strong subjective impression that the remote loudspeaker is making no contribution to the total effect, open circuiting its voice coil produces a sharp increase in the acoustic definition of the sound source, and places the virtual artiste at the position of the single speaker. Thus the use of a second speaker only appears to add "vagueness" to the apparent position of the artiste. This is a lesson that the film sound engineer learnt the hard way back in the early 1930's, when several of the film equipment companies endeavoured to obtain complete coverage of a large theatre by the use of a multiplicity of cone speakers mounted on flat baffles round the perimeter of the picture screen. Though superficially attractive, and technically sound from some points of view, the performance is poor, so this solution has been abandoned by all film sound engineers.

The previous discussion began with an indication that the speaker voice coils were connected in phase, for when they are out of phase the effects are quite different. With the listener seated on the centre line, as in Fig. 1 (a), reversal of the connections to one voice coil produces a well-defined impression that the artiste has been bisected and one half moved out to each of the loudspeakers. Further experience leaves the listener quite unable to decide where the artiste is supposed to be, presumably

because the listener is presented with an acoustic experience which never occurs in real life. When listening to an actual performance, all the frequency components below about 1 kc/s must arrive with the same phase, or at least the same polarity, at both ears, irrespective of the position of the sound source. Signals from a reproducer system that arrive with opposite polarity at the two ears serve to confuse the hearing system and render it unable to fix the position of the sound source, though it is easy to bias the brain by presenting it with some clues from the other senses.

The effects of a polarity reversal are less well marked to a listener seated off the speaker system centre line, for all the sound appears to be emitted by the nearer speaker, an illusion that is strengthened as the listener moves further from the centre. Further consideration of the effects of polarity reversal will be deferred as not being germane to the argument. Instead, consideration will be given to the apparent acoustic disappearance of the remote speaker when the listener is off the system centre line.

This is an effect that has been known as a nuisance by sound engineers for many years though the explanation is only of relatively recent origin. A typical situation where this nuisance occurs is in cinemas and theatres where it is necessary to mount the public address speakers on each side of the proscenium opening. Down the centre of the theatre there is a sharply defined line along which both speakers are heard and any artiste appears to be standing in the centre of the stage irrespective of his actual position. A slight movement of the head to one side of the centre line, often by only a few inches, moves the artiste over to the nearer loudspeaker while the sound from the further one seems to vanish. This is, as one might expect, the exact counterpart of experience in domestic surroundings.

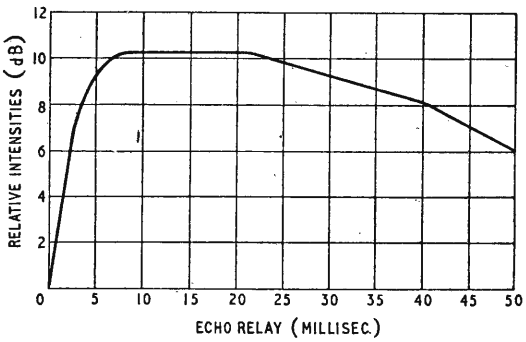

Fig. 2. Relative intensities for equal loudness as a function of the echo delay time.

This vanishing loudspeaker phenomenon is a simple example of the so-called "Haas effect," a subjective reaction that is of great importance when considering the influence of the hearing system. Working at Göttingen University, Haas discovered that the apparent position of the sound source in a multiple speaker installation is fixed at the position of the nearest loudspeaker, though all the loudspeakers contribute to the total loudness. This unsuspected result is due to the important part played by time of arrival differences when similar sound energy spectrum patterns arrive at the ears. A signal arriving at the ears from the nearest loudspeaker reduces the response to any similar signal arriving slightly later in time, the amount of the reduction being a function of the time of arrival difference of the two identical sound patterns. More precise information is given by the data in Fig. 2, which indicates the relative intensities of the two signals for both to sound equally loud when they differ in arrival time. Thus, for time of arrival differences between about 5 and 30 milliseconds, the second signal to arrive at the ears must be about 10 dB higher in intensity before it sounds as loud as the first signal. The velocity of sound in air is sufficiently close to 1,000 ft/sec (actually it is 1,125 ft/sec) to make it possible to substitute "path length difference in feet" for "echo delay in milliseconds" without any serious error. Where similar loudspeakers are connected in parallel the sound outputs will generally have sufficiently similar intensities and responses to make the data in Fig. 2 applicable. Thus the sound from the second speaker will appear to vanish at a path length difference of less than one foot, corresponding to a time interval difference of less than one millisecond. This is in accordance with practical observations.

If the time interval difference increases above about 40-50 milliseconds, the sound from the remote speaker, though not consciously appreciated as a second signal, begins to reduce the intelligibility of the first signal; and with still further increases in the delay time it appears as a separate echo. For all time differences greater than about one millisecond, it makes the apparent position of the nearer loudspeaker increasingly vague without actually moving this apparent position.

Thus the Haas effect is responsible for the fact that two loudspeakers radiating the same signal do not appear to be any larger than a single speaker. Though this is not quite so obvious, it is also the reason for an 18in speaker sounding little larger than an 8in speaker.

In marked contrast, a good stereophonic reproduction of an orchestra using the same two speakers at the same spacing will appear to fill the whole of the space between them. This is achieved because the two signals differ both in timing and in frequency content. Because of these differences reversal of the connections to either voice coil does not, in general, have the same drastic effect on the apparent position of the sound source.

Advantages of Paralleled Speakers

Two speakers in parallel do have appreciable advantages over a single speaker of the same size, and, in fact, have some advantage over a single speaker having the same cone area as the two speakers together. A 12in speaker of the normal type has an efficiency of about 1%, i.e. it converts about 1% of the electrical energy input to the voice coil into sound. This abysmally low figure is in large measure due to the very considerable disparity between the density of air and the density of those materials which are mechanically suitable for speaker cones. It is roughly true to say that if we could double the density of the air we could double the efficiency of our loudspeakers. This seems impossible, but it is in fact easily achieved, for when two speakers are mounted in close

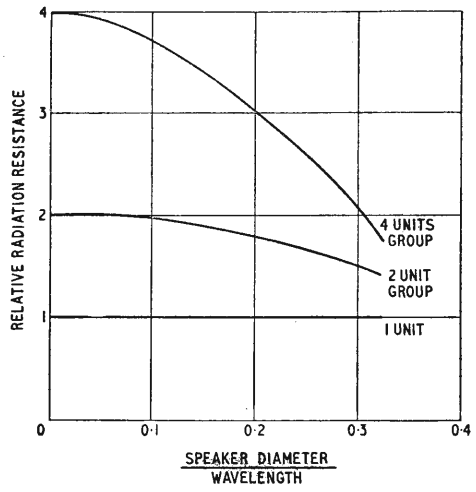

Fig. 3. Relative acoustic radiation resistance "seen" by each speaker of a closely spaced group.

proximity, each speaker benefits from the presence of the other. As the cone of one speaker moves forward it encounters, not free air, but air of a higher density due to the fact that the other cone is also moving forward and compressing the air in front of it.

Quite clearly any advantage due to this mechanism requires that the two cones be near together, for ideally the pressure variations produced by one speaker must be in phase with those produced by the other. This will only be achieved if the spacing between speakers is a fraction of the wavelength of the sound being radiated. Wolfe and Malter, and also Klapman, have made theoretical investigations of this problem and produced the curves shown in Fig. 3, from which it will be seen the radiation resistance seen by each speaker diaphragm is proportional to the number of such diaphragms in use. Thus two loudspeakers in parallel produce twice as much acoustic power when they are close together as they do when they are far apart. As the separation is measured in wavelengths and not in feet, this means that the power advantage is gained only at the low frequency end of the range. It is no mere academic advantage, for the addition of a second speaker produces an increase in the low frequency response that is immediately obvious even to the untrained ear.

Distortion Reduction

Paralleled speakers also have a significant advantage in reducing amplitude distortion. This distortion arises in loudspeakers due to non-uniformity of the field distribution over the depth of the gap in which the coil moves, and to non-linearities in the stiffness of the cone suspension. Both forms of distortion are similar in that the deflection of the voice coil for a given current is constant for small movements, but decreases rapidly, either as the coil moves out of the gap, or as the cone approaches the end of the travel permitted by the surround and centring

Paralleling a second speaker and adjusting circuit constants to give the same overall acoustic output as with one speaker means that the cone movement becomes less than that required by a single cone to give this acoustic output. The relative reduction in distortion can be much greater than the factor by which the cone movement is reduced.

Dissimilar speakers may be used in parallel to extend the frequency range. Alternatively, if the units are only slightly dissimilar, they may be used to smooth out the low frequency response, the intention being that dips in the response of one speaker should be filled by peaks in the response of the other. In every instance it is wise to use units having their bass resonances about 10 c/s apart, for when they are connected in parallel the overall impedance curve is significantly smoothed. At the resonant frequency of one cone the impedance of that speaker may rise by a factor of ten or twenty times. The combined impedance of the two speakers cannot do more than double, for the second voice coil appears in parallel and being "off resonance" has a low impedance. There are few better ways of achieving a good damping factor.

Thus we may summarize by saying that while two speakers in parallel have several advantages, the increase in source size that appears so obvious at first thought is not in fact achieved, two speakers being no larger in the acoustical sense than a single speaker.

My thanks are due to Chapman & Hall for permission to use illustrations from my book "High Quality Sound Reproduction."

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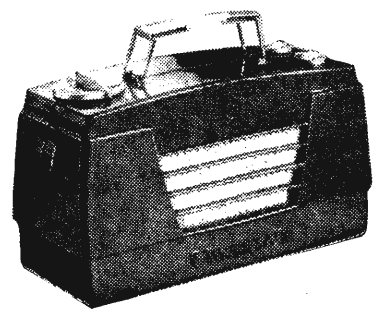
PROSPECTOR'S PORTABLE



The idea of combining a geiger counter with a portable radio receiver is one which should have a wide appeal to Canadians who have prospecting in the blood. The "Lodestar", made by Canadian Aviation Electronics of Montreal, weighs only 5lb and is housed in a tough plastics case, for which a polythene shoulder strap is available. In addition to normal wave-band selection, two switch positions give aural indication from the loudspeaker or visual indication in a neon flasher if the set is affected by the emanation from radioactive material of sufficient strength.

Component Developments

Trend of Design of Electronic Components Used by the Services

By G. W. A. DUMMER*, M.B.E., M.I.E.E.

AT present most components used in Service electronic equipment conform to the specifications in the Radio Components Standardisation Committee's (R.C.S.C.) lists[1] of fully tested and approved components which have been effectively standardized in this country for the past eighteen years. Many developments, however, are now in progress both at government Research establishments and in industry which will affect the future standardization of Service electronic components.

It may not generally be realized that Great Britain was the first country in the world to standardize Service radio components. In the 1920s Joint Service " K " specifications were drawn up under the aegis of the Wireless Telegraphy Board for 2½-in and 3½-in ammeters and voltmeters. These specifications laid the foundations for the dimensions of most of the 2½-in and 3½-in flush and projecting type instruments seen in Britain today.

The 1939-1945 war made it essential to produce large quantities of components quickly, the scale of increased production amounting to approximately three times the normal peace-time output. This led to severe rationalization of components by Joint Service Standardization Committees which are now the R.C.S.C. An example of the success of this rationalization is that in 1942 there were 1,500 different plugs and sockets in use in the Ministry of Aircraft Production alone and after rationalization only 200 were retained by the three Services. In addition, some 10,000 resistor types were reduced to 1,300 approved items; 8,000 fixed capacitor types were reduced to 750 preferred items, and 700 types of transformer laminations were reduced to 32 preferred items.

It is worth emphasizing that the situation on electronic components is constantly changing. There is a time delay in introducing new components because of the necessity for thorough approval testing, and it is difficult to withdraw components from Service use because of the world-wide organization of the Navy, Army and Air Force. It would be useful if it could be generally realized that there is a " standardization life " for every component, which may be 10 years or more.

There are many specifications for the Services and industry and, to the user, these may seem confusing. There are at the present time specifications for Service components prepared by the R.C.S.C., R.C.S., etc. (now D.E.F.), in addition to N.A.T.O. specifications, whilst for industry there are the Radio Industry Council (R.I.C.), International Electrotechnical Commission (I.E.C.) and British Standards Institution (B.S.I.) specifications. It would seem desirable for some of these specifications eventually to be merged into one Service and one international, or British industry, specification. As a long-term policy it is conceivable that these specifications may converge into one N.A.T.O. specification with individual country specifications agreeing with the main N.A.T.O. specification (at present concerned mainly with interchangeability) for the Services, and one I.E.C. specification for industry, with the individual countries agreeing with the I.E.C. specification as shown below:—

N.A.T.O.	Great Britain	R.C.S.C. and D.E.F. specifications
	France	C.C.T.U. specifications
	United States of America	J.A.N. or M.I.L. specifications
	Canada	J.C.N.A.A.F. specifications
	Belgium	National Defence specifications
	Denmark	" "
	Netherlands	R.C.S.S. and M.I.L. specifications
	Italy	National Defence specifications
I.E.C.	Great Britain	B.S.I. specifications
	France	Industry specifications
	United States of America	R.E.T.M.A. specifications
	Canada	Industry specifications
	Belgium	" "
	Sweden	" "
	Denmark	" "
	Netherlands	" "
	Norway	" "
	Italy	" "
	Austria	" "
	Japan	" "
	Switzerland	" "
	Portugal	" "
	Spain	" "
	South Africa	" "
	Yugoslavia	" "

New Component Developments:—Operational requirements have changed greatly in the post-war years and new developments such as guided missiles, automation techniques, high-speed aircraft, etc., are influencing component development considerably.

The single range of Service-type approved components may diverge in the future into several differing categories, which might be classed as:—

1. The reliable component
2. The transistor circuit component
3. The high temperature component
4. The short life, or guaranteed life, component
5. The very long life component

For some years there may be no clear definition between these types, but it is useful to discuss these developments in more detail.

1. The Reliable Component:—With the increasing complexity of electronic equipment used in the Services the need for increased reliability becomes more essential. It has now become accepted that in war the lives of a complete aircraft crew, tank crew or sea-going vessel crew may become jeopardized if the radio, radar or navigational systems fail at a crucial moment. The success of a complete operational mission, even a major battle, can depend on the electronic equipment.

*Royal Radar Establishment.

It is not easy to assess reliability of equipment under Service conditions, but from many sources of information failures in electronic components appear to occur in the following order[2]:—

(1) Valves
(2) Resistors
(3) Capacitors
(4) Transformers
(5) Switches
(6) Plugs and Sockets, etc.

This does not necessarily mean that resistors and capacitors have high fault rates, but that they are the main causes of failure because large quantities are used in equipments.

The reliability of an equipment depends also on the environmental operational conditions under which it is used. From analyses, the author would estimate that the fault rates with Service equipments are from ten to twenty times those of home radio and television sets, which use basically similar components.

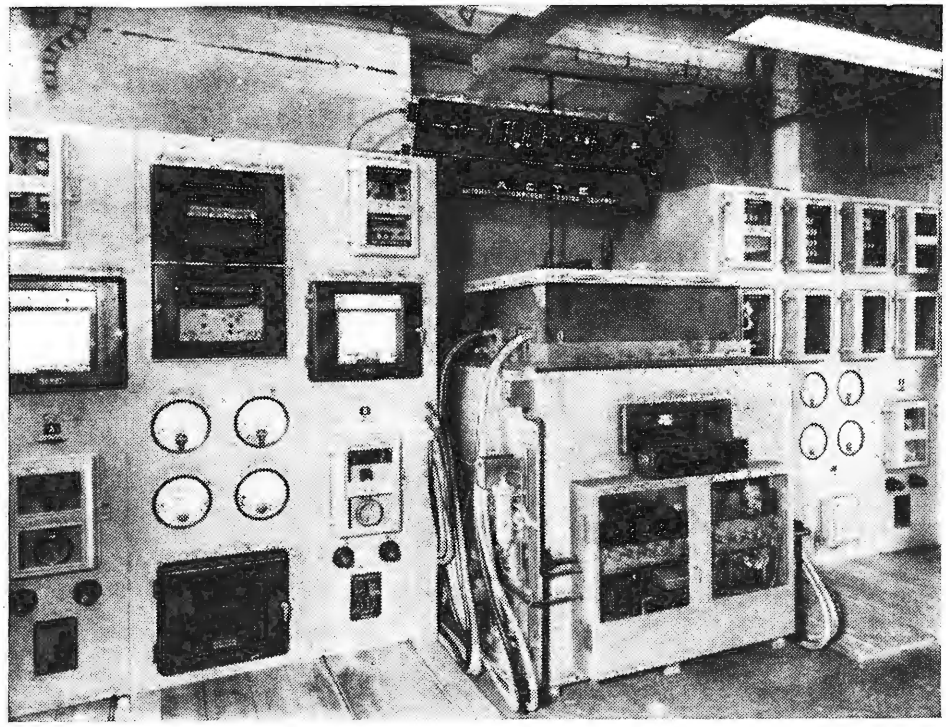
It is now being suggested by the author that the fault rates of these common components, such as resistors and capacitors, should be of the order of 0.01% per annum under laboratory conditions. In order to attain this low rate of failure it is essential that improved process control in manufacture and a higher standard of inspection of materials should be obtained. In addition, an important point arising directly from this requirement for increased reliability is that of mass testing. In order to evaluate failure rates of this order it is necessary to test very large quantities of components (of the order of 1,000); a machine designed by a British firm is about to go into operation at the Royal Radar Establishment for the automatic testing of 1,000 resistors. It is possible to feed instructions on coded tape to this machine for any series of tests it is required to make for any length of time up to six months. The coded signals control the sequence of testing and the appropriate climatic conditions in the test chamber. Rotary switches select each resistor in turn. They are measured on an automatic impedance bridge and recorded as change of resistance against the particular test conditions. The accuracy of measurement and recording is of the order of 0.5%. This is one of the first examples of automation in testing. Modifications of this machine, or further machines of this type for testing capacitors and other components, may be developed.

2. The Transistor Circuit Component:—In this type of component physical size comparable with that of the transistor is of importance, together with maximum reliability. Life times may well be of the order of 10,000 hours for Service equipment. The reduction in size of the transistor equipment is possible because of the lower voltages and currents used in transistors and many sub-miniature components have already been developed[3]. The danger to be avoided is extreme miniaturization affecting reliability, particularly for Service requirements.

In the United States of America a maximum voltage of 50 has been chosen for all transistor components and in this country a similar maximum voltage is being discussed by the Joint Service authorities. It is possible that agreed voltage figures may evolve to which all future Service transistor circuit components will be designed. At the moment these figures are 1.5, 3, 6, 9, 15, 30 and 50, but these are not yet finalized and await the outcome of discussions with the component industry. It would, however, be a most useful step to standardize voltages at this stage for all future transistor circuit components.

Considerable development is taking place in America and in this country on the design and development of these miniature components.

3. The High Temperature Component:—This requirement arises mainly in radio and radar equipment installed in high-speed, high-performance aircraft, although it is also required in guided



Modern equipment for the automatic testing of electronic components.

missiles and in some of the miniature high-power Army radio transmitters. In recent years considerable advances have been made in miniaturizing components. The use of these extremely small components in sealed assemblies aggravates cooling problems since there are smaller surface areas available to transfer waste heat to the surroundings, coupled with a general increase in power dissipation per unit volume as against conventional designs.

Various methods of cooling miniature equipments have been adopted, notably on airborne equipment. It is obvious that where components are available which can operate at the maximum temperature of, say, 150°C, in a confined space without cooling arrangements, considerable gains can be made.

The problem is particularly acute in airborne radar equipments where it is no longer possible to use the aeroplane itself as a heat sink. With the increased speeds of modern aircraft the temperature due to aerodynamic heating effects, such as friction, etc., becomes high and the rise in temperature in the Fairey D_2 during its record-breaking-speed flight was stated to be 100°C.

Some developments in high temperature components are described in detail in a recent publication[4], but in general the design of components for use at high ambient temperatures precludes the use of organic materials, such as paper or the currently known plastics, and requires the use of inorganic materials, such as glass or ceramics. Certain plastics, such as p.t.f.e., and materials, such as silicones, can be used with advantage. Some recent developments in resistors and capacitors are described in a series of books currently being published[5].

Testing components at temperatures of 100° to 150°C may also present difficulties, as handling them may need tongs or asbestos gloves.

4. Short Life Component:—This type of component is required for guided missiles, shell fuses, etc. Components must be extremely reliable and they may have a life of approximately 100 to 1,000 hours. This is not the flight time of the missile but the testing time necessary to set up and check the missile allowing for stand-by periods. Components must withstand high temperatures, vibration and long periods of storage, without deterioration.

They are expendable and whilst at the moment R.C.S.C. type-approved components are being used, because of the need for maximum reliability, in time reliable short life components may be developed which are comparatively inexpensive. It is possible that components with " guaranteed lives " may be produced.

A programme of work is being initiated by the R.R.E. on the relationship between life and ambient temperature of components in an attempt to establish initial data on a typical range of components such as resistors, capacitors, etc. The components will be tested to destruction and the information obtained will be valuable in improving the understanding of the effects of high temperature on the life of components.

It is, for instance, possible that certain types of impregnated paper-dielectric capacitors normally rated at 85°C can have a guaranteed life of 50 hours at a temperature of 150°C, with a slight increase of capacitance at this temperature.

5. The Very Long Life Component:—The laying of the transatlantic cable and of other long-distance cables has necessitated considerable study of long-term corrosion, electrolytic action, silver migration and general degradation of materials used in components. The life expectancy of the standard components used in the repeater amplifiers of these cables is of the order of 20 years[6]. The lessons learned in these studies will be of great importance in improving the reliability of the R.C.S.C. range of Service components and also of those components used in the Atomic Energy Research Establishments, etc., where a component failure may affect a very long-term experiment and render it useless.

The Influence of Automation Techniques on Components:—Although as yet few automatic assembly machines are available in this country it is probable that the shape of components may be affected when assembly machines of this type are used in increasing quantity.

In the United States of America several automatic component assembly machines are in use which are capable of assembling up to 10,000 sub-units per day[7].

Some proposals affecting future components are being made by Government authorities to the appropriate component manufacturers' committees such as:—

(a) In order to fit the insertion heads of these machines it is desirable that all future components, wherever possible, should be cylindrical in shape and should have axial leads.

(b) As holes are punched in the printed wiring chassis through which the components are inserted, the diameter of the leads becomes important. It has been suggested that all components should have two standard diameters, i.e., 20 s.w.g. and 26 s.w.g., with the possible introduction of 30 s.w.g. for miniature transistor components.

(c) Most Service components have, at the moment, lead lengths of $1\frac{1}{2}$ to 2 in. In component insertion machines only a fraction of this length is used, the rest being chopped off in the machine. The proposal is now being made for all components to be made with lead lengths of $1\frac{1}{4}$ in. This is already being standardized in America.

(d) One of the most important points in component design for automation techniques is the ease of soldering of the connecting leads. The success of the dip-soldering operation which accompanies automatic machines depends entirely on this and solder coated or plated component leads are an advantage.

In addition to the tubular, axial-lead type of small component it is possible that a range of larger components, such as transformers, electrolytic capacitors, switches, relays, etc., may be developed which can be inserted by " snap-in " methods prior to dip soldering.

Conclusions:—It would appear that the trend in component development for Service use is away from single standard range into divisions or branches of the standard " reliable " range to suit particular and increasingly severe operational requirements.

With the general trend towards transistor constructions and automatic assembly techniques it may well be that the electronic equipment of the future will need components much smaller in size, extremely reliable for a given life period, and capable

of being automatically inserted in printed-wiring chassis.

With the rapid development of transistors and semi-conductor materials, film resistors, etc., it may even be possible to envisage future electronic equipment as a solid block with no connecting wires. The block may consist of layers of insulating, conducting, resistive, rectifying and amplifying materials, the electrical functions being connected directly by cutting out areas of the various layers.

References

[1] Inter-Service Standards for Radio Components; R.C.S.C.

[2] G. W. A. Dummer, *et al*, "Maintainability of Services Equipment," *J. Brit. I.R.E.*, 15, No. 6, June, 1955, p 283.

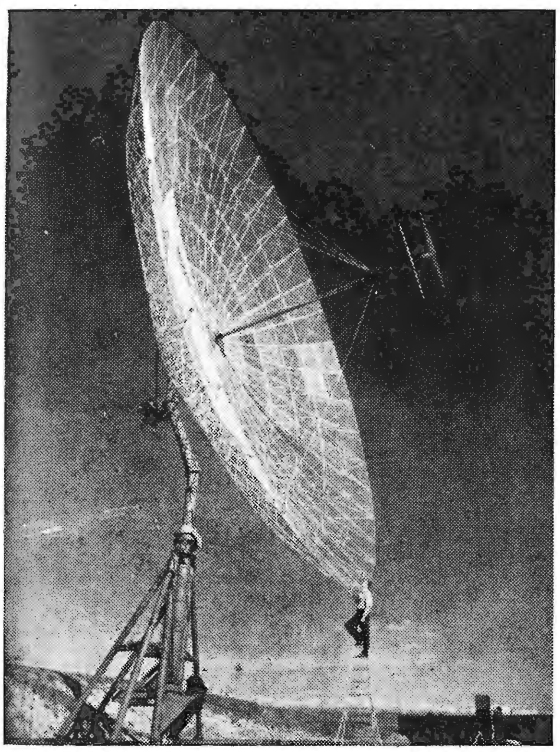
[3] G. W. A. Dummer, "Components for Transistors"—*Wireless World*, May, 1953, p 196.

[4] G. W. A. Dummer, "High Temperature Components"—*Wireless World*, October, 1956, p 510.

[5] Radio and Electronic Components; Vol 1, "Fixed Resistors"; Vol 2, "Variable Resistors"; Vol 3, "Fixed Capacitors"; Vol 4, "Variable Capacitors" (Sir Isaac Pitman & Sons Ltd.)

[6] Halsey, R. J. & Wright, F.C., "Submerged Telephone Repeaters for Shallow Water," *Proc. I.E.E.*, 101, Pt 1, No. 130, July, 1954, p 173.

[7] Markus, J., "Mechanized Production of Electronic Equipment," *Electronics*, September, 1955, p 138.



Specially designed 61-ft parabolic aerial system erected by the Stanford Research Institute, California, for gathering data on scattering and reflection of radio signals from meteor trails, and ionization associated with the aurora borealis, in the frequency range 100 to 1,000 Mc/s. Pulse transmitters of 50 to 70 kW output will be used initially in the 100 to 400 Mc/s range. A similar aerial has been erected also near Fairbanks, Alaska.

More Jobs for Computers

Recent Applications and Installations

Ever since computers came on the market as commercial products and computing time could be bought at so much an hour, the applications of these machines have been multiplying at a very fast rate, sometimes in the most unexpected directions. The following is just a random list of recent uses of both analogue and digital machines, and makes no attempt to present a balanced picture. It may, however, give some idea of the expansion which is likely in this branch of the electronics industry—already recognized by the formation of an Electronic Data Processing Section in the R.C.E.E.A. and the holding of a computer exhibition next year.

Payrolls continue to be the most popular application of digital computers, following the success of Lyons with their LEO I at Cadby Hall, London. Now, LEO I is also handling the payroll for 19,000 employees of the Ford Motor Company, while a LEO II machine is being installed at the Corby offices of Stewarts and Lloyds for their payroll and other work as well. The G.P.O. has ordered a system comprising two National-Elliott "405" computers for a payroll of 112,000 employees, amounting to £70,000,000 per annum.

Road Vehicle Suspension.—The effect of uneven road surfaces on vehicle suspension systems is being simulated by a Short Brothers analogue computer at the Brunswick Technical High School, West Germany.

Weather Forecasting.—An entirely new method of forecasting the pressure distribution for 24 hours ahead by calculation has been developed by the Meteorological Office, treating the movement of the atmosphere as a problem in classical hydrodynamics. To handle the heavy computation in less than the three hours it takes at present a Ferranti "Mercury" digital computer is being installed at the Dunstable forecasting office.

Aircraft Design provides an enormous list of applications for both analogue and digital machines, too detailed to be covered completely. For processing wind-tunnel data Armstrong Whitworth are using a Ferranti "Pegasus" digital computer, and other machines of this type have been installed by Hawker's, Vickers-Armstrongs and the Royal Aircraft Establishment. Short Brothers are using one of their own analogue computers for simulating aircraft take-off problems, while Metropolitan-Vickers have a system for simulating kinetic heating in aircraft and missiles which incorporates their "950" transistor digital computer.

Biophysical Research.—The task of calculating the positions of atoms in the complex molecules of living tissue has been undertaken by a biophysics laboratory of London University, using a digital machine at I.B.M.'s London computing centre. Large numbers of alternative structures have been calculated for correlation with the results of observational methods. In this way it is hoped to establish that the atoms are arranged in particular patterns which can be represented mathematically.

Motor Racing Results.—An electronic computing centre using I.B.M. digital machines was set up at Le Mans this year to work out the placings of the cars during every hour of the race. It also provided accurate placings at the end of the contest.

Town and County Councils.—A National-Elliott "405" digital computing system is now calculating and printing rate demands in the City Hall, Norwich, and will also be used for other accounting work. Orders for "Hec" digital machines have been received by the British Tabulating Machine Company from the County Councils of Middlesex, Nottinghamshire and West Riding, from the Brighton and Derby County Borough

Councils, from Birmingham Corporation and from Durban City Council.

Educational Establishments.—To celebrate the higher technological status of the Northampton College of Technology (formerly Northampton Polytechnic) a Ferranti "Pegasus" digital computer has been installed. One of these machines is due also for Sheffield University (the purchase being shared with the United Steel Company). The Royal Air Force College at Henlow has installed an Elliott G-PAC analogue computer for use in the study of guided missiles.

Rail Distances.—The British Transport Commission has recently used LEO I at Cadby Hall for working out distances between all possible pairs of railway stations and goods depots in Britain for the purposes of their new freight charges scheme. The 7,000 stations and depots gave 50,000,000 permutations, but they were reduced to 4,000 groups to simplify the task.

Fuel Systems and allied problems are being studied by H. M. Hobson, of Wolverhampton, with the aid of an Elliott G-PAC analogue computer, and Dowty Fuel Systems of Cheltenham have ordered a similar machine for the same purpose.

River Water Levels.—A I.B.M. "650" digital computer at the company's London computing centre has been used to calculate water levels at 30 points along the River Nile over a period of 48 years, the object being to study the relative merits of irrigation and hydro-electric power schemes.

Management Information, leading to better managerial control, is said by the Morgan Crucible Company to be one of the chief advantages derived from the "Hec" digital computer (British Tabulating Machine Company) installed at their Battersea headquarters. Accounting and mathematical computation is also being handled.

Insurance Policy Records will be maintained by the South African Mutual Life Assurance Society at Cape Town using a large electronic data processing system called "PERSEUS" which has just been ordered from Ferranti.

Technical Consultancy Service operated by Stenhardt Ingeniörsfirma, a small and specialized engineering company in Stockholm, has recently extended its facilities by the installation of a Short Brothers analogue computer.

Sales Statistics will be handled, among other things, by an Elliott "405" digital computer at Littlewoods Mail Order Stores, and by a Ferranti "Pegasus" at I.C.I., Blackley. Both machines are on order.

Flame Cutting Control.—New developments in oxygen cutting of metal plates by the British Oxygen Company have involved the application of Ferranti's methods of controlling machine tools by digital computers.

Hydromechanical Research.—For processing data from a water tunnel, and other uses, an English Electric DEUCE digital machine has been ordered by the Mechanical Engineering Research Laboratories at East Kilbride, Scotland.

The Dawn Chorus

A New Type of Audio-frequency Atmospheric

INTEREST in audio-frequency "whistler" atmospherics[1] has been considerable since it was realized that observations at various latitudes could give information on the electron density at heights well above the (at present) highest known ionospheric layer (F2). The recent discovery of a high-latitude form of whistler[2] offers prospects of also determining the strength of the earth's magnetic field at such great heights.

A recent paper[3] describes results on another type of audio-frequency atmospheric, which has been called the "dawn chorus" since it consists of many rising (typically from 2 to 4 kc/s) tones, sounding rather like a distant rookery; and it occurs most often in the early morning. This is in contrast to the single falling tone of "whistlers," which occur throughout the day.

Records are obtained as before, simply using an aerial (orientated for minimum local hum pick-up) feeding a band-limited (1 to 7 kc/s), high-gain (80 dB) audio amplifier. The output of this amplifier is for convenience recorded on magnetic tape for four minutes every three hours, two days a week.

Observations at Wellington, New Zealand, show good correlation between the strength of the dawn chorus and the amount of magnetic activity. When data from three American and two New Zealand stations were compared, good correlation was found between dawn chorus activities at stations which, though far apart, lie on approximately the same line of force of the earth's magnetic field. Observations were also made to determine whether the same dawn chorus is heard at different stations. Unfortunately, individual rising tones are weak and difficult to identify, so that occasional sudden bursts were used instead. These were received apparently simultaneously at Wellington and at Unalaska (Aleutian Islands), which lie on neighbouring magnetic lines of force. These results suggest that dawn chorus signals are propagated along magnetic lines of force, as are whistlers[4].

No correlation could be observed between dawn chorus and whistler activity. Also, no audible forerunners of dawn chorus signals, like the "clicks" generated by lightning which can often be correlated with whistlers, have been found. Thus it is unlikely that such signals originate in the lower atmosphere.

Results from various stations also show a pronounced daily variation in the strength of dawn chorus signals, the time of greatest signal strength remaining unchanged throughout the year. However, this time of maximum signal does vary with the geomagnetic latitude, and in a manner consistent with the idea that dawn chorus signals are initiated by positively charged particles which approach the earth in its (magnetic) equatorial plane, and are deflected by its magnetic field. Because of the correlation of dawn chorus with magnetic activity, and the daily variations in signal strength which occur at the same time throughout the year, such particles presumably come from the sun.

The rising tone cannot be caused by propagation effects as these are responsible for the *falling* tone of whistlers (the higher frequencies travel faster than the lower). A possibility is, however, that the frequency of a particular source increases as the incoming particles penetrate to lower heights. Proton plasma oscillations can perhaps produce suitable frequencies, in which case the lowest frequency in the chorus should increase as the observation station approaches the equator.

[1] Storey, *Phil. Trans.* A246, p. 113 (1953). Storey's results are also described in *Wireless World* Vol. 49, p. 338 (July 1953).
[2] Helliwell *et al. J. Geophys. Res.* Vol. 61, p. 139 (1956).
[3] McK. Allcock, *Austral. J. Phys.*, Vol. 10, p. 286 (June 1957).
[4] Morgan and Allcock, *Nature*, Vol. 177, p. 30 (Jan. 1956).

LETTERS TO THE EDITOR

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

Colour Television

I WOULD like to point out that your report on the Paris Colour Television Symposium (August issue) when referring to the comparative performances and costs of colour display devices misquotes me to such an extent that it completely reverses the meaning I had intended.

The order of performance that I gave was: (1) three-tube projection with best performance, (2) three-gun shadow-mask tube, (3) beam-indexing tube, (4) three-gun focus-grid tube, and (5) beam-switching tube with lowest performance. The order of increasing cost was: (1) beam-switching tube at the lowest cost, (2) beam-indexing tube, (3) three-gun focus-grid tube, (4) three-gun shadow-mask tube, and (5) three-tube projection with the highest cost.

CHARLES J. HIRSCH,
Hazeltine Research Corporation.

New York.

Projection Television

FROM the remarks of your correspondent O. V. Wadden in the September issue, it is obvious that he has never had the opportunity of seeing a forward projection television receiver in the home. I have been using for two years now a slightly modified Philips 1800 chassis throwing a picture 32 in × 24 in on a screen made from hardboard sprayed with aluminium paint. Far from having to darken the room, I can use 450 watts and still view comfortably.

I think that manufacturers have "missed the bus" by neglecting forward projection and concentrating on bigger, unwieldy and expensive direct view c.r.t.s. Everyone who has seen my picture says, "Where can I buy one like it?" I am a television engineer and see them all, but I would never go back to direct viewing.

Mr. Wadden's condemnation of forward projection probably arises from the fact that most demonstrators of these receivers are too greedy in screen size, with a consequent serious loss of light. For the same reason "Free Grid's" idea (July issue) of the projector in one wall of a room and the screen in the other is equally absurd unless, of course, he lives in a cupboard!

A. G. TUCKER.

London, N.W.6.

Transistor Oscillator Stability

MR. SCROGGIE'S reference, in his article on "Transistor Oscillator Stability," in your September issue, to a long-term frequency drift surprised me considerably as I have never seen any indication of this effect in an OC45, or for that matter in any other Mullard transistor. I should therefore be most interested to know if Mr. Scroggie did in fact observe this effect on any Mullard transistor.

L. P. MORGAN,
Mullard Research Laboratories.

Salfords, Surrey.

The author comments:

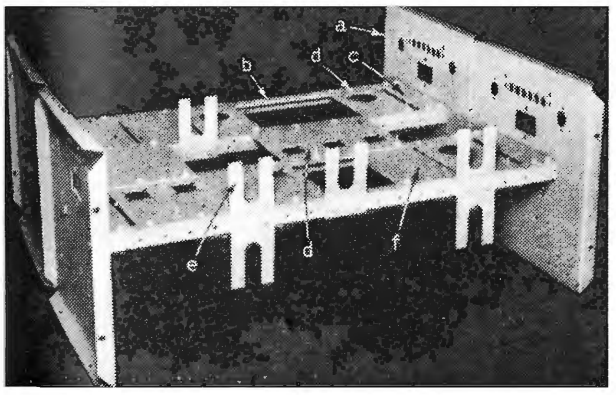
I would assure Mr. Morgan that I, also, did not observe the long-term frequency drift in any Mullard samples. The effect was no doubt an abnormality attaching to one or two experimental samples I used in my tests.

M. G. SCROGGIE.

Standard Chassis

THE improved version of the pre-fabricated chassis described in the September 1955 *Wireless World*, and said in our September issue of this year to be available in commercial form, is supplied as a kit of parts for assembling a chassis measuring 16 in × 7 in × 7 in. As the illustration shows, two such units can be joined together to provide a large chassis and any number, within reason, can be joined together in a similar way.

A single kit consists of 2 end plates (a), 2 runners (b), 2 brackets (c), 6 small and 3 large valveholder plates (d), 6 potentiometer brackets (e) and 6 blank plates (f). The various parts are made of cadmium-plated steel and the end plates have provision for mounting power-supply connectors, jacks, toggle switches and terminal strip.



The chassis kit is obtainable from Cowell Developments, 67, Long Drive, East Acton, London, W.3, and a single kit costs 45s complete with all necessary screws.

Transistor Audio Amplifiers

THIS is one of those subjects on which up-to-date information is rather scattered. However, a *Wireless World* book which has just been published covers practical and theoretical aspects of this field from the latest viewpoint. The authors, D. D. Jones and R. A. Hilbourne, are engaged in transistor developments at G.E.C.

The book deals mainly with germanium p-n-p transistors as these are the only type commercially available in Great Britain at present. An introductory chapter on this type of transistor has sections on its various equivalent networks. Small signal amplifier design is then discussed including such points as signal to noise ratio and tone controls. The chapters on power amplifiers evaluate the relative advantages of class A or class B operation, and also deal with mismatching and other causes of distortion. A number of practical small and large signal amplifiers are also discussed.

"Transistor A.F. Amplifiers" is obtainable from our publishers, Iliffe and Sons Ltd., price 21s (postage 8d).

Modern Thermionic Cathodes

Review of the Main Types and Their Relative Merits

By R. W. FANE*, M.Sc., A.Inst.P.

DURING and since the second world war the problem of obtaining thermionic cathodes yielding high current densities with long life has been the subject of intense research and development. The difficulties in the most commonly used oxide coated cathodes have become more and more apparent with the increased interest shown in microwave valves operating under extreme conditions.

Investigations into alternative methods of producing cathodes capable of withstanding ionic bombardment, gas poisoning, mechanical and thermal shock and at the same time yielding a high and stable current density (amperes per square centimetre) have led to some very interesting results. An outline of the most important developments and an assessment of their relative merits is given in the following pages.

The choice of material for use as a thermionic emitter is chiefly governed by considerations of melting point, ease of fabrication and the work function. This latter quantity appears in the well-known Richardson equation relating "saturated" or "temperature limited emission" to the absolute temperature, viz:—

$$I = AT^2 \exp.\ (-\phi/kT)$$

where I is the saturated emission in amperes per sq cm, A is a constant, amperes/cm^2/deg^2, T is the temperature in °K, k is Boltzmann's constant, 8.6×10^{-5} e.v./deg, and ϕ is the work function measured in electron volts (e.v.), ranging from rather less than 1 to 5 e.v. The value of I is difficult to determine experimentally as the emission, particularly in the case of oxide cathodes, is never truly saturated, an increase in anode-cathode voltage always giving rise to some increase in emission current (Schottky Effect). The value often taken (see Fig. 1) is that at which the current versus voltage curve departs from the space-charge-limited line (3/2 power law). Alternatively a logarithmic plot of the portion beyond the "knee" of the characteristic is extrapolated to zero volts to give the required value. The current which may be drawn using microsecond pulses is, in general, considerably higher than the d.c. rating and is considered to be the true emission for work function calculations.

For the purpose of this review all cathodes are considered as belonging to one of the following groups:—

(i) pure metals,
(ii) atomic films,
(iii) oxide emitters.

Pure Metals.—Tungsten has held pride of place in the first group for many years. As it is not readily fabricated into sheet its use is restricted to directly heated filaments and where robustness is of prime importance, giving some 500 mA/cm^2 at 2300°C with $\phi = 4.5$ e.v. and A=60 amperes/cm^2/deg^2. The expected life under such conditions is 10,000 hours. For unipotential cathodes, tantalum ($\phi = 4.1$) is preferred. The high temperature required makes radiation heating impracticable and such cathodes have been heated by bombardment with electrons from a subsidiary tungsten filament. Such a system has been used in some high power klystrons.

Atomic Films.—The characteristics of the second group are mainly determined by a thin film, believed to be one atom thick, of barium or thorium on a refractory metal. Some of the most important recent advances belong to this category, their behaviour being analogous to thoriated tungsten. In the first instance about 1% of thorium oxide was added to tungsten wire during manufacture to improve its mechanical properties. Later it was found that metallic thorium, produced by the reduction of the oxide at high temperature, diffused to the surface and formed an electric double layer with positive charge outermost reducing the work function to 2.6 e.v. Owing to the strong forces of adhesion the cathode can be operated at high temperatures without undue evaporation of active material. Further improvement is shown if the outer layer of the tungsten is converted to tungsten carbide. The active life of the filament depends upon the maintenance of the thorium layer and many thousands of hours are obtained at 1600-1800°C drawing 1-5 amperes/cm^2. While such filaments have been used extensively in medium and high power transmitting valves they cannot be used in microwave valves utilizing an electron gun structure where a planar cathode is necessary.

Similar properties are obtained with monatomic films of barium on tungsten, but in this case the work function is 1.6 e.v. Such a layer is, however, relatively unstable. An adsorbed layer of oxygen between the barium and the tungsten lowers the barium evaporation rate but some method of replenishment is necessary to make such a cathode of practical value. This has been achieved in the "L" type dispenser cathode announced by the Philips Laboratories in 1949[1]. In this, and other types to be described, porous tungsten is an essential part of the structure. This is produced by pressing tungsten powder at 50-100 tons/in^2 in a steel die and then sintering the compact at high

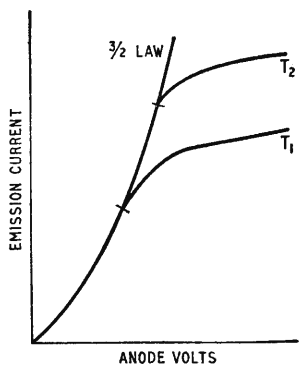


Fig. 1. Diode characteristics for two temperatures, T_1 and T_2, showing departure from the space-charged-limited line.

*Research Laboratories, Marconi's Wireless Telegraph Co.

temperature in a protective atmosphere. The porosity (ratio of pore volume to total volume) is 20-50%.

Fig. 2 shows the basic construction of a planar "L" cathode. A double-ended molybdenum cylinder is closed at one end by a porous tungsten plug. The cavity so formed contains barium and strontium carbonates. Heating the cathode to 1100°C in vacuum converts the carbonates to oxides. Continued activation at a higher temperature results in the reduction of barium (and strontium) oxide by the tungsten, yielding barium (and strontium) which diffuses to the surface and is continually replenished from the reservoir. Some controversy exists at present as to the exact nature of the emitting surface. At 1100°C the d.c. saturation current density is 2-3 ampere/cm². At 1000°C and a current density of about 1 ampere/cm² lives of 8-10,000 hours are obtained. Good performance has been given by such cathodes in microwave valves, particularly klystrons. Little has been published regarding the use of "L" cathodes in travelling-wave tubes, but the smooth surface should be of advantage in low-noise tubes although this is somewhat offset by the high operating temperature. A further consequence of the high temperature is the difficulty in mounting the cathode in a vacuum tube; for example mica supports have to be replaced by alumina ceramics.

The impregnated cathode[3], a modification of the above type, has simplified the structure by eliminating the need for a gas-tight weld round the tungsten plug, at the same time improving the temperature distribution and reducing the processing time. In this case the pores of the tungsten are filled with normal and basic barium aluminates, $Ba\,Al_2O_4$ and $Ba_3Al_2O_6$, the cavity containing the carbonates being dispensed with. The aluminates gives rise to barium oxide on heating, the behaviour of the cathode then being identical in all respects to the "L" type. A further improvement has been obtained by adding a small quantity of calcium oxide to the aluminates[3]. At 1100°C a d.c. saturation emission of 4 or 5 amperes/cm² is obtained, the peak microsecond pulsed emission being about 12 amperes/cm². A considerable reduction in the barium evaporation rate is also claimed which should result in considerably longer life.

The latest modification of the impregnated cathode has recently been described by Hughes and Coppola[4]. The improved impregnant, in powder form, is mixed with 50-50% molybdenum-tungsten alloy powder, pressed into a retaining molybdenum cylinder at 70 tons/in² and sintered at 2000°C in a hydrogen atmosphere. In a well processed valve d.c. emissions comparable with pulsed values can be drawn and the authors claim lives of 5,000 hours drawing a current density of 10 amperes/cm² at 1130°C. This simplified technique of producing such cathodes makes them an attractive commercial proposition. As with the types mentioned previously, exposure to atmospheric pressure after activation causes no permanent damage and repeated reactivation can be achieved.

Finally, the cathode described by Beck and his associates[5] is considered as belonging to the second group. A mixture of about 70% nickel and 30% barium and strontium carbonates is used. As pure nickel will not reduce barium oxide, some reducing agent, in this case zirconium hydride, is used (about 1%). After pressing into a metal retaining cylinder the cathode is mounted in the valve and heated to about 1100°C, causing the carbonates to dissociate and the nickel to sinter into a strong matrix. In general the temperature required for a given emission is about 100°C higher than that of an oxide coated cathode but resistance to poor vacuum conditions enables larger d.c. currents to be drawn. Although no evaporation rate information is available, lives of 5,000 hours at 1000°C and 1 ampere/cm² have been recorded. At this temperature a pulsed emission of 10-30 amperes/cm² could be obtained. Again, use can be made of such cathodes in demountable vacuum systems and the authors claim good results when used in klystrons and television cathode ray tubes.

Oxide Emitters.—The most important and oldest member of the final group is the oxide coated cathode. This consists of a coating of barium and strontium (and often calcium) carbonates on a nickel base. The reduction of the oxides, subsequently formed in vacuum, by impurities in the nickel (in particular silicon, magnesium and titanium) produces an excess of barium (and strontium) in the oxide crystals and is thought to be responsible for the cathode activity. The low work function, about 1 e.v., and long life (20-50,000 hours) accounts for the very extensive use of such cathodes in all low-power valves requiring some tens of mA/cm². As mentioned previously, however, resistance to ionic bombardment and gas poisoning is poor and the electrical properties of the coating limit the d.c. emission current density to less than 500 mA/cm² (at about 850°C) for a reasonable life. In pulsed operation with low-duty cycle the emission is from five to ten times higher than the d.c. values but a limit is ultimately set by arcing and a disruption of the coating. Some improvement in mechanical properties can be achieved by welding a nickel mesh to the base metal before applying the coating, thereby improving the bonding. The alkaline earth oxides are, however, employed as the basic active material in all modern types of cathodes, thermal efficiency having been somewhat sacrificed in favour of other desirable features.

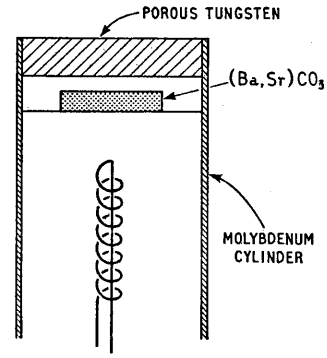


Fig. 2. Construction of the "L" type dispenser cathode.

Using oxide cathode materials in powder form, namely, nickel and alkaline earth carbonates, Mac-Nair, Lynch and Hannay[6] have briefly described "molded" or nickel matrix cathodes made by the pressing and sintering technique. Although d.c. current densities as high as 10 amperes/cm² at temperatures of about 1000°C are reported, no life-test studies have been made at such high currents. Lives of 5,000 hours with cathodes operating at 850°C and 500 mA/cm² have been obtained using high anode voltages. The pulsed emission is approximately six times the d.c. values. Conditions of ionic bombardment which produced a fivefold decrease in the

emission from an oxide cathode caused no significant change in the "molded" cathode.

Cathodes with similar properties but with a slightly different method of preparation have been developed at the Honeywell Research Centre[7]. In this case the carbonates have been chemically precipitated into the pores of a previously formed nickel matrix. The work function is 1-1.25 e.v. No life-test information is recorded. Although the above nickel cathodes appear to behave in a similar manner to oxide cathodes, results are largely empirical and the mechanisms involved are not completely understood. There have been no reports of such cathodes having been used in practical devices but they are likely to find application where a few amperes/cm² d.c. or tens of amperes/cm² pulsed emission are required at operating temperatures little above those of an oxide cathode.

Research into the thermionic properties of materials other than the alkaline earth oxides has yielded little of practical value, with the possible exception of thorium oxide. Coatings of this oxide on tungsten, tantalum or molybdenum have been used, for example, in power tetrodes and magnetrons, where a rugged cathode is required even at the expense of extra heater power. The life at current densities greater than 1 ampere/cm² has, however, been disappointing. A sintered mixture of molybdenum and thoria, called the "Cermet" cathode, has also been used, particularly in magnetrons, where electron bombardment would damage any conventional coating and the higher heat dissipation can be used to advantage.

Conclusion.—Some of the work which has been done on the various types of cathodes has necessarily been omitted but the most important parts of each section have been discussed to indicate the developments round which future valves, particularly those in the microwave field, will be designed. The scanty life-test information at present available and the relatively small number of valves which have been made incorporating the various cathodes make it impossible to give more than a tentative assessment of their relative merits.

Several very important features, such as recovery from gas poisoning, machinability and mechanical strength, smooth surfaces and low electrical resistance are, however, common to the various derivatives of both the atomic film emitter and the oxide cathode. For all ordinary low current applications the oxide cathode is still preferred.

The nickel matrix cathodes follow next as regards thermal efficiency and have many interesting features to commend them, including easy machinability—with tungsten special techniques have to be employed. Emission of 1 or 2 amperes/cm² d.c. at 830-900°C with a good life can be expected. Lives in excess of 5,000 hours have been obtained in these laboratories from cathodes of a similar type operating at 830°C drawing 1 ampere/cm² d.c. at high anode voltages.

The "L" cathode, and particularly the latest pressed type, are likely to find widespread use, although the more expensive mounting techniques and higher heater wattage required will limit their use to the more expensive high-power and microwave valves requiring high continuous current densities.

The utility of all the above-mentioned cathodes in low-noise travelling-wave tubes is not yet clear. Non-uniformity of emission over the cathode surface still remains a problem. Improved surface coverage by the barium in the case of the atomic film emitters and a finer and more even pore distribution in all cases may do a great deal to improve the noise characteristics.

Operating conditions of the various cathodes with an indication of expected life are summarized in the following table:—

Type	Operating Temp. (°C)	D.C. Emission (amperes/cm²)	Life (Hours)
Tungsten	2300	0.5	10,000
Tantalum	2100	0.5	10,000
Thoriated tungsten	1750	1–3	15,000
"L" and impregnated	1000	1	10,000
Improved impregnated and pressed	960–1130	0.5–10	>5,000
Nickel matrix ..	850–900	1	>5,000
Oxide coated ..	830	0.5	5,000

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Electronic Telephone Exchange

ALTHOUGH much development work has been done on electronic telephone exchanges they are not likely to come into widespread use in the public service for some time. There is no reason, however, why they should not be used extensively for private automatic installations in offices, factories, and so on. Here they offer the important advantages of small size and absence of moving parts, which are often a source of trouble. As an example, Pye Telecommunications have just produced a 10-line private automatic exchange which measures only 20in x 19in x 12in. The switching is done by Z50T cold-cathode valves, with two thermionic valves for shaping the incoming dialling pulses. It has an interesting storage feature by which if a wanted extension turns out to be "engaged" it is automatically rung again as soon as the person there replaces his handset.

Stabilization of A.C. Supplies

A Comparative Review of Methods of Voltage Control

By O. E. DZIERZYNSKI

THEORETICAL circuits and commercial apparatus for stabilizing a.c. power supplies are not so well known as those for d.c. supplies. A possible explanation is that a.c. voltage stabilization circuits demand certain special components for the degree of stabilization achieved to be comparable with that obtainable in d.c. systems. The power handling capacity (and consequently size) of a.c. stabilizers is also often greater than that normally required. However, it frequently happens that d.c. stabilization is not good enough owing to a.c. valves heaters being affected by mains voltage variations, with consequent uncertainty in gain.

In this article it is proposed to give a very general survey of possible a.c. stabilizing systems, pointing out their advantages and disadvantages.

Performance Requirements.—There are four main requirements for a mains voltage stabilizer. The first of these is the accuracy of stabilizing action.

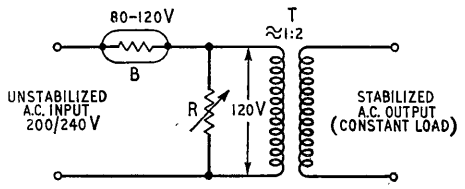


Fig. 1. Barretter stabilizer (constant load).

The requirement for this can be within ±0.05% up to within say ±2%, but stabilization to better than ±0.5% can be considered as very good. As an illustration of the meaning of this requirement, if the required mains voltage is 200V to within ±1%, the stabilized voltage can be allowed to drift between 198V and 202V, without any action being performed by the stabilizer. As soon as the voltage drops down to say 197.5V, the stabilizer will act to raise the voltage until the level is close to 200V. In an ideal case, the voltage should be set back to exactly 200V. Normally the value reached is somewhat higher—say 201V; but in a well designed stabilizer it should not come too close to the upper limit of 202V as overshooting effects may be experienced. Alternatively, the voltage may not be reset enough, and it would reach only say 198.5V.

The second requirement for a stabilizing system is the speed of response, which is defined as the accuracy of the system divided by the time taken to reset the voltage for a change equal to this accuracy (the regulating time); i.e. in the last example the time taken to reset upwards from 198V, or downwards from 202V. For instance, if this resetting time is 1 sec., the speed of response would be 1%/sec. The majority of a.c. voltage stabilizers do not act fast enough to deal with sudden mains voltage changes such as those produced by switching electrical apparatus.

It is important to realize that both these factors (speed of response and accuracy) are in practice interdependent. If, for instance, our voltage limits are set closer, say to within ±1V, with the same speed of response, the regulating time would be only 0.5 sec. Increasing the accuracy in stabilizing systems generally necessitates a slower response speed; otherwise overshooting and hunting effects will be unavoidable. Response speeds can be up to 5%/sec. in motor-driven systems (1/5 sec. for 1% change), but magnetic reactor stabilizers offer much higher figures (1/200 sec. for 1% change).

The third requirement associated with stabilizing systems is the output waveform. In certain applications it is important to have the power supply free from distortions of the original sinusoidal waveform. Unfortunately stabilizing circuits using non-linear elements, as for example saturated inductances, introduce such distortions. They can be removed by using low-pass filters, but this is rather a cumbersome remedy as the mains frequency is comparatively low so that filter elements (condensers, inductances) have to be large, and consequently expensive.

The stabilized power needed is the fourth and last requirement to be discussed. When these powers are large (say over 0.5 kW) motor-driven variable voltage transformers are preferred, as the cost of such regulating equipment rises very slowly with the controlled power, which is not the case for stabilizers with no moving elements.

Simple Stabilizing Circuits.—If we consider the case where a stabilized a.c. source is supplying a constant load, a quite simple stabilizing device can be designed (see Fig. 1). The barretter B is inserted in series with the primary of the step-up transformer T, and this stabilizes the current drawn from

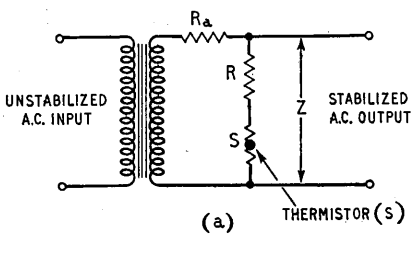
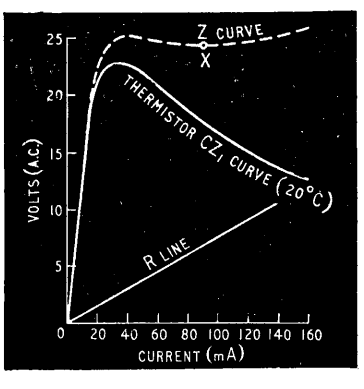


Fig. 2. Circuit of thermistor stabilizer and current/voltage relationships in the branch Z.



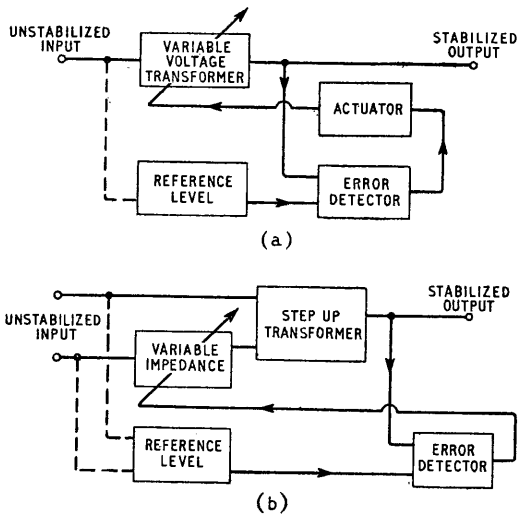


Fig. 3. General block diagrams of complex stabilizers.

the primary by a resistor R to secure a sufficiently high current through the barretter. In certain applications such a resistor R can be made variable (possibly in steps) to allow for varying loading conditions. It is obvious that, if the load is taken off, the shunting current in R must be made larger to maintain a constant voltage across the primary; so that R has to be set to its minimum value. Conversely with increasing loads, R has to be set to a higher value.

Another simple stabilizing system is the saturated core mains transformer. Even with only a small load on the secondary, the magnetic flux reaches saturation when the a.c. current approaches its maximum, and the output waveform is flattened. With increased loads, the waveform approaches a square wave shape, and consequently the output is rich in odd harmonics; though its r.m.s. value remains practically constant. As stated previously, if a better waveform is required, a filter can be provided. Even so this system still has the disadvantage of the heat developed in the saturated transformer, which resutls in a rather low efficiency, an important factor if large powers are required.

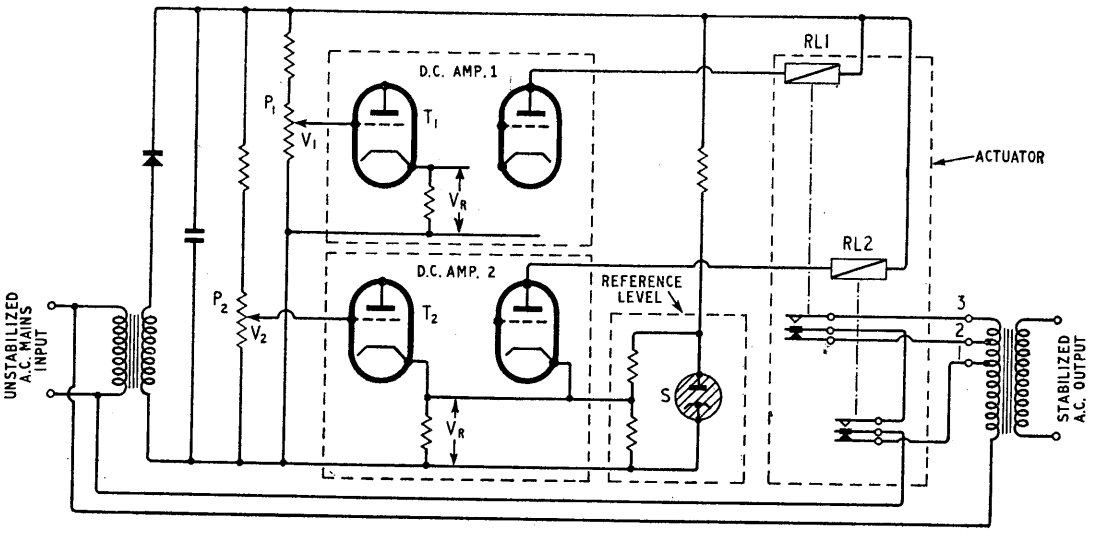


Fig. 4. Stabilization in steps using relays and tapped transformer.

the mains. With a constant load, the primary and secondary voltages will then be stabilized, and any voltage variations will occur across the barretter.

This method works quite successfully providing that the power required is not too large and, as previously stated, that the loading conditions are constant. The maximum available stabilized power can be calculated as follows. Assuming that, for instance, a barretter type 301 (G.E.C.) is employed, the required voltage drop across the latter would be about 100 volts, and the rated current 0.3 amps. Hence there would be about 120V (assuming 220-V mains) on the primary of the transformer, and the power delivered to the load would be given by

Power = 120 × 0.3 × efficiency of T ≈ 120 × 0.3 × 0.8 = 29 watts.

The transformer in such a circuit should have a step up ratio of about 1 : 2. Furthermore, the primary winding should be calculated for the actual barretter current, otherwise it is necessary to shunt

Fig. 2 (a) shows the use of a thermistor as a non-linear device for stabilizing a low a.c. voltage. An impedance Z connected across the load, consists of an ordinary resistor R and a thermistor S connected in series.

In Fig. 2(b) the voltage/current characteristic of a thermistor type CZ_1 (S.T.C.) is shown. The straight line on this graph represents the voltage/current characteristic of the resistor R. The third curve (dotted line) gives the resulting characteristic of the compound impedance Z. It can be seen from this curve that, by choosing a suitable value for R, the " dynamic resistance " at a point such as X on the impedance Z curve can be made very small.

The stabilizing action of the circuit in Fig. 2(a) then follows, assuming that for an average mains voltage of say 220V the stabilized output voltage corresponds to the point X on the impedance Z curve. Any tendency of the output voltage to vary is nullified by large current changes in Z (due to its

low "dynamic resistance") acting through the resistance Ra in series with the load.

The thermistor CZ_1 combined with a resistor R of 69 ohms will deliver only 25V stabilized a.c. If a normal stabilized a.c. mains supply is required (say 225V) 9 thermistor CZ_1's and a 620-ohm resistor could be connected in series.

Stabilizing action of this sort is very similar to that of reference tubes in d.c. circuits and gives good results, particularly when only low powers are needed.

Complex Stabilizing Systems.—Fig. 3 represents the basic functional diagrams of two more complex systems. In both of these circuits a reference level and the stabilized output feed the error detector. In the system of Fig. 3(a), the error detector output varies the stabilized output voltage through the variable voltage transformer by mechanical means. In Fig. 3(b) the output voltage is altered using a variable impedance (inserted in series with the primary of the step-up transformer) which is controlled by the error detector output purely by electrical means (no moving parts). The reference level device (voltage or current) is usually fed from two driving relays, RL1 and RL2. The reference voltage V_R derived from the d.c. reference tube S is connected in opposition with V_1, a fraction of the unstabilized a.c. voltage (obtained from the potentiometer P_1), in the grid circuit of the first valve T_1 of the d.c. amplifier No. 1. Similarly, in the grid circuit of the input valve T_2 of the second d.c. amplifier voltages V_R and V_2 are connected in opposition. Potentiometers P_1 and P_2 are adjusted so that V_1 is slightly greater than V_2, and, for mains voltages below 220V, both first valves T_1 and T_2 do not conduct ($V_R > V_1 > V_2$), and thus both the output relays RL1 and RL2 are energized.

As can be seen from the circuit, two sets of contacts on RL1 and RL2 are connected so that when both relays are energized, the mains lead is connected to tap No. 1 on the output transformer. For mains voltages between 220 and 240V, valve T_1 starts conducting, RL1 is de-energized and the mains are switched over to tap No. 2. Finally, for mains voltages higher than 240V, both T_1 and T_2 are conducting, both relays are off, and the mains are connected to tap No. 3. This method of mains stabilization, though rather crude, secures a mains voltage stable within limits of $\pm$ 5%, providing that the input voltage does not fall below 200V or rise higher than 260V. The d.c. amplifier used in this system could be similar to that described by the author in the September 1956 issue of *Wireless World* (p.441).

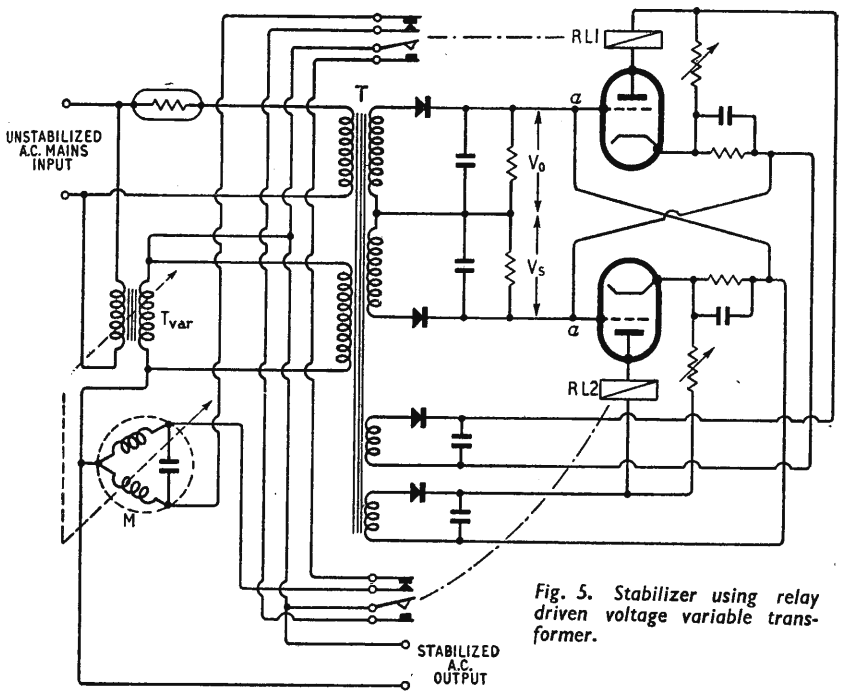


Fig. 5. Stabilizer using relay driven voltage variable transformer.

Figs. 5 and 6 show two circuits of stabilizers also belonging to the group of Fig. 3(a). In Fig. 5 the reference voltage is V_0 (d.c.) obtained by rectification of the a.c. supply from the transformer T which has a barretter B in series with its primary. The d.c. voltage V is of the same order as V_0 and connected in opposition with it. Consequently, with V_0 equal to say 400V, and V_s for a mains voltage of 220V also equal to 400V, the potential across the a.c. input. However, this is not essential, and in certain cases a dry battery might be employed; and therefore in Figs. 3 connections between the a.c. input and the reference level block are shown by dotted lines.

The "actuator" in Fig. 3(a) could be either a servomotor (including relays energized from the error detector) driving the variable voltage transformer continuously, or two (or more) relay systems switching different tappings on the mains transformer. Obviously, this second system can only regulate in steps. A more detailed treatment of such a circuit is given below.

Stabilizing Systems using Moving Parts.—Fig. 4 represents a stabilizing circuit employing

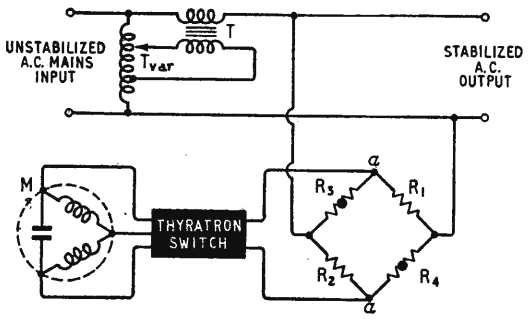


Fig. 6. Stabilizer using thyratron switched voltage variable transformer.

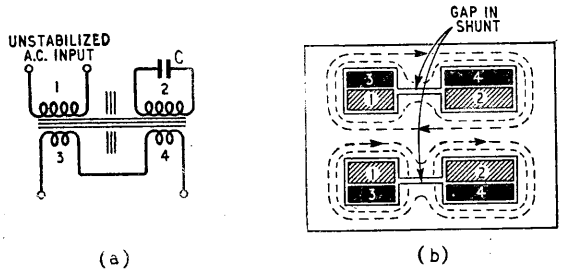


Fig. 7. "Sola" saturated transformer stabilizer.

$a-a$ is zero and valves T_1 and T_2 are balanced. The relays RL1, RL2 are just about to trip, as the initial bias for each valve is set slightly above cut-off. If the mains voltage now changes, a d.c. voltage appears across $a-a$ and, according to its sign increases the anode current in one of the valves and completely cuts off the other. This causes one relay to close its contacts and to switch on the induction motor M, which drives the voltage variable transformer T_{var} until V_s is restored to the value V_o. The relay then opens, and M is switched off.

The most important feature of this system is that, by boosting the voltages V_o, V_s (up to several hundred volts d.c.), it is possible to improve the sensitivity quite considerably, without using a two-stage d.c. amplifier. A certain amount of inconvenience is experienced with the h.t. supplies for the two valves as these have to be completely separate, as is shown in Fig. 5.

Thyratron Circuits.—Instead of a d.c. amplifier, thyratron circuits sensitive to the phase of an a.c. signal are sometimes employed. Fig. 6 shows a basic circuit of this type. Two ordinary resistors R_1 and R_2 and two thermistors R_3 and R_4 form a bridge. When the output voltage alters, owing to the non-linear voltage/current characteristics of the thermistors R_3 and R_4, an error a.c. voltage appears across the diagonal $a-a$. This voltage is proportional to the mains voltage variation, and its phase obviously changes when the error sign changes. A tapping on the voltage variable transformer T_{var} (driven by a reversible induction motor M actuated by relays in the thyratron switching circuit) supplies an auxiliary transformer T connected in series with the mains, and corrects the final output to the required constant level.

Stabilizing Systems with no Moving Parts.—The block diagram of Fig. 3(b) gives the most general representation of such systems. Its basic principle has already been mentioned, and as varying an inductance through its degree of saturation is the most efficient way of changing a series impedance such systems are usually the best. Very many circuits of this type have been developed, some of them similar to the previously mentioned simple saturated transformer.

For instance, Fig. 7(a) represents the circuit of a magnetic stabilizer made by the American firm Sola. Here the secondary winding No. 2 resonates with a condenser C. The core of the transformer contains a magnetic shunt with a special gap (as shown in Fig. 7(b)), and works close to saturation with a normal transformer load. Under these conditions the voltage across winding No. 2 reaches a high value at resonance. As the flux in the core approaches the saturation point, flux lines linking the primary winding with the secondary tend to be diverted through the gap, thus decreasing the effective transformer voltage ratio—see lower part of core in Fig. 7(b). Thus an increase in the primary voltage raises the secondary voltage only very slightly. The final stabilized output could be taken from winding No. 4 (windings 2 and 4 are in fact a step-down transformer). Winding No. 3 comprises a few compensating turns connected in the opposite way to those on No. 4, thus finally reducing voltage fluctuations across the output terminals to zero; or even making the output characteristic slightly negative, i.e. causing a decrease of output voltage with increasing mains input.

Fig. 8 illustrates another American stabilizing system comprising two reactors in series, one of which is bypassed by a condenser, which in this case does not resonate. Stabilization is produced by interaction between the non-linear characteristics of reactor R_2 and the linear characteristic of the condenser C (8b), and the consequent changing phases in the circuit. Considering the voltage/current curves in Fig. 8(b) it can be seen that, if the mains voltage drops from E_{02} to E_{01}, and causes a voltage drop across R_2 and C from V_2 to V_1, then the current delivered to R_2 and C becomes more leading as it flows more through the condenser C. As a result, the voltage on the primary of R_1 actually increases from V_{p2} to V_{p1} (see vector diagram Fig. 8(c)). With suitable choice of components, the output voltage E_2 or E_1 which is the sum of V_2 or V_1 and the corresponding secondary voltage V_{s2} or V_{s1} on

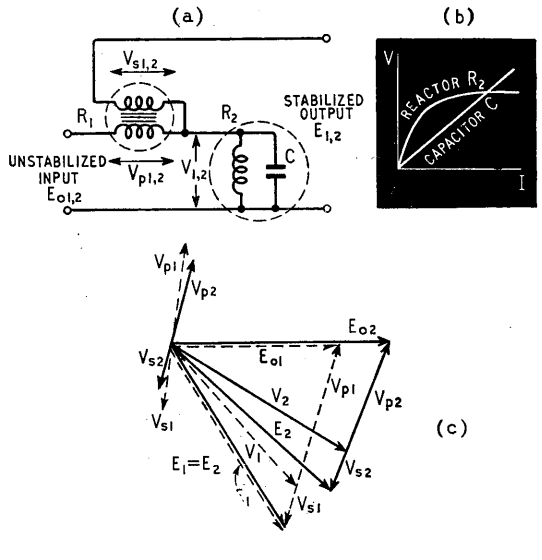


Fig. 8. Stabilization by vector interaction between non-linear reactor and condenser.

transformer R_1 will remain constant, as shown in the vector diagram.

Electronically Controlled Saturable Reactor.—An example of a mains voltage stabilizer using a saturable reactor controlled by an electronic valve is shown in Fig. 9. The auto-transformer T_1 has a series connected variable inductance W_{AC}/W_{AC} forming the a.c. winding of the transductor T_R. The inductance of the windings W_{AC}/W_{AC} can be controlled by varying the anode current of the 6L6 valve, which flows through the winding W_c. Three

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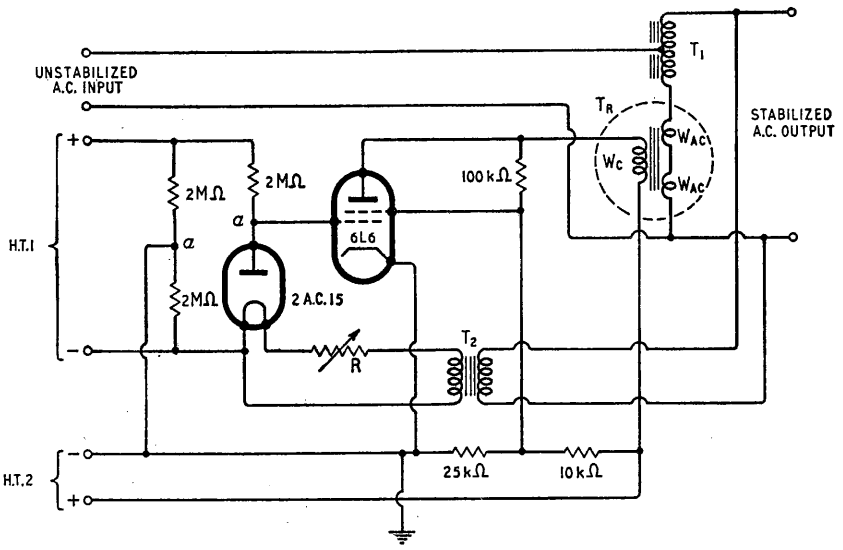
Fig. 9. Stabilizer using saturable reactor controlled by valve anode current.



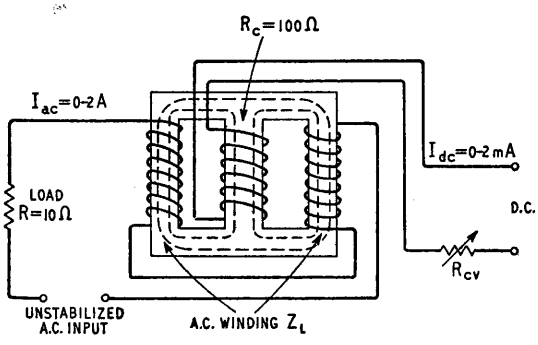
2MΩ resistors and the anode resistance of the 2AC15 diode are connected in a bridge (supplied by H.T.1). In a state of balance, i.e. when the output voltage has the required value V_2, the anode resistance of the 2AC15 is 2MΩ so that no voltage appears across the diagonal *a*—*a*, and consequently the grid voltage of the 6L6 is zero. Now, if the output voltage V_2 rises, the heater of the diode (which is fed by a transformer T_2 from this voltage) increases its emission, and the diode's resistance falls. The bridge then becomes unbalanced, and the grid of the 6L6 is driven negative. This reduces the current in W_c, and the inductance of W_{AC}/W_{AC} increases. As a result, the auto-transformer step-up ratio decreases and the output voltage remains almost unchanged. A similar action, but of course in the opposite sense, happens with a decrease in mains voltage.

This type of stabilization is quite rapid, as the delay with properly designed components is only of the order of 50 to 100 msec. The variable resistor R in the heater circuit of the 2AC15 is for obtaining different output voltages if required.

The Magnetic Amplifier.—The basic difference between a voltage stabilizer using the anode current of an electronic valve as a variable inductance controller, as just described, and systems using magnetic amplifiers, lies in the replacement of the electronic d.c. amplifier by a magnetic amplifier. The chief advantages obtained are the very high power gains possible (up to 10^6), greater robustness and other advantages due to the absence of valves, and high efficiency.

Fig. 10 represents the basic circuit for the magnetic amplifier. The impedance of the a.c. winding Z_L is high for zero (or very small) d.c. currents in the control winding (resistance R_C). The unstabilized a.c. input and the output load R are connected in series with Z_L.

Fig. 10. Elements of a magnetic amplifier.



Assuming that the initial conditions are with no d.c. current in the control winding (R_C open circuit) the initial output power in the load R will be rather low ($R << Z_L$). Now even a small d.c. current I_{dc} in R_c will cause a sudden drop in the value of Z_L by saturating the transductor core (flux lines shown dashed). The current I_{ac} through the load R is thus increased much more than the d.c. control current I_{dc}.

By using a high-permeability, square B/H curve magnetic core a few milliamperes change in I_{dc} can cause a change of up to several amps in I_{ac}. Assuming that the control winding has a d.c. resistance of say 100 ohms and the incremental control current is say 2 mA, the control power will be equal to 400 μW. This power could cause a change in a.c. current of 2 amps with an a.c. winding resistance of say 10 ohms, the a.c. power in R then equalling 40 W. Thus the power gain in this case would be 10^5.

If the a.c. power delivered to the load is rectified a high-gain d.c. amplifier can be obtained with this circuit.

Circuits Using Magnetic Amplifiers.—Fig. 11 shows the full circuit of a mains stabilizer using a magnetic amplifier.* The secondary voltage of the step-up transformer T is rectified, and the d.c. voltage fed into the error detector network formed by R_1, R_2, R_3 and C and the two control windings W_1 and W_2 (wound on the middle leg of the transductor core T_c). The essential feature of this network is that currents in W_1 and W_2 (which have the same number of turns) are arranged to act in opposition; and an increase in the current in W_2 decreases the flux in the core T_c. In a state of balance R_2 and R_3 are equal, so that the currents in W_1 and W_2 are equal. Consequently, there is no control flux in the transductor core, and the inductance of the a.c. winding is maintained fairly high. The word " fairly " is used as there is an additional feedback winding W_{fb} (also located on the central leg of the transductor core) which has some polarizing d.c. current derived

*See "Proceedings of the National Electronic Conference," (Chicago) Vol. 6, Sept., 1950, p. 45.

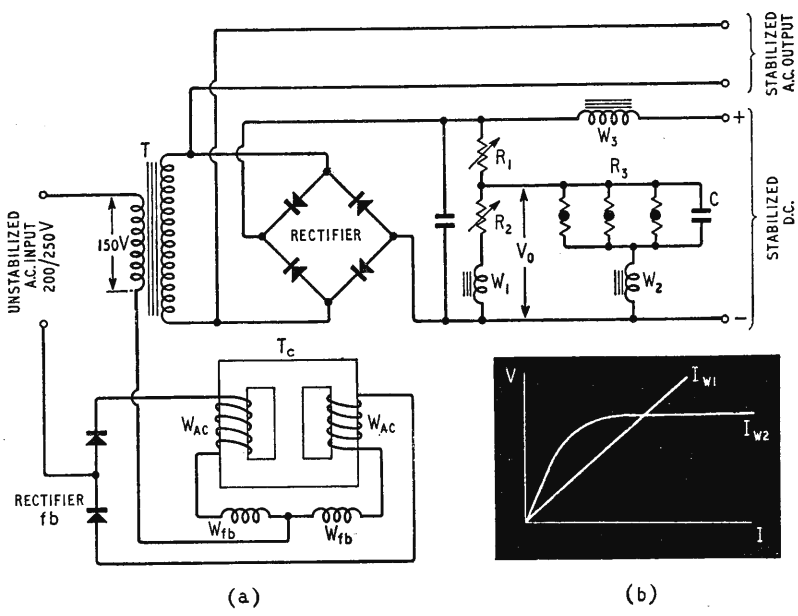


Fig. 11. Stabilizer using a magnetic amplifier.

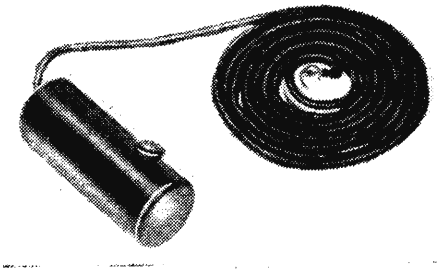
from the rectifiers fb. The result is that, even without a control flux from W_1 and W_2, the a.c. voltage drop across W_{AC}/W_{AC} is not very large, thus maintaining the required voltage on the primary of T (say 150 V). The second important feature of the error detector is that while R_1 and R_2 are linear, resistors R_3 are non-linear (thermistors).

Fig. 11(b) shows the d.c. currents in W_1 and W_2, I_{w1} and I_{w2} respectively, as a function of V_0 and thus of the stabilized voltage. It is obvious that even a small increase in V_0 would cause a much larger increase in the current in W_2 than that in W_1 (owing to the thermistors in series with W_2). Thus, as in a magnetic amplifier, the impedance of W_{AC}/W_{AC} would suddenly rise owing to the decrease in the saturation in the transductor core. As a result, the voltage drop across the primary of T would show only a very small increase, thus maintaining the a.c. output almost constant. A similar but opposite action compensates for a decreasing mains voltage.

The winding W_3 is a small compensating d.c. winding on the central leg of T_c to prevent fluctuations in the output voltage due to a varying load. In this way the stabilizing action is speeded up, as in this case the transductor is controlled not by the network W_1, W_2, R_1, R_2 and R_3 (which would give a slight delay due to the slowly changing voltage on condenser C), but directly by changing the current in W_3.

Historic Hearing Aid

The original bone conduction instrument made by C.M.R. Balbi in 1919 while engaged on development work for S. G. Brown has recently been presented to the Science Museum. This was the prototype of the Brown "Ossiphone" which was used in the Marconi "Otophone," believed to be the world's first commercial valve hearing aid. Mr. Balbi who has spent a lifetime in research into the problems of hearing is now living in South Africa where he has been working on direct stimulation of the auditory nervous system.



Commercial Literature

Television Aerials, for Bands I and III, v.h.f. aerials for Band II, and various accessories. A comprehensive illustrated catalogue of all types made by Aerialite, Hargreaves Works, Congleton, Cheshire.

Variacs (continuously adjustable mains auto-transformers). The complete range of types, with load ratings from 0.58 kVA to 7 kVA and input voltages of 115V and 230V, is given in an illustrated catalogue from Claude Lyons, Valley Works, Hoddesdon, Herts. Also included are Variacs with motor drive, ganged assemblies, portable types with carrying handles and types for permanent fixing to walls or benches.

Signal Strength Meter for television frequencies, with three ranges directly calibrated in microvolts and a decibel scale for comparison purposes. Has a self-contained stabilized power supply and a thermistor temperature compensation system. Leaflet from Radio-Aid, 22, Market Street, Watford, Herts.

Switches and Signal Lamps, a catalogue including new miniature toggle switches for 250V, 10A a.c. with a light snap action similar to that of microswitches. From Arcolectric (Switches), Central Avenue, West Molesey, Surrey.

Electrolytic Capacitor Bridge, for measuring capacitance between 0.1μF and 11,000μF. A continuously variable polarizing voltage supply of 0-600V is incorporated. Meters indicate direct-reading capacitance, polarizing voltage, leakage current and bridge balance. Power factor is read from dials. Specification on a leaflet from British Physical Laboratories, Radlett, Herts.

THE GYRATOR

By THOMAS RODDAM

2. A Modern Microwave Device with a Classical Physical Ancestry

In the first part of this article on the gyrator I adopted a quasi-historical approach and dealt with the way we thought about this problem in the rather short period 1944-46. The previous article showed that a rather abstract concept, a two-terminal pair "black box," could have impedance equation in which the transimpedances Z_{12} and Z_{21} were not equal, but satisfied the equation $Z_{12} = -Z_{21}$.

A device of this sort is passive, linear and constant, but it is not reciprocal. Combined with a reciprocal network it can produce a system which transmits freely in one direction and not at all in the other. This last property is the one which really made people sit up. As you know, one of the great problems of microwave radar systems was the need to use the same aerial for transmitting and receiving. This involves putting the enormous transmitting power, kilowatts or even megawatts, into the feeder or waveguide system which must also include the receiver mixer crystal. The literature is extensive and designs of TR boxes, anti-TR boxes and I don't know what abound. Non-linearity was the key to their design: the transmitted pulse ionized the gas in a special sort of valve and thus switched in some protection for the receiver. But this would only work with pulses and wasn't really too good at that. A completely linear and passive device, with no gas to get absorbed, offered tremendous advantages.

The first thing that any young beginner should do when he has some completely new idea, especially if it is in the field of wave propagation, is turn to the collected papers of Lord Rayleigh. In 1901* Lord Rayleigh described an optical one-way transmission system based on the Faraday effect. We must look back down the arches of the years to our school physics and see if we can recall what we learnt then about polarized light. As a digression, I can't let this opportunity go by without pointing out how important it is that technical education should be broad based rather than devoted to what some people call practical matters. Here we are on a microwave problem, and the basic theory is made up of two parts, why your bicycle stays upright (gyroscopic forces) and what you would see if you wore sun glasses to visit Elsie, Lacie and Tillie, the three sisters in *Alice in Wonderland* who lived in a treacle well in the Dormouse's story (polarized light). The sisters, as it happened, drew everything that begins with an M—such as memory and muchness. Had Lewis Carroll lived in this era he might well have added microwave devices.

Let us return to our polarized light. As you remember, if you pass ordinary light through a sheet of Polaroid it is sorted out and only the radiation of one polarization is allowed to pass. The usual picture shows a man shaking a clothes line vigorously in circles, a grating through which the line passes and a nice clean, parallel-to-the-grating wave going off beyond the grating. Before Polaroid was invented a device called a Nicol prism was used. This was a special arrangement of two bi-refringent crystals stuck together in such a way that for one polarization the light just got through the join while for the other it was totally reflected to one side.

Having polarized our light, we now look at it through a second piece of Polaroid and we find that when the axes are parallel the light passes through, but if the axes are at right angles most of the light is stopped. This is the background to the use of polarized glasses for snow and seaside sun glare. When electromagnetic waves (light or radio) are reflected from a plane surface there is one particular angle, the Brewster angle, at which almost all the reflected electromagnetic radiation is of one polarity, and at other angles there is quite a lot more of one than t'other. Polarized sun glasses absorb most of the reflected light and get rid of the glare.

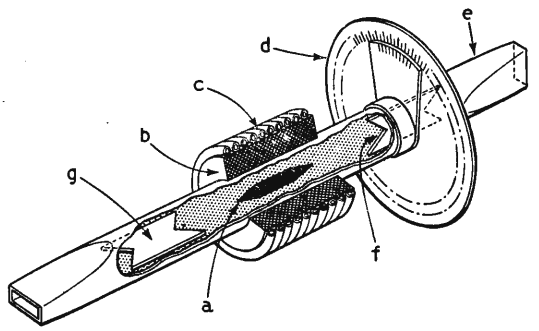


Fig. 1. Experimental arrangement for measuring Faraday rotation. (a) ferrite specimen, (b) winding, (c) cooling coils, (d) stationary protractor, (e) rotatable waveguide section, (f) radial vane to absorb vertically polarized waves, (g) radial vane to absorb horizontally polarized waves.

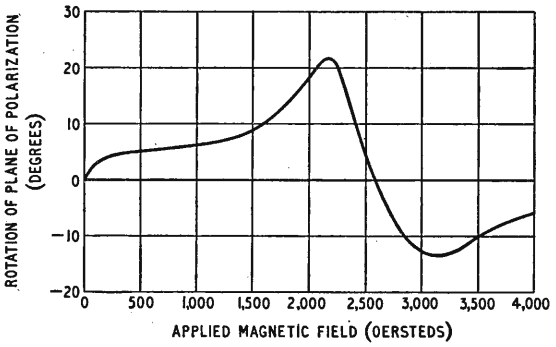


Fig. 2. Faraday rotation in a cylindrical specimen of ferrite. Frequency 8950Mc/s.

*Nature, Vol. 64, page 577.

But to return to our optical bench. We have a light at one end, a polarizer next to it and then, a bit further down, another polarizer and an eyepiece. Usually we put in some lenses, too, so that we have a clean source of parallel light, but these we can regard as frills. The first stage of the experiment is to turn one polarizer until the light reaching the eyepiece is a minimum: the polarizers are now said to be crossed. Now we put between the polarizers a tube filled with a solution of dextrose, which is a sort of sugar, and we find that light is streaming through the eyepiece. To get darkness again we must turn our viewing polarizer. Dextrose, therefore, rotates the plane of polarization and indeed owes its name to the fact that it produces a right-hand rotation. Now obviously a cylinder of liquid will have much the same properties whichever way we look through it and we find, if we care to test it, that our dextrose solution produces a right-hand rotation whether light travels from east to west or west to east. If we reflect the polarized light back, therefore, it will swing back to the original plane of polarization.

The next experiment is to turn out the dextrose, fill the tube with nitrobenzene and wind a solenoid round the tube. When a current flows through the solenoid the plane of polarization is rotated, but if we reverse the current, and thus reverse the magnetic field, the rotation of plane of polarization is in the opposite direction. I imagine that we should all have expected this because if a field H produces an effect θ, a field $-H$ will probably produce $-\theta$. Here, of course, I am relying on intuition to tell me that the whole operation is a linear one, but it seems a reasonable expectation, even if you haven't, as I have, checked it. This magnetically controlled rotation of the plane of polarization is called the Faraday effect, and it was discovered by Faraday in 1845.

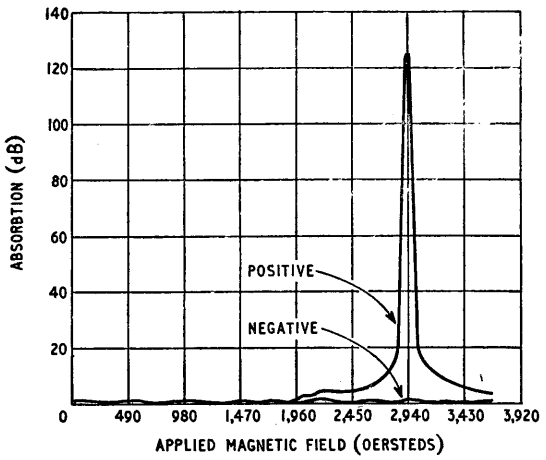


Fig. 3. Selective absorption of the positive and negative circularly polarized components of microwaves (9455Mc/s) with variation in the magnetic field.

In a system showing the Faraday effect a traverse from north to south will produce a rotation of $\theta°$, but a traverse from south to north will produce a rotation of $-\theta°$. A normal polarization rotator will produce a rotation of $\theta°$ whichever way the light is going.

Any reader who has turned up the reference to Lord Rayleigh's one-way system and has not started immediately on the construction of a one-way telescope for use at the seaside is invited to look now at Fig. 1 (based on Fig. 17 of "The Elements of Nonreciprocal Microwave Devices," by C. Lester Hogan, *Proc. I.R.E.*, Vol. 44, pp. 1345-1368, Oct., 1956). Here we have most of the optical bench of Fig. 2, apart from the side arms, but now it is something rather nearer home, a microwave guide system. A small cylinder of ferrite with coned-off

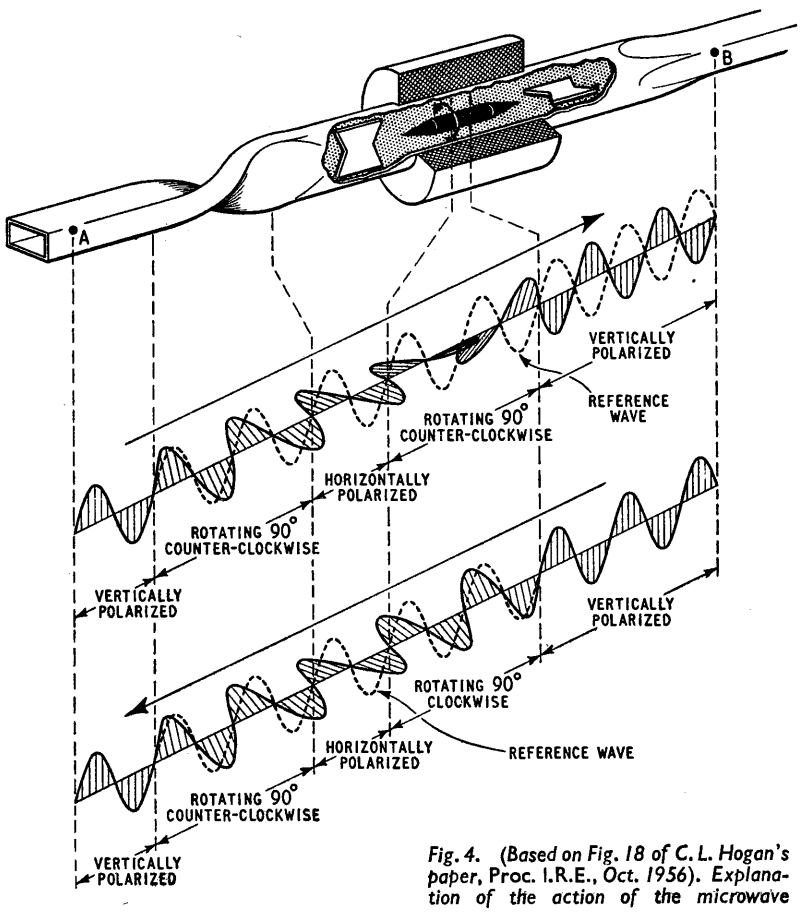


Fig. 4. (Based on Fig. 18 of C. L. Hogan's paper, Proc. I.R.E., Oct. 1956). Explanation of the action of the microwave gyrator.

ends to reduce reflections produces the Faraday effect and Figs. 2 and 3 (based on Figs. 15, 16, loc. cit.) show the amount of rotation and the cost in attenuation. These curves are for different sample sizes of different materials. In weak fields there is a fair amount of rotation for very little loss. It, therefore, becomes possible to make up devices similar to that shown in Fig. 2, but, of course, using ferrites and operating at, say, 9,000 Mc/s.

A typical system is that shown in Fig. 4 (Fig. 18, loc. cit.) and I don't think I can do better than quote Mr. Hogan's own words:

"The anti-reciprocal property of the Faraday effect affords a means of realizing a microwave circuit element which is analogous to Tellegen's gyrator. Such a gyrator is illustrated (in Fig. 6) along with diagrams which help explain its action. Beneath the gyrator are construction lines which indicate the plane of polarization of a wave as it travels through the gyrator in either direction. On each diagram is a dotted sine wave for reference only which indicates the constant plane of polarization of an unrotated wave. It is noticed that for propagation from left to right, the screw rotation introduced by the twisted rectangular guide adds to the 90° rotation given to the wave by the ferrite element making a total rotation of 180°. For a wave travelling in the reverse direction these two rotations cancel each other, producing a net zero rotation through the complete element. The unique property of the Faraday rotation becomes immediately apparent from this diagram. In the case of the rotation induced by the twisted rectangular guide, the wave rotates in one direction in going from left to right through the twisted section, and rotates in the opposite direction when it traverses the section from right to left. For the case of the rotation induced by the ferrite element, the direction of rotation is (the same) for either direction of propagation. The important characteristic of the element is the time phase relation between two points such as *A* and *B* in the upper diagram. It is seen with the help of the diagrams illustrating the rotating waves that the

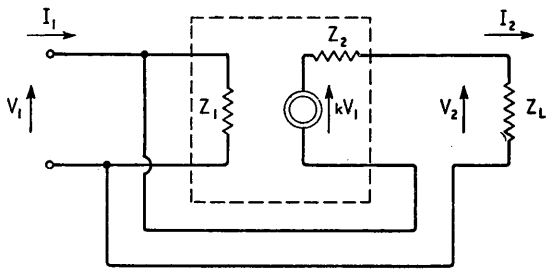


Fig. 5. An amplifier with feedback which can be designed to give impedance inversion. This is the first stage of equivalent gyrator design.

field variations are in phase at points *A* and *B* for propagation from left to right and they are 180° out of phase for propagation from right to left. In other words, the transmission line is an integral number of wavelengths long between *A* and *B* for propagation from left to right and is an odd integral number of half-wavelengths long for propagation from right to left.

"If the rectangular wave guides on each side of the ferrite are rotated about their common axis so as to make an angle of 45° with each other, then a one-way transmission system can be created which is similar to Lord Rayleigh's one-way transmission system of optics. This one-way transmission system can be used, for example, to isolate the generator or detector from the wave guide in microwave systems. In this application it has the great advantage over the attenuators which are presently used for this purpose in that it can be made practically lossless for the direction of propagation which is desired but the reflected wave will be completely absorbed and hence more complete isolation can be effected."

I do not think it would be very profitable to try to explain in words just why ferrites have this particular property. Essentially, however, the reason is that the waves travelling in the ferrite are coupled to the myriads of tiny gyroscopes, the electrons. Small as an

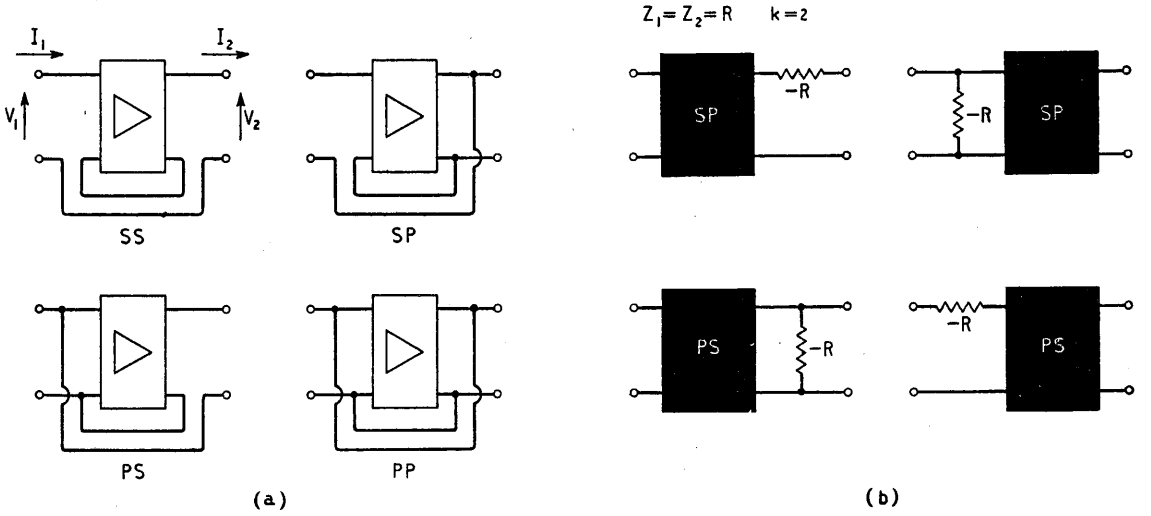


Fig. 6. (a) The four connections of feedback round the amplifier of Fig. 5 (S = series, P = parallel). Putting one of these complete units into circuit we have the four possible gyrator circuits shown at (b).

electron is, it is spinning about a central axis. In a magnetic field the electron axis precesses round the field axis and also pulls in towards it. Now there is a rather odd thing about systems which are kept stable by gyroscopic forces: a little friction may make them unstable. I think it is possible to find examples of this when bicycling. In any event, the direction of the magnetic field due to the signal has a very important effect on the electronic gyroscopes. Remember that the gyro axis is nearly along the axis of the steady magnetic field and that this is the direction of propagation. The signal field is linear, in a plane at right angles to this axis, but it can be split into two circularly polarized components in this plane, one clockwise and one anticlockwise. These two components interact quite differently with the electron and are, in simple language, shifted in phase relative to each other. Combining them again, this phase shift appears as a rotation of the polarization.

The fuller development of devices based on the ferrite gyrator involves much more microwave theory and practice than is appropriate to these columns. Indeed, having passed from "black box" to gyroscope to practical systems using sub-atomic gyroscopes, let us go on, or back, to some more "black boxes."

The circuit we shall consider is that shown in Fig. 5. The dotted box contains an amplifier with input impedance Z_1, output impedance Z_2 and gain k times. A feedback loop is shown, together with a load Z_L.

The input current is obvious given by:

$$I_1 = V_1/Z_1 + I_2 = V_1/Z_1 + (1 + k)\,V_1/(Z_2 + Z_L)$$

and the output current

$$I_2 = V_2/Z_L$$

The input impedance is given by V_1/I_1 and is

$$\frac{Z_1\,(Z_2 + Z_L)}{Z_2 + Z_L + Z_1\,(1 + k)}$$

We can make k anything we please, within reason. In particular, let us make $k + 1 = -Z_2/Z_1$, which means k must be negative. An odd number of valve stages will do this. Also, let Z_L be small compared with Z_2 so that $(Z_2 + Z_L) \approx Z_2$. The input impedance then becomes

$$\frac{Z_1 Z_2}{Z_L}$$

This means that if $Z_1 Z_2 = S^2$, the input impedance S^2/Z_L, is just the inverted form we met with the basic gyrator "black box." It looks, therefore, as though we are offered the possibility of making a gyrator with the aid of valves or transistors.

I must confess that I am not very certain whether there is any point in producing a gyrator system using valves and am almost as doubtful about the value of transistorized gyrators. I do not, therefore, propose to go further with the analysis which shows that a special case of the impedance inverter combined with a negative resistance (another valve), will produce a gyrator. The configurations are summarized in Fig. 6. These circuits are analysed by Bogert*, who gives the conditions required for what we might call "gyration."

It is very difficult at this stage to assess the overall future of the gyrator. We must, at the moment, look at it as a triad of almost completely detached character. The microwave Faraday effect devices are already with us. They will undoubtedly stay with us for some time, growing first of all more complex and then, later, more simple. The purely artificial, contrived gyrator is a less certain bet. It is possible, for example, to sketch out a circuit for an echo suppressor based on the gyrator, but will it be simpler, cheaper, more reliable than the straightforward circuits now in use? At first sight the answer is no. In any event, the echo-suppressor of the long physical telephone line is a device almost certainly doomed to vanish as the improvements brought about by ferrite cores and transistors make it profitable to operate shorter and shorter circuits as carrier systems. Purely passive gyrators may find a home in colour television transmission systems, if anyone can produce gyrators for the appropriate frequencies. Coloured rings and ghosts are obviously more annoying than the familiar black-and-white variety, and echo suppression can do a lot to reduce them. But can we make gyrators below the kilomegacycle range?

On the theoretical side, the gyrator has got rid of an anomaly and has cleared up our theoretical foundations. Although this may seem rather remote, it is ultimately of benefit to us all if we start off with no skeleton in the cupboard, and these oddities of failure of reciprocity certainly were skeletons in the network theorist's cupboard.

It is a wide traverse, from gyroscopes to electromagnetic-electrostatic couplings, to ferrites, to feedback circuits: all are linked together by a common theoretical concept, a common very simple pair of equations.

* "Some Gyrator and Impedance Inverter Circuits" by B. P. Bogert, *Proc. I.R.E.*, Vol. 43, page 793, July, 1955.

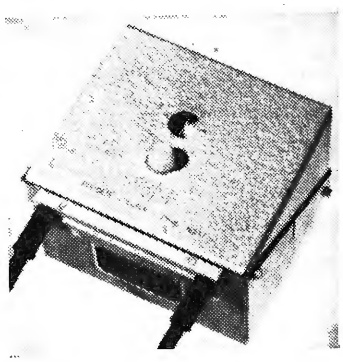
Process Control Timer

TWO ranges of 1 to 10 and 10 to 100 seconds are provided in the new Airmec N237 timer. The "start" signal can be either an open or short circuit, long or short pulse; and resetting is automatic. Two or more timers can be arranged to operate themselves successively, or, by returning the last timer to the first, an indefinitely continuing process is possible.

Scale calibration accuracy is within ±3%, the repetition accuracy being considerably higher. A change of mains input voltage of up to 10% affects the interval time by less than 5%. The full resetting time is roughly 1½ seconds, but a reset time of 1 second causes a timing error of less than 5%.

An alternative model to the one illustrated has a sealed screwdriver slot timing adjustment to prevent tampering.

The maker's address is Airmec, Ltd., High Wycombe, Bucks. The timer costs £14.



Airmec N237 process control timer.

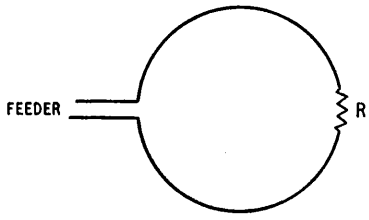
Technical Notebook

"Tandem" Particle Accelerator being made by Metropolitan-Vickers for the Atomic Energy Research Establishment has the novel feature that acceleration is achieved in two stages. Negative hydrogen ions at earth potential, formed in a high-frequency gas discharge, are extracted by preliminary accelerating electrodes, which produce a 6-MeV focused beam of circular cross-section down the centre of a main accelerating tube. Electrons are "stripped" from the negative ions by passing them through an extremely thin foil. This leaves the ions still moving in a forward direction with a net positive charge but with energy almost unchanged. The second stage of acceleration in the main tube is achieved by bringing the positive ions back to earth potential, so that the total energy communicated to them is 12 MeV. In this way the ions are accelerated to an energy twice as great as could be achieved in a single stage, while the insulation problems remain exactly the same as in a single-stage machine. On emerging from the lower end of the accelerating tube, the beam passes through a magnetic field which deflects the ions through a right angle and brings them to a focus on the target being used. Negative ions are more difficult to form than positive ions, so the beam current is smaller in the tandem machine than in a single-stage type, but this is a small price to pay for the saving in insulation.

Lenticular Colour Display for frame sequential colour television systems, performing the same sort of function as a rotating colour filter in front of the c.r. tube, has been devised by E. Allard of the French firm Société Telco. It consists of two identical and parallel lenticular plates with a vibrating colour filter in the focal plane between them. This filter is built up of groups of interlaced red, green and blue primary-colour elements corresponding to the lenticular pattern, and is driven by an electric motor and reciprocating mechanism. The arrangement is such that during the filter's cycle of movement the system transmits, over its whole surface, each of the primary-colour components in turn. The light efficiency is said to be the same as that of a rotating disc, but, of course, the arrangement is more compact. It makes possible flat filters for large c.r. tubes and is particularly suitable for projection purposes.

Arbitrary Waveform Generator described by C. B. House in D.S.I.R. unpublished report PB121157, will produce periodic waveforms in which the magnitude, slope, polarity and points of inflection can be controlled at will by simple resistance or voltage changes. It uses standard magnetic cores, diodes and switching transistors. When incorporated in an analogue computing system, the device will provide output transfer functions which can be adjusted to any desired complexity.

Unidirectional Loop Aerial.—The loop aerial, with its bi-directional figure-of-eight radiation pattern, is a familiar object to radio engineers. It is not generally known, however, that the device can be made unidirectional. This can be done in



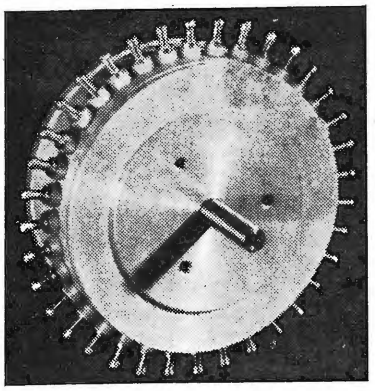
the case of a single-turn circular loop by breaking the conductor opposite the feed point and inserting a suitable terminating resistor, as shown in the sketch. A mathematical analysis and some practical results are given in the September issue of *Electronic and Radio Engineer*. Measurements were made at 110Mc/s on loops with circumferences of $\frac{1}{2}\lambda$ and $\frac{3}{4}\lambda$. Front-to-back ratios in excess of 5 to 1 were obtained using terminating resistors of 400-500 ohms.

Light Velocity Measurement by means of electron multipliers is suggested as a possibility by R. Gerharz in the *Journal of Electronics* for March, 1957. Use would be made of the extremely short ($\approx 10^{-8}$ sec) light pulses found to be emitted as a side effect of the impact of electrons on the magnesium oxide film on the dynodes of electron multipliers. A single pulse could be reconverted to electrical form by means of a photomultiplier, then amplified and used to initiate a new pulse. Thus a succession of pulses could be produced at a repetition frequency determined by the total electronic and optical delay time. The optical path would be via a mirror forming part of an interferometer. By moving this mirror, the length of the optical path, and hence the optical delay time, would be altered, and this would change the pulse repetition frequency. From accurate measurements of this frequency change (about 1.5kc/s), of the original frequency (about 20Mc/s) and of the mirror displacement (using the interferometer) the velocity of light could be determined.

Millimetre Wavelength Measurement by a new method is described in D.S.I.R. unpublished report PB111909 by M. B. Rapport, E. W. Ward and W. W. Balwarz. The method uses an intermediate medium interposed between a source of waves and a receiving aerial to create an interference phenomenon which provides a measure of the free-space wavelength. The results are independent of the aerial patterns and Fresnel zone effects, and are not appreciably affected by the orientation or position of the interposed medium. Results accurate to approximately 1% can be readily obtained.

New Type of "Maser" using gyromagnetic resonance in ferrites has been operated recently by Dr. M. T. Weiss at Bell Telephone Laboratories in the U.S.A. The ferrite sample is placed in a microwave cavity which can resonate at two frequencies (in one case both near 4,500Mc/s). A d.c. magnetic field of the correct strength and direction to cause gyromagnetic resonance at the sum of these frequencies (9,000Mc/s) is applied, and microwave power at this same sum frequency is also fed in As a result of non-linear coupling in the ferrite, and depending on the amount of r.f. power fed in, both amplification and oscillation at the two resonant frequencies (around 4,500Mc/s) can occur. Frequency changing between these two resonant frequencies is also possible.

Non-Linear-Function Pot'meter recently introduced by Salford Electrical Instruments is basically a *linear* potentiometer with its element tapped at 10° intervals and the connections brought out to turret-type terminals spaced around the body. These tappings allow fixed resistors to be shunted across sections of the element so that non-



linear functions can be constructed as desired. The main idea of this design is to avoid the need for the shaped-card type of potentiometers commonly used for producing non-linear functions, which are often difficult to replace when faulty. The new multi-tap potentiometers can be held in stock as standard items aad adapted to particular functions as the need arises.

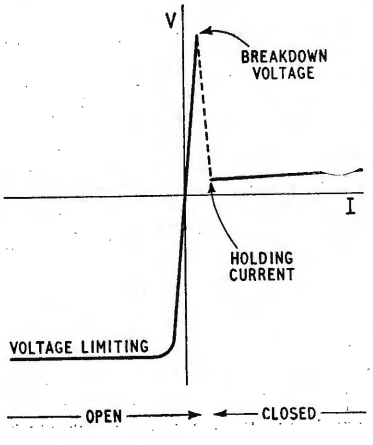
Optical Noise Filter might be a suitable description for an interesting subjective phenomenon mentioned at the recent Paris Colour Television Symposium. A speaker remarked that if television pictures are viewed through a small aperture about the size of a pinhole the noise seems to disappear, and, moreover, there is an apparent improvement in contrast and resolution. Another speaker, commenting on this, suggested that the small aperture might be comparable with a narrow-band filter, and mentioned in passing that the "reality" of television pictures is sometimes heightened by viewing them through a tube.

Inexpensive Digital Plotter for working at medium speeds is described by P. M. Kintner and E. A. White in an unpublished report, PB121056, available from the D.S.I.R. The system is built around a commercially available stencil cutting machine and, actuated by logical circuitry, will plot six points per second on a stencil suitable for reproduction by mimeograph or offset process.

Centimetre-Wave Semiconductor.—A new semiconductor device being tried out experimentally by Raytheon in America is said by *Electronics* for August 1957 to be "leading the way to reliable amplification at frequencies up to 10,000-Mc/s". Known as the "spacistor", it consists of a pellet of semiconductor material with collector and base connections made to opposite ends and with two other intermediate connections called an injector and a modulator. The high-frequency response is obtained by utilizing a high field strength across a reverse-biased junction to accelerate the current carriers so that their transit time is greatly reduced. The transit time is, of course, the thing which mainly determines the alpha cut-off frequency of conventional transistors. In the "spacistor" the injector, modulator and collector are biased positively with respect to the base. The input signal is applied in series with the modulator bias battery, while the output is obtained across a load in series with the collector battery. At low frequencies the power gain is said to be over 70dB. Earlier discussion of the principles appeared in *Proc. I.R.E.* for March 1957.

Soldering Stainless Steel, normally very difficult with conventional soldering fluxes, is facilitated by a new solder paint called Epatam 3311. It is made by Perdeck Solder Products, who claim that it allows stainless steel to be tinned and soldered as easily as copper or bright mild steel. The paint is merely applied straight from the tin, undiluted, and then heated to the normal soldering temperature. If used on brass or copper it can be slightly diluted with water for greater economy. It can also be used to advantage on surfaces with heavy contaminations such as iron welding scales, rust and grease. A pure-tin variety is available as well as the usual 40/60 and 60/40 tin-lead compositions.

Four-Layer Silicon Diode with bistable properties, suitable for use in waveform generation, switching and computing circuits, is the first product of the Shockley Semiconductor Laboratory of Beckman Instruments, California, U.S.A. It is a two-terminal device made by diffusion techniques.. The two states are an "open" or non-conducting state of 10-100MΩ and a "closed" or conducting state of 3-30Ω, and switching from one to the other is effected by the voltage applied. If this voltage is made to exceed a certain critical "breakdown" value (see diagram) the diode is switched from the "open" state to the "closed" state, and remains closed provided there is sufficient current to hold it there. If the current is reduced below this "holding" value (see diagram) the diode switches back to the "open" state again. A typical value for the breakdown voltage is 30V, with a current of several hundred microamps, while the voltage required to maintain the minimum holding current is about 1-2V. The physical action of the device is complicated, being explained on the basis of an equivalent structure containing two transistors and an avalanche diode. A full exposition, as well as several circuit applications, appeared in the August 1957 issue of *Electronic Industries*.



Travelling-Wave Frequency Multiplication is described by D. J. Bates and E. L. Ginzton in *Proc.I.R.E.* for July, 1957. Two helices in series are used. After "bunching" at the fundamental frequency in the first helix the electron beam enters the second helix. Here the harmonic components of the r.f. current induce fields on the helix. By making this second helix dispersive a particular harmonic may be selectively amplified by adjusting the helix voltage (with respect to the cathode). The experimental tube was designed to multiply frequencies from 0.5 to 1.0 kMc/s to frequencies from 2 to 4 kMc/s, and conversion gains of the order of 10 dB were obtained. The advantages of this method lie in these two factors of wideband operation and good conversion ratio.

Two-way Damping of the resonances in bass reflex loudspeaker enclosures is described by E. de Boer in *Audio Engineering* for July, 1957. The lower "vent" resonance is damped in the usual way by putting acoustically resistive material (such as layers of porous cloth) in the vent. But in addition, the upper "enclosure" resonance is damped by separating the loudspeaker and vent from the main enclosure volume by further resistive material. By thus controlling the resonances in more than one way, greater flexibility in cabinet design should be possible.

Magnetic-Core Delay Cable described in our August issue (p. 398) is actually made by Hackethal of Germany. In this country it can be obtained from the representatives, W. Wykeham and Company, 17-19, Cockspur Street, Trafalgar Square, London, S.W.1, who can deliver bulk supplies or sample uncalibrated lengths of five available types from stock. Columbia Technical Corporation are the representatives in the U.S.A.

Scientific Theories

By "CATHODE RAY"

"... the question is not whether they are true or false but whether they help or hinder"

DO you find this "second thought" business rather irritating? I don't mean my own efforts, which must be irritating enough, but the habit of scientists never to leave well alone. Having worked out a nice tidy explanation for something, they ought to be contented, one would think; but what do they do? Just when one has satisfactorily learnt their explanation, they come out with a new one which is far more complicated and probably quite incomprehensible. Worse still, several eminent scientists may invent quite different (but all very complicated and incomprehensible) theories, the only thing they have in common being rejection of the nice tidy commonsense explanation one has taken the trouble to learn.

This deplorable habit was well taken off in J. C. Squire's sequel to Pope's couplet:

> Nature and Nature's laws lay hid in night
> God said, *Let Newton be!* and all was light.
>
> * * *
>
> It did not last: the Devil, howling *Ho!*
> *Let Einstein be!* restored the status quo.

Can you remember when the transmission of radio and light was explained by the existence of an all-pervading æther? Just as the speed of sound waves through air, water or steel depends on the density and elasticity of the air, etc., so it was quite easy to calculate the density (very small) and elasticity (very great) of the æther. It seems obvious that some sort of medium must exist, even though it must needs be such an odd one as æther; otherwise how could radio power be conveyed from one place to another! It would be as absurd as supposing one man could punch another on the nose without coming anywhere near him. But after further consideration the scientists announced that there was no such thing as æther. As if that were not enough, the definite and understandable light waves turned into something unimaginable, behaving sometimes like waves and sometimes like particles.

The younger students will no doubt wonder why their elders shy at present-day theories, which *may* seem just as straightforward to them as the now discarded ideas did to us. But their time will come.

The less sophisticated may wonder why it is that when an explanation has been found and proved by the test of engineering practice to be right there should be any need to upset everybody by looking for another, especially when it turns out to be far-fetched.

These thoughts ran through my mind while I was contemplating a return to the subject of semiconductors. If the account I gave last summer was all right, why make it more complicated? Well, that story, simple though it was compared with what you will find in many of the books, might have seemed complicated to anyone brought up on the simple picture of conduction as a sort of sap flow through the solid stem of the conductor. But this simple conduction picture fails entirely to account for such things as metal rectifiers.

On a grander scale, Newton's "laws" were satisfactory for a century or two, but the wider range and greater accuracy of modern measurements have shown some discrepancies. That is not to say that they must be scrapped and the newer laws substituted everywhere. It would be a great nuisance always to use a very general and difficult theory when dealing with everyday affairs where a much simpler one is good enough, even though known to be unsound.

While agreeing that it may be expedient to use things known to be wrong, some people perhaps feel slightly conscience-striken about it. They may feel that one ought really to rely always on the truth, or at least what is believed to be the truth or the nearest known approach to it.

Understanding Natural Processes

I don't want to attempt an answer to Pilate's "What is truth?", or get involved in philosophy, metaphysics or religion; this is meant to be a strictly engineering discussion. Einstein (who, contrary to common impression, could talk and write with crystal clearness) said "It is difficult even to attach a precise meaning to the term 'scientific truth'." He also said "When we say we have succeeded in understanding a group of natural processes, we invariably mean that a constructive theory has been found that covers the processes in question." Quite so, you may say, but having found a theory that covers everything why not let it be?

Someone supplied the answer by remarking that while a billion observations in accord with a theory cannot prove it, a single contrary observation is enough to disprove it. So no theory is final. People can only invent theories on the basis of observations they and others made, and nobody will ever have knowledge of every event in nature. Moreover, all the observations are conveyed indirectly to the mind through sense organs and nerves; there is no direct contact with "reality."

I put the word in inverted commas, because it is doubtful what it means. One is apt to draw a distinction between an analogy, such as the old water pump for an e.m.f., and the real thing itself. But is this distinction clear? In a way, aren't all scientific explanations analogies? To explain crystal structure by talking about valency bonds is pure analogy and metaphor; one might almost say poetry. Words like "bonds" convey ideas that may help us to picture crystal structure, and even to predict quite correctly how it will behave in certain circumstances. So do descriptions of electrons being "knocked out" of atoms by "collisions." But calling them electrons instead of tiny billiard balls doesn't really make the

thing less metaphorical or more scientific. What is an electron? Just a concept. The word "electron" is shorthand for the continually changing collection of theory designed to fit the increasing collection of experimental evidence. Don't imagine we shall ever be able to say that now we know exactly what an electron is!

You see, it is a relatively simple matter to describe or define something complicated. One can specify a house in terms of bricks, boards, pipes, etc., because it is taken for granted that these are familiar things. If we are asked to say what a brick is, we may describe how it is made by baking a particular kind of clay, and if we are well up in chemistry we might give some formulæ. Asked then to say what the silicon in it is, do we consider the enquiry has gone far enough? Even if we happen to remember that the silicon atom has 14 electrons round a nucleus, we suspect we may be pressed to explain what an electron is, and saying it is (or has) a mass of so much and a negative electric charge of so much doesn't really explain it. Our predicament, sooner or later, is summed up by the rule in logic that it is futile to define the obscure in terms of the more obscure. So we can go on explaining only as long as there is something simpler and more easily understood to fall back on.

A Long Drink

But what *isn't* obscure? Do you *really* understand how the water pump works, in the e.m.f. analogy? How would you explain the process of drinking lemonade through a straw? Some would just say the drinker sucks it up. Another would say he produces a partial vacuum in his mouth, which draws it up. Another, perhaps, that the pressure of the atmosphere pushes it up. But what is the pressure of the atmosphere? It is explained as the result of the bombardment of the surface of the lemonade by countless air molecules continually whizzing about in all directions. But what makes them whizz? Here the discussion begins to get highly involved and can go on for a long time.

Even if we take that as read, however, isn't the bombardment story just another analogy? It sounds plausible because we know that intense bombardment of an unlatched door by snowballs would exert pressure on it, probably enough to push it open. But we have no right to assume that air molecules are like snowballs or any other missiles of which we have experience. They do not behave in the same ways as the larger objects we can see. Scientists may use less crude analogies, but I suspect they are still only analogies, for the reasons we have already considered.

That is not to say that analogies, even our crude ones, are to be despised. (If they were, I might as well give up.) The massive technical progress of this century is due to people who are guided by mental pictures or concepts—of such things as electric currents—that for the most part are probably quite crude and remote from reality. Any resemblance between electrons "bombarding" an anode and bullets hitting a target may be purely coincidental, but in practice it is quite helpful, and in my opinion legitimate so long as it isn't allowed to run away with one's intelligence.

The fact that many different explanations can be given of a single phenomenon such as lemonade flowing up a straw doesn't mean that one of them is right and the rest wrong; it all depends on how much is taken for granted. The delightful simplicity of the first will do if sucking is accepted as one of the basic principles of the universe. Shockley's classic book *Electrons and Holes in Semiconductors* is divided into three parts, which are three different treatments of the same subject, suited to different readers—or the same reader at different stages of progress.

That is an example of several different but legitimate accounts of the same thing. There can also be different accounts as it were side by side rather than one on top of another. Recently we saw that potential could be defined in two very different ways, one depending on the concept of field strength and the other on the concept of work. With regard to field strength, some people rely on lines of force. These lines are only a concept; that is to say, a way the mind has of seeing something. Other people are content to think of just fields. But fields too are a concept; a way of imagining and referring to the supposed causes of certain effects. Others discard fields and consider only the velocities and accelerations of charges. I have no doubt that if there are beings of equal or greater intelligence elsewhere in the universe they will have quite different concepts for electromagnetism. Among concepts the question is not whether they are true or false but whether they help or hinder. The field concept seems to have been a great help; but later might it be seen to hinder, by excluding some more fruitful concept?

Sometimes there have been lengthy scientific arguments about which of two concepts was right. For instance, some scientists held that when a spectroscope produces coloured light when white light is passed into it, this proves that white light is composed of light of all colours. Others contended that white light is entirely random, and the spectroscope creates coloured light from it, almost as a valve oscillator creates a.c. of various frequencies from d.c. As Eddington said about this, "The mistake was . . . in claiming that we could decide experimentally between two equally permissible forms of description."

So far I haven't even mentioned the word "mathematics," which omission some readers may count as grave as "Hamlet" without the Prince of Denmark. The more "advanced" the treatment of a subject, the more mathematical it is likely to be. In fact, there is a tendency to elevate mathematical equations to a supreme status in science, as if they were the language of ultimate reality itself. This seems to be like enthroning electronic computers as the intellectual lords of the universe. Mathematical symbols are just shorthand for concepts, and mathematical operations are shorthand for reasoning about them. The same results could, theoretically, be obtained by the use of words, but this would often be far too laborious and involved to be practicable. Calling a thing "F" instead of "force" doesn't in itself add to what we know about the nature of force, but it may make it practicable, as nothing else would do, to arrive at certain conclusions about it. While on the one hand it would be silly to regard, say, mechanical transport as the answer to everything, it would be equally so to despise it when undertaking a long journey. I hope the analogy is clear!

Ferrites for F.M.

FREQUENCY MODULATION USING FERRITE-CORED COILS

By T. W. G. CALVERT, B.Sc. (Eng.).

UNTIL recently, frequency modulation and control in electronic apparatus has nearly always been effected by means of a reactance valve circuit. Due to the development of new materials, however, there are now several alternatives to this method. For example, the discovery of ferro-electric materials has made it possible to vary the capacity of a condenser by applying a voltage. Another capacity which can be voltage controlled is that of a germanium p-n junction. Ferrites have made it practicable to make use at radio frequencies of the change of inductance which occurs when a magnetic flux is applied to the ferromagnetic core of a coil. In this article the use of ferrite-cored coils for frequency modulation and control is described.

It is well known that the permeability of a ferromagnetic material changes when a magnetic field is applied to it. Also, that if a coil is wound on the material, its inductance changes with the permeability, and thus with the magnetic field. When the coil is part of a resonant circuit, it is possible to change the frequency of oscillation by applying a magnetic field to the core.

A remote tuning unit, which depended for its operation on the change of permeability of a magnetic material subjected to a changing magnetic field, was described by Boucke in 1936, and a similar system was described by Kramolin in 1938[1]. These devices made use of an iron-dust, or laminated nickel-iron core to carry the winding. Their use was limited because of uncertain operation, low power sensitivity, and the ability to operate only at low radio frequencies.

The last decade has seen the development of magnetic ferrites. These are non-metallic substances which combine good magnetic properties (initial permeabilities between 10 and 3,000), with a very high resistivity (0.1-1,000 ohm-metres). Other magnetic materials, such as laminated nickel-iron or powder-dust cores have resistivities of the order of 0.1-1 microhm-metres, which may be increased only at the expense of the permeability. The high resistivity of ferrites enables them to be used up to very high frequencies as core material for coils.

From the literature on the ferrites made by Mullards under the trade name Ferroxcube, it was decided that grade B4 would be suitable for this application. This grade of Ferroxcube is available in many sizes, but rods 2in long and 0.25in diameter were found to be convenient.

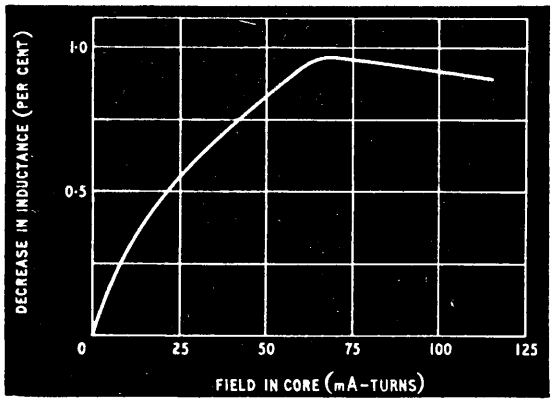


Fig. 1. Change of inductance when the control current is passed through the r.f. coil.

Applying the Field

A varying field in the ferrite core of an r.f. coil may be produced in three main ways, namely:—

(1) By passing a modulating or control current through the r.f. winding of the core.

(2) By passing a similar current through a separate winding on the core.

(3) By producing the field externally and applying it to the core.

The first two methods, (1) and (2), have been investigated by the author, and the third, (3), was fully described by Slater in 1954[2].

(1) A coil of 46 turns of 28 s.w.g. wire was wound on the 0.25-in diameter ferrite rod and its inductance measured. The change of inductance at 1 Mc/s which was observed when direct current was passed through the coil is shown in Fig. 1. This direct current must be obtained from a high-impedance source if the Q of the coil is not to be appreciably affected. In this case it was found to be convenient to connect the r.f. coil in the anode circuit of a pentode valve.

It is seen from Fig. 1 that a linear change of the order of 1% may be obtained. A series of coils were now wound with 40, 20, 10, 5, 2, and 1 turn respectively of 28 s.w.g. wire, and tests carried out over a range of frequencies from 1 to 50 Mc/s. It was found that up to 14 Mc/s the percentage inductance changes were similar to those obtained at 1 Mc/s, but above 14 Mc/s the amount of change began to decrease, reaching zero at 45 Mc/s. As might be expected, the current required increased as the number of turns was reduced, but the ampere-turns required remained fairly constant up to 14 Mc/s.

The fall in inductance change as the frequency was increased above 14 Mc/s could be due to losses in the core. However, as B4 Ferroxcube can be

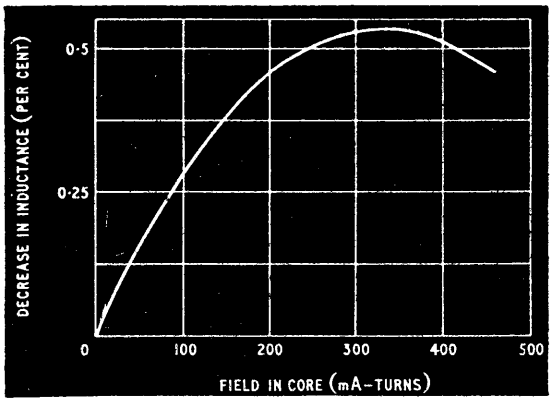


Fig. 2. Change of inductance when the control current is passed through a separate interleaved coil.

used as a core material up to 100 Mc/s, this seems improbable. It is more likely that, since the number of turns falls as the frequency increases, the approximation to a solenoid becomes less valid, and the flux produced by the control current is not in the ferrite core, but in the surrounding air, so that it has no effect on the permeability of the core.

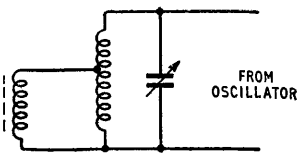
(2) The control flux in the ferrite core may also be produced by passing a current through a separate winding on the core. This is clearly a simplification, since the control current need not be derived from such a high impedance source as with a combined r.f. and control winding. Initially, a control coil of 50 turns was wound on top of the r.f. coil of 46 turns of 28 s.w.g. wire already wound on the ferrite rod. This, however, decreased the Q of the r.f. coil so much that no inductance measurements were possible. With a control coil of 300 turns split into two sections, and wound on either side of the r.f. winding, the inductance of the coil was measured, but no change could be detected when current was passed through the control coil. The only arrangement which did give an appreciable change of inductance was that in which the r.f. and control coils were interleaved bifilarly. The results, which are shown in Fig. 2, are similar to those for (1), shown in Fig. 1, but the maximum inductance change was only 0.6% as compared with 1%, and nearly 10 times as many "control ampere-turns" were required for a given inductance change.

These results suggest that it is necessary to have very close coupling between the r.f. and control windings, so that the control flux passes through the part of the core associated with the r.f. coil. Thus, the best results were obtained when the two windings were combined, as in (1), giving the closest coupling possible; smaller inductance changes were obtained when the two windings were closely coupled by interleaving them; and no inductance changes at all were detectable when the control winding was wound in two sections on either side of the r.f. winding.

(3) An alternative to producing control flux by passing current through windings on the ferrite core, is to place the ferrite, with an r.f. coil wound on it, in the gap of a permanent or electro-magnet.

When a ferrite core carrying an r.f. winding was placed in the gap of a powerful permanent magnet, the inductance of the winding was reduced by 55%. This large change, which is more than 50 times

Fig. 3. A method of producing frequency modulation at v.h.f. The flux in the core may be produced either by passing current through the coil on the core, or by placing the core in the gap of an electromagnet.



greater than the maximum obtained in earlier tests, is consistent with the results of Slater[2], who recorded inductance changes of more than 60%. Slater used an r.f. coil wound on a small ferrite core, placed in the gap of a stack of U-shaped nickel-iron laminations which carried control windings, thus forming an electromagnet. With such a large change of inductance, there was an appreciable hysteresis effect.

From the results described above, it is seen that when the flux in the core of a coil is produced externally to the core, i.e., the magnetic circuit is complete, then the inductance changes which result are of the order of 50 times greater than those obtained when the flux is produced by a coil on the core itself, and the magnetic circuit is incomplete. The great difference between the two sets of results is thought to be due to the demagnetizing effect of an incomplete magnetic circuit, which causes the flux in the ferrite core to be diluted.

Thus there are three systems, two of which are very simple, in that there is no associated electromagnet, but which give maximum inductance changes of only about 1%, i.e., a frequency change of about 0.5%. The third system, which is more complicated, requires the control winding to be wound on a subsidiary core of nickel-iron laminations, but inductance changes of up to 60% are obtainable, i.e., frequency changes of up to 30%.

All three methods of applying flux to the core become ineffective as the frequency is raised, i.e., as the number of turns on the r.f. coil is decreased. This may be avoided by using the circuit shown in Fig. 3, where the ferrite-cored coil is tapped onto another coil. The total inductance is reduced without reducing the number of turns on the ferrite-cored coil. The disadvantage is that the percentage inductance change of the combination will be less than that of the ferrite-cored coil alone.

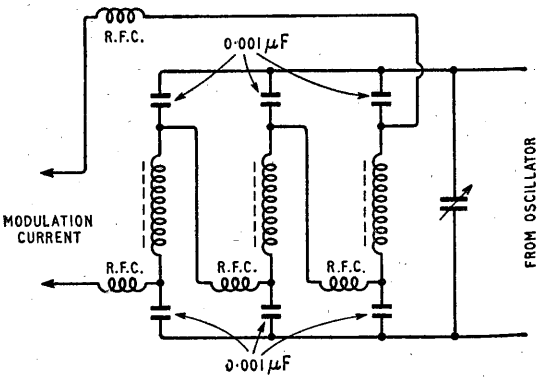


Fig. 4. This circuit provides modulation at v.h.f. without reducing the maximum frequency deviation. More ferrite cored coils must be added as the frequency is increased.

Fig. 4 shows an alternative circuit which enables the inductance to be reduced without reducing the percentage frequency deviation. The essential point of this circuit is that the ferrite-cored coils are connected in series at modulating frequencies and in parallel at radio frequencies. This circuit would function in an oscillator, giving total frequency deviations even at very high frequencies of up to 0.5%.

The first two systems, giving frequency changes of ±0.25% and ±0.15% respectively, are suitable for an f.m. signal generator. (The ± 75 kc/s maximum deviation of the B.B.C. v.h.f./f.m. signals represents a change of less than ±0.1%.) They could also be used to apply a.f.c. to a radio receiver. However, as a simple ferrite-cored coil will not give any frequency change above 45 Mc/s, for v.h.f. such as the 90 Mc/s f.m. broadcast band it would be necessary either to use the third or fourth harmonic of the local oscillator, or one of the circuits shown in Figs. 3 and 4. The author has used method (1) to provide frequency sweep in a wobbulator. (A wobbulator enables the response curves of tuned circuits, e.g. i.f. transformers, to be displayed on a cathode-ray oscilloscope.) The wobbulator was built for use with a short wave receiver tuning over the range 4.5-15 Mc/s. Since the receiver had an i.f. of 465 kc/s, the frequency deviation of ±25 kc/s, obtainable at a typical input frequency of 10 Mc/s, was quite sufficient to show the whole response curve of the i.f. transformers.

Although the system which produces the control flux in an auxiliary Ni-Fe core is more complicated, and therefore more expensive, there is the advantage that the control current need not be derived from a high impedance source. Scroggie used a method similar to this to provide automatic frequency correction in an f.m. receiver[3]. With a possible frequency change of 30%, this method is very suitable for control applications, such as the remote tuning of a radio receiver. It also gives linear frequency modulation of up to ±2%, which is a much greater deviation than is easily obtainable by other methods.

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(2). F. Slater. "A Ferrite Frequency Modulator," *Marconi Instrumentation*, No. 8, p. 186 (1954).

(3). M. G. Scroggie. "An Unconventional F.M. Receiver," *Wireless World*, Vol. 62, p. 258 (June, 1956).

Books Received

An Introduction to Automatic Digital Computers, by R. K. Livesley. Describes in general terms the sort of facilities available in stored-programme "mathematical" machines and concentrates mostly on principles of programming, with particular emphasis on routine engineering problems. Pp. 53; Figs. 10. Price 8s 6d. In the Cambridge Engineering Series. Cambridge University Press, Bentley House, Euston Road, London, N.W.1.

Modern Computing Methods, by the staff of the N.P.L. Mathematics Division. Numerical methods of solving mathematical problems suitable for computing machines, with worked examples. Covers linear equations and matrices, differential equations, roots of polynomial equations, latent roots of matrices, finite-difference methods and relaxation methods. Pp. 129; Figs. 18. Price 10s. 6d. H.M.S.O., York House, Kingsway, London, W.C.2.

Ceramic Insulators for Telecommunication Purposes. A revised specification defining tolerances on ceramic insulators used as bushings or in radio and electronic components in high- low-voltage and r.f. circuits. An appendix gives guidance to engineers and draftsmen on the design of ceramic insulators for most economical production. Pp. 15; Figs. 4. Price 1s. R.E.C.M.F., 21, Tothill Street, London, S.W.1. Price 1s.

Guide to the Specification and Use of Quartz Oscillator Crystals. Pp. 40; Figs. 11. Price 5s. Radio Communications and Electronic Engineering Association, 11, Green Street, London, W.1.

Propagation des Ondes Electromagnetiques de Haute Fréquence, by J. Ortusi. The first volume in the series "Collection des Annales de Radio-électricité" covers in its first-part general waveguide theory, waveguide junctions and discontinuities; including guides containing ferrites and dielectrics. A second part discusses u.h.f. terrestrial propagation, and has some useful nomograms. Pp. 320; Figs. 110. Price 3,240 fr. (French). Société Française de Documentation Electronique, 12, rue Carducci, Paris 19.

Valve and Television Tube Equivalents, by B. B. Babani, covers British, American, European and Service types of receiving and transmitting valves. Pp. 66. Price 5s. Bernards, The Grampians, Western Gate, London, W.8.

T.V. Fault Finding, by the staff of the *Radio Constructor*. Revised edition with many illustrations from TV screens gives circuit details of, and correction methods for the various types of fault. Pp. 104; Figs. 112. Price 5s. Data Publications, Ltd., 57, Maida Vale, London, W.9.

Understanding Hi-Fi Circuits, by Norman H. Crowhurst. Deals simply with various amplifier and preamplifier stages, overall feedback and damping, and crossover networks and other speaker sound distribution systems. Pp. 224; Figs. 179. Price 2.90 dollars in soft cover edition. Available in Gt. Britain from The Modern Book Co., 19-23, Praed Street, London, W.2. Price 23s.

Transistor Engineering Reference Handbook, by H. E. Marrows, contains a large amount of data on commercial American transistors, components for use with transistors, and transistor circuits, and includes a classified bibliography and manufacturers' directory. Pp. 286; many figs. Price 80s. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2.

Industrial Rectifying Tubes, by members of Philips Electron Tube division. Vol. 13 in the Philips technical library series on electron tubes deals with construction, operation and applications (battery charging and industrial) of hot-cathode gas-filled rectifiers. Pp. 126; Figs. 100. Price 15s. Cleaver Hume Press, Ltd., 31, Wrights Lane, London, W.8.

Receiving Aerial Systems, by I. A. Davidson, B.A., discusses generally television and radio aerials, including their mechanical design and installation, and also cables and accessories. Pp. 152; Figs. 70. Price 21s. Heywood and Co., Ltd., Tower House, Southampton Street, London, W.C.2.

Subjective Colour for Television?

Experimental Film Based on the Benham's Top Principle

By C. E. M. HANSEL*, M.A.

IT is well known that people watching certain television "commercials" on ITV have observed colour effects on their receiver screens. As the same colours were reported by a number of independent observers there is no reason to doubt that they did experience sensations of colour, and it is of interest to see how these could arise.

It has long been known that colour sensations can be aroused by viewing a black and white top rotating in white light. Benham's top (Fig. 1) is the best known means by which these colours can be produced. If Benham's top is rotated in monochromatic illumination from the middle part of the spectrum it is still possible for an observer to experience a variety of colours.

The effect was demonstrated by Helmholtz. He showed that if a simple top (Fig. 2) in which one half is black and the other white is rotated, there appears to the observer to be a blue fringe behind the black as it leaves the white area and a red fringe extending into the black area as it advances into the white area. These colour fringes were attributed to differences in the retinal action times of the photoreceptors bringing about the sensations of blueness and redness, for the time taken for the sensation of blueness to arise after onset of illumination is known to be less than that for redness.

* Department of Psychology, University of Manchester.

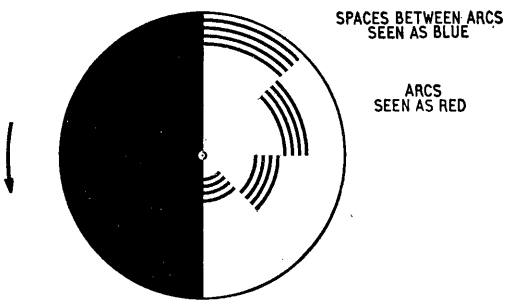


Fig. 1. Structure of the well-known Benham's top

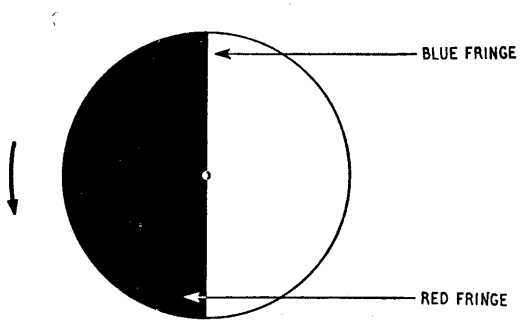


Fig. 2. Simple top used by Helmholtz to demonstrate subjective colours.

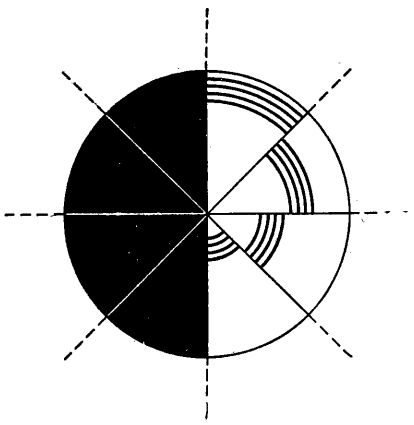


Fig. 3. Benham's top shown divided into eight segments.

As the white area of the top advances into the black area, light strikes the corresponding part of the retina but as the sensation of blueness is aroused more quickly than that of redness, a blue fringe is seen at the leading edge of the white area. Similarly, a red fringe is seen where the black area advances into the white area.

Benham's top is a modified form of Helmholtz's top in which the area of the edge is increased by means of the arcs and, as we should expect, the blueness extends over the white area between the arcs, whereas the redness is seen in the arcs themselves. These colour effects can be obtained in monochromatic light provided that the photoreceptors which normally evoke the sensations of blueness and redness have sensitivities extending over the wavelength being used.

In 1951 I suggested to the B.B.C. that they might produce colour effects in normal television transmitters by utilising this principle, and for this purpose a black and white film was constructed which, on projection, gave the impression of objects of different colours against a coloured background†.

A simple technique was developed which utilized the principle of Benham's top but which enabled the colours to be superimposed on drawings. Ben-

† The B.B.C. did not follow up this suggestion but demonstrations of subjective colour effects by means of tops were given on American television in 1953.

ham's top may be divided into eight segments (Fig. 3). Areas shaded in accordance with these eight segments are projected successively on to a screen, but the segment containing the arcs is replaced by a system of dots, thus increasing the length of the black-white boundary areas, on which the effect is to some extent dependent.

The desired colour effect for a particular area is obtained by shading the area on successive frames to conform with the code shown in Fig. 4(a). Projection at the rate of 24 frames per second‡ then gives three complete cycles per second and is accompanied with a coarse flicker. In order to decrease the flicker effect the coding may be modified as in Fig. 4(b). A particular area may also be split up into sub-areas, giving further decrease in flicker.

The sequence of 8 frames to a cycle may be modified and 6-, 4- or 3-frame cycles used. With 24 frames per second as used in film projection, a cycle of 8 frames has been found to be too long, and one of 4 frames is more effective, although in this case colour effects are not so pronounced (see Fig. 5).

By using these techniques it is possible to construct cinematograph films which, on projection, will appear coloured. Sets of cards are prepared with the different areas shaded in accordance with the code for the desired colour effect and these are photographed in sequence on successive frames of the film. A similar technique could be used on photographs of natural objects. In this case the dot pattern would be replaced by the actual area of the photograph (which would have to have some lines or shading added if these were not already present).

‡ For television film scanning, of course, this would have to be increased to 25 frames per second, since the film frame rate has to be related to the television standards.—ED.

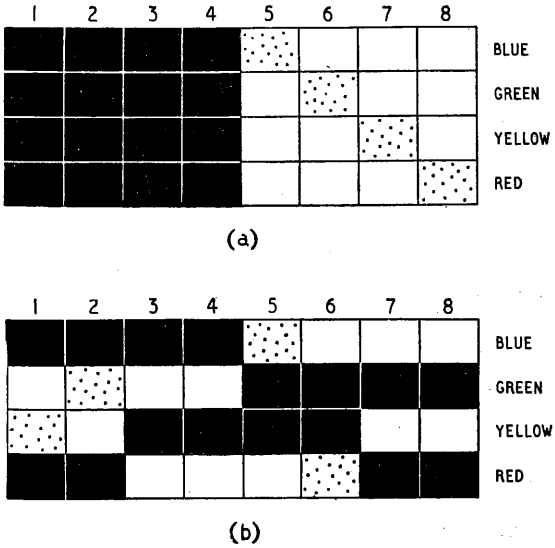


Fig. 4. (a) Adaptation of the 8 segments of the top in Fig. 3 to a cycle of 8 successive film frames. A different sequential pattern is used for each colour, and dots replace the arcs of Fig. 3. In (b) are modified code patterns used for reducing flicker.

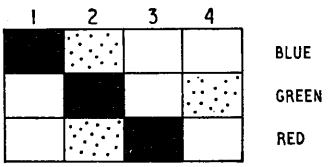


Fig. 5. Simplified 4-frame coding system for use at a film projection rate of 24 frames per second.

In television, where a single scanning spot is used on a c.r. tube, a particular area of the screen is illuminated for only a small fraction of the total presentation time for each frame. The cumulative action of the eye largely compensates for this, however, and it is possible that more effective means of obtaining colour effects could be devised by utilizing the fact that the image is traced out by a small moving illuminated area. Special techniques could be developed which would utilize the full 50-c/s scanning rate of the interlacing odd and even lines, rather than the 25-c/s scanning rate which would result from using film.

It was reported by the viewers on ITV that a person was seen wearing a blue tie with white spots. Although we should rather expect that a blue tie with black spots should be seen, there is no reason to doubt that the colours were subjective and were produced by characteristics of the film approximating to those described above.

CLUB NEWS

Bexleyheath.—At the October 10th meeting of the North Kent Radio Society, E. Hasted (G3BHF) will speak about filter circuits The club meets fortnightly at 8.0 in the Congregational Hall, opposite Bexleyheath Clock Tower. Sec.: D. W. Wooderson (G3HKX), 39 Woolwich Road, Bexleyheath, Kent.

Birmingham.—Mullard films "Mirror in the sky" and "The principles of the transistor" are being shown at the October 25th meeting of the Slade Radio Society at 7.30 at the Y.M.C.A. Sec.: C. N. Smart, 110, Woolmore Road, Erdington.

Bury.—The October meeting of the Bury Radio Society will be held at 8.0 on the 8th at the George Hotel, Kay Gardens. "Matching matters" is the title of the talk to be given by R. Hammans (G2IG). Sec.: L. Robinson, 56 Avondale Avenue, Bury, Lancs.

Dorking.—A film show will be given at the next meeting of the Dorking and District Radio Society at 7.45 on October 8th at the Star & Garter Hotel, adjacent to Dorking North station. Sec.: J. Greenwell (G3AEZ), Wigmore Lodge, Beare Green, Near Dorking, Surrey.

Reading.—The next meeting of the newly formed Reading Amateur Radio Club will be held at 7.30 on September 28th at Palmer Hall, West Street, when Roland Page (G5TP) will describe and demonstrate "A table-top 150-watt transmitter." Sec.: L. R. Mitchell (G3BHK), 965 Oxford Road, Reading.

PUBLICATION DATE

Owing to a temporary rearrangement of our printing schedule the publication date of the November issue of *Wireless World* will be advanced to October 15th.

News from the Industry

E.M.I.—With the merging of E.M.I.'s domestic radio interests with those of Thorn Electrical and the recent setting up of a new company (E.M.I. Records, Ltd.) to handle the marketing of records, E.M.I. Sales & Service, Ltd., has been reoragnized. R. J. T. Hewitt is appointed general manager and will act as deputy to the recently appointed managing director, H. A. Lewis. There are two main divisions within the company, one handling consumer products (household appliances, reproducers, car radio and components) and the other capital goods (magnetic tape, professional tape-recording equipment and sound and vision distribution equipment). The divisional managers are F. W. Goodman (consumer products) and P. H. Wetherill (capital goods). A. Thorpe is appointed works manager.

H.M.V. and Marconiphone.—Consequent upon the agreement between E.M.I. and Thorn regarding the manufacture and marketing of receivers under the trade names Marconiphone, H.M.V. and Ferguson, the British Radio Corporation, Ltd., was formed to merge these interests. Now two new marketing companies have been formed, "His Master's Voice" Radio and Television Sales, Ltd., and Marconiphone Radio and Television Sales, Ltd., with offices and showrooms at 21, Cavendish Place, London, W.1. The directors of both companies are F. W. Perks (E.M.I.) and S. T. Holmes and G. J. Strowger (Thorn). The marketing of Ferguson receivers will continue through Ferguson Radio Corporation.

English Electric are to supply a DEUCE computer to the Mechanical Engineering Research Laboratories (East Kilbride, Scotland) which is part of the Department of Scientific and Industrial Research. This will be the fifth DEUCE computer in Government service and will be employed mainly in calculations in hydro and thermo-mechanical problems. It will be the first machine of the series to be equipped for high-speed paper tape and punched card inputs.

Texas Instruments, Ltd., the British subsidiary set up nine months ago by the American Texas Instruments, Inc., open a factory at Dallas Road, Bedford, on October 1st. It is initially concentrating on the production of silicon rectifiers and transistors.

OVERSEAS TRADE

Television film recording equipment (telerecording) has been ordered from Marconi's for the Prague studios of the Czechoslovakian television service. The equipment is similar to that mentioned in our March issue (p. 137), the outstanding feature being the "fast pull-down" film mechanism, which enables each frame of film to be moved into position during the blanking period between television frames—from 1.4 to 1.8 msecs. The Prague installation will have a number of additional features, including a waveform monitor and facilities for separate synchronous magnetic sound recording.

EXACTING STANDARDS of cleanliness are observed in this dust-free, air-conditioned zone of the AVO factory, at Douglas Street, London, S.W.1, within which instruments are built, calibrated and tested.

Helsinki.—Among the 450 representative United Kingdom products shown on the Council of Industrial Design stand at the British Trade Fair at Helsinki (September 6th-22nd) were two television sets (Ekco portable and Pye console), three sound receivers (Bush MB60 portable, Philco A3655 and R. M. Electric "Minitone" portable), and two record reproducers (E.A.R. "Chairside" and Pilot "Music Master").

Echo sounders, including the new MS30 open-boat type for inshore fishermen, are being shown by Kelvin Hughes at the International Fisheries Trade Fair at Copenhagen (September 27th to October 6th).

Vienna Trade Fair.—Products of the various companies in the Pye group, including domestic television and sound equipment, industrial and underwater television, scientific instruments, communications gear and components, were exhibited at the International Trade Fair held in Vienna from September 8th to 15th.

Netherlands.—Although no British radio manufacturer has an individual stand at the Radio Fair in Amsterdam (September 19th to 26th) U.K. products are on many of the stands. Some of the well-known names quoted in the preview of the show published in our Dutch contemporary *Radio Bulletin* are: Avo, Bakers-Selhurst, Belling-Lee, Colvern, Daly, E.M.I., Egen, Ferguson, Ferranti, Goodmans, Gresham, Leak, Morganite, Muirhead, Pam, Painton, Pamphonic, Pye, Q-Max, Racal, Truvox, W.B., Wharfedale and Wingrove & Rogers.

Angola.—The British Consulate in Luanda has prepared a report on the domestic receiver market in Portuguese East Africa. Whereas in 1949 the U.K. supplied over 1,000 receivers, which was 40% of the country's purchase, last year's figure of 740 was but 6% of the imports. The Netherlands supplied 40% of last year's receivers, U.S.A. 30% and Germany 20%.

Central American agency of U.K. manufacturers of components, accessories and test equipment is being sought by Henrique Stol Representaciones, Frontera 115 Dept. 303, Col. Roma, Mexico D.F. Among the accessories listed are pickups and cartridges, microphones, speaker magnets and cones, car aerials, amplifier and record-changer kits, and recording blanks.

Miniature Soldering Iron.—Oryx Electrical Laboratories, Ltd., of 98, Dominion Road, Worthing, Sussex, manufacturers of the Oryx sub-miniature soldering iron, are making a change in their sales policy and invite inquiries from overseas for exclusive agencies.

NEW ADDRESSES

Minnesota Mining and Manufacturing Co., Ltd., have moved their offices to a new building, to be known as 3M House, in Wigmore Street, London, W.1. (Tel.: Hunter 5522.)

Antiference, Ltd., have opened a new factory on the Bicester Road, Aylesbury, Bucks. (Tel.: Aylesbury 2511), where all sales, service and accounts matters are now being dealt with.

Anders Electronics, Ltd., manufacturers of test and measuring equipment, have transferred their office to 103, Hampstead Road, London, N.W.1. (Tel.: Euston 1639.) The dispatch department and warehouse remain at 91, Hampstead Road.

Marine Aerials, Ltd., manufacturers of the "Marinette" indoor television aerial, have moved from Deptford High Street, to 17a, Clifton Rise, New Cross, London, S.E.14. (Tel.: Tideway 3066.)

Electronic Products, of Ruislip, has been merged with Nesco Products, Ltd., of 149, Stanwell Road, Ashford, Middlesex (Tel.: Ashford 3555). K. B. Hobday is the managing director of the combined company, which will continue to make Nesco public-address loudspeakers and is specializing in the automatic assembly of components on printed circuit boards.

OCTOBER MEETINGS

LONDON

3rd. I.E.E.—Address by T. E. Goldup (president) at 5.30 at Savoy Place, W.C.2.

4th. Television Society.—"Recent investigations into the operation of image orthicon camera tubes" by Dr. R. Theile (Institut für Rundfunktechnik, Nuremberg) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

15th. Institute of Physics (Electronics Group).—"In electronic beams" by Dr. D. Meltzie at 5.30 at 47 Belgrave Square, S.W.1.

15th. Physical Society (Acoustics Group).—"Present state of acoustic theory as applied to small rooms" by J. Moir at 5.30 in the Physics Department, Imperial College.

15th. Institution of Post Office Electrical Engineers.—"Thirty years of radio development in the Post Office" by H. G. Beer at 5.0 at the I.E.E., Savoy Place, W.C.2.

16th. I.E.E.—"Some radio aids for high-speed aircraft" by Dr. J. S. McPetrie at 5.30 at Savoy Place, W.C.2.

16th. Radar Association.—Lecture at 7.30 at the Anatomy Theatre University College, Gower Street, W.C.1.

17th. Television Society.—Discussion on servicing modern television receivers at 7.0 at 164 Shaftesbury Avenue, W.C.2.

18th. B.S.R.A.—"Plastic deformation and wear of gramophone records" by Dr. D. R. Barlow at 7.15 at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2.

23rd. British Kinematograph Society.—"Simple techniques in television film production" by John Lamont, R. Evans and W. H. Cheevers (Associated-Rediffusion) at 7.30 at the Royal Society of Arts, John Adam Street, W.C.2.

28th. I.E.E. — "Domestic high-fidelity reproduction" by J. Moir at 5.30 at Savoy Place, W.C.2.

31st. Television Society.—"Performance of television receiver turret tuners" by K. H. Smith (Siemens Edison Swan) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

CHELTENHAM

4th. Brit.I.R.E.—"Radio engineering" by C. T. Lamping at 7.0 at the North Gloucestershire Technical College.

GLASGOW

10th. Brit.I.R.E.—"Reception problems of Scottish television" by W. Boyd at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

25th. Society of Instrument Technology.—"Computer control of machine tools" by A. A. Lodge at 7.15 at the Scottish Building Centre, 425 Sauchiehall Street.

MANCHESTER

3rd. Brit.I.R.E.—"High-quality sound equipment" by K. Davin and F. C. Gibson at 6.30 at Reynolds Hall, College of Technology, Sackville Street.

9th. I.E.E.—Address by K. J. Butler, chairman of N.W. Radio and Telecommunication Group at 6.45 at the Engineers' Club, Albert Square.

NEWCASTLE

21st. I.E.E.—Address by W. Gray, chairman of N.E. Radio and Measurements Group at 6.15 at King's College.

SHEFFIELD

9th. Society of Instrument Technology.—"Computers in heavy industry" by Dr. C. M. Wilson at 7.0 at the University, St. Georges Square.

WOLVERHAMPTON

9th. Brit.I.R.E.—"Transistors—circuits and applications" by M. D. Cooper at 7.15 at the Wolverhampton and Staffordshire Technical College, Wulfruna Street.

LATE-SEPTEMBER MEETING

27th. R.S.G.B.—"Trends in aerial design for the amateur" by S. Kharbanda, G2PU, (Labgear) at 6.30 at the I.E.E., Savoy Place, London, W.C.2.

RANDOM RADIATIONS

By "DIALLIST"

Good Going

WITH five transmitters (Croydon, Lichfield, Winter Hill, Emley Moor and Black Hill) already at work, the Glamorgan station due to come into action before the end of this year, the Isle of Wight transmitter scheduled for completion by next summer and a station in the North East by the end of 1958, the Independent Television Authority can't be said to have let the grass grow under its feet in the comparatively short time that it has been in existence. Over 85% of the population will then be within the I.T.A. service areas. The Authority plans that its programmes should cover almost the whole of the country within the next three years. The task wasn't an easy one when a beginning was made, for little or nothing was known about the propagation of vertically polarized television transmission in Band III and it was expected that there would be reception snags due to such things as blind spots and ghost-producing reflections. Actually, the service areas have mostly proved to be rather larger than was expected. Some of the good beyond-the-fringe reception that has been reported from many places is undoubtedly due to sunspot pranks and is not likely to last indefinitely. But, taking them by and large, all of the Band III stations are putting up a good show.

Polarization Problems

AT the time of writing Black Hill's test transmissions have been playing up in the matter of polarization. Outside the main service area a strong *horizontally*-polarized signal is found to be coming in some places. I'm not really surprised. When I lived in Hertfordshire some 50 miles from Wrotham I found quite accidentally that its transmissions could be very well received with a vertical dipole. And, if you remember, I gave some account in these notes a month or two ago of the experiences of a Lancashire reader who was regularly receiving Wrotham and found that it didn't seem to matter two hoots whether the apology for a dipole that he had made was arranged horizontally or vertically. I've just heard from a reader living in Launceston, in Cornwall, that before North Hessary Tor came into action on full power he used frequently to receive the f.m. transmissions from Wenvoe and Wrotham by means of his vertical channel-5 television aerial, normally used for receiving Wenvoe. Wrotham, as I've remarked before, seems to hold the B.B.C. record for long-distance v.h.f. reception. A kind correspondent tells me that during a recent visit to Germany he had no difficulty in receiving Wrotham with a 3-valve Grundig set using a simple home-made dipole.

Fringe Area TV Sets

I AM glad to see that so many firms this year are producing fringe-area TV receivers as counterparts to their standard sets. A very large number of the inhabitants of these islands live just outside the service areas of both B.B.C. and I.T.A. transmitters. Such people receive a weak signal, and one of their most common complaints is that the line scan won't stay locked. The reason is, of course that the sync pulses received in such areas aren't of sufficient amplitude to hold the ordinary sync separator-differentiating circuit-oscillator line scan to its correct frequency. Various forms of fly-wheel sync have been introduced, and these can be a very great help. The trouble, though, about many of them is that they mean extra valves and bits and pieces, and so add considerably to the cost of the sets.

The Synchroguide System

One method of keeping the line timebase running at exactly the right speed greatly takes my fancy. This is the synchroguide, which was originally developed in the U.S.A. and is now being used to a considerable extent in this country. Only two triodes are needed, and these can be in the form of a double triode. The first is the control valve, to whose cathode are applied negative-going sync pulses. This valve is biased back so far that only the tips of the pulses make it conductive. Valve number two is a blocking oscillator. The positive-going pips of its grid-voltage waveform are applied to the grid of the control valve. When the timebase speed is correct these pips coincide with the leading edges of the sync pulses. Anode current then flows, and both its amplitude and duration are conditioned by the phase relationship of the sync pulse and the pip. From this current is derived a voltage which is applied to the grid of the blocking oscillator. Should it be running too slowly the pip is late in arriving at the cathode of the control valve; anode current flows for a longer period and the biasing pulse

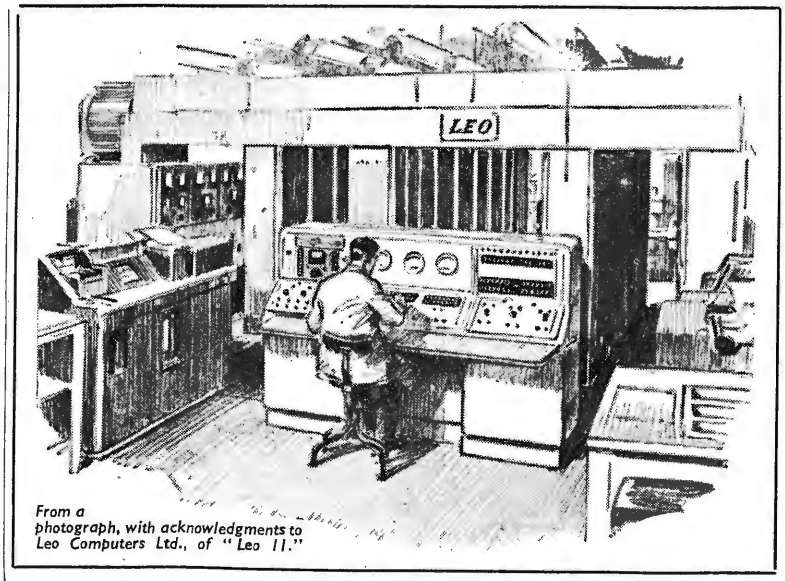
is lengthened, so speeding up the blocking oscillator. If the speed is too high, the resultant biasing pulse is shortened and the oscillator slowed down. Like so many ingenious ideas, it's beautifully simple. And it works well, provided that the TV set has effective a.g.c.

VHF/FM Comes Into Its Own

IT'S good to see that the majority of sound receivers, other than battery portables and the less expensive kind of mains sets, are provided this year with a Band II range for the reception of f.m. transmissions. Only the more expensive sets with high-quality audio stages will be able to do full justice to the excellent quality of the B.B.C.'s now almost country-wide system; but all will confer the advantage of freedom from almost every kind of interference. You get a silent background and, if you have an outdoor dipole, complete freedom from all sorts of interference. Some sets have a built-in ferrite aerial for Band II. That's all right, if you happen to live at the top of a high building (as I do), or in a place where there is little interference from the ignition systems of motor vehicles. But if you try to use the v.h.f. range with a built-in ferrite aerial on the ground floor of a house, or near a road carrying no small volume of motor traffic, you're liable to disbelieve the "no interference" claim made for the service. Give it a fair chance and you'll have no complaints to make.

FM and TV

WRITING from Rawthorpe, near Huddersfield, a reader sends me an interesting account of reception of both f.m. from Holme Moss and the a.m. sound from the Emley Moor television station on his f.m. set. The transmitting aerials of both stations can be seen from windows in the upper part of his house. By detuning from the Holme Moss Home Service frequency (93.7 Mc/s) towards that of the Third Programme (91.5 Mc/s) he can bring in the I.T.A. sound (196.25 Mc/s). His set has a.f.c., which enables him to "drag" the transmission further away from the Home. Then, by reducing the h.f. reproduction by means of the tone control, he can cut down the background noise until it's quite inoffensive. When the set is tuned to the Home Service there is no interference from Emley Moor. Have any other readers had similar experiences?



From a photograph, with acknowledgments to Leo Computers Ltd., of "Leo II."

UNBIASED

By FREE GRID

Canned Concerts

I HAVE previously pleaded in these columns for manufacturers to give us a wireless set with a built-in tape recorder and a time switch so that if some programme to which we wish to listen clashes with an important "date" we can arrange for it to be bottled in our absence.

There is obviously no technical difficulty whatever in producing such an instrument, but probably there is a legal snag in connection with recording rights and that is why nothing has been done about it so far. I was glad to see, however, that a start was made in the right direction with a tape recorder at the 1955 Radio Show with space for a v.h.f. radio receiver, and some of the German sets that are on the market in this country approach the problem in a remarkably sensible way.

German manufacturers have obviously realized that a set with a built-in tape recorder would be very expensive and one of them has therefore produced a receiver in which there is provision for adding the tape recorder afterwards, and I understand that others are doing the same thing. This particular manufacturer also makes a tape recorder and he has left a space for housing it. You may say that there is not much to shout about in a mere space and nor is there until you buy a tape recorder to fill it up. It is at any rate a beginning. Maybe in next year's model we shall see a space left for a time switch.

Another point I like about all these "hi-fi" sets from the fatherland is that they all have a special outlet socket for coupling up a tape recorder so that you can feed straight from the diode into the amplifier of the recorder, so by-passing the set's amplifier with its "non-recordogenic" (horrible but apt expression) characteristics.

Telly Nellie

BECAUSE of the intuitive flair women have for diagnosing trouble in bawling babies I have always held the opinion that they would make far better radio service technicians than men. I recollect once spending a convivial evening with a young doctor when his wife was out. Their sleeping baby upstairs suddenly let out a piercing yell. We both went upstairs to see what was the matter and although we, metaphorically, "turned all the knobs" we failed to reduce the howling by a single dB.

Eventually the youthful medico got out his stethoscope and was about to carry out a thorough examination when his wife came home, angrily pushed us aside and without more ado diagnosed the trouble intuitively. I don't recollect exactly what the trouble was but I know safety pins came into it.

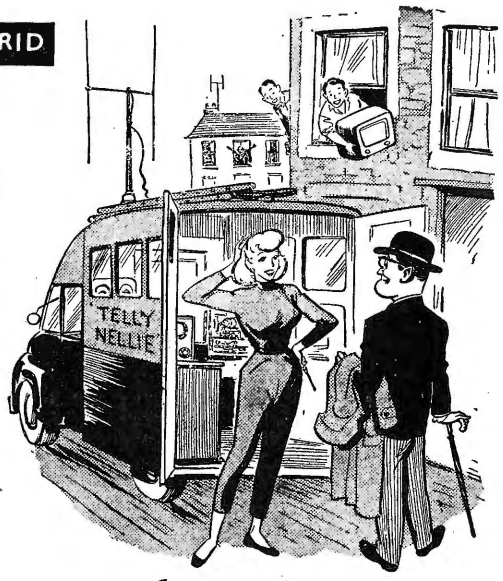
Some time ago I told you of a dealer who employs girls as service technicians, finding their intuitive faculties cheaper and quicker than an oscilloscope but recently I came across a far more remarkable instance of the same sort of thing. I was visiting friends in a small village which lies just within the fringe area of the London TV stations. Each house had a very complex aerial array and I was told that sets have to be kept up to concert pitch in order to get good results. I was also informed that consistently good reception in that and neighbouring villages is only made possible by the activities of a girl who has fitted up a small motor van as a mobile service station.

To obtain her services it is only necessary to telephone her HQ a few miles away and if already out on a job a message is sent to her in the van by a mobile radio link. She is known throughout the countryside as Telly Nellie and uses the slogan "Send for Telly Nellie." When her van arrives at a customer's house she runs a long cable to plug into the mains in the house and removes the set to her mobile test bench for first-aid work. In the case of a serious fault she takes it to her HQ.

I had the good fortune to see her when her van drew up in the village street and had a chat with her. She is not only a competent service technician but also an extremely attractive girl and I was not surprised to learn that many of the lads of the village were having constant trouble with their TV sets. There seems to be much scope for this sort of service in country districts and also for alternative names such as Radio Rita and Video Vera.

Ernie's Innards

I WAS informed by the P.R.O. of the Lead Development Association that Ernie's innards were encased in lead and in reporting this in the August issue I said I wondered if this was because he might be a bit radio-active. A G.P.O. engineer now writes telling me that Ernie is not encased in lead but, like a good civil servant, he is conventional in his attire. He assures me that the only lead in him is the normal lead sheathing of connecting cables.



Competent and comely

Seeing While You Soak

IF any of you are thinking of taking my tip (Oct., 1956, issue) to instal bathroom TV, you will at once be confronted with the problem of steaming up of the screen. However, there is no need to adopt a Spartan regime of cold baths as all you need to do is to instal a car windscreen wiper to keep the TV screen clear.

Recently I moved into a new house and asked the local electricity authority, if, whilst installing an immersion heater in the bathroom, they would mount on the skirting board an outlet socket. They were adamant in their refusal.

After much argument, however, they agreed to instal a step-down transformer under the floorboards to provide a six-volt feed to a skirting board socket for my electric shaver which has an optional six-volt input.

Technically speaking there ought to be no difficulty about operating a television set from a six-volt a.c. supply provided that I can find a TV set manufacturer enterprising enough to fit to his product a power transformer with a six-volt input winding. Maybe a set with this special power-input arrangement exists already.

Another great advantage of my six-volt idea is, of course, that you can shave in comfort and cleanliness as one of the greatest objections to certain electric shavers is that they act like a mowing machine without a grass box and tend to bespatter your chest with facial fungus. For those of you who only want to shave in the bath and not to enjoy TV I would point out that all you need is an inexpensive bell-ringing transformer as its voltage output is just right, although quite inadequate, of course, for a TV set.

'packaged' power

saves design time and effort

It's so easy to put in a ready-made, self-contained, completely reliable Power Supply sub-unit!

Performance figures unaffected by capacity loading on the H.T. output.

A COMPLETE RANGE OF SELF-CONTAINED UNITS READY TO BUILD INTO YOUR PROJECT	SRS 156	AS 619	AS 516	AS 517	AS 515	AS 615	AS 616
VOLTAGE	±150V	±150V to ±180V	±250V or ±300V	±250V or ±300V	±250V or ±300V	±250V or ±300V	±250V or ±300V
CURRENT	0-40ma	0-200ma	0-50ma	10-100ma	0-150ma or 50-200ma at 250V. 100-200ma at 300V.	0-500ma	0-1A
A.C. OUTPUTS	6.3V 4A C.T. 6.3V 1A	6.3V 4A C.T. 6.3V 4A C.T. 6.3V 1A C.T.	6.3V 4A C.T. 6.3V 1A	6.3V 4A C.T. 6.3V 2A C.T. 6.3V 1A	6.3V 4A C.T. 6.3V 4A C.T. 6.3V 1A	6.3V 5A C.T. 6.3V 5A C.T.	6.3V 10A C.T.
D.C. SOURCE IMPEDANCE	<2Ω	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω
STABILISATION FACTOR BETTER THAN	400:1	400:1	400:1	400:1	300:1	400:1	400:1
A.C. SOURCE IMPEDANCE 40c/s—100kc/s	<2Ω	<2Ω	<0.25Ω	<0.25Ω	<0.5Ω	<0.5Ω	<0.5Ω
RIPPLE AND NOISE CONTENT	<350μV	<300μV	<250μV	<300μV	<1mV	<300μV	<300μV
DIMENSIONS	9⅛" × 6⅛" × 6¼" high	10" × 10" × 6 15/16" high	9⅛" × 6⅛" × 6¼" high	9½" × 7⅛" × 6¼" high	9⅛" × 9⅛" × 6⅞" high	19" × 12½" × 10½" high	19" × 19" × 10½" high
WEIGHT	14½ lbs	21½ lbs	14½ lbs	20½ lbs	21½ lbs	80 lbs	approx 150 lbs

From this complete range of regulated power supply sub-units you can choose, ready-made, the right power source for your prototype or production equipments. Why waste design time and effort on a part of the problem which we have already thoroughly covered for you?

These robustly made units are giving excellent service in many forms of electronic equipments, computers, simulators, industrial controls, etc. Educational and servicing establishments find them most useful as bench instruments because of their compactness.

SOLARTRON

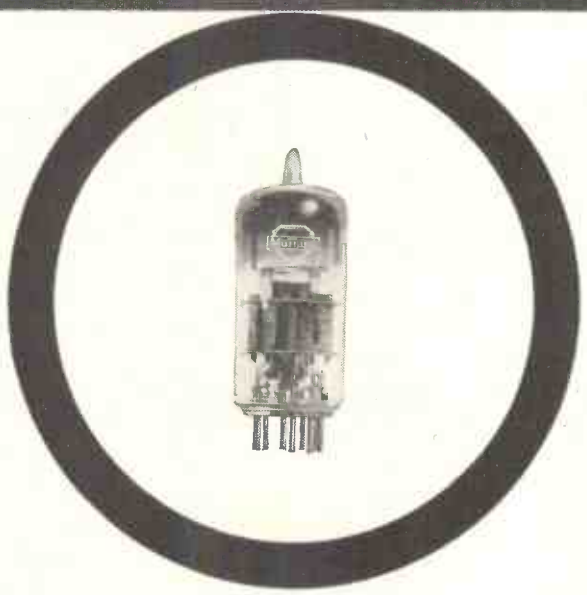
Notable features are

- ★ LONG TERM RELIABILITY
- ★ LOW SOURCE IMPEDANCE
- ★ VERY LOW RIPPLE AND NOISE CONTENT
- ★ GOOD STABILISATION RATIO
- ★ LOW COST. DELIVERY EX STOCK

Power Supply Sub-units

THE SOLARTRON ELECTRONIC GROUP LTD • THAMES DITTON • SURREY • ENGLAND

Telephone: EMBerbrook 5522 • Cables: Solartron, Thames Ditton



E88CC

a new high speed Double Triode for- computing, switching and scaling

Close tolerance characteristics

Close tolerances of standing current, slope, balance and cut-off add to equipment reliability and life.

Low impedance

High anode current at zero bias and low anode voltage provide high speed capabilities.

High slope — controlled cut-off

A high slope of 12.5 mA/V and a short grid base ensure small drive requirements.

Low cross capacitances

Sections are physically screened, thus materially reducing cross capacitances and permitting sections to be used independently.

The employment of a frame grid construction in this valve is largely responsible for its outstanding characteristics. This also enables a good noise factor to be achieved in r.f. or i.f. input applications thus making the E88CC suitable for use in Radar, Communications, Television Studio Equipment, etc.

Further technical information concerning the E88CC is available on request.

Mullard
COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT

ABRIDGED DATA

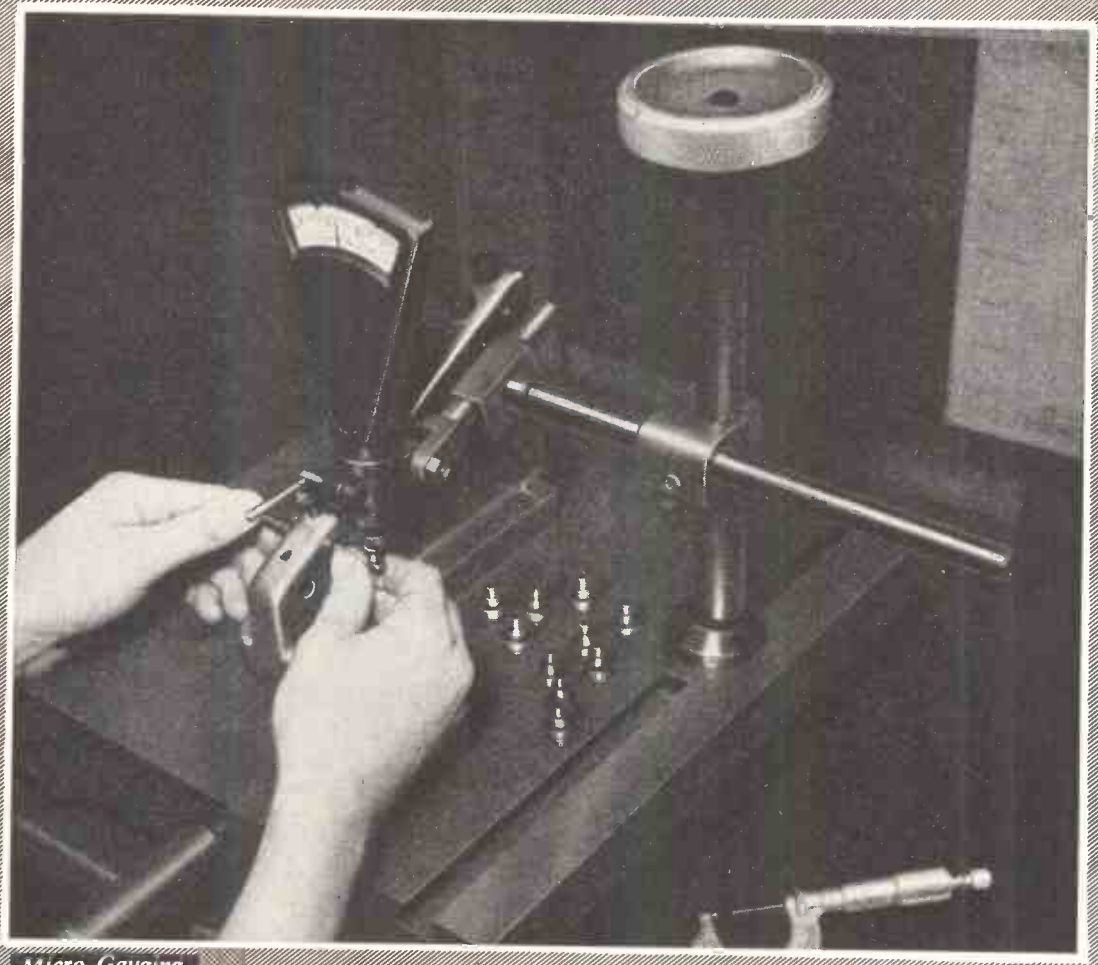
Vh = 6.3V Ih = 300mA

Computer operation	
Va(b)	150V
Vg (Ia = 100μA)	−7.0±1.5V
Vg (Ia = 5.0μA)	−15V
Vg difference (Vg.′~Vg″ at Ia = 100μA)	<−2.0V
Cascode amplifier	
Vb	100V
Vg(b)	+9.0V
Rk	680 ohms.
Ia	15±0.8mA
gm	10.5 to 15 mA/V
Noise factor (f = 200Mc/s)	4.6dB
Req (r.f.)	300 ohms.
Base	B9A

Mullard

Mullard Limited, Mullard House, Torrington Place, London, W.C.1

MVT 323a



Micro Gauging

"Why GARRARD is best" series No 7

ACCURACY in the manufacture of components for Garrard record playing equipment is essential, and to ensure that the high standards are maintained, strict inspection is applied at all stages of manufacture. The gauge illustrated above checks the concentricity of motor pulleys to an accuracy of one ten-thousandth of an inch. This is only one of the many inspections carried out on components produced by the Garrard factory. One more reason why Garrard units are the finest in the world.

Garrard AUDIO PERFECTION

THE GARRARD ENGINEERING AND MANUFACTURING CO. LTD SWINDON · WILTS

Announcing THE NEW

AIRMEC L.F. PHASE METER TYPE 206

THE Airmec L.F. Phase Meter Type 206 has been designed to enable measurements of gain and phase-shift to be made on any four-terminal network operating in the frequency range 20 c/s-100 kc/s.

Phase is indicated directly on a six inch meter having four scales and the gain or loss values are indicated by the difference between two attenuator settings.

Frequency Range:	20 c/s to 100 kc/s.
Accuracy:	±2° from 100 c/s to 20 kc/s. ±5° at other frequencies.
Input:	1 mV to 1 V
Difference in Input Level:	Up to 60 db.
Input Impedance:	12 M ohms.
Attenuators:	Calibrated 50 db step and 10 db slidewire attenuators with an accuracy of ± 0.2 db for each 10 db.
Display:	6 inch meter calibrated in four ranges 0° to 360° ; −90° to +90° −180° to +180° ; +90° to +270°.

Full details of this or any other Airmec instrument will be forwarded gladly upon request.

AIRMEC LIMITED HIGH WYCOMBE BUCKS. ENGLAND

Telephone : High Wycombe 2060 *Cables :* Airmec High Wycombe

V.H.F. radio telephones

A.T.E. single-channel radio telephone equipment takes over where landlines are impracticable or uneconomic.

Providing communication services over relatively short distances—normally between points within optical range —V.H.F. Radio telephones have many applications, including fixed point to point communication for industrial, mining and agricultural purposes, and portable equipment for transport.

The equipment may be mains or battery driven, fixed or portable.

A range of equipment is available with the following characteristics.

★ *Frequency or amplitude modulation*
★ *Frequency bands* 156-184 *Mc/s or* 54-87 *Mc/s*
★ *Transmitted power* 0.6 *W*-10 *W*

AUTOMATIC TELEPHONE AND ELECTRIC COMPANY LIMITED

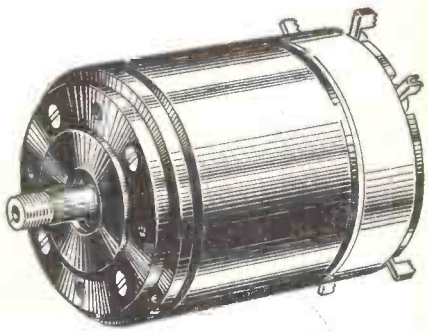
STROWGER HOUSE . ARUNDEL STREET . LONDON . W.C.2. Telephone: TEMple Bar 4506

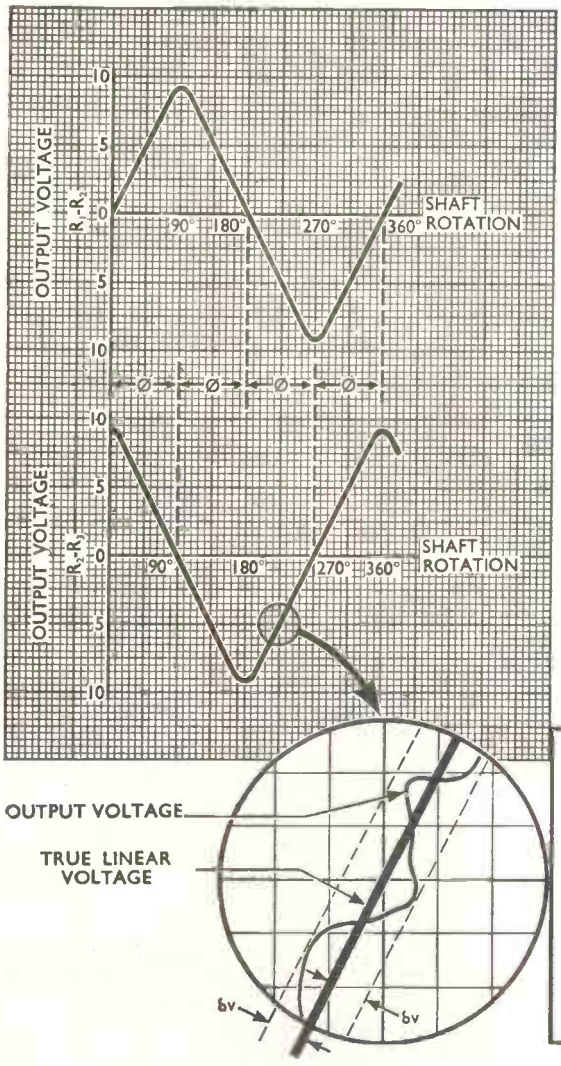
Telegrams : Strowger Estrand London. *STROWGER WORKS, LIVERPOOL, 7.]* AT 14641

A NEW APPROACH...

The SPERRY 15 VLT Synchro

(*Variable Linear Transformer*)





The Sperry size 15 Variable Linear Transformer gives two output voltages whose amplitudes vary linearly with shaft rotation. It consists of a rotor with two windings at right angles which rotates in a stator having a single winding. If the Synchro is connected as shown, the voltages $V_{R_1 - R_2}$ and $V_{R_2 - R_3}$ vary linearly as shown in the accompanying graphs.

SUPPLY:—The unit is designed to work with a 1000 c.p.s. 10-volt signal applied to the stator, but will work at other frequencies including 400 and 50 c.p.s. with suitable adjustment of the signal level.

TRANSFORMATION RATIO:—The rotor output voltage, when the stator is excited at 10 volts 1,000 c.p.s., is arranged to rise to 5 volts when the rotor is displaced 45° from a null position. This transformation ratio of 2:1 varies ± 0.2 per cent between the windings in any one model and ± 0.5 per cent between models.

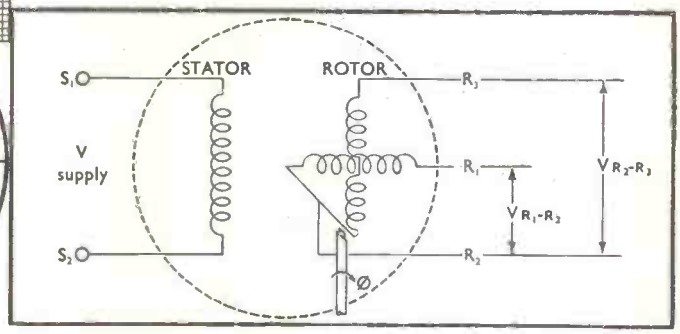
NULL SPACINGS:—Ø = 90° ± 4'.

LINEARITY:— The rotor output voltage rises linearly from the null position

δ = ± 0.4% 0°—60° displacement
δ = ± 0.5% 60°—75° displacement

Expressed as a percentage of the output voltage at 60°.

Linear Synchros offer a new approach to a wide range of computing problems and may also be used for position control and signal modulation.



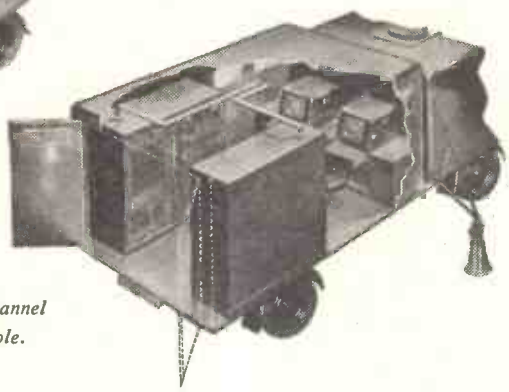
Advice on their application to your problem is available

SPERRY SYNCHROS

SPERRY GYROSCOPE COMPANY LIMITED, GREAT WEST ROAD, BRENTFORD, MIDDLESEX. Telephone: EALing 6771

COSSOR RADAR

C.R.21



Either single or twin channel installations are available.

C.R. 21 is a new high-power surveillance radar. It is available either complete and self-contained in mobile form as illustrated above or as a series of units readily installed in a building.

The large reflector provides a narrow beam-width that assists in giving a high definition display. In the vertical plane, coverage is obtained through 45° without beam switching or tilting.

Unwanted permanent echoes can be cancelled by means of the latest type of Moving Target Indication circuits. Rain responses can be eliminated by circular polarisation.

Modern aircraft speeds and heights, together with mounting traffic densities are constantly increasing the demands on radar performance. C.R. 21 is well aligned to the present and future requirements of the jet age.

Accessibility: The magnetron, like all major units, is readily accessible.

Each electronic chassis is serviced from the front—whilst operating if desired.

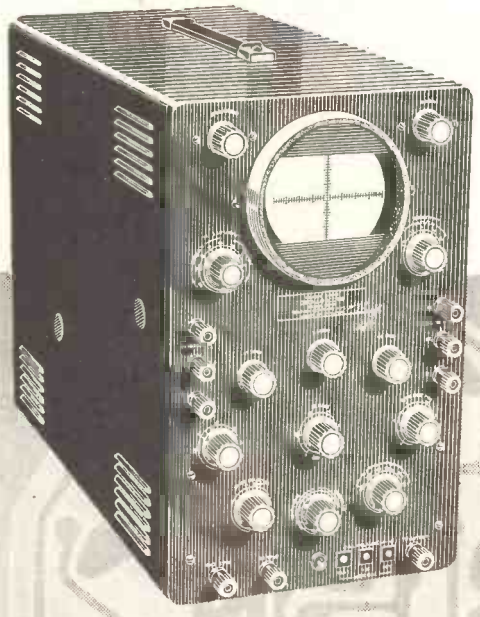
COSSOR RADAR & ELECTRONICS LIMITED

One of the Cossor Group of Companies

COSSOR HOUSE · HIGHBURY GROVE · LONDON, N.5

Telegrams: Cossor, Norphone, London Telephone: CANonbury 1234 (33 lines) Cables: Cossor, London

PERFORMANCE ASSURANCE WITH



COSSOR

PRINTED CIRCUITS

Model 1071K ***Double Beam*** *Kit Oscilloscope*
List Price £57.10.0

AN INSTRUMENT RANGE IN KIT FORM

Q. *Why has Cossor Instruments decided upon this innovation ?*

A. To make available a range of first-class measuring instruments at a **considerable saving in cost to the Buyer.**

Q. *Are Kit instruments inferior in performance to their Factory-built equivalents ?*

A. Certainly not. If assembled and wired exactly in accordance with the Manual of Instructions.

Q. *A certain skill must, surely, be required to build these instruments ?*

A. None beyond the ability to use a small soldering iron.

Q. *How can a performance specification be maintained without setting up test equipment ?*

A. Largely by the use of PRINTED CIRCUITS which allow no interference with the layout of critical parts of the circuit.

Q. *How many Kit instruments are at present available ?*

A. Three. Two Oscilloscopes, a Single-Beam and a Double-Beam, and a Valve Voltmeter. Others will follow shortly.

Q. *Could I have more information on these interesting instruments ?*

A. With the greatest of pleasure. Just write to :

COSSOR INSTRUMENTS LIMITED

The Instrument Company of the Cossor Group

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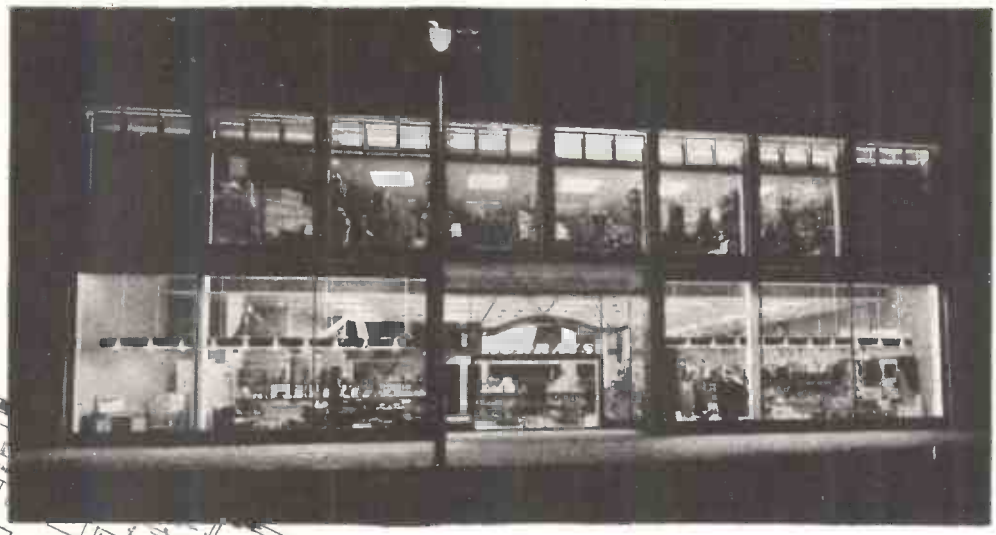
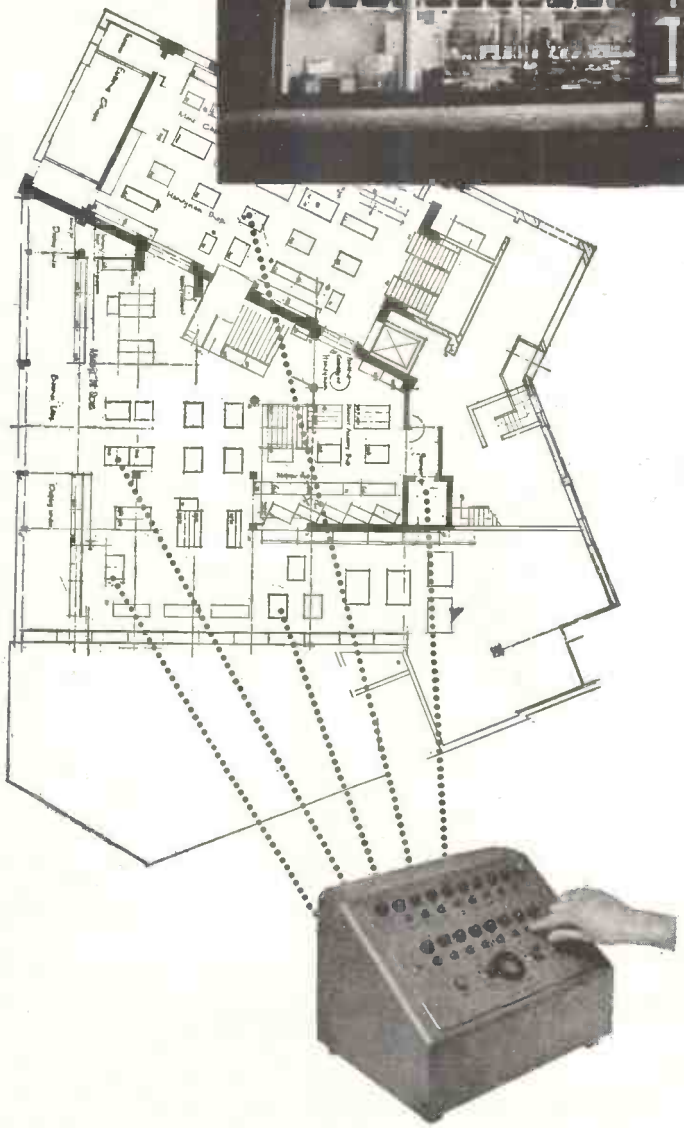
Murray's (High Wycombe) Limited





department store locates staff in seconds

There are no flashing lights, distracting bells, buzzers or loudspeakers in this modern 5 storey department store, opened this year by Murray's, High Wycombe, Ltd. because internal communication is handled by the Multitone Personal Call staff location system. Senior members of the staff carry light pocket receivers, only 5 in. long and 1 in. diameter. To call anyone carrying a receiver, anywhere in the building, the switchboard operator sends out a signal which affects only that particular receiver. A direct spoken message can follow if required.

A complete installation of this type, with up to 50 receivers can be installed on easy rental terms, inclusive of maintenance, or low outright purchase price. This personal call system could save time and trouble in *your* building. Write and we'll send you details.

multitone personal call **STAFF LOCATION SYSTEM**

Multitone Electric Company Ltd., 12-20 Underwood Street, London, N.1. Tel: Clerkenwell 8022

CRC 13M

£1,000 IN PRIZES!

A EUROPEAN TOUR

FOR WINNING
Wholesalers and Retailers !

T.V. Sets, Radios and Record Players
for **your** customers !

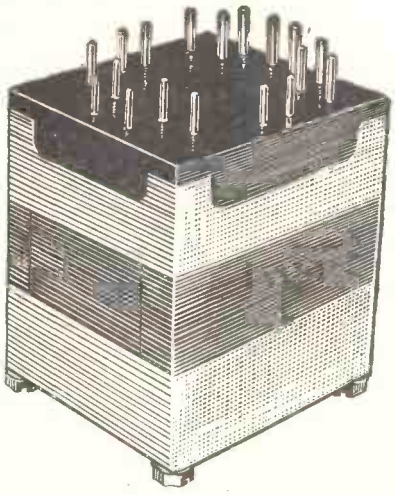
You can profit from
POWER POINT!

FOR FULL DETAILS
write to :—E. V. LIMITED,
Camp Bird House,
Dover Street, London, W.1.
Telephone: Hyde Park 8292.

POWER POINT **is backed by attractive display material and a carefully planned advertising campaign.**

POWER POINT **is a "must" for anyone with a record player !**

ARE ALREADY IN USE ABROAD !



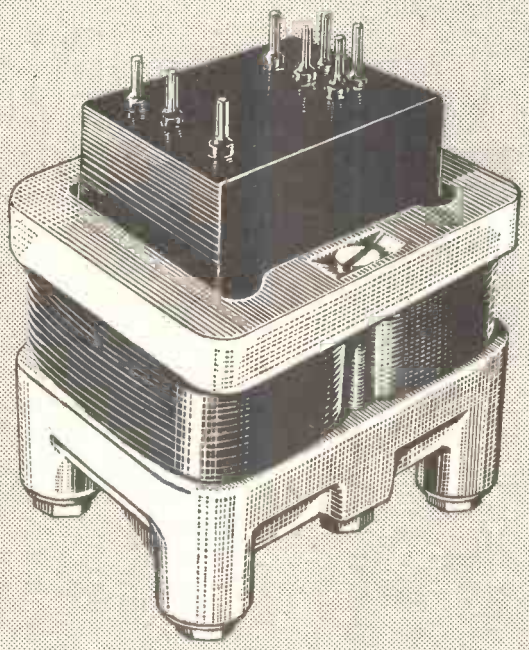
R120 and R130 laminated series.

FORTH SERIES

TRANSFORMERS AND CHOKES

smaller in size— lighter in weight

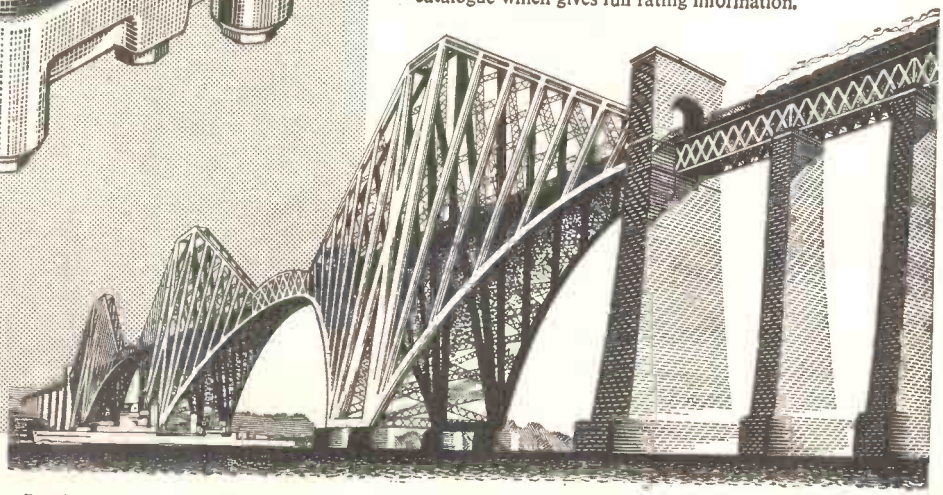
R200 'C' Core series.



FERRANTI

The new range of Ferranti Resin Cast Transformers and Chokes has been named after this famous Scottish landmark which represented a remarkable advance in engineering design when it was constructed over 60 years ago. To-day, the new techniques in manufacture and construction of 'C' Core Transformers have enabled Ferranti Ltd. to make a significant contribution to Electronic Engineering.

The Forth series components will have particular appeal to designers of airborne equipment since savings in weight and volume of up to one-third can be achieved over the resin cast and oil-filled units now available. Moreover, the quality requirements of the Joint Service Specification RCS.214 are met in every respect. Please write for a catalogue which gives full rating information.



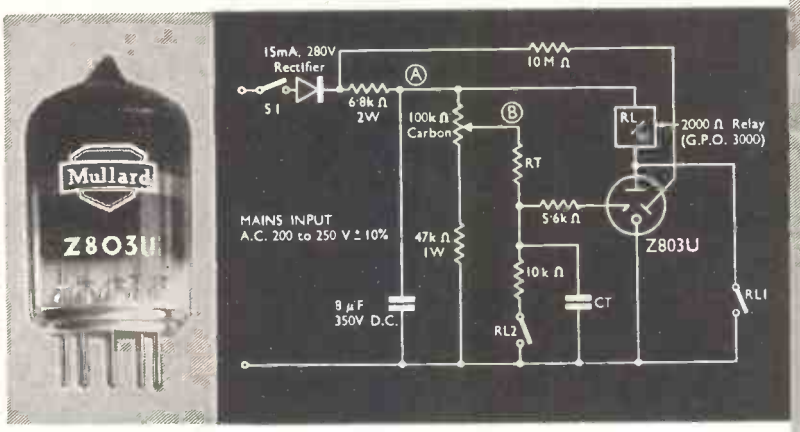
FERRANTI LTD • FERRY ROAD • EDINBURGH 5

ES/T41

FOR TIMER SIMPLICITY AND ACCURACY

Z803U

TRIGGER TUBE



The Z803U trigger tube can be used for a variety of timer, voltage control and general relay applications. It has an extremely stable trigger voltage over a very long operating life and offers the advantages of all Mullard cold cathode tubes—no heater supply requirements, no waiting for "warming up" and good mechanical strength.

Typical of the applications of the Z803U is the simple interval timer described here which can cover the range between 5 seconds and 10 minutes. It may be operated direct from any a.c. mains supply between 200 and 250 volts.
To start a timing sequence the mains supply is switched on (S1). The d.c. voltage at point A will then rise, in about 100 milliseconds, to between 184 and 282 volts, the actual level depending on the value of the local mains voltage. The timer capacitor CT will start to charge up through RT, the timer resistor.
When the voltage on CT reaches the critical trigger voltage of the Z803U the tube will fire, pulling in the relay, partially discharging the 8 microfarad smoothing capacitor, and lowering the voltage at A. The relay will self lock on contact RL1 thus extinguishing the Z803U, and the relay current will then be limited by the 6.8 kΩ series resistor. Contact RL2, which should make after RL1, re-sets the timer capacitor to zero volts.
However, the relay drops out only when S1 is opened. A new sequence can then be started on reclosing S1.
The 100 kΩ preset potentiometer allows the timing circuit voltage to be set up so as to compensate both for component tolerances and for the value of the local supply voltage. The pre-firing voltage at point B will be about 170 volts.
The values of RT and CT will be set by the required time interval T′, and can be determined from the fact that $T' = 1.6\ RT.CT$.
RT should be a high stability resistor, while CT must be a capacitor, with a small power factor, e.g., a paper or plastic film capacitor. All other components are of ± 10% tolerance.

Mullard

Mullard

COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT

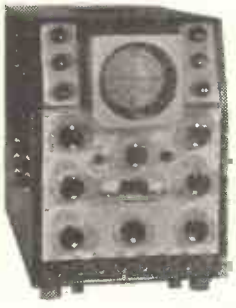
MULLARD LIMITED, MULLARD HOUSE, TORRINGTON PLACE, LONDON, W.C.1

MVT 3140

COSSOR INSTRUMENTS LTD

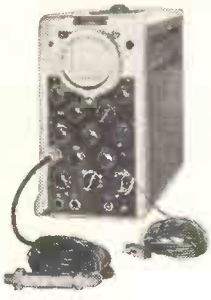
MODEL 1058—SINGLE BEAM OSCILLOGRAPH

This Model is fitted with a 4-in. dia. tube with post-deflection acceleration and direct-coupled Y amplifier with a sensitivity of 0.25 V/cm and bandwidth 0—6 Mc/s (— 50%). An X amplifier of gain five times is provided. The time base is repetitive or triggered and a special facility provides synchronisation from either frame or line sync. pulses with a 1 V double amplitude pulse (positive) television signal. (Leaflet CL. 149.)



MODEL 1049 MK. IIIA—DOUBLE BEAM OSCILLOGRAPH

With direct-coupled amplifiers of gains 900 and 30 operating from d.c. to 400 kc/s and 800 kc/s respectively. Stabilised power supplies provide alternative tube operating voltages of 2 kV and 4 kV. Voltages and Time Intervals may be measured on either beam. Direct-coupled time base provides a repetitive, triggered or single-stroke scan with a time range of 1.5 sec. to 150 μ sec. Provision is made internally for Z modulation of the traces. (Leaflet CL. 112.)



MODEL 1063—HYDRAUDYNE

This pressure-testing equipment is compact and portable and permits the display, analysis and measurement of static and dynamic pressure conditions in all pneumatic and hydraulic systems. Complete with Transducer and all necessary ancillary items, the Hydraudyne is normally fed from alternating current mains supplies but may be driven from a rotary converter fed by a 12-volt accumulator. (Leaflet CL. 182.)

MODEL 1045K—KIT OSCILLOSCOPE

This up-to-date single-beam Oscilloscope, utilising printed circuits, is offered in kit form for construction by the purchaser. A marked economy is thus achieved whilst valuable technical experience of this type of instrumentation is automatically gained. (Leaflet CL. 215.)

COSSOR INSTRUMENTS LTD

MODEL 1071K

A double-beam Oscilloscope in kit form providing two identical Y Amplifiers of bandwidth d.c.—3 Mc/s with a sensitivity of 0.5 V/cm. A Pre-amplifier is included to increase sensitivity to 5 mV/cm up to 500 kc/s. The repetitive or triggered time base has a range of velocity from 10 msec./cm to 0.05 μsec./cm and an X Amplifier providing up to 5 screen diameters is included. Y calibration. (Leaflet CL. 207.)

MODEL 1042A

Model 1042A Oscillograph has been designed especially for the Radar field and provides an amplifier of bandwidth d.c. to 5 Mc/s with a sensitivity of 1 V d.c./cm. The triggered time base provides spot velocities from 0.066 cm/msec. to 2 cm/μsec. with direct calibration. Velocities for delayed sweep are provided. A low frequency amplifier of bandwidth 10 c/s to 4 kc/s is provided to increase the sensitivity to 20 mV peak/peak/cm.

MODEL 1065

Designed for the display and measurement of pulse phenomena and employing an amplifier of bandwidth 0-14 Mc/s (— 50%) providing a useful deflection up to 20 Mc/s. The sensitivity is better than 250 mV/cm. Time base velocities from 40 cm/sec. to 5 cm/μsec. with continuously variable delay of time base start when desired. Calibration of voltage and time by Y and X shifts. A 25 Mc/s oscillator provides intensity modulation pips spaced at 0.04 μsec. intervals for accurate measurement of pulse rise-times.

MODEL 1050A—OSCILLOGRAPH TROLLEY

Strongly constructed of steel tubing and fitted with rubber-tyred swivel castors, this trolley provides a very convenient mobile stand for Cossor Oscillographs, enabling them to be wheeled easily to any location in laboratory or factory. (Leaflet CL. 121.)

Advance

CIRCUIT MAGNIFICATION METER

INDUCTANCE CAPACITANCE

- *Direct reading of 'Q' Range 10-400*
- *'C' by substitution*
- *Rapid calculation of 'L' and 'Z'*
- *No 'Set-Zero' problems*
- *Small and portable (15½ x 10¼ x 6½ - 14lb)*

MODEL T1 NETT PRICE IN U.K. **£55**

The "T1" is an easily operated and convenient instrument for making R.F. measurements of circuit magnification ('Q'), inductance, capacitance and power factor at frequencies between 100 kc/s and 100 Mc/s. Its portability and excellent specification make it a valuable addition to the electronic laboratory as well as for production testing.

Full technical details in Leaflet W31 available on request

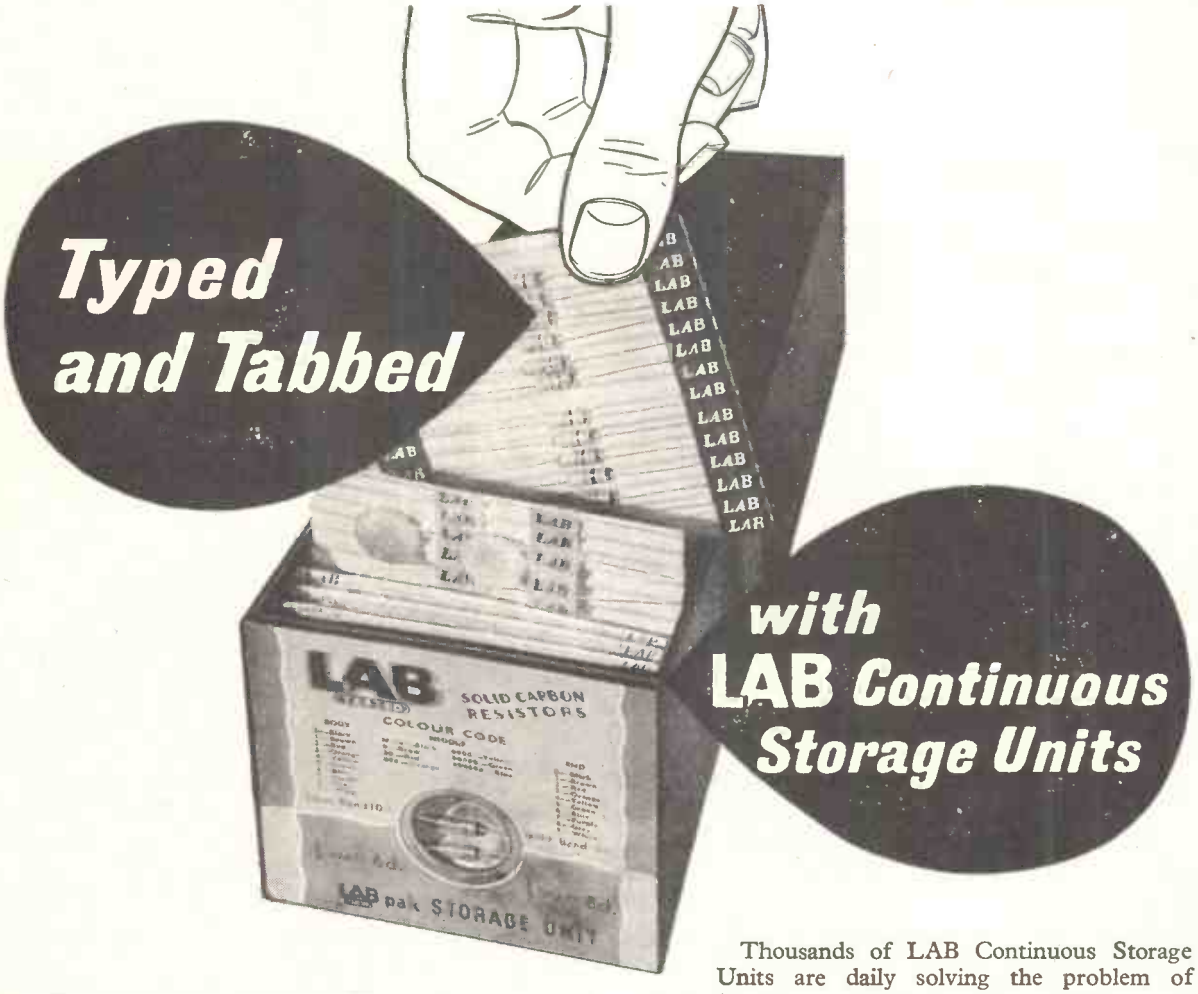
The MODEL T/2

A version of the Model T1 providing additional facilities for comparing 'Q,' Inductance and Capacitance, and is most suitable for the production testing of coils.
Full technical details in Leaflet W44. **£70** Nett Price in U.K.

Export inquiries invited.

ADVANCE COMPONENTS LIMITED - ROEBUCK ROAD - HAINAULT - ILFORD - ESSEX - *Telephone: HAInault 4444*

C



REF.	WATTS	MAX. VOLTS	OHMS	MIN. ORDER FOR FREE UNIT	UNIT STORAGE CAPACITY
			RESISTORS		
T	½	250	10 to 10M	240	720
R	1	500	10 to 10M	180	500
			Tolerances available ±20% 10% 5%		
			HIGH STABILITY RESISTORS		
HS3	½	750	1 to 500M	93	500
			Tolerances available ±5% 2% 1%		
			WIREWOUND RESISTORS		
LM	5 & 10	—	5 to 100K	72	300
LP	5 & 10	—	5 to 100K	72	300
			CERAMICAPS		
CER	Tubular	500	3 to 470pf	141	500
HK	Tubular	500	470 to 5000pf	141	500
HKD	Disc	500	470 to 5000pf	141	500
			Tolerances available ±2% 10%		

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

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

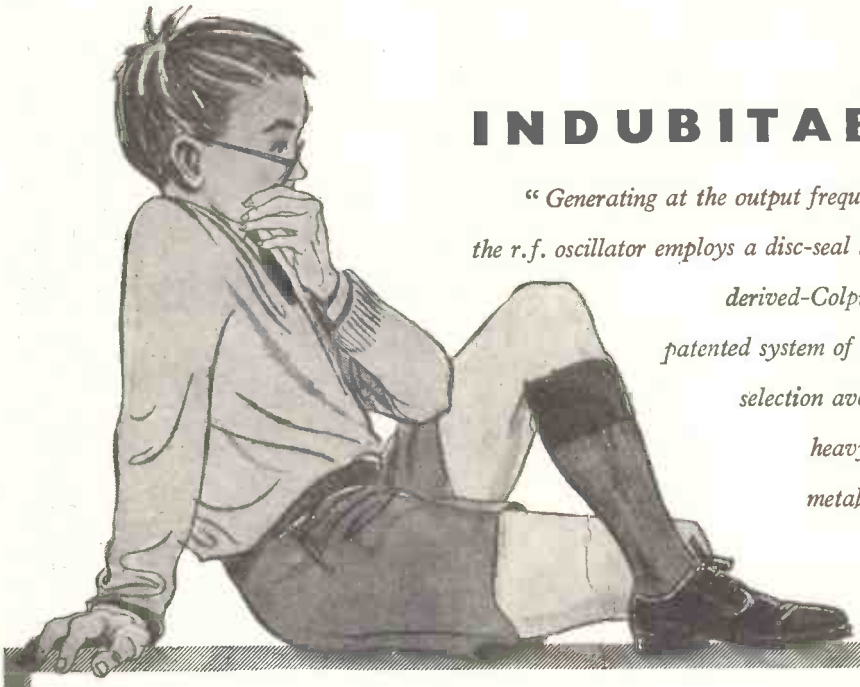
MAKE UP YOUR ORDER TODAY — DELIVERY EX-STOCK

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

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

THE RADIO RESISTOR COMPANY LIMITED

50 ABBEY GARDENS, LONDON, N.W.8 • *Telephone:* Maida Vale 5522

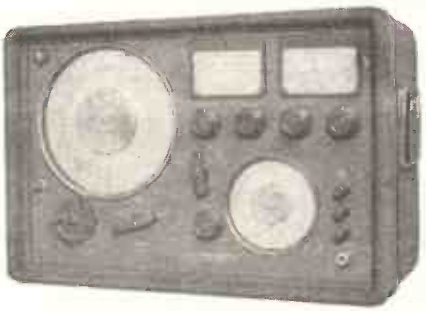


INDUBITABLY . . .

" Generating at the output frequency without multipliers, the r.f. oscillator employs a disc-seal triode in a shunt-fed derived-Colpitts circuit in which the Marconi-patented system of contactless waveband selection avoids the necessity for passing heavy r.f. circulating currents through metal-to-metal contacts ".

OUR young friend may ponder the problem of which Marconi instrument is being described but many well-informed electronic engineers will have realised already that the subject under discussion is the Marconi TF 1066 FM/AM Signal Generator—an instrument notable for its stability, its unique incremental tuning system and the complete absence of spurious sub-multiples in its output.

You didn't know Marconi Instruments made such a signal generator? Write out one hundred times "The Marconi TF 1066 is an outstanding instrument capable of the broadest application"—or better still, write to us for leaflet G103



FM/AM SIGNAL GENERATOR

Type TF 1066

10 to 470 Mc/s. Output: 0·2μV to 200 mV at 50 ohms. Internal 400-c/s modulation: f.m., variable up to 100 kc/s deviation; a.m. variable up to at least 40% depth. External modulation: 30 c/s to 15 kc/s. Incremental tuning: ±100 kc/s max. with direct calibration valid at all carrier frequencies. An exceptionally versatile general-purpose instrument and, in particular, a high-quality f.m. generator.

MARCONI INSTRUMENTS

AM & FM SIGNAL GENERATORS · AUDIO & VIDEO OSCILLATORS
FREQUENCY METERS · VOLTMETERS · POWER METERS
DISTORTION METERS · FIELD STRENGTH METERS
TRANSMISSION MONITORS · DEVIATION METERS
OSCILLOSCOPES, SPECTRUM & RESPONSE ANALYSERS
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MARCONI INSTRUMENTS LTD · ST. ALBANS · HERTFORDSHIRE · TELEPHONE: ST. ALBANS 56161

London and the South: Marconi House, Strand, London, W.C.2. Tel: COVent Garden 1234

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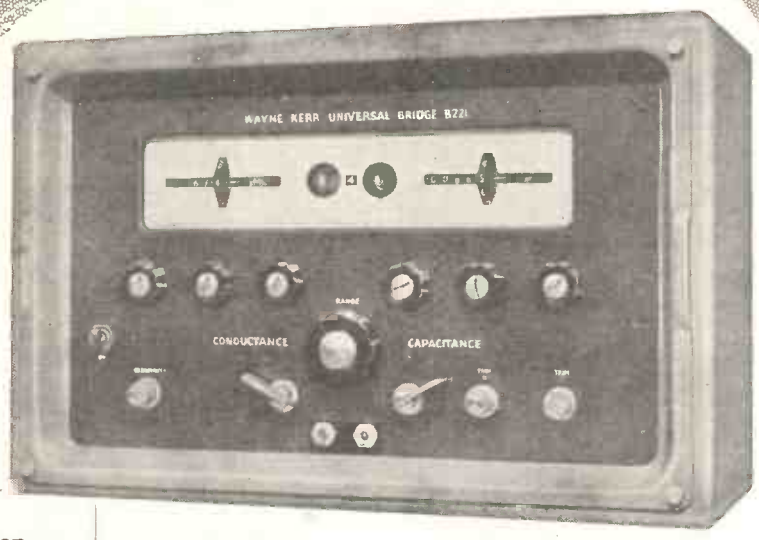
WORLD-WIDE REPRESENTATION

TC103

WAYNE KERR UNIVERSAL BRIDGE B.221



Specification

BRIDGE ONLY:
Capacitance: 0.0002 pF to 10 μF in 7 ranges. Accuracy $\pm\frac{1}{4}\%$. Conductance: 0-$\pm$ 100 mmho in 7 ranges. Inductance: 1mH to infinity in 7 ranges. Measuring Frequency: 10,000 radians/sec. (1592 c/s.) Power Supply: 110/115 and 200/250 V 40/60 c/s. Dimensions: 17" x 7" x 11½" high. Weight: 25 lbs. approx.

WITH LOW IMPEDANCE ADAPTOR:
Capacitance: 1μF—100,000μF in 4 ranges. Resistance: 0-100 Ω in 4 ranges: Discrimination on lowest range 50$\mu\Omega$. Inductance: 0-10 mH in 4 ranges. Discrimination on lowest range 5mμH.

PRICES:
Bridge, £175. Low Impedance Adaptor £15

50 MICRO-OHMS TO 10,000 MEGOHMS .0002 PICOFARAD TO 100,000 MICROFARADS, 5 MILLIMICROHENRIES TO INFINITY

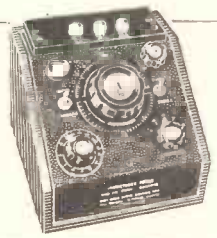
● *Accuracy to 0.25% is achieved with complete stability.* ● *Two decades and a continuously variable control indicate independently the resistive and reactive terms to four significant figures.* ● *Adaptors for measurement of conductivity, dielectric constant and loss factor of solids and liquids.*

The B.221 is a highly accurate transformer ratio arm bridge of very advanced design. It provides facilities for the two, three, or four-terminal measurement of impedance or transfer admittance over an extremely wide range at an operating frequency of 10,000 radians/sec. (1592 c/s).

Measurement is unaffected by the impedance of the test leads, which can therefore be of any length. Consequently the instrument is ideally suitable for the determination of temperature coefficient of components under test conditions or, in fact, any remote in situ measurement. A novel mechanism automatically displays the cyphers, decimals and units of measurement. This gives direct reading and avoids any confusion which might be caused by the large multiplying factors involved.

The basic range of the instrument covers impedances from 10,000 megohms to 10 ohms and this is extended to 50 micro-ohms by the use of the Low Impedance Adaptor. Other adaptors have been designed for measurement of conductivity, dielectric constant and loss factor of solids and liquids.

WAYNE KERR

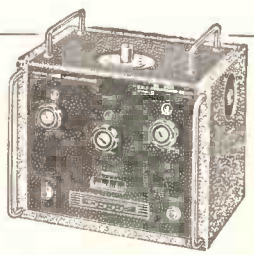


Inductance Meter Type M.149

A small portable instrument designed for the simple and direct measurement of inductance values between 0.05 μH and 100mH. Price £65.

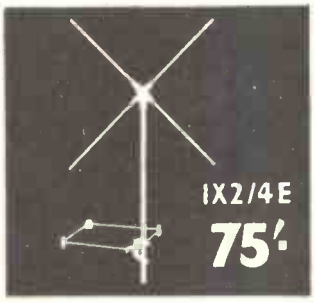
Admittance Bridge Type B.901

An extremely stable transformer ratio-arm bridge designed for unbalanced measurements on aerials, feeders, cables and components at frequencies between 50 and 250 Mc/s. Price £175

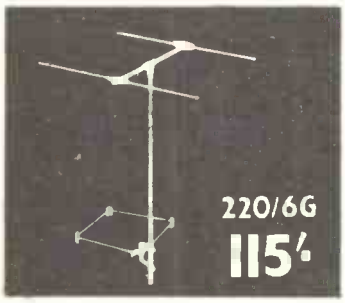


THE WAYNE KERR LABORATORIES LIMITED, ROEBUCK ROAD, CHESSINGTON, SURREY. TELEPHONE: LOWER HOOK 1131

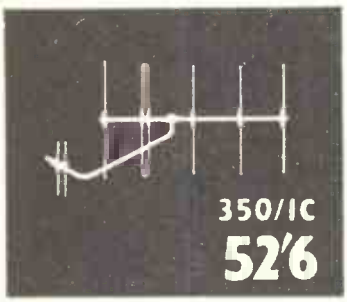
ANTIFERENCE aerials



BAND I *A complete range of Antex (illustrated) Di-pole, "H," Fringe and Indoor models is available. Outdoor models can easily be adapted for Band III by adding Band III Grip-on aerials.*



BAND II *Indoor and outdoor models to suit all conditions and to provide the very best results for VHF/FM equipment. Models for fitting to existing TV masts are available.*



BAND III *3, 5, 8, 10 element and Stacked Arrays for outdoor installation and a comprehensive range of indoor models.*

Specially Designed EXPORT RANGE

Antiference offer a specially developed range of competitively priced Television and VHF/FM aerials for export including Horizontally or Vertically Polarised Single or Stacked Yagi Arrays, Broad-Band and All-Band types for International Frequencies including Continental (C.C.I.R.) and American channels. Full details of this specially designed Export Range on request from Export Department, ANTIFERENCE LIMITED, AYLESBURY, BUCKS.

NOW BAND III & HIL-O AUTOMATIC WITH Clik-Mec

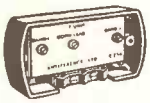
Far in advance of any other form of pre-assembly —"click" and they're fixed!

STANDARD **PLUG & SOCKET**

R.E.C.M.F. SPECIFICATION. Robust and simple to fit.

PLUG TVP/1
SOCKET TVS/1

Both 8D each



"Y" BOXES

For combining or dividing Band I and Band III Television Aerial down leads.

Outdoor Model Y.1.— 16'6

Indoor Model Y.2.— 12'6

HIL-O *17 models to provide perfect Band I/Band III reception with only one aerial. All incorporate the patented Electronic Coupling exclusive to Antiference.*

ANTIFERENCE LIMITED

BICESTER RD., AYLESBURY, BUCKS.

THE ANTIFERENCE GROUP Antiference Ltd., Aylesbury & London ● Antiference (Canada) Ltd. ● Antiference (Australia) Pty. Ltd. ● Antiference Installations Ltd.

Antiference Aerials are supplied through Appointed Antiference Distributors to all leading Radio and Television Dealers. We regret that we cannot supply direct to members of the public.

DHB/4093

"... the finest instrument of its kind"

Sir John Barbirolli, the world famous Conductor of the Halle Orchestra has said of these instruments: "... And to think that I can remember the old phonograph cylinder and that we have now arrived at the incredible perfection of the Black Box—surely the finest thing of its kind ever produced."

The Pye Black Box range of Record reproducers offers a choice of models to suit everyone. The original De-Luxe Black Box is magnificently presented in an elegant hand-painted Chinese Lacquer finish, while the Traditional Black Box, finished in a rich natural mahogany, has the same pleasing lines and its own air of distinction. The latest addition to the range — the Super Black Box — features the amazing new 'Infinite Throat' Electrostatic Loudspeaker and is available in 'Contemporary' or 'Traditional' finishes. All models play four speeds of records and can be operated automatically or by hand.

Hi Fi **PYE BLACK BOX**

The World's Finest Range of Record Reproducers

Pye Limited, Auckland, C.I., New Zealand.
Pye Pty. Ltd., Melbourne, Australia.

Pye Corporation of America, 1149 Raritan Avenue, Highland Park, New Jersey, U.S.A.

Pye Radio and Television (Pty.) Ltd., Johannesburg, South Africa.
Pye (Ireland) Ltd., Dublin, Eire.

Pye Limited, Tucuman 829, Buenos Aires. Argentine.
Pye Limited, Mexico City.

Pye (Canada) Ltd., Northline Road, Toronto.
Deutsche Pye G.m.b.H. Berlin-Zehlendorf-West, Roonstrasse 2, Germany.

PYE LIMITED · CAMBRIDGE · ENGLAND

Radar

PORTABLE OSCILLOSCOPES

TYPES

301 and 302

SPECIFICATION

Type 301

Y AMPLIFIER 2 Stage Cathode Follower to Y Plates. Bandwidth: 20 c/s-6 Mc/s (3 db) usable to 10 Mc/s. Sensitivity: 100 mv/cm.-300 v/cm. in 8 ranges through frequency compensated attenuator. Input impedance 1 Megohm across 15 pf.

C.R. TUBE Emitron type 3AFPI. Diameter 70 mm. Green trace. Pre-set astigmatism correction. E.H.T. 800 volts. Vertical shift $>$ 10 cm. Horizontal shift $>$ 30 cm.

TIME BASE Entirely new Miller-Multivibrator circuit combining the excellent properties of the multivibrator with the linearity of trace achieved by Miller feedback. Continuously variable expansion to 30 cms. Sweep range ·5μS/cm. to 50mS/cm. Recurrence frequency (repet.) 5 c/s.-100 kc/s. Flyback suppressed.

SYNCHRONISING Repetitive or Triggered. Internal or External. Positive or Negative. Provision for synchronising from the frame pulse in a television waveform. Input resistance 2 Megohms. Trigger initiates the scan.

MISCELLANEOUS Calibration voltage (sinusoidal) 10 v. pp. at mains frequency available. Detachable viewing hood and transparent lattice with 1 cm. rulings. Adjustable tilting stand for easy viewing. Removable door encloses controls and provides stowage for leads. A.C. mains supply (externally adjustable) 200-250 v. 50 cycles. Power consumption 85 watts. Dimensions 12$\frac{1}{4}$" $\times$9" $\times$7". Weight 19 lbs.

Type 302

As for type 301 with the following exceptions.

Y AMPLIFIER 2 stage balanced amplifier with cathode followers to Y plates. Single ended input. Bandwidth: D.C. - 3 Mc/s (3 db). Usable to 7 Mc/s.

C.R. TUBE. Emitron type 3AFP7. Blue trace. Long persistence.

TIME BASE Sweep range ·5μS/cm. to 500mS/cm. Recurrence frequency (repet.) $\frac{1}{2}$ c/s-66 kc/s.

MISCELLANEOUS A.C. mains supply either 200-250 v. 50 cycles or 100-130 v. 400 cycles.

waveforms LIMITED

Radar Works, Truro Road,
London, N.22.
Telephone: Bowes Park 6641-2-3

New addition to the Thorn family of miniature indicator lampholders designed to use the Atlas midget panel lamp which is only 0.575" in length and 0.249" in diameter

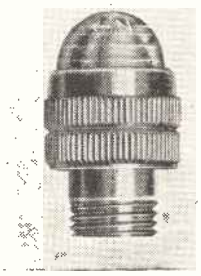
INTRODUCING THE **Thorn**

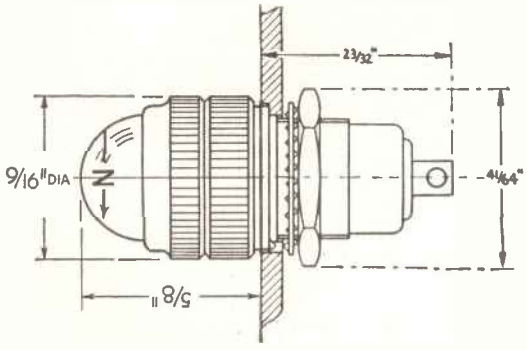
ROTARY SHUTTER

LAMPHOLDER

SHORT AND LONG SHANK VERSIONS

This lampholder represents an outstanding advance in space-saving—the outside diameter of the complete device is only $\frac{9}{16}$". Here, then, is the smallest of all dimmer indicator lamps. The cap contains a rotary shutter with built-in stops to restrict rotation between the fully-shuttered and the fully-open positions. When fully shuttered there is sufficient illumination for night vision. Glass lenses are engraved with the direction of rotation and letters indicating night and day conditions. The short shank version is designed for panel fitting where there is no "Plasteck" panel intervening between the indicator cap, and the lampholder. The long shank version is for use where a "Plasteck" panel intervenes and/or where the extended length may be necessary to suit special installations. Both components are designed to screw into the standard lampholder body used for Plasteck lighting L/H body 80/10/0063 earth return. This can be supplied as double pole version if required. Colour of cap: red, green, amber, blue or clear. Can be supplied with 28V, 12V or 6V bulb.

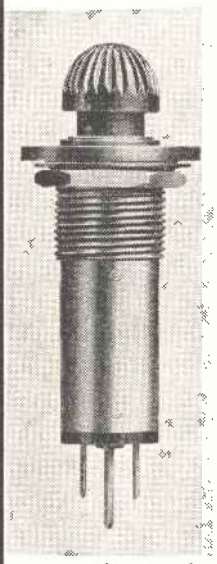




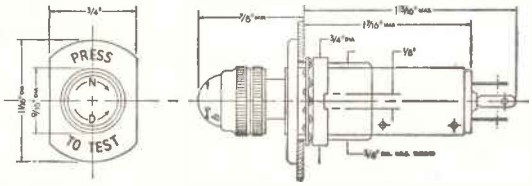
AND THE MINIATURE

PRESS-TO-TEST

FITTING



Extreme compactness has been achieved in this new "Press to Test" component. For installation a round hole $\frac{1}{4}$" diameter is all that is necessary in the mounting panel. The component can be extracted from either the front or from the back of the panel. There are two versions one with 3 terminals (solder or screw 1 terminal common) and the other with 5 tag terminations, solder (1 terminal common). The internal contact assembly are so arranged as to be free from normal aircraft vibration conditions and pre-determined contact pressures are maintained in the design technique. The front indicator plate can be engraved "Press to Test" or for any other engraving to suit operational requirements. The lampholder cap may be either the indicator or rotary shutter type. Colour of cap: red, green, amber, blue or clear. Can be supplied with 28V, 12V or 6V bulb.



For full information write:

AIRCRAFT COMPONENTS DIVISION
THORN ELECTRICAL INDUSTRIES LTD
GREAT CAMBRIDGE ROAD, ENFIELD
MIDDLESEX. TEL: ENFIELD 5353

SIEMENS

CONTACT COOLED SELENIUM RECTIFIERS

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R. H. COLE (OVERSEAS) LTD.

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WORLD FAME ASSURED

When we introduced the Goldring "500" Variable Reluctance Cartridge our claim for it was a modest one—simply that it was a very good high fidelity cartridge at a very reasonable price. Amateurs and experts throughout the world have described the "500" in rather more glowing terms, and we have been happy to accept their judgment. But we have not been content to leave matters there. Development work has proceeded on a new cartridge—*the first in Great Britain to be designed specifically around a diamond stylus.* Full advantage has been taken of the technical superiority of the diamond and, in addition, its long playing life obviates the need for compromise between optimum mounting arrangements and extreme simplicity of stylus replacement. This new cartridge—the "600"—will delight both the musically meticulous and the hi-fi "fanatic". Our claims for it are not this time so modest. The reception of the "500" points clearly to the "600" being destined for world fame.

The "600" is similar in shape and size to the latest version of the "500". Replaceable styli —diamond for L.P. and sapphire for 78 r.p.m. Mu-metal shield. Specifications for both cartridges are broadly the same but the "600" has a much-extended frequency response, the effective mass at stylus tip is reduced by almost 100% and compliance is substantially increased. Improved transient response and "presence" are not easily defined mathematically but are very evident aurally.

Price 8 gns *plus* P.T. *£3.5.6*

GOLDRING '600'

GOLDRING
MANUFACTURING COMPANY
(GREAT BRITAIN) LIMITED
486-488 High Rd, Leytonstone, London E11
Leytonstone 8343

the amplifier of tomorrow

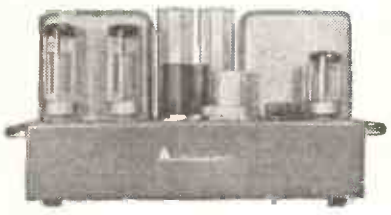
Audiomaster

an amplifier which really does sound better than any other

Craftsmanship and component quality control to standards which have never before been approached, together with close inspection in actual production, guarantee that the Audiomaster you buy will give the same phenomenal performance as the original prototypes. This rigid adherence to published specifications ensures a reproduction of the highest fidelity, from records, radio, tape or microphone and the maintenance of this masterly performance over many years of hard work.

The facilities and performance of the Audiomaster Pre-amplifier leave nothing to be desired. For example, any first-class medium impedance tape head can be connected *directly* and the unit will amplify and equalise according to the characteristic required. Max. sensitivity 1 mV.

Block condensers, high stability resistors and craftsmanship of the highest order ensure years of service to the Audiomaster's high standards. Total distortion less than 0.1% at 30 watts output. Harmonic distortion less than 0.5% at 20 watts. Damping Factor of 50. Hum and Noise level better than 85 db relative to 20 watts.



for reproduction that's out of this world . . .

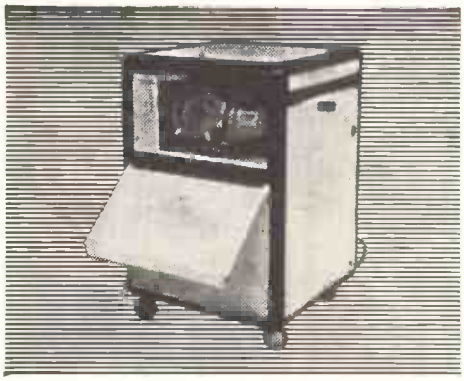
this amplifier of tomorrow

Audiomaster

A W. & N. Electronics product distributed throughout the U.K. by **Musicraft**

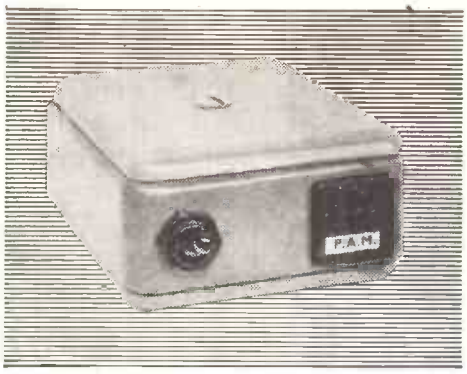
Write for full information, or better still, see it and hear it at Musicraft's showrooms. Export Trade enquiries welcomed.

20/22, High Street, Southall, Middx. *SOUthall 3828*
13, King Street, Richmond, Surrey. *RIChmond 6798*

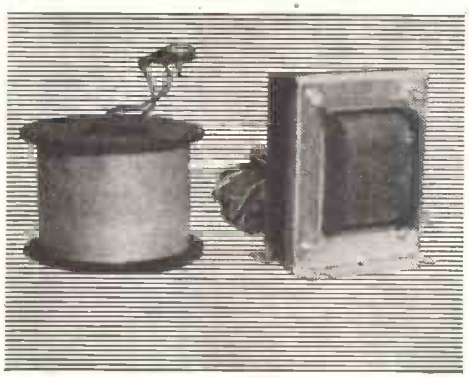


"NERA" MODEL PC. 50, a floor console projection television receiver, designed for industrial use with Closed Circuit Television. Picture sizes — 30″×22″, 40″×30″, and 48″×36″, on special activated aluminium screens.

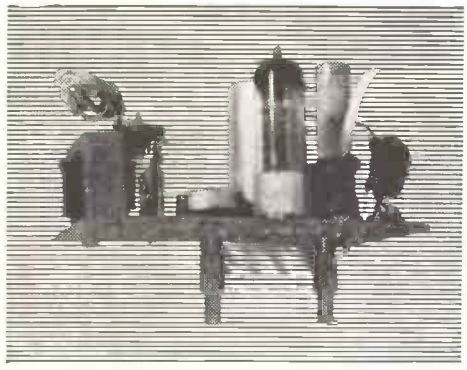
Transistor Battery Portable Counter designed for counting small production quantities. Maximum rate 4 per second, with a built-in photo-electric cell, or alternative remote photo-electric cell probe. Battery life gives 250,000 continuous counting operations. Size 4½″×3¾″×1⅞″.



Small Audio Amplifier using Printed Circuit technique for use in Record Players.



Typical types of Coil Winding. Focus coil and small mains transformers for Television Receivers.



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The NEW De-Luxe
TAPE RECORDER TR3

Case finished in Red and Cream with gilt styling and fittings.
Size 18½in. x 15in. x 9in. for A.C. Mains 200/250 v. 50 cycles.
TRADE ENQUIRIES WELCOMED

for £5·18·0

DEPOSIT & 8 MONTHLY PAYMENTS OF £5.16.3
OR
CASH 45 gns.
plus 21/- post & packing.

THE *"Petite"* PORTABLE

MAY BE BUILT FOR

£7·7·0

plus 3/- post & packing.

Batteries extra.
HT 10/- (Type B126) or equivalent.
LT 1/6 (Type AD 35) or equivalent.

- ★ Size only 8in. x 8in. x 4½in.
- ★ Weight, including batteries, 5½lb.
- ★ 4 valves of the economy type.
- ★ Medium and longwave superhet circuit.
- ★ High Q frame aerials.
- ★ High sensitivity on both wavebands.
- ★ Prealigned IF transformers.
- ★ 5in. speaker of the latest type.
- ★ Automatic on/off switch operated by lid.
- ★ Designed in our own laboratory.
- ★ Backed by an up-to-date Technical Information Dept.
- ★ Components available separately if desired.
- ★ Simple to construct, using normal soldering methods.
- ★ Mains unit will be available later.
- ★ Instruction book 1/6.

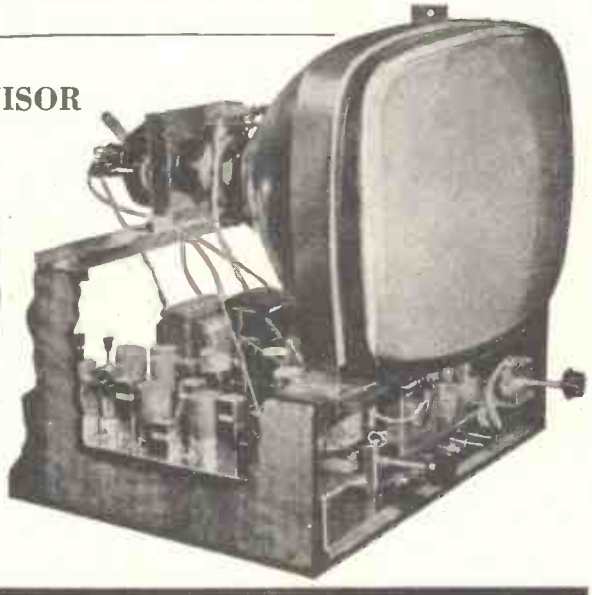
Build the NEW "MAYFAIR" TELEVISOR

which gives complete SAFETY to the constructor!

These Televisors use a double wound mains transformer which gives you complete safety from contact with the mains supply when handling the chassis or controls.

★ B.B.C. & I.T.A. DESIGN

WITH NEW TURRET TUNER MAY BE BUILT FOR **£33.7.11** PLUS COST OF C.R.T.



Build in 5 Easy Stages. Full Construction details available. Instruction Book 3/6 Post Free.

CONSOLE CABINETS with full length doors for 14in., 16in. and 17in. tubes. PRICE £14/14/-. H.P. Terms: Deposit £7/7/6 and 9 monthly payments of 18/6. CONSOLE CABINETS. Half door £12/12/-. H.P. Terms: Deposit £6/6/- and 8 monthly payments of 18/3. On above cabinets add 21/- for pkg. and carr.

PREMIER RADIO COMPANY,

YOU'LL DO BETTER WITH PREMIER

B.S.R. T.U.8 3-speed Record Player £4/12/6 plus 2/6 post and packing.

P.U. complete with arm 36/-.

CABINETS — PORTABLE

MODEL PC/2
Grey Lizard Rexine covered 45/-
Overall dimensions 15 in. × 13½ in. × 6¾in. Clearance under lid when closed 3in.

MODEL PC/2 DE LUXE
Two colours, wine and grey, with cut-out for speaker and amplifier 55/6
Dimensions 15in. × 14in. × 7½in.

MODEL PC/3
Grey Lizard Rexine covered..... 69/6
Overall dimensions 16¾in. × 14½in. × 11in.
Clearance under lid when closed 3¾in.

MODEL PC/3 DE LUXE
As above but with cutouts for Speaker and Amplifier 79/6
Dimensions as above.

THE ABOVE CABINETS ARE COMPLETE WITH CARRYING HANDLE FASTENERS AND PANEL.
Packing and Postage 3/- each.

Junction Transistors 10/- each
Equivalent of the OC70 Type

CONTINENTAL STYLE CABINET

Dark Piano finished with gold and black styling, overall size 39in. long, 32¾in. high, 16in. deep. Two sliding doors, concealing on the left a black panel 18½in. × 20½in. finished in medium mahogany, and on the right a detachable board 12½in. × 18½in. and a shelf which may be used for record storage. Cash Price 18 gns., plus 25/- pkg. and carr. Credit Terms: Deposit £2/18/- and 8 monthly payments £2/4/11.

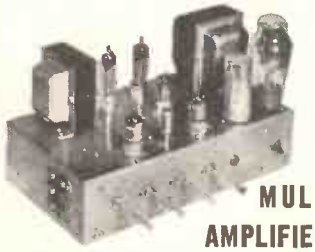
The new Spencer West Band Three converter is now available at £6/5/- plus pkg. and post 3/-.
Spencer West Pattern Unit 25/- plus 1/- pkg. and post. For elimination of B.B.C. interference or I.T.A.

PREMIER BUREAU DE LUXE

A superb cabinet in finely figured walnut veneer. Interior light sycamore with rexine matching lining. Overall dimensions: 33in. high, 34in. long, 17½in. deep. Uncut control panel on right-hand side approximately 16in. × 10½in., uncut baseboard on left-hand side 15¾in. long, 13½in. deep. Two full size felt-lined storage cupboards in the lower part of the cabinet.
Cash price 16⅔ gns.
Credit Terms: Deposit £2/3/10 and 8 monthly payments of £2/2/10. Packing and Carriage 25/- extra.

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

SEND 2½d. STAMP FOR OUR AUTUMN CATALOGUE

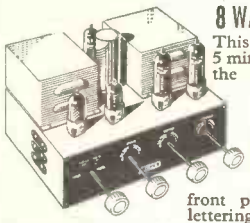


Why not make the best!

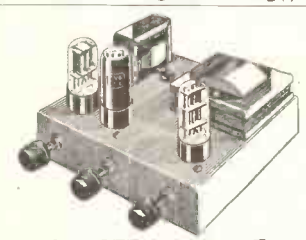
MULLARD AMPLIFIER KIT

NOW SUPPLIED WITH ULTRALINEAR OUTPUT TRANSFORMER.
All the components for model 510, PLUS pre-amplifier, on one chassis (total six valves), chassis gold hammer finished. May be purchased for £12/12/- plus pkg. and post 7/6. This version complete and tested £15/15/-. Or pre-amplifier and tone control in a separate unit £14/14/- plus pkg. and post 7/6.

8 WATT AMPLIFIER



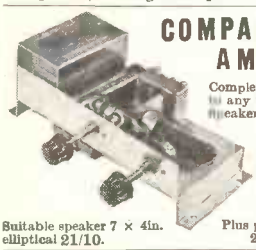
This design includes 5 miniature valves of the latest types, an Ultralinear Output Transformer suitable for Speakers of 3 and 15 ohms. and a very attractive perspex front panel with gold lettering, complete set of parts £8/8/-. Postage and Packing 5/- extra.



4 WATT AMPLIFIER

MAY BE BUILT FOR **£4.10.0** Plus 2/6 Pkg. & Postage

Instruction Book 1/- post free.
A steel case is now available, complete with engraved panel, for 15/6 extra. The amplifier may be supplied complete for £5/5/- plus pkg. and post 3/6, or fitted in case at £6 plus pkg. and post 3/6. Engraved panel 3/6. Post Free.



COMPACT GRAM AMPLIFIER

Complete ready to connect to any type of Pick-up and speaker (3 ohms) A.C. Mains 200/250 v. Volume and tone control fitted with knobs. Overall size 7½in. long × 3½in. wide × 2½in. high.
£2 : 19 : 6
Plus packing and postage 2/6.

Suitable speaker 7 × 4in. elliptical 21/10.

2-BAND TRF RECEIVER MAY BE BUILT FOR £5.15.0

plus pkg. and post 3/-

3 BAND SUPERHET RECEIVER

MAY BE BUILT FOR **£7.19.6** Plus 3/- Pkg. & Postage

These two receivers use the latest type circuitry and are fitted into attractive cabinets 12in. × 6½in. × 5½in. in either walnut or ivory bakelite or wood. Individual instruction books 1/- each, post free.

TERMS OF BUSINESS
Cash with order or C.O.D. over £1. Please add 1/- for Post Orders under 10/- 1/6 under 40/-. Unless otherwise stated.

Limited Quantity Only!

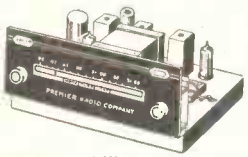
COLLARO R.C. 54 CHANGERS

at **£7.19.6** plus 5/- post and pkg.

COLLARO R.C. 456 4-Speed AUTOCHANGER
Designed to play 12in., 10in. and 7in. Records intermixed in any order at 16, 33⅓, 45 or 78 r.p.m. Capacity 10 records. New reversible Dual Stylus Crystal Pick-up for use on 100/250 v. 50 cycle A.C. mains, £9/15/- plus packing and postage 5/-. Deposit 25/- and 8 monthly payments of 25/-.

NEW FM TUNER

for the Home Constructor



A new design using the latest circuit techniques. Includes 4 valves plus magic eye tuning indicator, permeability tuning and an integral power supply. Two controls only, a gear driven slow motion tuning control and an output volume control with on/off switch. Suitable for fringe area reception.
All components may be purchased for £8/15/- plus packing and postage 3/6.
OR less Mains Transformer and Rectifier £7/12/6 plus packing and postage 3/-.
Power requirements HT 230 v. 50 mA., LT 6.3 v. 1.5A. Dial size 3½in. × 11⅛in., overall size 11⅛in. long, 5½in. deep, 4½in. high.

★ **IT WILL PAY YOU TO VISIT OUR NEW HI-FI DEMONSTRATION ROOM**

THE NEW TSL FM TUNER HIGH STABILITY MODEL

6 Valves including Magic Eye and Power Supply using the latest type Gorler permeability Unit complete with first audio stage and preset output volume control. Maximum radiation less than 10 microvolts per metre. Sensitivity better than .5 microvolts. Cash price £17/10/- (inclusive) or Credit Terms: Deposit £2/3/9 and 8 monthly payments of £2/3/4. Postage and packing 5/- extra.

STIRLING VHF/FM TUNER UNIT

A cleverly designed Unit suitable for installation either in existing equipment or as an external Unit. Completely self contained with its own power supply. The latest type permeability tuned circuit is used, tuning drift being negligible. Size 7½ × 7½ × 2½in. Cash Price £13/13/-. Postage and Packing 2/6 extra. Cr. Terms £1/15/- deposit and 8 monthly payments of £1/13/6. Plus postage and packing of 2/6.

WHY BUY SURPLUS OR RE-CONDITIONED TUBES WHEN THESE FULLY GUARANTEED WIDE ANGLE TUBES ARE AVAILABLE? THE LATEST TYPE 17in. RECTANGULAR TUBE AT £17 (INCL. TAX), POST AND PACKING 21/- EXTRA

TUNING CONDENSERS (Miniature type)
2-gang .0005 mfd. 5/-.

THE JASON "ARGONAUT"

MW/FM DESIGN

★All Premier components are designer approved ALL components to build the complete Receiver, including output stage, may be purchased for £15/5/-, or all components less output stage but including Power Supply, for £13/19/6, plus packing and postage 3/6 on each.

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Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: F. L. DEVEREUX, B.Sc.
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OCTOBER 1957

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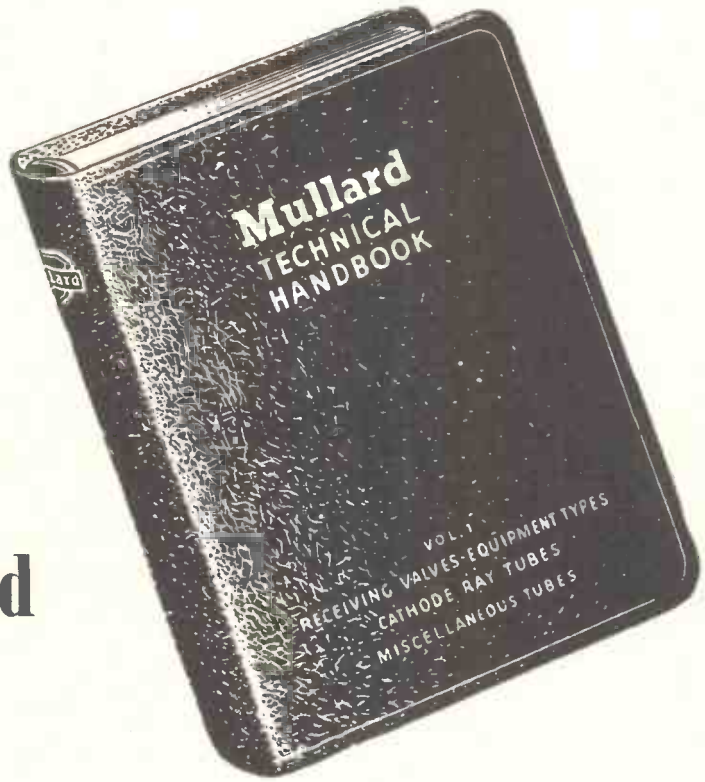

A service for all who need complete data on Mullard valves, tubes and semiconductor devices

The Mullard Technical Handbook is a loose-leaf publication, issued on a subscription basis and containing data sheets on all Mullard valves, tubes and semiconductor devices in current production.

From one to twenty pages are devoted to each type, data including: standard ratings, recommended operating conditions and performance figures for various applications, limiting values, characteristic and performance curves.

Subscribers receive supplementary or revised sheets automatically as they are issued and thereby have early intimation of new introductions.

At present the Handbook comprises four volumes with the following contents:—

VOLUMES I and IA
Data on current Receiving and Amplifying Valves. Cathode Ray Tubes. Crystal Diodes and Transistors. Photocells. Cold Cathode Tubes. Small Thyratrons. Miscellaneous and Special Tubes.

VOLUME 2
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Data on Power Valves for Transmitting and Industrial Equipment.
Power Rectifiers. Large Thyratrons. Microwave Devices.

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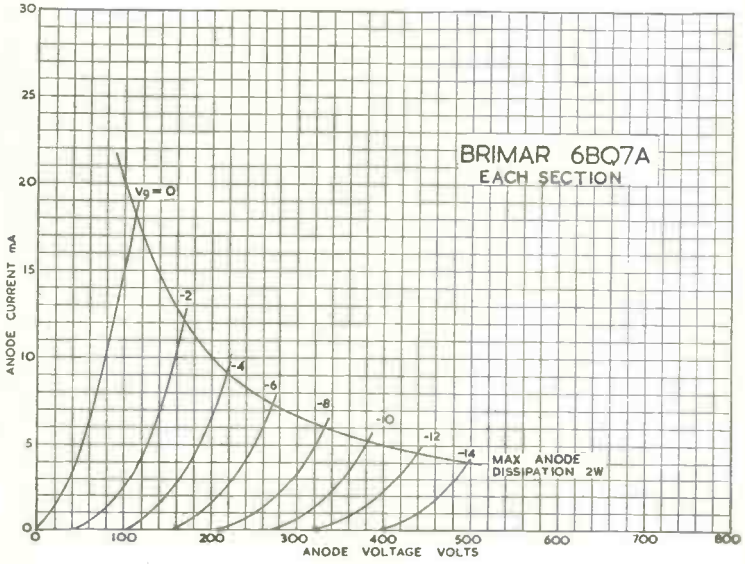
BRIMAR 6BQ7A

The Brimar 6BQ7A is a double triode consisting of two independent high slope sections with similar characteristics. The valve is particularly useful as a cascode R.F. amplifier for television receivers and also as a combined oscillator and mixer for frequency modulation receivers. It can, of course, be used wherever high slope triodes are required, and features low interaction between the sections as an internal screen is provided which is brought out to a separate base pin.



Cut this out for further reference or write to the Publicity Department at Footscray for a data sheet.

Name .....

Address .....

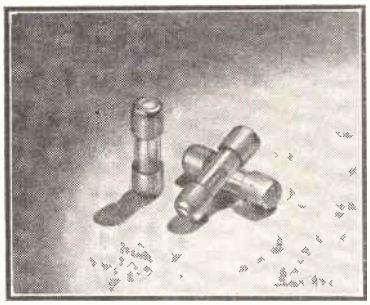
.....

W.W.

TYPICAL CHARACTERISTICS

Heater voltage	6.3. volts
Heater current	0.4 amp.
Anode voltage	150 volts
Cathode bias resistor	220 ohms
Anode current	9 mA
Mutual conductance	6.4 mA/V
Amplification factor	39
Anode resistance	6,100 ohms
Grid cut-off voltage (I — 10μA)	—10 volts approx.

"BELLING-LEE" FUSE-LINKS

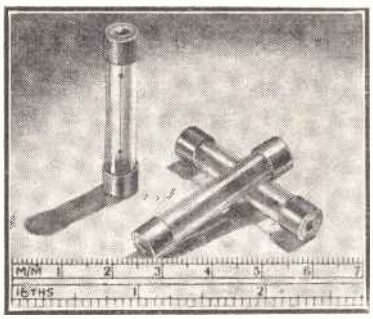


MINIATURE (GLASS)

L.562 ($\frac{5}{8}$in. × $\frac{3}{16}$in.)

50mA to 7A

Designed to blow within ½ second on 100% overload. The glass body is colour coded and the rating is coded on the nickel-plated caps.

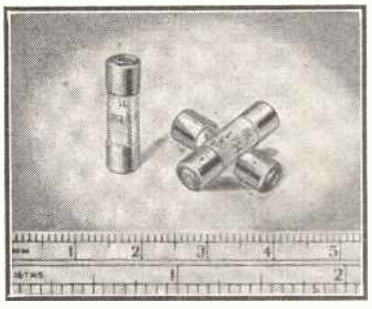


"MAG-NICKEL" delay fuse (glass)

L.338 ($1\frac{1}{4}$in. × $\frac{1}{4}$in.)

250, 500 & 750mA colour coded

Conform to the dimensions and blowing requirements of our standard L.1055 and can withstand a surge current of 10 to 30 times their rated current for a period not exceeding 0.01 second.



"MINIFUSE" miniature (ceramic)

L.754 ($\frac{5}{8}$in. × $\frac{3}{16}$in.)

10, 15 & 25mA

Primarily designed for the protection of small meters, test and laboratory gear, etc., "Minifuses" are designed to carry their rated current indefinitely and blow within 0.01 sec. at 3½ times their rated current.

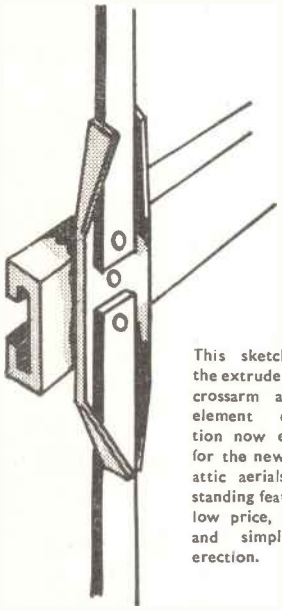
BELLING & LEE LTD

GREAT CAMBRIDGE RD., ENFIELD, MIDDX., ENGLAND

Telephone: Enfield 3322. Telegrams: Radiobel, Enfield

"BELLING-LEE" NOTES

We sincerely hope that by the time this is being read, the test transmitting aerial made by us for St. Hilary will be sending out a signal that will have been received by a very large number of people during the best part of a month. The signal from the test transmitter cannot be strong, but in general wherever the transmitter has been used, it has covered the area, though weakly. Its purpose is to provide something for the trade to focus on for alignment of aerials.



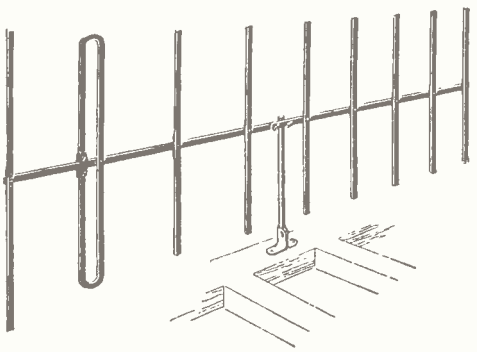
This sketch shows the extruded channel crossarm and strip element construction now employed for the new band III attic aerials. Outstanding features are low price, lightness and simplicity in erection.

We must emphasise that the transmitter is owned, manned and maintained by the Independent Television Authority to whom all enquiries and reports should be made.

There will be hundreds of thousands of indoor aerials such as the "Golden V" used up to five or eight miles from the transmitter. Further out, other aerials will come into their own. But please don't expect that everywhere within five miles of St. Hilary will manage with an indoor aerial.

By far the greatest number of aerials used will still be the outdoor type although the small length of the elements does allow even a nine-element to be used in the loft, but this would only be as good as a six-element out of doors. North of the Severn, except for the coastal regions, there will be trouble. Reception of Wenvoe up the valleys is bad enough, but the band III signal from St. Hilary will be worse. You can expect more and better "ghosts," calling for careful selection and siting of multi-element arrays, and please do believe that in a difficult site the movement of the aerial a fraction of a wavelength can make all the difference between entertainment value and no signal at all.

So far as distance is concerned, as long as there is "line of sight" there should be little trouble up to 50 (or many more) miles. For example towards Yeovil there are forty-five miles of flat country, but the fact that there is some rising ground immediately to the north of Yeovil would lead us to expect some difficulty in reception of a band III signal from St. Hilary. This is only quoted as an example. Places very much closer to the transmitter, often with higher ground between, will be much worse off. Parts of Swansea will get a better signal than parts of Neath, but there will be part of both towns where it will be almost impossible to receive a really good signal. During September we will be showing our colour film on band I—band III reception to hundreds of dealers in the area to be served by St. Hilary. Please note that it is not our policy to rush in and be the first firm to give a talk in a new transmitter area, and to book up orders. We deliberately postpone our meetings until a test signal has been "on the air" for a short time, so that a considerable number of the audience will have something definite in their minds. They are not sitting listening to some vague statements. They know more about local conditions than we do, and they are in a position to ask significant questions, which we can generally answer. We certainly consider the questions and answers part as most useful both to our audience and to us.

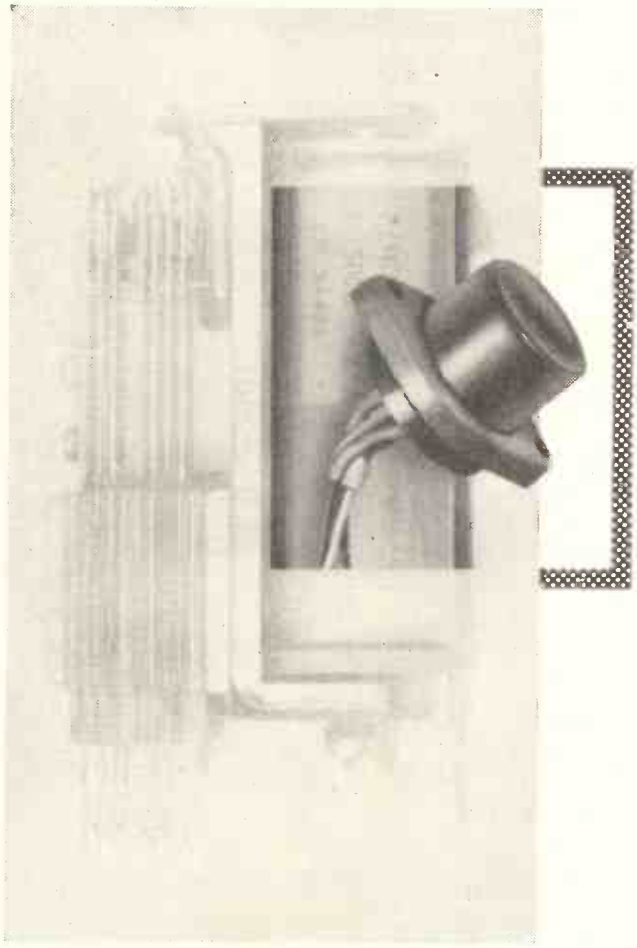


We now offer a band III attic aerial range with up to 9 elements on a short mast. These are light and simple in construction and practically spring into action.

Advertisement of
BELLING & LEE LTD.
Great Cambridge Rd., Enfield, Middx.
Written 15th August, 1957

E·M·I

SUB-MINIATURE RELAYS



Designed for compactness and reliability.

FEATURES

* Lightweight
* High Speed
* Fully Tropicalised (R.S.C. 165)
* Long Life

APPLICATIONS

* Guided Weapons
* Airborne Radar and Radio
* Portable Electronic Equipment

MAIN CHARACTERISTICS

* Weight 0.7 oz. (20 grm)
* Operating Temperature —40°C to 100°C
* Operating Power 300 mW
* Contact Loading 120 mW
* Single pole balanced armature type
* Will withstand high accelerations

PRICES

R1A/6 —for 6 volt operation—£4.10.0
R1A/12—for 12 volt operation—£4.10.0
R1A/24—for 24 volt operation—£4.10.0
Series R1—similar electrically to series R1A but different physically—£3.10.0

OTHER E.M.I. EQUIPMENTS

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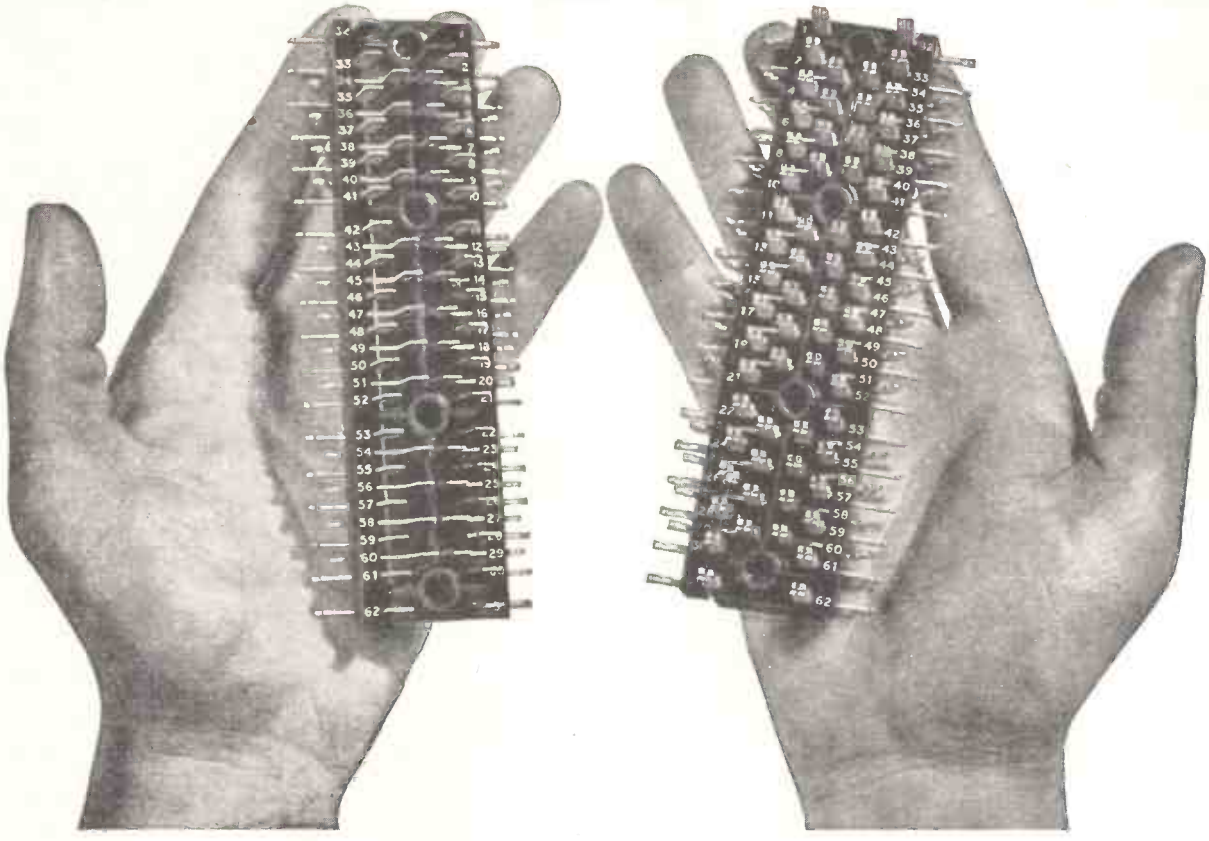
E.M.I. ELECTRONICS LTD

INSTRUMENT DIVISION · HAYES · MIDDLESEX · Tel: SOUthall 2468 (Ext. 1013 & 655)

EE115



Holding out for good connections?

There are almost certainly enough high grade ones in this 62-way connector. It was designed to fulfil an Admiralty requirement that could not be met by any other connector, and you will find it suitable for many rack-mounting applications where low contact resistance, high voltage and current capacity and excellent insulation are major factors.

SPECIFICATION

Contact Resistance:	less than 3 milli-ohms
Insulation:	2kV. between contacts
Voltage rating:	750V. r.m.s. working
Current rating:	10A. max. per single contact
Insertion pressure:	30 lbs.
Withdrawal pressure:	13 lbs.

31-way connector also available with identical specification except insertion and withdrawal pressures are 20 lbs. and 9 lbs. respectively.

A.I.D & A.R.B — APPROVED

POWER CONTROLS

LIMITED

POWER CONTROLS LIMITED, EXNING ROAD, NEWMARKET, SUFFOLK

Telephone: Newmarket 3181/2/3 Telegrams: Powercon Newmarket

WIDE RANGE CAPACITANCE BRIDGE

Designed for the accurate measurement of capacitance and resistance in the range 0·002pF to 100μF and 1Ω to 10,000MΩ respectively.

All measurements are made in the form of a three terminal network and components can be measured in situ. Accuracy within ± 1% Frequency 1592 c/s (ω=10,000).

Full technical information on this and other 'Cintel' Bridges is available on request.

CINEMA TELEVISION LTD

A COMPANY WITHIN THE RANK ORGANISATION LIMITED

WORSLEY BRIDGE ROAD · LONDON · S.E.26
HITHER GREEN 4600

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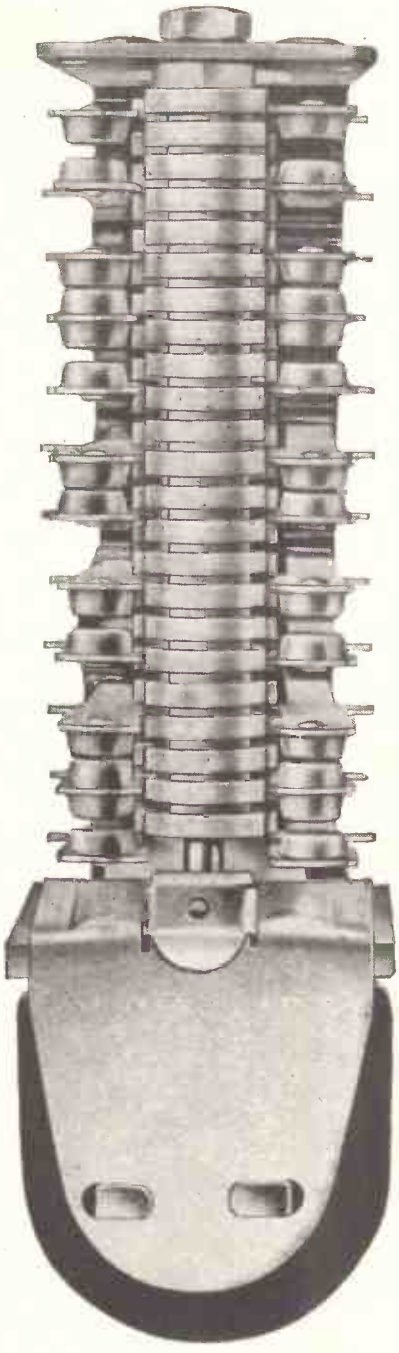
Atkins, Robertson & Whiteford Ltd., Industrial Estate, Thornliebank, Glasgow
F. C. Robinson & Partners Ltd., 122 Seymour Grove, Old Trafford, Manchester 16



You don't often see a relay like this!

Series 258

- Fast operating
- Negligible bounce
- Exceptional life
- Exceptional insulation

MAGNETIC DEVICES LIMITED

Magnetic Devices LTD.

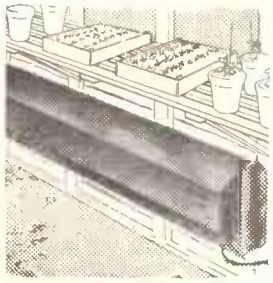
A.I.D. AND A.R.B. APPROVED

MAGNETIC DEVICES LTD., EXNING ROAD, NEWMARKET, SUFFOLK

Telephone: Newmarket 3181/2/3 Telegrams: Magnetic Newmarket

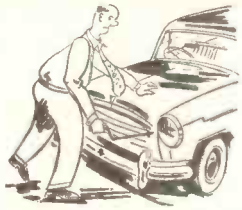
MD 21A

INSTANTUS HEATER



Convector heater, 1 kW. rating, 4ft. long, made from heavy gauge sheet steel (galvanised). Can be used for greenhouse, workshop, aviary, etc., etc. Price £2/10/-, or with thermostat, £4/5/-, carriage 5/-. GUARANTEED 5 YEARS.
2 KW MODEL. Free standing thermostatically controlled, £5/17/6.

DON'T BE CAUGHT LIKE THIS



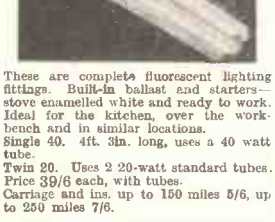
CAR STARTER CHARGER KIT

All parts to build 6- and 12-volt charger which can be connected to a "flat" battery and will enable the car to be started instantly. Kit comprising the following.

Mains transformer	22/6
5-amp. rectifier	17/6
Regulator Stud Switch	3/6
Resistance Wire	2/-
Resistance Former	2/6
Mains on/off Switch	2/6
0-5 amp. Moving Coil Meter	12/6
Construction Data	1/6

or if bought all together price is 52/6, plus 2/6 post and packing.

FLUORESCENT LIGHTS



These are complete fluorescent lighting fittings. Built-in ballast and starters—stove enamelled white and ready to work. Ideal for the kitchen, over the workbench and in similar locations.
Single 40. 4ft. 3in. long, uses a 40 watt tube.
Twin 20. Uses 2 20-watt standard tubes.
Price 39/6 each, with tubes.
Carriage and ins. up to 150 miles 5/6, up to 250 miles 7/6.

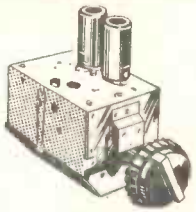
POCKET TRANSISTOR RECEIVER

All the parts to build cigarette box receiver, £2/17/6. Includes Ferrite aerials but not the earpiece, battery or case.

WESTINGHOUSE (U.S.A.) METERS

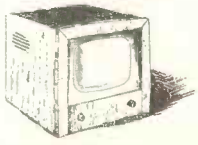
All moving coil flush mounting type, outside diameter of face 3¼in.

0-500 v. D.C.	20/-
0-1.5 kV D.C. external multiplier	25/-
0-2.5 kV D.C. external multiplier	25/-
0-15 v. A.C.	15/-
0-1 mA.	25/-
0-50 mA.	15/-
0-100 mA.	15/-
0-150 mA.	15/-
0-250 mA.	15/-
0-500 mA.	15/-



TURRET TUNER

Brand new stock, not surplus, with coils for Band I and III, complete with valves PCC84 and PCF80—I.F. Output 33/38 Mc/s with instructions and circuit diagram 79/6. With knobs 3/6 extra, post and ins. 2/6.



14" T.V. CABINET

14in. T.V. cabinet of the latest styling made for one of our most famous firms—beautifully veneered and polished—limited quantity—19/6 each. Carriage and packing 3/6 extra.

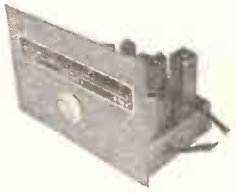
CABINETS FOR ALL

The CONTINA

Another addition to our range of cabinets. This is of new revolutionary design, styled after the best of Continental radios. Externally, it is finished in highly polished dark walnut veneer, with panelling picked out in gold. Interior is of same very high standard, its veneer being light mahogany which contrasts nicely with the dark walnut and generally gives a very pleasing appearance. The doors slide on metal runners and are fitted with gold insert finger plates. A really excellent cabinet for any home—size 3ft. 1½in. long, 1ft. 3in. deep, 2ft. 1½in. high, including legs which are 10in. from floor. Motor board 12¼in. × 17in., equipment aperture 17¾ × 9¼in. gives ample space for 8in. speaker. Ample storage space for recordings. Price £19/19/-. carriage and insurance, 20/-.

F.M. TUNER

This is a high fidelity unit which although moderately priced has a performance equal to the highest priced. Its stability is very good and extremely good results have been received with the simplest of aerials as far away as Eastbourne. The unit is made up ready to work and has its own power supply for A.C. mains. Demonstration at all our branches. Price 12 gns. or £1/12/- down and 6 payments of £2. Post plus insurance 5/.



THIS MONTH'S SNIP

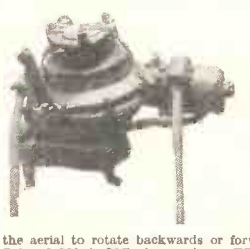
TAPE DECK—Made by the famous Truvox Company. This contains exactly the same essentials as the current model. Only the styling is different. It also takes the stereophonic head.

Specification: 3 S.T.H. shaded pole motors with silent friction drive eliminating wow and flutter. Push-button controls, electrically and mechanically interlocked. Patented electric type push-button controlled brake. Tape loading on the drop-in principle, accommodation for reels of 7in. diameter. Tracking sense to British and American standards. Playing times: up to 3 hours with L.P. Tape or 2 hours with Standard Tapes. Two tracks side by side with safety gap. Positive Azimuth adjustment of Record/Player head. High Impedance Heads. Overall size 14½in. × 12½in. × 5in. approx. 120 only of these fine decks offered at non-repeatable price of £17/10/- or £3/10/- down and eight monthly payments of £3. Non-callers add 10/- carriage and insurance.

EX-ROYAL NAVY SOUND POWERED TELEPHONE

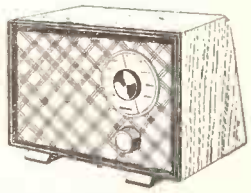
These require no batteries and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or where several telephones are used together, will indicate which one is being called. Size 7¾ × 9 × 7½in., wall mounting, designed for ships' use but equally suitable for home, office, warehouse, factory, garage, etc Price 57/6 each, plus 4/6 carriage.

UNITS FOR CONTROLLED AUTOMATIC ROTATION



We have two items of equipment which form part of the radar system RC84. These two units work together to form a Tower rotating device, with remote control.
Item 1, known as Tower 24A, is in fact the geared driving motor which rotates the mast. This is quite a heavy construction and would rotate a heavy scanner, reflector, beam array, etc., etc.
Item 2, known as Indicator 1-221-A is the remote controller which enables the azimuth position of Tower 24A to be controlled from a remote point. Conversely, it enables the azimuth position of the tower to be known at any time. Both the Tower and the Indicator contain selsyn transmitter/receivers and it is these that provide the impulses which cause the aerial to rotate backwards or forwards.
Prices 1-221-A £25 plus carriage. TR24A £35 plus carriage.
Special discount of £5 for cash with order or C.O.D. if both units purchased together.

OUR 19/6 COLUMN



THE SKYSEARCHER

This is a 2-valve plus-metal receiver set useful as an educational set for beginners, also makes a fine second set for the bedroom, workshop etc. All parts, less cabinet, chassis and speaker, 19/6. Post & ins. 2/6. Data free with parts or available separately 1/6. 3-valve battery version also available at the same price.

ALL-MAINS AMPLIFIER

Powerful three-valve Mains amplifier ideal for dances, parties, etc. Complete less chassis cabinet and speaker (available if required)—data 1/6 (free with parts). Price 19/6, plus 2/6 post and insurance.

"CHIMELITE" 19/6

It is a hall light, as well as a double chime and you can make in a couple of evenings for the total cost of only 19/6 including instructions post 2/- — data available separately price 2/-

SIMPLEX TRANSISTOR KIT

Makes ideal bedroom radio, uses one transistor and one crystal diode. Complete less case 19/6. case 5/- extra, post and ins. 1/6

A.C./D.C. MULTIMETER KIT

Measures A.C./D.C. volts and ohms. All the essential parts including 2in. moving coil meter, selected resistors, wire for shunts, range selector, switches, calibrated scale and full instructions, price 19/6 plus 1/9 post and insurance.

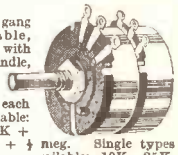
BAND III CONVERTER

Suitable London, Midlands, North, Scotland etc. All the parts including 2 valves, coils fine tuner, contrast control, condensers and resistors. (Metal case available as an extra) plus 2/6 post and insurance. Data free with parts or available separately 1/6.

ANOTHER SNIP

Heavy duty castors—Ideal for fitting to T.V. instrument trolley. Current value 12/6—special snip price 7/6 set of four, plus 1/- post.

MORGANITE POTENTIOMETERS



Single and 2 gang types available, standard size with good length spindle, all new and boxed. Gang type 3/- each —values available: 5K + 5K, 100K + 100K, ½ meg. + ½ meg. Single types 1/- each, values available: 10K, 25K, 50K, 100K, 250K, 1 meg., 2 meg.

CRYSTAL MICROPHONE

Miniature crystal type has high gain and is suitable for all purposes—tape recorders —amplifiers. Price 4/9, post and ins. 9d.

VARIABLE RHEOSTAT TRANSISTORS

A good range of transistor parts, miniature transformers, electrolytics, etc., available at all branches.

Red Spot and audio..	10/-
Blue Spot 1.6 Mc/s ..	15/-
White Spot 2.5 Mc/s..	20/-

W.D. CIRCUIT DETAILS

Diagrams and other information extracted from official manuals. All 1/6 per copy, 12 for 15/-.

American Service Sheets	R.109 78 receiver
A.1134	76 receiver
BC.348	R28/ARC5
BC.312	R1116/A
R.103A	RA-1B
B.C.342	AR88D
RA-1B	AN/APA-1
R-208	78
R-1155	76
R-1124A	R.T.18
R-1132A/R-1481	CAY-46-AAM-
R-1147	RADAR
R-1224A	A.S.B.-3.
R-1082	Indicator 62A
R-1355	Indicator A.S.B.3
B.C.1206-A/B	Indicator 62
B-455-A (or -B)	Indicator 6K
B-454-A (or -B)	R.F. unit 24
B-453-A (or -B)	R.F. unit 26
Transmitter T1154/	R.F. unit 25
B.D.J.N.	R.F. unit 27
Fifty-eight walkie-talkie	Wireless set No. 19
Frequency meter B.C.221.	Demobbed valves

CHASSIS ASSEMBLY

Three-colour 3-waveband scale covering Standard, Long, Medium and Short wavebands, scale pan, chassis, punched for standard 5-valve superhet, pulley driving head, springs, etc., to suit. Scale size 14½ × 3½in. Chassis size 15 × 5 × 2in. deep. Price 15/- plus 1/6 post. Note: We can supply cabinet for this. 39/6 and 5/- p. and p.

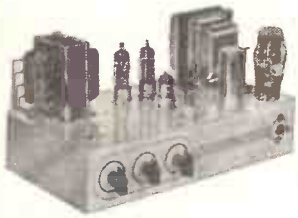
Complete T.V. Commercialising Outfit Sent for 14/6

Hundreds of people have already fitted our T.V. converter and now enjoy BBC and ITA programmes—you can do the same. Our outfit contains: ITA Converter—ITA Aerial—36ft. Co-ax Down Lead—Interference Suppressor—Illustrated detailed instructions—nothing else to buy, all for £8/10/-, carr. and ins. 4/6 or 10/- deposit and 9 monthly payments of £1.

FREE THIS MONTH

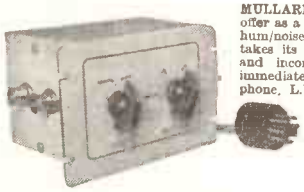
To all "Wireless World" readers who send S.A.E. we will present free a copy of our booklet:—

"THE VACUUM DELAY THERMAL RELAY"



MULLARD AMPLIFIER

A Quality Amplifier designed by Mullard. Power output exceeds 10 watts. Frequency response almost flat from 10 to 20,000 C.P.S. For use with the Acos "Hi G" and other good pick-ups. Made up and ready to work is £12/10/- or £1/10/- down and 8 payments of £1/10/-, plus 10/- carriage and insurance.



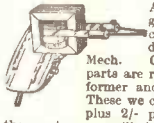
MULLARD PRE-AMP. We are pleased to offer as a ready-made unit. It uses the low hum/noise high gain pentode type EF86. It takes its power supply from the amplifier and incorporates 2 switches to provide immediate compensation, for radio, microphone, L.P. and 78 records. The price of this unit is £4 post and insurance 3/6 extra.
Or 10/- down and 9 payments of 10/-. If purchased with above, combined price is £16 or 30/- down and 8 payments of £2.

AUTO-CHANGER 30/- DEPOSIT

3-SPEED & 4-SPEED GRAMOPHONE AUTO-CHANGER

Latest types by all famous makers are invariably in stock at competitive prices. BSR Monarch, Garrard, etc. Latest models from £8/10/-, or deposit £1/10/- and 8 payments of £1 plus 5/- carriage and insurance.

MAKING A SOLDER GUN



A 7-second solder gun of the type costing £3-£4 was described in Prac. Mech. Only two essential parts are required—(a) transformer and (b) push switch. These we can supply at 13/6, plus 2/- post. The rest of the parts you will have in your own "junk" box. Copy of the article concerned given free with the kit.

CLOCK CASE

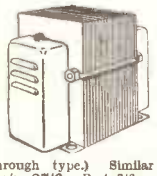
Also suitable for barometer or other instrument. Nicely polished. Price 4/6, post and packing 1/6.

Clock numerals to suit these cases etched on metal, 2/6.
Post 9d. if ordered separately.

BABY ALARM

Unlike most baby alarms, this not only enables you to hear baby but also to talk to him. Price complete with one microphone and 100ft. twin flex £6/19/6, carriage 3/6, additional microphone, 19/6.

TRANSFORMERS SNIP



Standard tapped mains input. Output 6.3 at 3 amp. 5 v. at 2 amp. and 350-0-350 at 80 milliamps. Ex-equipment but guaranteed perfect. 9/6 plus 2/6 post and packing. (Note this transformer is a half shrouded drop-through type.) Similar voltage but 250 m/a. 27/6. Post 3/6.

MINI-RADIO

Uses high-efficiency coils—covers long and medium wavebands and fits into the neat white or brown Bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, £4/10/-, plus 5/6 post. Constructional data free with the parts, or available separately, 1/6.

BARGAINS TO CLEAR

4 watt 3 valve Amplifier. Built to Hi-Fi standards with a control panel which can be used separately or fixed to chassis. Separate bass and treble controls. A.C. mains operated. £4/19/6 plus 5/- post and insurance.

AC Superhet 5 Valve Chassis, Medium and two Short, unused but less valves and mains transformer. Uses standard octal range, 27/6 (again coil pack worth much more), non-callers add 6/6.

AC Superhet 7v 5 Waveband Chassis. H.F. stage. Unused, less valves and power pack. Slightly soiled. Coil pack worth twice as much, circuit diagram supplied, £2/15/-, carriage and insurance 7/6.

AC 4 Valve Superhet, complete with valves but less scale and pointer, unused. Circuit diagram supplied, 39/6 plus.

Note that the above three chassis although unused will need checking. On account of low price no guarantee is given. Nor, we regret, can technical assistance be given.

.1mfd. 350 v. small tubular metal. Made by Dubilier. 2/6 per dozen.

Germanium Diodes. B.T.H. with wire ends. 10d. each or 9/- dozen.

Midget I.F. Coils, dust cored, size 1⅜ × 1in. 465 Kc/s, 4/6 pair.

Standard size I.F. Coil, dust cored, 465 Mc/s, 4/6 pair.

Coil Pack for Superhet, 465 Kc/s I.F. Medium and 2 short waves, 9/6.

Cathode Ray Tube. VCR 97. Instrument type, new 7/6 each carriage 3/6.

Bakelite 5 amp. electric wall switch. "Hicraft," 9d. each or 8/- per dozen.

Series, parallel and off-electric wall switch, made by Crabtree. Price 1/3 each or 13/6 per dozen.

Amplifier, ex-Government unit 1134, contains one double triode and one triode, 6/6, post and insurance 2/6.

Connecting wire, PVC covered 24 swg. copper, 2/6 per 100ft. or 5 coils different colours for 10/-.

Scanning coils, by very good maker, new and unused, 4/6 complete.

Choke, 200 m.a., first-class. Made for Services—new, 6/6, post 1/6.

10v. Superhet 1½ metre, ex-Govt., but unused. Complete with valves. Easily converted for Band III, 39/6, carriage and packing 7/6.

Mains Transformer, 250-0-250, 60-80 m.a. 6.3v. Standard mains input. Half shrouded 12/6, post and insurance 2/6.

R.F. 25 Tuning Unit. New, unused and complete with valves, 9/6, post 2/6.

Cathode Ray Tube, VCR 517, 8/6 each, carriage 2/6.

Mains Lead, metal screened to stop interference, 9d. yard.

Thermo-couple, mounted on valve base, useful for experiments and schools. 6/6 each.

Midget push-pull input transformer and push-pull output transformer, to match, 8/- the pair.

Note: Orders for small components over £2 are post free, otherwise please add sufficient.

ELECTRONIC PRECISION EQUIPMENT LTD.

266 London Road, Croydon.
Phone: CRO 6558.
Half-day Wednesday.

42-46 Windmill Hill, Ruislip, Middlesex.
Phone: RUISLIP 5780.
Half-day Wednesday.

152-153 Fleet St., E.C.4.
Phone: FLEET 2833.
Half-day Saturday.

29 Stroud Green Road, Finsbury Park, N.4.
Phone: ARCHWAY 1049.
Half-day Thursday.

Post orders should be addressed to E.P.E. LTD., Dept. 2, 66, GROVE ROAD, EASTBOURNE.
All enquiries to Eastbourne address and please enclose S.A.E., terms are cash with order.

Stern's "fidelity" TAPE RECORDER

IT HAS EVERYTHING — EXCEPT A HIGH PRICE

TESTED AND APPROVED AT THE TRUVOX LABORATORIES

IT INCORPORATES: The NEW TRUVOX Mk. IV TAPE DECK together with the "fidelity" MODEL HF/TR2 TAPE AMPLIFIER (both fully described on this page), and a Rola 10×6in. P.M. speaker.

● BEFORE CHOOSING YOUR TAPE RECORDER YOU SHOULD HEAR THIS MODEL—TRULY "Hi-Fi" RECORDINGS ARE OBTAINABLE and it is comparable to much higher-priced Recorders.

Alternatively send S.A.E. for ILLUSTRATED LEAFLET.

PRICE . . . Including CRYSTAL MIKE and 1,200ft. reel of PLASTIC TAPE.

£49.10.0. (OR £3 EXTRA WITH REV. COUNTER.)

(Plus £1/10/- carriage and insurance, of which £1 is refunded on return of Packing Case.)

CREDIT SALE: Deposit £12/8/- and 9 monthly payments of £4/10/8.

HIRE PURCHASE: Deposit £24/15/- and 12 monthly payments of £2/5/11.

A COMPLETE KIT OF PARTS TO BUILD

The "fidelity" TAPE AMPLIFIER Model HF/TR2 including POWER SUPPLY UNIT

FOR ONLY £12.0.0 (Plus 5/- carr. and ins.)

This amplifier has been expressly designed to meet the requirements of the enthusiasts for High Fidelity reproduction. It is based on a new design, completed by the Mullard Technicians and only really high-grade components are incorporated; truly **HIGH FIDELITY** Recordings are obtainable whilst "Hi-Fi" reproduction is assured by use of a high-quality Output Transformer by Gilson. It incorporates a "magic eye" Recording Level indicator, a two-position equaliser for 3¾in. and 7½in. speeds, and an effective Tone Control arrangement. Monitoring and Extension Speaker Socket are incorporated and in addition a position is provided to enable it to be used as an independent Amplifier for Gramophone Records or Radio Tuning Unit. Overall size: 11in. × 6in. × 6in. high. Suitable for nearly all makes of Tape Decks. When ordering, please advise make of deck in use.

THE ASSEMBLY MANUAL, PRACTICAL DIAGRAMS, etc., are available for 2/9 or send S.A.E. brief details.

WE ALSO SUPPLY THE HF/TR2 ASSEMBLED AND READY FOR USE FOR £16.0.0. (Plus 6/- carr. & ins.). H.P. TERMS. Deposit £8 and 9 monthly payments of £1. CREDIT TERMS: Deposit £4 and 9 monthly payments of £1/9/4.

THE NEW TRUVOX MkIV TAPE DECK

UNDOUBTEDLY ONE OF THE BEST TAPE DECKS ON THE MARKET.

PRICE £27.6.0 (Plus 10/- carr. and ins.)

CREDIT TERMS: Deposit £6/17/- and 9 monthly payments of £2/10/-.

H.P. TERMS: Deposit £13/13/- and 12 monthly payments of £1/5/4.

SPECIFICATION:— ● 3 B.T.H. shaded pole motors with silent friction drive eliminating wow and flutter. ● Push-button controls, electrically and mechanically interlocked (patented). ● Patented electric-type push-button controlled brake. ● Inching to assist editing; tape loading on the drop-in principal accommodation for reels of 7in. diameter. ● Tracking sense. To British and American standards. ● Playing times: Up to 3 hours with L.P. Tape or 2 hours with Standard Tapes. ● Two tracks side by side, with safety gap. ● Playing time indication by precision revolution counter or large visual type indicator plate, according to choice. Positive Azimuth adjustment of Record/Player Head. ● High Impedance Heads. ● The metal work is Gold Hammered finish. ● Overall size 14¼in. × 12⅝in., from top of face of panel, overall depth 5in.

The Mk. IV DECK CAN ALSO BE SUPPLIED INCORPORATING PRECISION REV COUNTER for £30/9/-. H.P. TERMS: Deposit £15/4/6 and 12 months of £1/8/3. CREDIT SALE: Deposit £7/12/3 and 9 months of £2/15/10.

STERN'S TAPE PRE-AMPLIFIER and ERASE UNIT

Provides the "Link" between the HIGH-QUALITY AMPLIFIER and TAPE DECK.

STERN'S MODEL HF/TR1.P . . . A completely assembled Pre-Amplifier with own Power Supply. Can be supplied correctly matched for use with Truvox, Brenell or Collaro Decks, and incorporates Recording Level Indicator and Monitoring facilities. Please send S.A.E. with any inquiry.

PRICE **£11.10.0** (plus 5/- carr. and insurance)

WE MAKE SPECIAL PRICES FOR COMBINED ORDERS

WE WILL SUPPLY

(a)	The model HF/TR2 AMPLIFIER and POWER UNIT, both fully assembled, together with the TRUVOX MK IV TAPE DECK for ..	£38 10 0
	ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS	£35 0 0
(b)	The model HF/TR2 AMPLIFIER and POWER UNIT both fully assembled, together with the TRUVOX TAPE DECK incorporating PRECISION REV COUNTER	£41 10 0
	ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS	£38 0 0
(c)	The model HF/TR2 AMPLIFIER and POWER UNIT, both fully assembled, together with the COLLARO TRANSCRIPTOR	£35 0 0
	ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS	£31 10 0
(d)	The Model HF/TR1P TAPE PRE-AMPLIFIER together with the TRUVOX MK IV TAPE DECK	£35 0 0
(e)	ALTERNATIVELY as in (d) above but Truvox Deck incorporating PRECISION REV COUNTER	£38 0 0
(f)	The model HF/TR1P TAPE PRE-AMPLIFIER together with the COLLARO TRANSCRIPTOR	£31 10 0

PLEASE INCLUDE 12/6 to cover cost of Carriage and Insurance.

HIRE PURCHASE and **CREDIT SALE TERMS** are available on all above (excluding Kits of Parts). Send S.A.E. for details.

NOTE . . . The Collaro Transcriptor is in short supply and there may be a delay in delivery. We will however book an order.

The Deck switches of the Transcriptor must be "wired-up." We will complete this wiring, for use with either the HF/TR2 or the HF/TR1.P, for an extra charge of £1.0.0.

Home Constructors!

YOU CAN BUILD A COMBINED TAPE RECORDER-RADIOGRAM AT HALF THE NORMAL COST.

As will be seen from this advert. there are several combinations with or without a Record Player. This is a very popular and successful combination and we will supply ALL ITEMS FOR..... **£79.0.0**

WE SUGGEST . .

(a) The TRUVOX MK IV DECK (with Counter £3.0.0 extra).
(b) The HF/TR1.P TAPE PRE-AMPLIFIER.
(c) The MULLARD 5-10 with "fidelity" Pre-amplifier.
(d) STERN'S F.M. TUNER UNIT.
(e) COLLARO R.C.456 AUTOCHANGER.
(f) TAPE and MICROPHONE.

OTHER TAPE EQUIPMENT

PORTABLE CASE as illustrated above	£5 0 0
ACOS CRYSTAL MICROPHONE	£2 10 0
ROLA 10in. × 6in. P.M. SPEAKER (7in. × 4in. 19/6)	£1 10 0

PLASTIC TAPE of all lengths—L.P. and Standard. IN STOCK
WE WILL SUPPLY ALL ABOVE including a 1,200 ft. reel Plastic Tape for £9 5 0

Open Monday to Friday 9 a.m.—6 p.m. Saturday 9 a.m.—1 p.m.

STERN RADIO LTD.

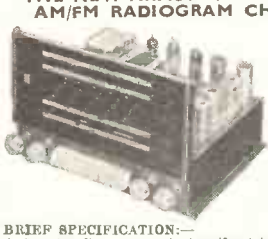
(DEPT 109/W)

109 & 115, FLEET ST., LONDON, E.C.4

Telephone: FLEet St. 5812/3/4

IT'S MUCH BETTER — MODERNISE YOUR OLD RADIOGRAM — IT'S MUCH CHEAPER

THE NEW ARMSTRONG P.B. 409 AM/FM RADIOGRAM CHASSIS



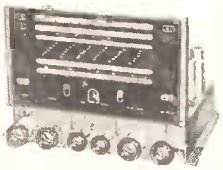
PRICE **£29.8.0** (Plus 7/6 carr. and ins.).

TERMS: Credit Deposit £7/7/- and 9 monthly payments of £2/14/-. H.P. Dep. £14/14/- and 12 monthly payments of £1/7/3.

BRIEF SPECIFICATION:—
A 9 valve line up employing the latest MULLARD preferred-type valves. ● Provides complete coverage of the VHF/FM Transmissions, plus the SHORT, MEDIUM and LONG waves. ● Has Push-Pull output, with negative feedback, for 6 watts Peak output. ● Quick action "Piano Key" Selectors and separate Bass and Treble Controls. ● Has "Magic Eye" Tuning Indicator. ● Dimensions 13in. × 9¼in. × 8in. high. Dial size 11¼in. × 5¼in.

THE ARMSTRONG MODEL A.F. 105 AM/FM RADIOGRAM CHASSIS

A Genuinely Hand Made Chassis



Developed to meet the needs of those who require really high quality radio and record reproduction but who, for reasons of expense or lack of room in existing or proposed cabinets, cannot consider the normal high-fidelity system. The A.F.105 is as good as, or better than, many of the high quality amplifiers, and Associated units. Independent and continuously variable Bass and Treble controls give a wide range of control. SEND S.A.E. FOR DETAILS.

PRICE **£37** (Plus 7/6 carr. and ins.).

CREDIT SALE TERMS: Deposit £9/5/- and 9 monthly payments of £3/7/10.
HIRE PURCHASE TERMS: Deposit £18/10/- and 12 monthly payments of £1/14/4.

THE DULCI MODEL H.4

COMBINED AM/FM RADIOGRAM CHASSIS

A 4 Waveband Receiver designed for first-rate reproduction of Radio and Gram.

PRICE **£24.6.6** (Plus 7/6 carr. & ins.).

CREDIT TERMS: Deposit £6/2/- and 9 monthly payments of £2/4/7. H.P. TERMS: Deposit £12/3/3 and 12 monthly payments of £1/2/7.

BRIEF SPECIFICATION:—
- Covers Short, Medium, Long and F.M. Wavebands.
- Employs full A.V.C.
- The Latest 7-valve line-up.
- For 3 or 15 ohm P.M. Speakers.
- "Magic Eye" Tuning Indicator.
- Excellent Tone range up to 4 watts output.
- Internal aerial for local stations.
- Overall size 12in. × 8¼in. × 7¼in. high.

A Good Quality Chassis and Well Recommended.

THE FOLLOWING DULCI TUNER UNITS ARE IN STOCK

MODEL H.4T. This model is the "TUNER UNIT VERSION" of the H.4 Radiogram Chassis illustrated and described above. It has the same coverage of A.M. and F.M. Wavebands (4 altogether) and precisely the same in size and appearance, except that it has three Controls only, being: TUNING, WAVECHANGE and Volume On/Off, mounted centrally on the chassis. A self-contained Tuner incorporating own Power Supply.

PRICE **£20.17.0** (plus 7/6 carr. & ins.).

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/18/4. H.P. TERMS: Deposit £10/8/6 and 12 monthly payments of 19/4.

THE MODEL A.F.O.—3 Waveband A.M. only RADIOGRAM CHASSIS

PRICE **£11.16.4** (plus 7/6 carr. & ins.).

H.P. TERMS: Deposit £5/18/4 & 8 monthly payments of 17/3.

This is a standard 6-valve A.C. Mains Superhet Receiver Chassis covering Long — Medium — Short Wavebands, having Gram and Extension Speaker Sockets. Reproduction from both Radio and Gram is really good and it makes an ideal Chassis for a simple domestic installation. Overall size is 12in. × 7in. × 7¼in. high.

Really Modern Demonstration Rooms are now available for the convenience of callers.

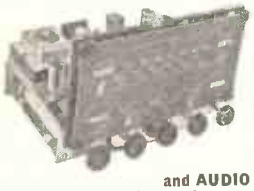
THE DULCI MODEL H.3 COMBINED AM/FM RADIOGRAM CHASSIS

This model is very similar to the model H.4 described above but covers 3 WAVEBANDS instead of 4 (omitting the Short Band) and is for 3 ohm Speakers only. Overall size is as for the H.4.

PRICE **£20.17.0** (Plus 7/6 carr. and ins.).

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/18/4. H.P. TERMS: Deposit £10/8/6 and 12 monthly payments of 19/4.

THE DULCI MODEL H.11



"The Heart of High Fidelity"

A COMBINED and SELF-POWERED AM/FM TUNER "HI-FI" CONTROL UNIT and AUDIO PRE-AMPLIFIER

Incorporating switching and connections for direct use with TAPE EQUIPMENT.

PRICE **£29.3.10** (Plus 7/6 carr. and ins.).

CREDIT TERMS: Deposit £7/6/- and 9 monthly payments of £2/13/6. H.P. TERMS: Deposit £14/12/6 and 12 monthly payments of £1/7/-.

A truly High Fidelity Unit containing the functions of an A.M./F.M. Tuner—Pre-amplifier Tone Control Unit, all on one chassis, designed for use with any High Quality Main Amplifier (i.e., the Mullard 5-10 at £9/10/-, or Williamson, etc.).

BRIEF DESCRIPTION:—
- Covers 4 wavebands being Short—Long—Medium and the V.H.F./F.M. Band.
- Separate Bass and Treble Controls.
- Gram Equalising.
- Magic Eye Tuning.
- Latest BVA 7-valve line-up, plus two matched Diodes.
- Overall size 12in. × 9in. × 7¾in. high.

THE DULCI VHF/FM TUNER

A self contained Tuning Unit providing complete F.M. coverage.

PRICE **£17.10.0** (Plus 5/- carr. & ins.)

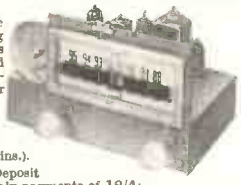
CREDIT TERMS: Deposit £4/7/6. and 9 monthly payments of £1/12/1. H.P. TERMS: Deposit £8/15/- and 11 monthly payments of 17/8.

BRIEF DETAILS:—
(a) Designed to operate with any make of Amplifier and most Radio Receivers.
(b) Incorporates its own Power Supply.
(c) Has the highly efficient GERLER INDUCTANCE TUNING HEART.
(d) A "Magic-Eye" TUNING INDICATOR is incorporated.
(e) Employs the latest valve line-up—EABC80, ECC85, two EF89's 6 × 4 (Rectifier) and EM80 Indicator.
(f) A very attractive Dial (size 10¼in. wide × 6in. high) is incorporated and the overall size of Chassis is 6in. deep × 9in. wide × 5¼in. high.

The T.S.L. V.H.F./F.M. TUNER is also in stock. It is very similar to the above Dulci F.M. Unit both in general appearance and performance.

PRICE—PRECISELY the same as the Dulci V.H.F./F.M Unit.

Stern's "fidelity" F.M. TUNING UNIT



A 5-Valve Tuner incorporating the latest Mullard Permeability Tuned Unit. Price assembled less Power Supply:

£14.10.0

(Plus 7/6 carr. and ins.).

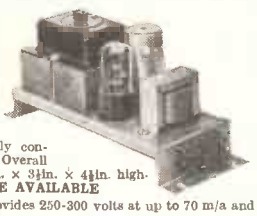
TERMS: (a) H.P. Deposit £7/5/- and 9 monthly payments of 18/4: (b) Credit Deposit £3/12/6 and 9 monthly payments of £1/6/7. Provides "Hi-Fi" reproduction with any make of Amplifier and many Radio Receivers. It incorporates:
● The latest Valve line-up—ECC85, 2 type EF85, EF91 and EM80. ● A "Magic Eye" Indicator. ● Power consumption is 1.7 amps at 6.3 volts and 25 m/a at 250 volts

STERN'S "fidelity" COMBINED A.M. and F.M. TUNING UNIT

This is IDENTICAL to the Stern's F.M. Tuner illustrated above, but in addition incorporates the MEDIUM WAVEBAND and thereby also provides a selection of foreign stations. PRICE **£18.18.0** (Plus 7/6 carr. and ins.).

TERMS:—(a) H.P. Deposit £9/9/- and 10 monthly payments of £1/1/-: (b) Credit Deposit £4/15/- and 9 monthly payments of £1/14/7. Send S.A.E. if further data required.

STERN'S POWER SUPPLY UNITS



Fully smoothed with all output connections terminated to Connecting Blocks, thereby enabling ease of connecting to a Radio Tuner Unit or Amplifier, etc. (the Compact 5 Amplifiers are immediately connected in this way). Overall size of Units is 9¼in. × 3¼in. × 4¼in. high.

TWO MODELS ARE AVAILABLE

Type "A" Unit provides 250-300 volts at up to 70 m/a and 6.3 volts at 3¼ amps.

PRICE **£2.17.6** (Plus 2/- carr. and ins.)

Type "B" Unit provides 250-300 volts at up to 100 m/a and 6.3 volts at 3¼ amps.

PRICE **£3.3.0** (Plus 2/- carr. and ins.).

WE ALSO SUPPLY THESE UNITS AS COMPLETE KITS OF PARTS

A detailed wiring-up leaflet is supplied (this is available separately for 9d.), and they are very quickly and easily assembled.

Type "A" Unit Complete Kit. PRICE £2/9/6.
Type "B" Unit Complete Kit PRICE £2/15/-.
(Carriage and insurance is 2/- extra.)

RECORD PLAYERS

THE VERY LATEST MODELS ARE IN STOCK

MANY AT REDUCED PRICES!!!

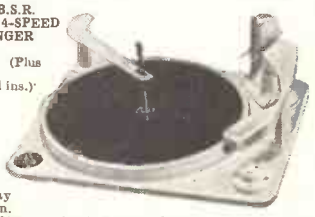
TRANSCRIPTION UNITS—AUTOCHANGERS SINGLE RECORD PLAYERS

Send S.A.E. for ILLUSTRATED STOCK LIST

CASH ONLY OFFER!!!

This latest B.S.R. MONARCH 4-SPEED AUTOCHANGER

£8.7.6 (Plus 5/- carr. and ins.)



● They play MIXED 7in. 10in. and 12in. records of same speed.
● Minimum baseboard size required 14in. × 12¼in., with height above 5¼in., and height below baseboard 2¼in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

WE ALSO HAVE A FEW ONLY

COLLARO MODEL 456 4-Speed "Mixer" Autochangers. The Units are BRAND NEW and incorporate the STUDIO "O" Pick-up.

PRICE **£9.10.0** (Plus 5/- carr. and ins.).

FOR CALLERS ONLY We have in stock various KITS OF PARTS including F.M. Tuners, AM/FM Tuners, Midget Battery Portable and Mains Units, etc., etc. . . We also have the most comprehensive stock of WIRELESS and ELECTRICAL COMPONENTS.

Open Monday to Friday 9 a.m.—6 p.m.
Saturday 9 a.m.—1 p.m.

STERN RADIO LTD.

AMPLIFIERS
PRE-AMPLIFIERS

HIGH FIDELITY FOR THE HOME CONSTRUCTOR

TUNING UNITS
RADIORECEIVERS

—COMPLETE KITS OF PARTS FOR THE "Hi-Fi" ENTHUSIAST—

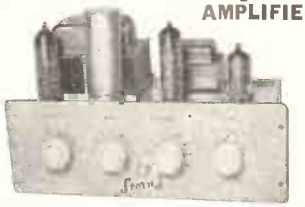
QUALITY OF THIS NATURE HAS NEVER BEFORE BEEN OFFERED AT SUCH LOW COST

STERN'S REMOTE CONTROL UNIT

Designed in particular for use with the MULLARD 5-10 Main Amplifier.

Ideally suited for simple domestic installation as an alternative to the more elaborate Pre-amplifier (shown and described opposite). Tone Control facilities are really excellent and in conjunction with the "5-10" Main Amplifier reproduction is of very high quality. Perfectly suitable for use with all the popular Record Players (B.S.R., Collaro, Garrard) and the modern Radio Tuner Units. Front Panel contains: (a) Coloured Indicator; (b) Separate BASS and TREBLE CONTROLS; (c) 3 position Selector Switch; (d) Volume Control. Inputs on back for Radio and Gram. and Gram equalising is incorporated.
FULL DATA is contained in the 5-10 MAIN AMPLIFIER MANUAL at 1/6.

THE MULLARD "3-3" QUALITY AMPLIFIER



A small Compact Amplifier capable of VERY HIGH QUALITY REPRODUCTION on both RADIO and GRAM.
PRICE for Complete KIT OF PARTS.... **£6.19.6**
(plus 5/- carr. & ins.)
Alternatively supplied ASSEMBLED and READY for USE **£8.12.6**
(plus 5/- carr. & ins.)
The complete SPECIFICATION and ASSEMBLY DIAGRAMS are available for 1/6.
Developed from the very popular 3 valve 3 watt. Amplifier designed in the Mullard Laboratories. We strictly adhere to their specification but in addition we have added switched equalising for L.P. and 78 records and a position for Radio Inputs, plus additional power to feed a Radio Tuning Unit. Extremely simple to assemble and ideally suitable to incorporate with an F.M. Tuner and Record Player in a small installation.

BRITAINS FINEST "HI-Fi" AMPLIFIER

The GENUINE WILLIAMSON

"Still sets the standard for all amplifiers." Many versions of the Williamson have been offered to the public at various low prices, but the 'only Williamson' is the Amplifier built to the designer's specification and employing the very highest grade Components that he specifies, i.e. PARTRIDGE TRANSFORMERS, CHOKES, etc. It is only in doing this that the exceptionally high standard that has made this Amplifier so famous, particularly in America, is obtained. . . WE HAVE DONE THIS ! ! ! . . . and we offer these KITS OF PARTS, including Partridge and other high grade Components, as follows—
(a) To build the MAIN AMPLIFIER ONLY (Illustrated above.) **£14.10.0**
(b) To build the TWIN POWER SUPPLY UNIT only **£13.10.0**
(Insufficient space to illustrate this.)
(c) COMPLETE KIT to build both above **£27.0.0**

We will also supply COMPLETELY ASSEMBLED and will be pleased to quote. Credit and H.P. Terms are available. The complete SPECIFICATION and general ASSEMBLY INSTRUCTIONS are available for 3/6.

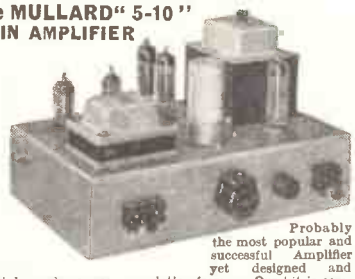
Our "fidelity" PRE-AMPLIFIER, illustrated and described above, or alternatively the RCA Pre-Amplifier at £16/5/-, is recommended for use with the Williamson.

DEPT. 109/W

109-115 FLEET ST. LONDON. E.C.4

Phone : FLEet Street 5812-3-4.

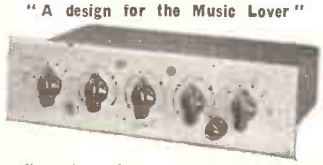
The MULLARD "5-10" MAIN AMPLIFIER



Probably the most popular and successful Amplifier yet designed and certainly needs no recommendation from us. Our kit is complete to MULLARDS specification including the latest ULTRA LINEAR OUTPUT TRANSFORMER and the recommended Mullard Valve line-up. All specified Components are supplied and Power Supply is available to drive a Radio Tuner Unit.
PRICE OF COMPLETE KIT OF PARTS **£9.10.0**
(Plus 5/- carr. & ins.)
or alternatively we supply—
FULLY ASSEMBLED AND TESTED for **£11.10.0**
(Plus 5/- carr. & ins.)
The ASSEMBLY MANUAL containing FULL SPECIFICATION is available for 1/6. It also includes full data on the REMOTE CONTROL UNIT.

STERN'S "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT

"A design for the Music Lover"



This unit can be used with any Main Amplifier. Briefly it has inputs for all types of MICROPHONES, HIGH and LOW GAIN PICK-UPS and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL. (b) STEEPCUT FILTER. (c) Continuously variable BASS and TREBLE CONTROLS, a variable OUTPUT CONTROL which enables its use with any type of Amplifier, and Jack Sockets are incorporated for TAPE RECORD and TAPE PLAYBACK.
Used with the "5-10" the reproduction is comparable to that normally associated only with the very expensive commercially made High Fidelity Amplifiers.
PRICE OF COMPLETE KIT OF PARTS **£6.6.0**
WE ALSO OFFER IT ASSEMBLED READY FOR USE £8 (plus 5/- carr. & ins.).
The ASSEMBLY MANUAL contains full specification, and is available for 1/6.

SPECIAL PRICE REDUCTIONS FOR PURCHASERS OF A COMPLETE "Hi-Fi" AMPLIFIER WE WILL SUPPLY...

(a) The COMPLETE KIT of PARTS to build both the MULLARD 5-10 and the REMOTE CONTROL UNIT for **£11.11.0**
(b) The COMPLETE KIT of PARTS to build both the MULLARD 5-10 and the "Fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for **£15.15.0**
ALTERNATIVELY WE WILL SUPPLY ASSEMBLED and FULLY TESTED, as follows—
(a) The MULLARD 5-10 and the REMOTE CONTROL UNIT for..... **£14.0.0**
CREDIT SALE TERMS, £3.10.0 Deposit and 9 monthly payments of £1.5.8. H.P. TERMS, £7 Deposit and 9 monthly payments of 17/9.
(b) The MULLARD 5-10 and the "Fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for..... **£18.18.0**
CREDIT SALE TERMS £4.15. Deposit and 9 monthly payments of £1.14.7. H.P. TERMS. £9.9. Deposit and 12 monthly payments of 17/6.
WHEN ORDERING PLEASE INCLUDE 7/6 to cover cost of Carriage and Insurance.

A COMPLETE KIT OF PARTS, STERN'S "HIGH QUALITY" 8-10 WATT AMPLIFIER

Has power supply available for Radio Tuning Unit.
Price of COMPLETE KIT OF PARTS (plus 5/- carr and ins.). **£7.10.0**
WE ALSO OFFER IT ASSEMBLED and READY FOR USE for **£9.10.0**
(plus 5/- carr. & ins.).
This amplifier has proved one of the most popular models yet offered to the HOME CONSTRUCTOR. It provides really excellent reproduction up to 8 watts, employing 6V6's in push-pull and incorporating negative feedback. Provides for the use of both 3 and 15 ohm Speakers. The Complete SPECIFICATION and BUILDING INSTRUCTIONS are available for 1/6.
"Wire-to-Wire" Diagrams areincluded and all Components are available separately

SPECIAL CASH ONLY OFFER ! !

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER, and a matched 6½in. P.M. SPEAKER, ALL FOR **£8.7.6**
(plus 7/6 carr. & ins.).
The Amplifier consists of a 2 Stage design incorporating the modern B.V.A. valves types ECC83, EL84 plus EZ80 Rectifier and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger, and is attractively finished in Maroon and Grey colour Rexine
WE ALSO SUPPLY SEPARATELY—
(a) The 2-Stage (plus Rectifier) AMPLIFIER.. £4.2.6
(b) The PORTABLE CARRYING CASE £3.17.6
(c) 6½in. P.M. SPEAKER 16/9
Carriage and insurance, 4/- extra.
We also have a smaller PORTABLE CASE Ideal for Record Players. PRICE ONLY £3/3/- (plus 3/- carr. & ins.). Attractively finished in high grade Rexine and robustly constructed with initial measurements at 13½ × 15½in. high. It will therefore accommodate all makes of Record Players including Autochangers. An uncut baseboard is also supplied.

THE FOLLOWING HIGH FIDELITY AMPLIFIERS ARE IN STOCK

STERN'S COMPACT 5 AMPLIFIERS. Expressly developed for very high quality reproduction of Gram Records and particularly FM Transmission. Available in 2 models as follows.

COMPACT "5-2". A two-stage high sensitivity amplifier having separate Bass and Treble Controls. Price **£6.6.0**

COMPACT "5-3". A three-stage version of the "5-2", but having an additional stage incorporating negative feed-back. Price **£6.16.0**

Power supply is obtainable from a small separate unit. Price (additional to above), £2.10.0.

THE DULCI MODEL D.P.A.10. A 10 watt. "Ultra Linear" High Fidelity Amplifier with separate PREAM-TONE Control Unit **£19.19.0**

THE LEAK MODEL TL/10 and "POINTONE" PRE-AMPLIFIER. A universally known Amplifier and now quite accepted as one of the best in production. **£28.7.0**

THE ARMSTRONG MODEL A.10 Mk. II. With associate PREAMP-TONE CONTROL UNIT, this model is perfectly consistant with Armstrong's very high reputation. **£32.0.0**

THE ROGERS "JUNIOR". With associate PREAMP-TONE CONTROL UNIT. **£26.0.0**

THE RCA "ORTHOPHONIC". 12-20 watt. high Fidelity Amplifier and associate PRE-AMPLIFIER TONE CONTROL UNIT **£41.0.0**

HIRE PURCHASE and CREDIT TERMS are available on all models.

Illustrated and Descriptive leaflets are available. Send S.A.E.

SELENIUM RECTIFIERS

L.T. Types

2/6 v. ½ a.h.w...	1/9
6/12 v. ½ a.h.w...	2/9

F.W. Bridge

6/12 v. 1 a.....	4/11
6/12 v. 2 a.....	8/9
6/12 v. 3 a.....	11/9
6/12 v. 4 a.....	14/9
6/12 v. 6 a.....	19/9
6/12 v. 10 a.....	25/9

H.T. Type H.W.

120 v. 40 mA...	3/9
250 v. 50 mA...	5/9
250 v. 80 mA...	7/9
250 v. 150 mA.	9/9
300 v. 250 mA.	12/11

BATTERY CHARGING EQUIPMENT

ASSEMBLED CHARGERS

6 v. 1 a.....	19/9
6/12 v. 1 a.....	27/9
6 v. 2 a.....	29/9
6/12v. 2 a.....	38/9
6/12 v. 4 a.....	56/9

Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. and packing 3/6.

BATTERY CHARGER KITS Consisting of Mains Transformer F.W. Bridge. Metal Rectifier, well ventilated steel case, Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.

6 v. or 12 v. 1 amp.....	22/9
6 v. 2 amps.....	25/9
6 v. or 12 v. 2 amps. ..	31/6
6 v. or 12 v. 4 amps. ..	53/9

BATTERY CHARGER KIT Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and ammeter. Only 49/9. Post 3/-.

ASSEMBLED CHARGER 6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only **47/9** Carr. 3/6.

All for A.C. MAINS 200-250v., 50 c/s. Guaranteed 12 months

Assembled 6v. or 12v. 4 amps.

Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. **75/-** Ready for use with mains and output leads. Carr. 3/9. Or Deposit 13/9 and five monthly payments 13/9.

AM/FM RADIOGRAM CHASSIS PUSH PULL 6-8 WATTS OUTPUT

Current manufacture. For 200-250 v. mains. Covers L. and M. Wavebands plus F.M. Valve line up: 12AT7, 6BJ6, 12AH8, HABC30, 19A85, 19AQ5, 19AQ5, 35W5. Only 22 gns. plus 7/6 carr. Or deposit £2/12/- and 9 monthly payments of £2/12/-. Guaranteed 12 months.

CO-AXIAL CABLE. 75 ohms. ¼in., 8d. yard Twin screened feeder 11d. yard.

DIAL BULBS. M.E.S., 8 v. 0.2 a., 6/9 doz. 6.5 v. 0.3 a., 5/9 doz. 2.5 v. 0.3 a. 3/9 doz.

ELECTROLYTICS (current production). NOT Ex Govt.

Tubular Types		Can Types	
8 mfd. 450 v...	1/9	16μF 450 v. ..	2/9
8 mfd. 500 v...	2/6	16 mfd. 500 v.	3/9
16μF 350 v...	1/11	32μF 350 v. ..	2/11
16μF 450 v. ..	2/9	32 mfd. 450 v.	4/9
16μF 500 v. ..	3/9	100 mfd. 450 v.	4/9
8-16μF 500 v.	4/11	8-8μF 450 v...	2/11
25μF 25 v.....	1/3	8-16μF 450 v.	3/11
50μF 12 v.....	1/3	16-16μF 450 v.	3/11
50 mfd. 25 v...	1/9	32-32μF 350 v.	4/9
50μF 50 v.....	1/9	32-32μF 450 v.	5/9
100 mfd. 12 v.	1/9	100-100 mfd. 350 v.	5/9
100 mfd. 25 v.	2/3	64-120 mfd. 350 v.	7/6
3,000 mfd. 6 v.	3/9	100-200 mfd. 275 v.	6/11
6,000 mfd. 6 v.	3/11		

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

EX GOVT. STEP UP/STEP DOWN TRANSFORMERS. Double wound 80/100 watts. 10-0-100-200-220-240 v. to 5-0-75-115-125-135 v. or Reverse. Only 11/9, plus 2/9 post. 10-0-100-200-220-240 v. to 9-0-110-122-136-148 v. or Reverse. 200 watts, 35/9 plus 7/6 carr.

EX GOVT. METAL BLOCK PAPER CONDENSERS

4 mfd. 500 v.....	2/3	8 mfd. 500 v.....	4/6
4 mfd. 1,000 v. ..	3/9	10 mfd. 500 v. ..	3/9

OIL FILLED BLOCK CONDENSERS Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

THE SKY FOUR T.R.F. RECEIVER

A design of a 3 valve 200-250 v. A.C. Mains L. & M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, SP61. 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-Point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

5 CORE FLEX. Henleys circular rubber 14/36. Each lead colour coded. 1/6 yard.

EX GOVT. MAINS TRANSFORMERS

230 v. 50 c/s. input 120-0-120 v. 40 mA.	5/9
Pri. 0/110/200/230/250 v. 275-0-275 v. 100m/a., 6.3v. 7 a., 5 v. 3 a.	18/9

HEAVY DUTY OIL FILLED MAINS TRANSFORMERS Suitable welding or soil heating. With input of 200-250 v. 50 c.p.s., output is 12 v. 80-100 amps. Only £6/19/6, carr. 7/6.

EX-GOVT. VIBRATOR UNITS. 12 v. input 280 v. output. Suitable for car radio, etc. 16/6.

MANUFACTURERS SURPLUS TRANSFORMERS. Primary 200-240-250 v. Drop through type 250-0-250 v. 70 mA. 6.3 v. 3 a., 11/9. Postage 2/9.

EX GOVT. SMOOTHING CHOKES

250 mA., 5 H., 50 ohms.	12/9
150 mA., 10 H., 50 ohms.	10/11
100 mA., 10 H., 100 ohms.	6/9
100 mA., 5 H., 100 ohms., Tropicalised	3/11
50 mA., 50 H., 1,000 ohms.	6/9

EX-GOVT. CASES. Well ventilated, black crackle finished, undrilled cover. Size 14—10—8½ins high IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post. Size 13½in. × 8in. × 6½in. with undrilled perforated cover finished in stoved grey enamel, 7/9, plus 2/9 post.

SPECIAL OFFERS. Small 2 gangs .0005 mfd., 4/9. Electrolytics 32-32-32 mfd. 250 v., 2/9 each or in lots of six, 2/3 each.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagrams, 39/9, or ready for use, 46/9.

Type BM2. Size 8 × 5½ × 2½in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2v. ACCUMULATORS** when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions 49/9 or ready for use 59/6.

JUNCTION TRANSISTORS for Audio stages. Only 7/6.
MINIATURE MOTORS. 24/28 v. D.C. or A.C. Size only 2½ × 1½ins. Spindle 1½ins. long, ¼in. diam. Made by Hoover Ltd., Canada. Price only 9/9.
M.E. SPEAKERS. 2—3 ohms R.A. 8in. Field 600 ohms, 11/9.

T.V. CABINETS. For 15 16 or 17in. tube. Table model with doors. 79/6 carr. 7/6.

R.S.C. TRANSFORMERS

FULLY GUARANTEED. INTERLEAVED AND IMPREGNATED.

MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 m.A., 6.3 v. 2 a., 5 v. 2 a.	17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	19/9
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	25/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
250-0-250 v 100 mA. 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300-0-300 v. 100 mA., 6.3 v. 4 v. 4 a. c.t., 0-4-5 v. 3 a.	26/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300v. 130 mA., 6.3v. 4 a., c.t., 6.3v. 1 a., suitable for Mullard 510 Amplifier	33/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t. 0-4-5 v. 3 a.	26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a., suitable Williamson Amplifier, etc.	49/9
450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	69/6

TOP SHROUDED DROP-THROUGH TYPE

260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	22/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v. 4 a., c.t., 5 v. 3 a.	22/9
350-0-350 v. 100 mA., 6.3 v.-4 a. 4 a. c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9

VIBRATORS. Oak and Wearite Synchronous 7 pin 2 v., 7/9, 6 v. 8/9.

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a. ..	5/9	6.3 v. 3 a.	8/11
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/6
0-4-6.3 v. 2 a.	7/9	12 v. 3 a. or 12 v. 1 a.	7/9
		25 v. 1.5 a...	17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 16/9; 0-3.5-9-17 v. 3 a., 17/9; 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s.

120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v. 250 mA.	9/11

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc.	3/6
Small Pentode 5,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000Ω to 3Ω	4/9
Push-Pull 8 Watts 6V6 to 5 ohms.	8/9
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω	15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push Pull EL84 to 3 or 15 ohms.....	16/9
Push Pull 15-18 Watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms....	21/9
Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9

SMOOTHING CHOKES

250 mA., 5 H., 100 ohms.	11/9
150 mA., 7-10 H., 250 ohms.	11/9
100 mA., 10 H., 200 ohms	8/9
80 mA., 10 H., 350 ohms.	5/6
60 mA., 10 H., 400 ohms.	4/11
1 amp. 0.5 ohm. L.T. type	6/6

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

NEW 1957 DESIGN. HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to-follow wiring diagrams. Cover as illustrated 17/6 extra. Only **10** GNS. Carr. 10/-. Or Factory built with 12 months' guarantee **£12/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 35/9** and 9 monthly payments of 28/11.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B., 30-20,000 c/cs., Tone Controls ± 12 D.B. at 50 c/cs., + 12 D.B. to − 6 D.B. at 12,000 c/cs., Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES,** etc. We can supply Microphones, Speakers, 12 v. Rotary Converters, etc., at keen cash prices or on terms with amplifiers.

EXPORT ENQUIRIES INVITED

LT/45 HIGH QUALITY TAPE DECK AMPLIFIER

COMPLETE with POWER PACK and OSC. STAGE. Suitable for Collaro, Lane, Truvox, Aspden, Brennel, etc., etc. State make of Deck when ordering. Chassis size 12-7-3in Overall size 12-7-6¼in. For 200-250 v. 50 c/cs. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum input required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Negative feed-back equalisation. Linear frequency response ±3 D.B. 50-11,000 c/cs. Facilities for recordings at 15in., 7½in. or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. Separate gain and output controls. Valves type ECC83, ECC83, EL84, EZ80, EM34. Output 4 watts. Unit supplied with makers' 12 months' guarantee. We know of no other make which represents the same exceptional value. We can supply Decks and microphones with above at a special inclusive price. Leaflet 6d.

12 Readp for use. GNS. Carr. 7/6.

LINEAR LG3 MINIATURE 3 WATT GRAM. AMPLIFIER

For 200-250 v. 50 c.p.s. A.C. Mains. Overall size only 6¼ × 4¼ × 2¼in. Fitted vol. (with mains switch) and Tone Control. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohms speaker. Guaranteed 12 months Only **49/9** carr. 3/9.

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

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v., 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-**, or assembled ready for use **25/-** extra, plus 3/6 carriage. Or Deposit **22/-** and five monthly payments of 22/- for assembled unit.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit. etc. **ONLY** 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only **£3/15/-**, carr. 3/6 or factory built 22/6 extra. Or Deposit 18/6 and five monthly payments of 18/6 for assembled unit.

P.M. Speakers 3 ohm recommended for use with A7, A5, LG3 or L45 amplifiers.

Plessey 12in 29/11, 6½in. Celestion and Goodmans with high flux density magnet 19/9. 10 × 6in Goodmans Elliptical 27/9.

COLLARO RC457 4 SPEED AUTO-CHANGERS

With studio pick-up with turnover head. BRAND NEW. Cartoned, latest model. For 200-250 v. 50 c.p.s. A.C. mains. Very limited number at only **£8/19/6.** Carr. 5/6.

COLLARO RC54 3 SPEED AUTO-CHANGER

As above unit but for normal 3-speed requirements. Brand new cartoned but for 110 v. 50 c.p.s. A.C. mains. So that the unit can be operated from normal 200-250 v. A.C. mains we are supplying free with every changer a suitable auto-transformer with input and output voltages clearly marked. Limited number only. 7 gns. Carr. 5/6.

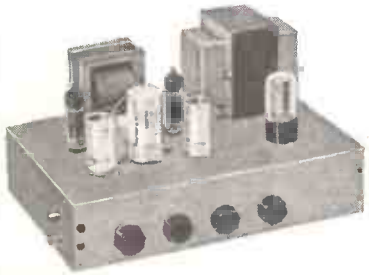
PORTABLE CABINETS. Exceptionally attractive design. Finished in 2 tone rexine. Provision for speaker and amplifier. Inside dimensions 17½ × 12½in. Depth 7in. plus lid 1½in. Carriage 5/-. **59/6** SPECIAL OFFER. Above cabinet, LG3 Amplifier 6½in. speaker, and RC457 changer 14 GNS. Carr. 8/6.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with Garrard, B.S.R. or any other record playing unit. and most microphones. Total negative feedback 12 db. Separate Bass and Treble Controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves used. Size only 6 × 5 × 5¾in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5/19/6.** Or Deposit 22/- and five monthly payments of 22/-. Send S.A.E. for leaflet.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker, of orthodox design, supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Price only **£5/17/6.** Or Deposit 13/- and nine monthly payments of 13/-.

R.S.C. ULTRA LINEAR 12-14WATT AMPLIFIER



NEW 1957 MODEL A11 HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL, PRE-AMP. STAGES

Two input sockets with associated controls allow mixing of "mike" and gram. as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE** "Lift" and "Cut" Frequency response ±3dB, 30-30,000 c/cs. Six negative feedback loops. Hum level 60 dB. down. **ONLY** 23 millivolts **INPUT** required for **FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD** or **LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS,** etc. **OUTPUT SOCKET** with plug provides 300 v. 30 m.a. and 6.3 v. 1.5 a For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-230-250 v 50 c/cs. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Despite improved performance due to use of latest miniature valves price remains as previous model but extra input now standard.

Only **8** GNS. or factory built 45/- extra. Carr. 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 17/6. **TERMS ON ASSEMBLED UNITS. DEPOSIT 25/6 and nine monthly** payments of 25/6.

LINEAR "DIATONIC" 10-WATT HIGH FIDELITY AMPLIFIER. Incorporating pre-amp. For A.C. mains input 200-230-250 v. 50 c.p.s. A compact attractively finished unit with two separately controlled inputs, and outputs for 3 and 15 ohm speakers. Separate Bass and Treble controls. Five latest type miniature Mullard valves. Only 12 Gns. Send S.A.E. for leaflet and credit terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. 24/10/9. Please state whether 3 ohm or 15 ohm required.

P.M. SPEAKERS. 2-3 ohm 5in. Goodmans 17/9. 7 × 4in. Elliptical, 19/9, 6½in. Rola, 19/9. 8in. Rola, 19/9. 10in. R.A., 28/9. 12in. Plessey 3 ohms, 10 watts, 59/6.

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F. and double Diode Second Detector. Delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W., Ch., and Vol. Output will load most Amplifiers requiring 500 m.V. input depending on Ae. location. Only 250 v 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-point wiring diagrams and instructions, 2/6.

RECORDING TAPE. 1,200 ft. Reels Puretone, Medium Coercitivity, 15/9.

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS, 2.

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5s. Open to Callers: 9 a.m. to 5.30 p.m. Saturday until 1 p.m., S.A.E. please with all enquiries.

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NORth 6295/6/7

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SURPLUS—P.N.P.
RED SPOT (Audio/Experimental Applications) ..... 10/- ea.
BLUE SPOT, R.F. up to 1.6 Mc/s. ..... 15/- ea.
WHITE SPOT, R.F. up to 2.5 Mc/s. ..... 20/- ea.
STANDARD—
BRIMAR
T.S.1 ..... 18/- ea.
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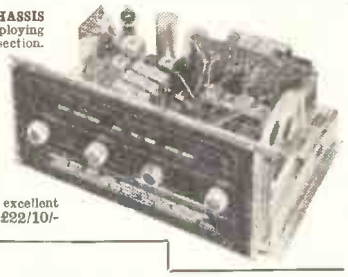
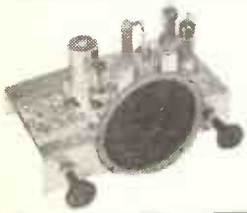
OC70 ..... 21/- ea.
OC71 ..... 24/- ea.
OC72 ..... 30/- ea.
(ALL POST FREE)

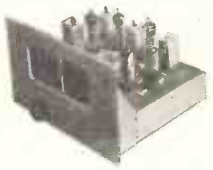
RC4.FAM AM/FM RADIOGRAM CHASSIS A new style AM/FM Chassis employing a printed circuit F.M. Tuner section. Valve line-up: 8 valves: ECC85, 6BA6, 12AH8, 6BA6, 6AL5, 6AT6, EL84, 5Y3. Most attractive dial 12×5¼in. fully illuminated, with figures in green, red and white on black background. Four controls: Tuning, Volume, Wavechange and Tone/On/Off. Dimensions /overall): 13×9×6in. Frequency coverage (four wavebands). 1,000-2,000 m., 200-550 m., 15-50 m., 88-100 mc/s. This is an excellent and very efficient chassis. Price £22/10/- plus 5/-. P. & P





SWITCH TUNED FOUR STATION RECEIVER CHASSIS (Manufacturers' Surplus). A most attractive unit covering 4 pre-set stations in the medium waveband. A complete receiver (less cabinet) including built-in good quality 5in. loudspeaker, and frame aerial. Employs Universal Superhet circuit and miniature valves:—UCH42, UAF42, UL41, UY41. Dimensions (overall):—5×9×5in. For use on AC/DC mains 200/250 v. Absolutely brand new. Few only at £5/5/- plus 2/6 P. & P.

ANNOUNCING OUR NEW F.M. TUNER KIT! (printed circuit). This is our printed circuit version of the Osram 912 F.M. Tuner—using T.C.C. printed circuit and condensers, incorporating 5 valves and two germanium diodes. Attractive black and gold dial, with gold escutcheon plate. Dial aperture only 5 × 2in. Osram F.M. booklet plus our additional instructions and individually priced components list—2/6 post free or the Kit absolutely complete at £8/8/- plus 2/6 P. & P. Alignment service available if required. We are demonstrating at 18 Tottenham Court Road.



THE JASON FM TUNER

Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in mc/s., and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 9in. × 5in. Chassis 7in. × 4¼in. × 1¼in. Complete standard kit £8/15/- plus 2/6 P. & P. Fringe area kit £7/15/- plus P. & P.

DULCI

DULCI H.3 AM/FM Chassis (7 valve). Covering Long, Medium and F.M. bands. Most attractive dial in RED and GOLD on BLACK background. £20/17/- plus 5/- c. & p.

All Dulci products available ex stock. Illustrated leaflets and H.P. terms available.

Demonstrating at Tottenham Court Road!

SPEAKERS & ENCLOSURES

Full range in stock by WHARFEDALE, W.B., T.S.L., etc. Your enquiries welcomed.

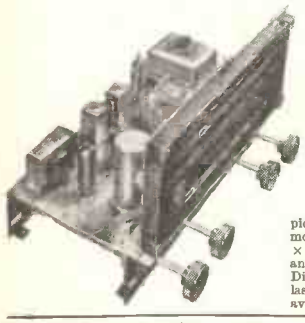
OUR NEW BRANCH IS NOW OPEN AT 162, HOLLOWAY ROAD, LONDON, N.7.

Telephone: NORTH 6295/6/7.

Situated approximately half-way between "Nags Head" and Highbury Corner. One minute from HOLLOWAY ROAD and DRAYTON PARK Tube Stations. Two doors from the NORTHERN POLYTECHNIC.
Early closing Thursday at 1 p.m. Open all day Saturday until 5.30 p.m.
The service that we are noted for at Tottenham Court Road is available! Old and new friends welcome!
ALL MAIL ORDERS and CORRESPONDENCE in future to HOLLOWAY ROAD please.

FM POWER PACK KIT. We can now supply complete kit for power pack suitable for the above F.M. tuner or any other similar type. Price for the complete kit is 37/6 only or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X4 and built on chassis size only 6 × 4 × 1¾in. Optional extra for power pack. Bulgin Octal Plug 2/3.

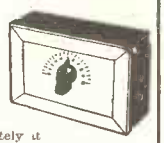
BY LEADING MANUFACTURER!!! *(limited quantity)*
6½" Dual Concentric Cone Loudspeakers. 3-5 ohm speech coil. This is a quality unit at only 35/- each brand new



DULCI F.3.AM. RADIOGRAM CHASSIS

We are very fortunate in being able to offer a further limited quantity of this very popular and efficient chassis at a greatly reduced price.
Specification: Three wavebands, Long, Medium and Short. Valve line-up: X79, 6BA6, 6AT6, EL84, 6X4 (or equiv.). Four controls: Tone, ON/OFF. Volume. Wavechange. Tuning. Output 4 watts matched to 3-5 ohms. Incorporates latest Ferrite Rod Aerial. Input sockets for crystal or magnetic pick-up. Provision for mains supply to gram motor. Overall dimensions 12in. L. × 7in. D. × 7¾in. H. Attractive dial with Red, Gold and Green lettering on Black background. Dial size: 11¼in. × 4¼in. Price, whilst stocks last, only £10/5/-, plus 3/6 P. & P. Terms available.

JUST RELEASED!!!
THE NEW R.C. TRANSISTOR/RECEIVER KIT
This receiver, covering medium waveband, which can be assembled in about 1 hour, will give amazing volume and tonal quality when used in conjunction with a good aerial and earth. Incorporating PNP Transistor and Germanium Diode. For headphone reception.
Included with the kit of parts is a handsome plastic case in black and white, measuring 4¼ × 2¼ × 1¼in. This case accommodates the complete receiver, including battery.
PRICE OF COMPLETE KIT: 25/- plus 1/3 P. & P.
Lightweight high resistance headphones can be supplied separately at 15/- pair. If, however, the kit is purchased complete with headphones this will be supplied at a **SPECIAL INCLUSIVE PRICE OF 37/6** plus 1/6 P. & P.
Optional extra. 100ft. coil single 7/36 coloured P.V.C. covered wire, suitable for both aerial and earth. 2/6 only.



THE TELETRON COMPANION

At last we are able to offer an efficient pocket portable TRANSISTOR receiver. This is a regenerative three transistor unit covering Medium and Long Wavebands. Dimensions only: 4in. × 3in. × 1in. Completely self contained in a smart plastic cabinet. Employs highly efficient Teletron coils and circuitry. Complete set of components with full assembly instructions only 89/6 plus 1/3 p. & p. or all parts sold separately if required.
Instruction leaflet and price list 6d post free!

STOP PRESS!!! By leading manufacturer. AM/FM chassis. Seven valves—ECC85, ECH81, EF85, EABC80, EL84, EZ80, EM81. Covers long, medium, and F.M. bands. Separate bass and treble controls, illuminated volume control on extended lead. Attractive easily read edge lit dial. Incorporates Mullard F.M. tuner section. Overall dimensions: 12" L. × 10" W. × 10" D. Brand new and fully guaranteed. Whilst stocks last only £18/19/6 plus 5/- P. & P. H.P. or Credit Sale Terms available.

JUST ARRIVED! Further limited stocks of Acos HGP37 crystal pick-up insert complete with sapphire styli, suitable for B.S.R. Monarch, etc. Brand new only 18/6 and 9d. P & P.

CONSTRUCTORS NOTE!!
RADIO DATA BOOKS AVAILABLE, i.e. Valve guide, Colour code, etc. Send stamp for list.

Have YOU had a copy of our 109 page comprehensive CATALOGUE? This invaluable publication is only 2/-, post free.

AM/FM KIT

Introducing the JASON AM/FM KIT for medium waves and F.M.!
This is a very high quality chassis incorporating 8 of the latest miniature valves, plus DM70 magic eye. Kits are available for chassis complete with output stage at £15/5/-. Also less output stage but with own built-in power pack at £13/19/6 only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Fully illustrated Data Booklet with full construction details, plus individually priced component list, available per return of post 2/- post free. Both plus 3/6 P. & P.

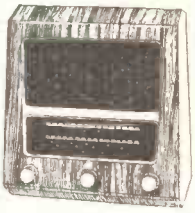
Our advantageous H.P. and Credit Sale terms are available on any single item over £5. Your enquiries invited.

If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

Open: Tottenham Court Road: 9 a.m. to 6 p.m. Mon. to Fri., Sat. 1 p.m. Holloway Road: 9 a.m. to 6 p.m. daily except Thurs., when we close at 1 p.m.

THE FIRST AND STILL THE BEST !!

THE "SUPERIOR FOUR" KIT Our superior four-valve receiver A.C. mains, 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6SG7, 6 X5GT and 6 V6GT. Chassis ready drilled. Cabinet size 10½in. × 10in. wide. Maximum depth at base 5in. tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6 post free. Our price for comolete kit, £6/9/6. Please add 2/6 P. & C. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wave-change switch: dial, pointer, drum pulleys drive spindle, drive spring and knobs, at 45/-, plus 2/6 P. & C. N.B.—Our kits are even supplied with sufficient solder for the job.



THE R.E.P. 1-Valve RECEIVER. All dry battery operation, for use with head phones, the complete kit is available at 42/-, less batteries plus 2/- P. & P. or full instructions at 9d. post free.

VALVES. We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list of brand new imported valve types, fully guaranteed. P.T. paid. Also all usual surplus types available such as 6V6GT, etc.

THE R.C. RAMBLER ALL-DRY PORTABLE KIT Full assembly details with practical and theoretical diagrams, 1/6 post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. Cream plastic top panel, with dial engraved in red and green adds to the very imposing appearance of this model which is housed in attractive cream and grey leatherette covered attache-case type cabinet, measuring only 9in. × 7in. × 5¾in. Weight less batteries 4¼lb., with batteries 6¼lb. This set really has everything. Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up 3V4, 1R5, 1S5, 1T4. The required components, exactly as specified, including cabinet can be supplied from stock at the special inclusive price of £7/7/- plus 2/6 p. and p. (less batteries) Uses Ever-Ready 90 v. H.T. type B126 at 10/-. Also L.T. 1.5 v A.D. 35 at 1/6.

RAMBLER MAINS UNIT. For using our popular all-dry "Rambler" on A.C. Mains. Complete kit, when assembled fits snugly into battery compartment, supplied at 47/6 plus 1/6 packing and postage. Includes all required components, and full assembly instructions. N.B.—This unit is completely self-contained in a metal box measuring 7in. × 2½in. × 1½in. and is ideally suitable for many all-dry battery portables requiring 90 v. H.T. and 1.5 L.T.

IMPORTANT ANNOUNCEMENT. IT HAS BEEN BROUGHT TO OUR ATTENTION THAT THE WORDING OF OUR ADVERTISEMENT ON THE RAMBLER MAINS UNIT IS INCORRECT. THIS UNINTENTIONAL ERROR HAS NOW BEEN CORRECTED AND WE TRUST OUR APOLOGIES WILL BE ACCEPTED FOR ANY MISUNDERSTANDING CAUSED.

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

THE R.C. 2 AMP. BATTERY CHARGER KIT. Includes handsome well-ventilated black stove-enamelled steel box, size: 7¼in. × 3¾in. × 3¼in. Fully shrouded first quality transformer, brand new G.E.C. rectifier. Mains fuse, etc., for charging 6 or 12 v. batteries at 2 amp. Absolutely complete kit with full practical and theoretical instructions. Price 36/6 plus 2/6 P. & P. Can be supplied assembled and tested at 45/- plus P. & P. Heavy duty crocodile clips suitable for car battery lugs, optional extra at 1/6 per pair.

SURPLUS BARGAINS—METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 4in.	M.C.	Rectangular	110/-
50 microamp	D.C. 3½in.	M.C.	F.R.	95/-
100 microamp	D.C. 2½in.	M.C.	F.R.	45/-
200 microamp	D.C. 3½in.	M.C.	F.R.	65/-
500 microamp	D.C. 2in.	M.C.	F.R.	18/6
750 microamp	D.C. 2½in.	M.C.	R.P. (scaled 0-100)	15/-
1 mA.	D.C. 2in.	M.C.	F.R.	17/6
1 mA.	D.C. 2in.	M.C.	F.Sq.	22/6
1 mA.	D.C. 2in.	M.C.	F. Sq. (1954 by Elliott)	25/-
1 mA.	D.C. 2½in.	M.C.	Desk Type	30/-
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
100 mA.	D.C. 2½in.	M.C.	F.R.	10/6
.5 amp	R.F. 2in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2½in.	M.C.	F.R.	10/-
120-0-120 amp.	D.C. 2in.	M.C.	F. Sq. (shunt required)	15/-
150 amp.	A.C. 4in.	M.I.	R.P.	45/-
1 amp.	R.F. 2½in.	Thermo	R.P.	7/6
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
30 amp.	D.C. 2½in.	M.I.	F.R.	12/6
15 volt	A.C. 2½in.	M.I.	F.R.	10/-
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
200 volt	D.C. 3½in.	M.C.	F.Rd.	35/-
300 volt	A.C. 2½in.	M.C.	F.R.	35/-
300 volt	A.C. 3½in.	M.I.	F. Rd.	30/-

SPECIAL U.S. 0-1 mA. 2½in. taken from equipment but perfect, 22/6 each. R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.
METER RECTIFIERS. 1 mA. by G.E.C. at 6/6, also 5 mA. by G.E.C. at 6/6.

THE R.C. 3/4 WATT AMPLIFIER KIT. Compare the advantages. Treble, base AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250 v. Valve line-up: 6V6GT, 6SG7 metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 4in. × 1½in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at £4/5/- only, plus 2/6 packing and post or Instruction Book fully illustrated for 1/-. Post free. This amplifier can be supplied assembled, tested, and ready for use at £5/5/- plus P. & P. Hearing is believing.

VALRADIO T/V TUNER. Limited stocks of this well-known unit available at much reduced price. An ideal prefabricated front end for any superhet T/V receiver with 16 mc/s I.F. Continuously variable tuning covering ALL bands from 40-100 mc/s and 170-225 mc/s. Valve line-up: PCC84, PCF80 (series heaters). Whilst stocks last only £3/19/6 plus 2/- P. & P.

RETURN OF A WINNER !!!

(Exclusive)

We have been most fortunate in obtaining further limited supply of this fine and popular cabinet. Instantly recognised as being of leading High Quality manufacturers stock, this trolley-type cabinet is finished in polished dark solid walnut. Can easily be adapted to accommodate tape recorder, amplifier, radio-gram etc., etc. External measurements: 24½in. × 16in. × 29in. The whole is mounted upon "easy run" castors. Unrepeatable at this price £5/19/6, plus 15/- C. & P.

RC2.A. Small Portable Gram Amplifier. This little Amplifier is built around a Printed Circuit and employs the very latest highly efficient valve type ECL82. It is ideal for use where space is limited. Although of such small size 7in. × 5½in. × 2in. (overall) with a control panel 2¾in. × 1¾in., reproduction is excellent. A wide range tone control is provided. Output approx. 3 watts max. For use on A.C. Mains 200/250 v. NOTE THE PRICE 59/6, plus 2/- P. & P.

RC1.A. AMPLIFIER. A small high quality gramophone amplifier employing the latest circuitry and highly efficient miniature valves. Very neat chassis finished in bronze stove enamel. Size (overall) 5¾ × 4 × 5in. Valves 6X4, ECL82. Output 3 watts max. Controls: Volume, Tone/On/Off. For use on AC mains 200/250 v.

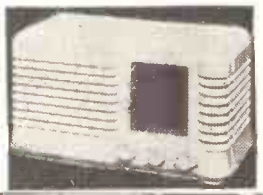
Price £3/19/6 plus 2/- P. & P.

RC3.A. Small 3-Valve Portable Gram Amplifier. An excellent little amplifier for portable gram, giving high quality output. Separate Bass and Treble controls. 2-3 watts output. Valve line-up: EZ80, EL84, ECC83. Provision for mounting 6½in. loudspeaker. Fully isolated from mains 200/250 v A.C. Overall size: 6½in. L. × 5¾in. H. × 2¼in. D. PRICE £3/19/6 (less Speaker and Output Transformers), plus 2/6 P. & P.

RC4.A. (STALLION). This is supplied complete with high flux 8in. P.M. Speaker and Baffle. Incorporating three octal type valves 6Q7, 6V6 and 6X5, this robust and well-made unit is ideal for use in the larger type of record player and is equally suitable for use in conjunction with a radio feeder unit. Separate bass and treble controls are provided: also provision is made for an extension speaker and mains supplies to gram. motor. Output approx. 4 watts. Size overall 13in. × 4in. × 9in. high. For use on A.C. Mains 100/200/250 v. PRICE £5/19/6, plus 2/6 P. & P. H.P. terms £2/19/6 deposit and four monthly payments of 16/6 per month. Fits our portable cabinet "G" at 85/- without modification.

RECORD PLAYER CABINETS—to suit all types of single record and auto-changer units. Priced from 45/-. Send stamp for fully illustrated list.

THE "ECONOMY FOUR" T.R.F. KIT. A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up 6K7, 6J7 and 6V6 Chassis ready drilled. Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown Bakelite or wooden walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/5 post free. This is allowed if kit is purchased later. Plus 2/6 packing and carriage for complete kit.



GRAMOPHONE MOTORS are in SHORT SUPPLY!
COLLARO AC 3/554: Three speed, single player for A.C. mains 200/250 v. cream finish, complete with turnover crystal pick-up incorporating the well-known high output "T" type head. Strictly limited quantity at £6/19/6 plus 3/6 p. and p.

FOUR-SPEED CHANGERS
Collarc RC456 Mixer Auto-Changer in cream with Studio "O" insert. £9/15/- B.S.R. Monarch Mixer Auto-Changer, in cream and gold. £8/15/-. Both plus 3/6 p. and p. H.P. Terms available. Stocks rapidly diminishing.

THE STAAR "GALAXY"
Four speed Mixer Auto-Changer. Fingertip stop, start and speed change control. Modern duo-tone finish. Beautifully made and moderately sized to fit almost any cabinet. For A.C. mains operation 110-250 v. Price: £12/16/3 inc. plus 3/6 C. & P.
Also available ready mounted on playing desk. For A.C. mains operation 200-250 v. Price £14/3/11 inc. plus 3/6 C. & P. Both brand new, boxed and fully guaranteed.

RECORDER AMPLIFIER
(Well known manufacturer's surplus). This is a brand new amplifier designed for use with a famous wire recorder. A simple modification is all that is required to make this unit ideal for use with any Tape Deck. Specifications: Valve line-up 7C5, 2AU7, 6BE7, 6BR7, 6X4. Neon Record Level Indicator. Controls: Volume/Record Level. Tone Control, Record/Playback Switch. High and Low level inputs for Mike and Radio. External Speaker Socket. Built-in 5in. Loudspeaker with High Flux magnet: Separate Power Pack. Dimensions: Amplifier 5¾in. H. × 11¼in. W. × 2¾in. D. Power Pack: 6¼in. × 6in. × 5in. High (overall). Full modification details are supplied. Price £8/19/6. P. & P. 3/6.

10in. CABINET SPEAKER. Ideal for P.A. etc. Comprises solid wood cabicet complete with carrying handle. Painted dark brown, with built-in good quality 10in. P.M. speaker, 3 ohm speech coil, complete with lead and Igranic Jack plug. Brand new. Price only 45/-, plus 3/6 P. & P.

CLYNE RADIO LTD.
18, Tottenham Court Road, London, W.1
And at
162, Holloway Road, London, N.7.

LOOK! THOUSANDS OF BARGAINS AVAILABLE WHICH WE ARE UNABLE TO ADVERTISE. IT IS WORTH YOUR WHILE TO PAY US A VISIT

SMOOTHING CHOKE BARGAINS

4H. 22.5 mA.	4/6	10H. 120 mA.	8/6
8H. 50 mA.	5/6	15H. 60 mA.	5/6
8H. 250 mA.	10/6	15H. 300 mA.	10/6
9H. 100 mA.	7/6	20H. 120 mA.	10/6
10H. 60 mA.	4/6	30H. 30 mA.	3/6

Collins potted choke 8H. 100 mA. 8/6
Bargain Parmeko choke 5H. 200 mA. 5/6
Rich and Bundy choke 50H. 120 mA. 15/6
Swinging choke 8/40H. 30/300 mA. 10/6
Swinging choke 3.6/4. 2H. 250 mA. 10/6
P.P. under 10/- 1/3, over 10/-, 2/-.

8 MFD. PAPER CONDENSERS. Brand new T.C.C. visconol type. 750 volts working 5/6 each. P.P. 1/-.

CONVERTOR TRANSFORMERS. Midget. Input 220/240 volts. Output 220 volts 25 mA., 6.3 volts 1 amp. New, 10/6. P.P. 1/-. Midget contact rectifier to suit, 7/6. P.P. 6d.

DYNAMO EXPLODER UNITS

Used for detonating explosive charges. Operation is by hand generator, giving 1,800 volts D.C. across output terminals. Ideal also for use as photo flash generator. Brand new only £3/19/6 each. P.P. 5/-.

CHARGING AND MODEL TRANSFORMERS.
1. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 1 amp., 9/9
2. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 2 amp., 14/3.
3. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 4 amp., 16/6
4. Pri. 200/250 v. Sec. 6.3 v. 3 amp., 8 v. 1.5 amp. 9/6.
5. Pri. 200/250 v. Sec. tapped, 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volt 2 amp., 18/6. Postage 1/6 all types.

L.T. METAL RECTIFIERS. Full wave and bridged. 12 v. 1 amp., 6/3; 12 v. 2 amp., 9/3; 12 v. 4 amp., 13/9; 24 v. 1 amp., 12/6; 24 v. 4 amp., 22/6. P.P. 1/- all types.

0-1 MA. METERS

Brand new moving coil meters, round flush mounting with 2½in. scale, calibrated 0/300 volts. Resistance 100 ohms. Supplied complete with rectifier. 25/- each. P.P. 1/-.

AMERICAN BD-91 SWITCHBOARDS. 25 line, complete with automatic ringer and seat, etc., brand new, £50. P.P. £2.

INSTRUMENT POTENTIOMETERS. Brand new Colvern type. 100,000 ohms, 10 watts, 3½in. dia. Ideal for bridges, etc., 10/6. Ditto twin gang 5,000 ohms, 10/6. P.P. 1/-.

INSTRUMENT TRANSFORMERS. Parmeko. Input 230 volts. Output H.T. 195 volts 85 mA. tapped 130 v. and 65 v. L.T. 6.3 v. 5 amp., 6.3 v. .3 amp. Brand new, 14/6. P.P. 1/6.

ADMIRALTY 12 VOLT D.C. MOBILE AMPLIFIERS

Separate mic. or gram. inputs. Output 10 watts, matched, 3, 15 or 600 ohms. Not new, but all tested, £8/19/6 each. P.P. 5/-.

SOUND POWERED BALANCED ARMATURE EARPIECES. Brand new, 3/6 each. P.P. 9d. inserts only, 1/9. Brand new sound powered handsets, 19/6 each. P.P. 1/-.

G.P.O. BELL UNITS. Supplied brand new complete with 2 bells, induction coil, etc., 7/6 each. P.P. 2/6.

BARGAIN GRAM MOTORS

Garrard centre drive motors complete with turntables. 200/250 volt A.C. Adjustable mechanically from 0 to 45 r.p.m. Only 22/6 each. P.P. 3/-.

TRANSMITTER/RECEIVER No. 19 MK. II COMPLETE KITS

Brand new in original transit cases. Equipment comprises TX/RX, 12 volt rotary power pack, variometer, control boxes, all necessary connecting leads, aerial base and mounting platform. For R.T. or C.W. frequency coverage A set, 2 to 8 mc/s. B set, 229 to 241 mc/s and intercom system. Complete with 15 valves and tuning meter. Only £11/19/6 each. P.P. £2.
Also available transmitter/receiver complete with power pack only, in very good condition, £5/10/- each. P.P. 15/-.

CHEAP "C" CORE TRANSFORMERS

Wonderful offer. Made to highest specification, fully potted, hermetically sealed, ceramic terminations, fully tropicalized. **ALL BRAND NEW.**
1. 230 v. primary. Sec. 510/0/0510 v. 300 mA. 375/0/375 v. 100 mA. 6.3 v. 9 a. 2 × 6.3 v. 2 a. 2 × 6.3 v. 1 a. 6.3 v. 1.5 a. 6.3 v. .5 a. 5 v. 3 a. 82/6. P.P. 5/-.
2. 230 v. primary. Sec. 360/0/360 v. 200 mA. 360/0/360 v. 65 mA. 6.3 v. CT. 5 a. 6.3 v. CT. 2 a. 6.3 v. 5 a. 5 v. 4 a. 5 v. 3 a. 65/-. P.P. 4/6.
3. 230 v. primary. Sec. 350/0/350 v. 400 mA. 25 v. 1 a. 21 v. .5 a. 6.3 v. 5 a. 6.3 v. 1 a. 5 v. 4 a., 75/-. P.P. 5/-.
4. 230 v. primary. Sec. 665/0/665 v. 50 mA. 800 v. 5 mA. 4 v. 4 a. 2 v. 1.5 a., 42/6. P.P. 2/6.
5. 200/250 v. primary. Sec. 350/0/350 v. 180 mA. tapped 250 v. 6.3 v. 1.5 a. 5 v. 3 a. 12/6. P.P. 2/6.
6. 115/230 v. primary. Sec. 430/0/430 v. 200 mA. common tapping 950 v. 5 mA. 35/-. P.P. 2/6.
7. 200/250 v. primary. Sec. 250/0/250 v 50 mA. 6.3 v. 1 a. 19/6. P.P. 1/6.
8. 230 v. primary. Sec. 3,850 v. 5 mA. 4 v. 2.5 a. 4 v. 1 a. 52/6. P.P. 3/-.
9. 230 v. primary. Sec. 1,250/0/1,250 v. 5.5 mA. 6.3 v. 1 a. 6.3 v. 1 a. 4 v. 1 a., 42/6. P.P. 2/6.
10. 230 v. primary. Sec. 2 × 6.3 v. 5a. 2 × 6.3v. 1a. 35/-. P.P. 2/6.
11. 230 v. primary. Sec. 2 × 6.3 v. 0.75 a. 2 kv., 12/6. P.P. 1/3.
12. 230 v. primary. Sec. 6.3 v. 5 a. 6.3 v. 4 a. 2 × 6.3 v. 3 a. 6.3 v. 2 a. 6.3 v. 1.5 a. 6.3 v. 1 a., 45/-. P.P. 3/-.
13. 230 v. primary. Sec. 3 × 6.3 v. 3 a. 6.3 v. 1.5 a., 32/6. P.P. 2/6.

Many other types in stock.

As above specification but not C core.
1. 200/250 v. primary. Sec. 330/0/330 v. 180 mA. 2 × 6.3 v. 2 a. 5 v. 3 a., 42/6. P.P. 3/-.
2. 230/250 v primary. Sec. 2 × 350/0/350 v. 52 mA. 4 × 55 v. 30 mA. 2 × 5 v. CT. 3 a., 39/6. P.P. 3/-.

AMERICAN MINE DETECTORS. Model SCR-625C. Completely portable, battery operated and complete with instructions. Can be used to detect any hidden metals. Supplied in perfect condition. £12/10/- each. P.P. 10/-.

EDDYSTONE POWER UNITS. S441B. 200/250 watt A.C. input. Output 300 volts 200 m/a. and 12 volts 3 amps. Double choke and condenser smoothed. Uses 5U4 rectifier. Housed in compact grey metal case. Supplied in perfect condition. 49/6. each. P.P. 7/6.

EX-NAVY SOUND POWERED TELEPHONES

This type requires no batteries to operate and can be fitted in moments. Uses hand generator for calling, giving an extremely loud buzzing note, and also a neon indicator. Ideal for field activities, factories, office, etc. Only 45/- each. P.P. 4/6.

METER BARGAINS

50 microamp 2½in. Pj. M.C.	49/6
100 microamp 2½in. FM. M.C.	39/6
200 m/amps. 2½in. FM. M.C.	9/6
1 amp. RF. 2½in. Pj. T.C.	5/-
300 volt A.C. 2½in. FM. M.I.	25/-
1.5 amp. A.C./D.C. 2in. FM. M.I.	6/6
500/0/500 microamp 2½in. FM. M.C.	25/-
20/0/20 amp. Lucas car type	8/6
2ma. meter rectifiers, STC	5/6

MAINS VOLTAGE REGULATOR TRANSFORMERS. Will give variable output from 185 watts to 250 watts at maximum current of 25 amps. Supplied in good condition. £15 each. P.P. 10/-.

UNISELECTOR SWITCHES. Standard P.O. type. Double wipers, 25 positions. 4 bank, 35/-. 8 bank, 52/6. Postage 1/-.

CHEAP MAINS TRANSFORMERS. Standard replacement type. Pri. 200/250 v. Sec. 250/0/250 v. 80 mA. 6.3 v. 4a. tapped 4 v. 5 v. 2 a. Tapped 4 v. Brand new, 18/6, Ditto 350 v. 18/6. P.P. 1/6.

CHEAP P.M. SPEAKERS. All new and unused. 3 ohm coils.

Plessey 2½in.	16/-	Elac. 10in.	27/6
Goodmans 3½in.	17/6	Plessey 12in.	32/6
Elac 5in.	17/6	Elac 7 × 4in.	18/6
Elac 6½in. ...	17/6	Plessey 10×6in	27/6
Elac 8in.	19/6	Std. O/P tr.	3/9

Postage under £1 1/3 over 2/-.

MINIATURE SLOW MOTION DRIVES

Dia. 1¾in. Scale 0-100, for ¼in. spindle. Complete with locking device. Brand new, 7/6. P.P. 1/-. Large. type available as above 7/6.

VOLTAGE REGULATOR TRANSFORMER. Input 220 volts. Output variable from 200 to 240 volts 7.5 amps., 87/6 each. P.P. 5/-.

A.C. MAINS POWER PACKS. Input 230 v. Output 250 v. 50 mA. 6.3 v. 2 a. fully smoothed, 5Z4 rectifier. Housed in metal box with other useful gear including, 2XEF50, VR137, EA50, and Y65. 32/6 each. P.P. 3/-.

4 SPEED RECORD CHANGERS

Brand new B.S.R. 4 speed changers, UA8 £8/12/6.
Brand new COLLARO RC546. 4 speed changers, £8/15/-. P.P. 3/6.

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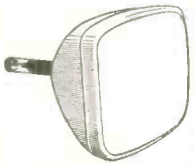

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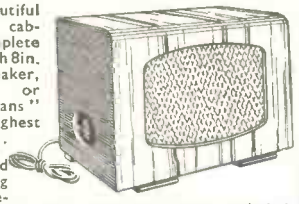

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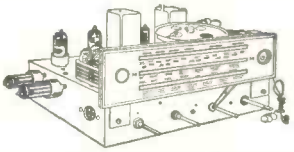

8 valve, uses 2-EL42, 2-EBF80, ECH81, EBC41, EZ80, EM34. Latest models. 3 wave band and gram. Switched. Over 10 watts output. Full tone range. 4 knob control. Size 12in. x 7½in. x 7¼in. Less valves. Ins., carr. 5/6.

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Complete with valves. Telescopic aerial. Instruction booklet FREE with each order. Ideal for Walkie-Talkie conversion. Test set 172A. Ex-W.D. P. & P. 4/6.

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Single earphone and headband. C-LR. Ideal for crystal sets, extension on radio, etc. P. & P. 1/3.

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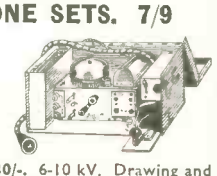

Ex-W.D. Wireless remote control unit. E.MK.II. New condition. Morse tapper, switched, jack plugs etc., less phone. P. & P. 3/6.

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Complete chassis by famous manufacturer. R.F. EHT unit included. Drawing 2/6 or FREE with order. Chassis in 3 separate units (Power, s/vision, time base interconnected). These chassis can easily be fitted into existing console cabinets. Less valves and tube. Channels 1-2, 3-5. Easily converted to I.T.A. Ins., carr. 10/6.

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Latest improved circuits. Higher E.H.T. (brilliant picture). Improved sensitivity (for greater range). Chassis easily adapted to any cabinet. As supplied to many well known Rental and Hire Cos. 17in. RECTANGULAR tube on adapted chassis. All channels. Valve line up (5 valves) 6SN7, 6V6, EY51, two 6D2s.

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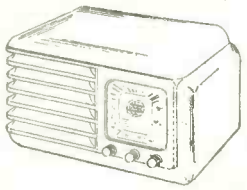
A.C./D.C. MIDGET RADIO. 99/6



5 valve, CCH35, EF39, EBC33, CL33, 35Z4 or metal rec; 3 control knobs. Switched for gram. In attractive brown plastic cabinet. 15 x 7½ x 9in. Ins., carr. 4/6.

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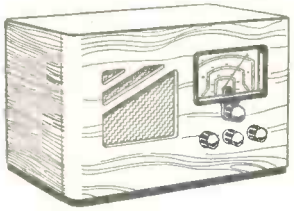

5 valve (octal) s/het, 3 w/band receiver. A.C. Gram., P.U. sockets. In wooden cabinet, 18½ x 11½ x 8½in. Ins., carr. 7/6.

RADIOGRAM CHASSIS. 39/9

3 w/band and gram. s/het, 5 valve (octal). Ideal for table gram., giving high quality output, 4 knob control. 8in. P.M. speaker, 7/9 with order. Set of knobs 2/-. Chassis 12 x 6 x 7¼in. Ins., carr. 4/6.

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350-0-350 v. 80 m.a. 4 v., 4 v. heaters. 200-250 v. prim.	3/9
350-0-350 v. 80 m.a. 4 v., 12 v. heaters, 200-250 v. prim.	2/9
280-0-280 v. 80 m.a. 6 v. 2 a., 4 v. 2 a., 4 v. 2 a. 200-250 v prim. Drop through, half shrouded (All above 2/3 post.)	5/9
425-0-425 v. 5 v. at 6 a., 6.3 v. at 12 a., 6.3 v. at 6 a. 200-250 v. screened primary. (P. & P. 2/6)	17/6
0-200-250 v. heater transformer. 4 v. at 2½ amp. (P. & P. 1/9)	8/9
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3 Light Lounge Fitting, with flex and lamp holders and 3 shades in glass or plastic. Special purchase makes us able to sell at this very cheap price. P. & P. 2/9.

Boxed VALVES 3 months' guarantee

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6H6M	1/9	210VPT	3/9	EF50	2/9	PP225	3/9
6N7GT	4/9	7193	3/9	EL32	6/9	RL37	1/9
6B8G	3/9	AR6	1/9	KTW61	5/9	VR21	1/9
6SG7	3/9	CV188	3/9	L410	1/9	VW48	9d.
8D2	3/9	EB34	1/9	LP220	1/9	EF37	4/9
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50 Microamp.	D.C. M/C	2½in.	Flush circ., scaled 0-100	59/6
100 Microamp.	D.C. M/C	2½in.	Flush circ., scaled 0-1,500	39/6
500 Microamp.	D.C. M/C	2in.	Flush circular	17/6
500-0-500 Micro-amp.	D.C. M/C	2½in.	Flush circular, scaled 100-0-100 V.	25/-
1 Milliamp.	D.C. M/C	2in.	Flush square, Fe/NFe	22/6
150 Milliamp.	D.C. M/C	2in.	Flush square	7/6
200 Milliamp.	D.C. M/C	2½in.	Flush circular	10/6
1 Amp. Thermo-couple		2½in.	Projecting circular	6/9
4 Amp. Thermo-couple		2in.	Flush square	6/9
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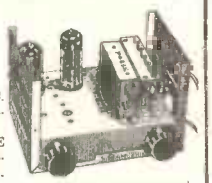

Complete with built-in power supply, 230-250 v., A.C. mains. Case 5¾in. long, 3¾in. wide, 4¼in. high. Incorporating gain control and band switch.

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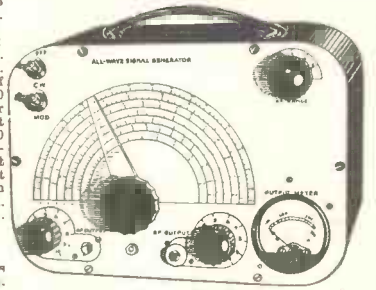

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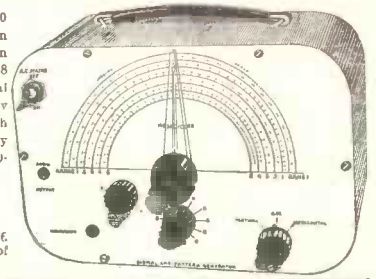

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Approx. size 6½ × 2½ incorporating 2 valves, contact-cooled metal rectifier, bass and treble lift controls and double wound mains transformer **39/6** Plus P. & P. 3/6. 230-250 v. .....

5" P.M. SPEAKER AND O.P. TRANSFORMER

if purchased with the above **18/6**. Plus P. & P. 1/6.

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Model 456. A.C. Mains 200/250v. Turnover crystal head. Brand new. Fully guaranteed. (Suitable for use with above amplifier.) P. & P. 5/-. **£8.19.6**

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Comprising 2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-10. 0-100 and 0-500. Milliamps 0-10, 0-100; ohms 0-10,000. Front panel, range switch, wire wound pot (for ohms zero setting), two toggle switches, resistors and meter rectifier.

Complete in case, grey hammer finish. **19/6** P. & P. 1/6.

Point to point wiring diagram 1/-, free with kit.

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incorporating ferrite rod aerial

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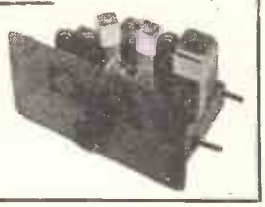
JASON F.M. TUNER UNIT 87-105 m/cs

F.M. TUNER-UNIT (87 mc/s—105 mc/s) by Jason. As described in Radio Constructor. Designer Approved Kit of parts to build this modern highly successful unit, drilled chassis and superior type dial as illustrated, coils, cans and all quality components, etc., for only 5 Gns., post free. Set of 4 spec. EF91 or equiv. valves 30/-, post free. Illustrated handbook with full details, 2/-, post free. Free with Kit. 48-hr. Alignment Service, 7/6 and 2/- p.& p.



ELECTROLYTICS ALL TYPES NEW STOCK

TUBULAR		CAN TYPES	
25/25 v., 50/12 v.	1/9	8+8/450 v.	4/6
50/50 v. 4/500 v.	2/-	8+16/450 v.	5/-
100/250 v.	1/9	8+16/500 v.	5/6
8/450 v.	2/3	16+16/450 v.	5/6
8/500 v.	2/9	16+16/500 v.	6/-
8+8/500 v.	4/6	16+16+8/350v.	5/6
8+16/450 v.	5/-	32+32/350 v.	5/6
16/450 v.	3/6	32+32/275 v.	4/6
16+16/450 v.	5/6	50+50/350 v.	6/6
32/350 v.	4/-	60/350 v.	6/6
32/500 v.	5/-	60+250/275 v.	12/6
32+32/350 v.	5/6	64+120/275 v.	11/6
32+32/450	6/6	100+200/275v.	12/6
		100/270 v.	6/6

MIDGET TRANSISTOR TYPES. 2μF, 4μF, 8μF, 6V, 3/9; 6μF, 10μF, 16μF 3V, 3/9; 32μF 1½V, 3/9

CONDENSERS.—Mica, Silver Mica. All pref. values, 3 pf. to 1,000. pf. 6d. each. Ditto ceramics 9d. each. Tubulars, 450 v. Hunts and T.C.C. .001 mfd.-.01 and .1/350 v., 9d. each. .02-1/500 v., 1/- each, .25 Hunts, 1/6. .5 Hunts, 1/9. .001 mfd. 6kv. 5/6. .001 mfd. 20kv. 9/6.

CLOSE TOLERANCE CONDENSERS S/Mica. 10% Type, 5 pf.—500 pf., each 1/-; 600 pf.—5,000 pf., each 1/3.
1% Type, 1.5 pf.—50 pf. (Tol. 1 pf.), 1/9; 56 pf.—500 pf., each 1/9; 575 pf.—5,000 pf., each 2/-.

RESISTORS.—Pref. values 10 ohms 10 megohms.

CARBON		WIRE-WOUND	
20% Type, ½ w., 3d.; ¼ w., 5d.; 1 w., 6d.; 2 w., 9d.		5 w.	25 ohms—1/3
10% Type, ½ w., 9d.;		10 w.	10,000 1/6
5% Type, ½ w., 1/-;		15 w.	ohms 2/-
1% Hi-Stab. ½ w. 2/-		5 w.	15,000— 1/9
WIRE-WOUND POTS		10 w.	33,000 ohms 2/3

Pre-Set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto, Carbon Track 50 K., to 2 Meg., 3/-.

3w. LAB. COLVERN, Etc. Standard Size Pots 2½in. Spindle. High Grade. All Values. 100 ohms to 50 K., 5/6; 100 K., 6/6. W/W EXT. SPEAKER CONTROL, 10 Ω 3/-

SENTERCEL RECTIFIERS. E.H.T. Type, Fly-Back Voltages. K3/25 2 kV., 5/-; K3/40 3.2 kV., 6/9; K3/45 3.6 kV., 7/3; K3/50 4kV., 7/9; K3/100 8 kV., 13/6, etc. MAINS TYPES.—RM1 125 v. 60 mA., 4/9; RM2 125 v. 100 mA.,; 5/6 RM3 125 v. 120 mA., 7/6; RM4 250 v. 250 mA., 16/-; RM4B type 270 mA., 17/6.

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

TYGAN FRET (Murphy pattern) 12in. × 12in., 2/-; 12 × 18in., 3/-; 12 × 24in., 4/-, etc

NEW BOXED VALVES ALL GUARANTEED

1R5, 1T4	7/6	EABC80	9/6
1S5, 1S4	7/6	EB91	6/6
3S4, 3V4	8/-	EBC33	8/6
5Z4	9/6	EBC41	10/6
6AT6	8/6	ECC84	12/6
6K7	6/6	ECF80	12/6
6K8	8/6	ECF82	12/6
6Q7	8/6	ECH42	10/6
6SN7	8/6	ECH81	10/6
6V6	7/6	ECL80	10/6
6X4	7/6	EF41	10/6
6X5	7/6	EF80	10/6
7C5	9/-	EF86	12/6
7Y4	8/6	EF91	8/6
DAF96	9/-	EM85	11/6
DF96	9/-	EL41	10/6
DK96	9/-	EL84	11/6
DL96	9/-	EY51	10/6
35L6	10/6	EZ40	8/6
		EZ80	8/6
		MU14	9/6
		PCC84	10/6
		PCF80	10/6
		PCF82	10/6
		PCL83	12/6
		PL81	11/6
		PL82	10/-
		PL83	11/6
		PY80	9/6
		PY81	9/6
		PY82	8/6
		U22	8/6
		UBC41	9/6
		UCH42	10/6
		UF41	10/-
		UL41	10/6
		UY41	8/6

SPECIAL PRICE PER SET
1R5, 1T4, 185, 1S4, or 3S4, or 3V4 27/6
DK96, DF96, DAF96, DL96 .... 35/-
6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5.. 35/-

TRANSISTORS. Mfrs. surplus PNP Junction type. Audio Type, 800 kc/s 250mW, 9/6; R.F. and I.F. Mixer Type, 2.5 Mc/s, 19/6. All tested and guaranteed.

Vol. Controls

Log. ratios, 10,000 ohms—2 Megohms. Long spindles. 1 yr. guarantee. Midget Ediswan type. No. Sw., 3/-; S. P. Sw., 4/-; D.P. Sw., 4/9. Linear Ratio, 10,000 ohms—2 Megohms. Less switch, 3/- each. Coax plugs 1/2. Coax sockets, 1/-. Couplers 1/3. Outlet boxes, 4/6.

80 ohm CABLE COAX

STANDARD ¼in. diam., Polythene insulated. GRADE "A" ONLY.

8d. yd.

SPECIAL—Semi-air spaced polythene. 80 ohm Coax ¼in. diam. Standard core. Losses cut, 50%. **9d. yd**

IDEAL BAND 2/3.

TRIMMERS, Ceramic, 4 pf.—70 pf., 9d.; 100 pf., 150 pf., 1/3; 250 pf., 1/6; 600 pf., 1/9. PHILIPS Beehive Type—2 to 8 pf. or 3 to 30 pf., 1/- each.

LOUDSPEAKER.—PM. 3 ohm., 2½in. Elac., 17/6; 3½in. Goodmans, 18/6; 5in. R. and A. 16/6; 6in. Celes., 18/6; 7 × 4in. Goodmans Elliptical 18/6; 8in. Elac., 20/-; 10in. R. and A., 25/-; 10in. WB-HF1012. 99/9; 12in. Plessey 15 ohm with 6 × 4in. Tweeter and Cross Over Filter, 97/6.

TRS RADIO COMPONENT SPECIALISTS

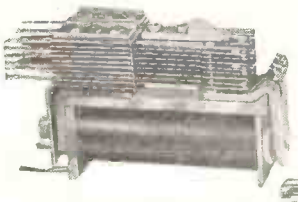
70 BRIGSTOCK RD., THORNTON HEATH, SURREY

Phone: THO 2188. Hours 9 a.m.—6 p.m., 1 p.m. Wed. Open all day Saturday. By THORNTON HEATH STATION.

TRANSFORMER & COIL/WINDING CAPACITY AVAILABLE FOR PROTOTYPES & SMALL RUNS.

Terms: C.WO. or C.O.D. Kindly make cheques, P.O.s, etc., payable to T.R.S. Post and Packing up to ½lb 7d., 1lb. 1/1, 3lb. 1/6, 5lb. 2/-, 10lb. 2/9. Bargain Lists. 3d.

RELAYS P.O. TYPE 3000.



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CONTACTS UP TO 8 CHANGE OVER

KEY SWITCHES

PROMPT DELIVERY ALL TYPES UP TO 4co/6co

METERS GUARANTEED

F.S.D.	Size	Type	Price
100 Microamp	2½in.	MC/FR	50/-
250 Microamp Multi-Sc.	3½in.	MC/FR	55/-
500 Microamp Sc. 15Kv.	2in.	MC/FR	18/6
1 Milliamp	2in.	MC/FS	27/6
5 ,,	2in.	MC/FR	17/6
30 ,,	2½in.	MC/FR	12/6
100 ,,	2½in.	MC/FR	12/6
20 Amp.	2½in.	MI/FR	25/-
25 ,,	2½in.	MI/PR	7/6
50 ,,	5in.	MI/PR	60/-
50-0-50 Amp.	2in.	MC/FS	12/6
20 Volt	2in.	MC/FS	10/6
250 ,,	2½in.	MCR/P	30/-
300 Volt A.C.	2½in.	MI/FR	25/-
300 ,, A.C.	5in.	MI/PR	60/-

CROSS POINTER METERS. With 2 separate 100 microamp movements. Brand new. **22/6,** post 2/-.

METER RECTIFIERS. Full wave bridge 1 m/a or 5 m/a. **7/6** each. 50 m/a **5/-** each, post 6d.

CIRCUIT TESTER in wood case 9in. × 6in. × 4in. 2½in. Flush Round meter, 50 milliamps, basic movement 10 M/A with leads, 10Ω potr. provision for 1.5 v. batt. Ideal for conversion, **17/6,** post 2/6.

TELEPHONES—SOUND POWERED—NO BATTERIES REQUIRED. Just connect with twin flex for clear speech. Transmitter/receiver units **4/6** ea. Twin flex **4½d.** yard. Post 1/-.
If 2 units are connected in series and one used for speaking and one for listening, perfect 2-way conversation can be made.

TELEPHONE SETS. For perfect communication between 2 or more positions. Wall Type, one, pair of units, **£5.** Batteries **5/6.** Twin wire **5d.** yard. Desk Type, now available, latest modern style. Two complete units ready for use, **£8/17/6.** Wire **5d.** per yard. Post 3/-.

ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Far. 250 v. 10 amp. A.C. Ideal for greenhouses, etc., **35/-.** Post 2/-.

CONDENSERS METALMITE. 350 vt. wkg., .001, .002, miniature, **12/-** doz. .005, .01, .02 **10/-** doz. .05 **12/-** doz. .1 **13/6** doz. .25 Metalpack **16/-** doz. 1.0 Metalpack **24/-** doz. Post 1/-.

BATTERY CHARGERS
Ideal for charging 24 volt batteries on electrically propelled vehicles. Rating 22 v. 10 amps., controlled by two 4-position rotary switches for fine and coarse control which enables 6/24 vt. Batts. to be charged. Input 200/250 v. A.C. 50 cy., fused for A.C. and D.C. Brand new **£17/10/-.** Carr. 15/-.

CHARGING RECTIFIERS. Full wave Bridge 12 volts 2 amps., **13/6,** 4 amps., **22/6,** suitable transformers 2 amp., **24/-,** 4 amp., **27/3,** post 2/-.

JACK PLUGS. Cylindrical bakelite screw on cover. 2 Contact. Ideal for amplifiers etc., **2/6** each, **24/-** doz., **£9** per 100.

AIR BLOWERS. 230 vt. A.C. .57 h.p. 15in. fan, 6in. outlet. Brand new **£25.** Carriage in England 20/-.

PORTABLE BLOWERS. 200/250 v. AC/DC 300 watts with switch and leads, 1¾in. outlet. **£5,** carr. 7/6.

VOLTAGE REGULATORS. Input 230 v. A.C., 21 amp. Output5 7.5 v. to 228 in 16 steps with current limiting reactor. These variable transformers are brand new and not removed from equipment. **£12/10/-** each, carriage 10/-.

ROTARY CONVERTERS. Input 24 volt D.C. Output 230 volt A.C., 50 cy., conservatively rated at 100 watts. **92/6.** Also available in a strong ventilated metal case with switch, input plug and output socket. **105/-,** carr. 7/6.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base, 4ft. 10in. also in stock.

PHOTOMULTIPLIER No. 931A. Ideal for film scanning, spectography. Alpha counting, colorimetric measurement, etc., supplied complete in light proof chamber with lamp, wired with the resistor network. **70/-.**

VERNIER DRIVES. Muirhead scaled 0/180 deg. Ratio 38 to 1. Diam. 3in. **10/6.** Post 1/6.

RADIO ACTIVITY MEASURING INSTRUMENTS. Philips Type 1092c. A portable self-contained unit in haversack. Scaled 0 to 10 millirontgens per hour, using Mullard Geiger Counter MX115. **£25.**

HEADPHONES. Balanced Armature Type DHR. **17/6** per pair, post 1/6.

HEADPHONES. High resistance 4,000Ω Type CHR, new. **12/6** pair, post 1/6.

VENT-AXIA FANS—EXTRACTION OR INTAKE. 230/250 volts A.C. 6in. diam. blades **130/-.** 12 volt D.C. **90/-,** post 2/9.

RATIO ARM UNITS. Sullivan. 600 ohms + 600 ohms. **50/-,** post 2/-.

WHEATSTONE RESISTANCE BRIDGE. 1 to 10,000 ohms. Plug type, **£5.**

SWITCHES. 1 hole fixing, 3 amp. 250 vt. Single Pole change over. **1/6** each, **12/-** doz. **£37/10/-** per 1,000.

L. WILKINSON (CROYDON) LTD.

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RADIO TRADERS LTD.

23 WARDOUR ST., LONDON, W.1 (Coventry Street end)

Phone No. GERrard 3977/8 *Grams: "Radiotrade"*

SPECIAL OFFER OF CURRENT MANUFACTURE ELECTROLYTIC CONDENSERS
8 mfd. 450 v. **2/6** each; 16 mfd. 450 v. **3/-**; 32 mfd. 450 v. **4/-**; 8 x 8 mfd 450 v. **3/9**; 8 x 16 mfd. 450 v. **4/-**; 16 x 16 mfd. 450 v. **4/6**; 32 x 32 mfd. 350 v. **5/-**. Bias Condensers: 25 mfd. 25 v. **1/6**; 50 mfd. 50 v. **1/9**. Please note we can offer special discounts for quantities.

W.W. RESISTORS. 5 watt **1/6**; 10 watt **2/6**; 15 watt **3/-**; 20 watt **3/6**. We carry stocks of resistors from 2 watt to 150 watt W.W. Your enquiries invited.

HIGH STABILITY RESISTORS. ¼ watt 5% **6d.**; ½ watt 5% **9d.**; 1 watt 5% **1/-**. A few values in 1% and 2% still available.
ALL ORDERS FOR RESISTORS C.O.D. PLEASE, AS WE CANNOT GUARANTEE TO STOCK ALL VALUES.

W.W. V/CONTROLS. ALL WELL-KNOWN MAKES. Pre-set types **2/6**; Spindle types **3/-**; Carbon type, less switch spindle and pre-set **2/-**. With switch **3/6** each.

CRYSTAL DIODES. Westinghouse WG5B **1/6** each, B.T.H. **1/3** each. Special price for large quantities.

SEMI-MIDGET 2-GANG. .0005 Condenser, size 2⅜ x 2 x 1⅞in. **6/9** each.

AM/FM GANG CONDENSER. Double 500 pf, double 27 pf size 3¾ x 1¾ x 1⅜in., **9/6** each.

ELECTROLYTIC CONDENSERS. Manufacturers' Surplus, in perfect condition. 100 mfd. x 200 mfd. 350 v. surge **5/6** each; 100 mfd. x 100 mfd. 425 v. surge **5/6** each; 150 mfd. 450 v. wkg. **5/6** each.

BIAS CONDENSERS. 3,000 mfd. 6 v. **3/6** each; 2,500 mfd. 3v. **3/6** each; 1,000 mfd. 12 v. **1/6**; 25 mfd. 25 v. **1/3**; 50 mfd. 12 v. **1/-**.

MANUFACTURERS PLEASE NOTE. We hold large stocks of Nitrogol, Visconol and other block-type Condensers, your enquiries are invited.

MIDGET MICA CONDENSERS. .0001, .0002, .0003, .0004, .0005 **5/-** per dozen.

200 Assorted Moulded Mica Condensers, popular values	**£2 10 0**
200 Assorted Silver Mica Condensers, popular values	**£2 10 0**
200 Assorted Carbon Resistors, ¼, ½ and 1 watt. Good selection	**£1 10 0**

PAXOLIN SHEET. 18 x 4½ x 1/16in. **1/6**; 10 x 10 x 3/32in. **1/6**; 20 x 10 x 3/32in. **3/-**; 10 x 10 x 1/8in. **2/-**; 20 x 10 x 1/8in. **4/-**. Minimum P. & Pkg. 1/6.

BARGAIN OFFER OF BATTERIES

4½ v. Heavy Duty Bell Battery. Size 6½ x 4½ x 2¼in.	2/6
72 v. H.T. 1.5 v. L.T. Size 6 x 5 x 1⅜in.	2/6
150 v. H.T. Size 2¾ x 5½ x 1⅜in.	5/6
67½ v. Size 2¾ x 3¾ x 2¾in.	6/6
60 v. H.T. 1.5 v. L.T. 3½ x 3¾ x 1¼in.	4/6

All batteries sealed and unused. All plus 1/6 post and pkg. Special reduction for quantities.

4-way Push Button Units **2/6** each. Knobs for same **3/-** per doz.

WEARITE COILS. PA4, PO4, PA5, PO5, **1/3** each ..... doz.	12/-
VALVE HOLDERS. Moulded B9A **7/6**; B7G **6/-**; Int. Oct. **9/-**; Eng. Oct. ..... doz	4/6
VALVE HOLDER FITTED WITH LOWER CAN 1/6 per doz. extra. Screening cans for B7G and B9A ..... doz	6/-
Paxolin V/H Int. Oct. B9A, B7G, **5/-** per doz.; Eng. Oct., 5-pin 7-pin ..... doz.	3/-
BELLING-LEE PLUGS AND SOCKETS, 5 pin **1/9**; 7 pin **2/-**; 10in. ..... each	2/6

Transistors. Junction type red spot by well-known manufacturers, 10/- each.

AIR-SPACED TRIMMERS, 5, 10, 15, 20, 25, 50; and 75 of pre-set and spindle types **2/-** each ..... doz.	21/-
PYE PLUGS AND SOCKETS 1/6 per pair, "T" pieced...each	1/9
GROMMETS, 1 grs. assorted grommets, ⅛in. to 1in. ..... gross	8/6
POST OFFICE LAMP JACKS No. 10 **1/-** each ..... doz.	9/-
Lamp Covers for same ..... doz.	3/-
OUTPUT TRANSFORMERS. Multi-ratio **5/-** each.	
WESTECTORS. WX6, WX12, W4 **1/-** each ..... doz.	9/-
SIGNAL LAMP HOLDERS. Panel mounting, complete with adjusting lampholder **2/-** each ..... doz.	21/-

Special offer Westinghouse Rectifier 14A1116 ½ wave 300 ma. **10/6** each.

POINTER KNOBS. Small black with white line, standard ⅛in. spindle ..... doz.	7/6
WANDER PLUGS. Red and black ..... doz.	2/-
PHILIPS TRIMMER TOOLS 1/- each ..... doz	10/6

CASH WITH ORDER OR C.O.D. ALL ORDERS DEPT. W.I.
ALL ORDERS FOR LESS THAN £2 ADD POSTAGE

We invite your enquiries for items not listed

Trade Counter open 9 to 6 Monday to Friday

Also 9 to 1 Saturdays. Callers welcomed

WHOLESALE MANUFACTURERS AND EXPORT ENQUIRIES INVITED

TCS TRANSMITTERS

The renowned American TCS Model designed by the Collins Company for static or mobile use. Covers 1.5-12.0 mc/s. in 3 bands, and is complete with 7 valves, employing 2 of 1625 in P.A. Stage, 1 each of 1625 in Buffer and Modulator Stages, and 3 of 12A6 in Oscillator Stage. Provision for VFO or Crystal Control. 4 Crystal positions. Radio Telephone or Radio Telegraph. Has Plate and Aerial Current Meters. Power Requirements 12v LT & 400v HT. In black crackle case, size 11 x 13 x 11in., condition BRAND NEW AND UNUSED. ONLY **£12/10/-** (carriage, etc., 15/-).

We can also supply the TCS RECEIVER, which matches the Transmitter in size and appearance, and covers similar frequencies. Complete with 7 valves, 1 each of 12SA7 and 12SQ7, 2 of 12A6 and 3 of 12SK7. Power Requirements 12v LT & 225v HT. IN BRAND NEW CONDITION. ONLY **£8/10/-** (carriage, etc., 15/-), OR THE TRANSMITTER AND RECEIVER TOGETHER £20 (carriage, etc., 30/-).

The double Dynamotor Power Unit, Type 21881B for 12 volts operation, delivering 400v for Transmitter and 225v for Receiver, is available at **£12/10/-** (carriage, etc., 15/-).

R1155 SUPER SLOW-MOTION TUNING ASSEMBLY. As used on all late model 1155s. Easily fitted to "A" sets, etc. ONLY **12/6.**

RF UNITS TYPE 26: For use with the R.1355 or any receiver with a 6.3 v. supply. This is the variable tuning unit which uses 2 valves EF54 and 1 of EC52 Covers 65-50 Mc/s. (5-6 metres). Complete with valves, and BRAND NEW IN MAKER'S CARTONS... ONLY **25/-** each. Brand New Type RF 24, 5 positions covering 15-30 Mc/s., ONLY **7/6** (postage 2/6).

A.C./D.C. BLOWERS. 220/250 volts, 300 watts. 1½in. diam. outlet. Complete with filter pads. BRAND NEW. ONLY **£4/19/6.**

INSULATION TESTERS (MEGGERS). Read up to 20 megs. at 500 volts pressure. Overhauled, and in perfect order. With leather carrying case. ONLY **£9/19/6,** OR less case **£8/10/-.**

POWER UNIT TYPE 3. Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA. and 6.3 v. 4 amps. Fitted with H.T. current meter, and voltmeter. For normal rack mounting and has grey front panel size 19in. x 7in. ONLY **70/-** (carriage, etc., 7/6).

EHT TRANSFORMERS. 5.5 kV. (Rect.) with 2 v. 1 a., **79/6,** 7 kV (Rect.) with 2 v. 1 a., **79/6.** 7 kV. (Rect.) with 2 v. 1 a., **89/6.** 2.5 kV. (Rect.) with 2-0-2 v. 1.1 a., 2-0-2 v. 2 a. (for VCR 97 tube, etc.), **42/6** (postage 2/- per trans.).

6 v. VIBRATOR PACKS. Output approx. 130 v. at 30 mA., fully filtered and smoothed. Complete. ONLY **12/6.**

100-0-100 VOLTS METERS by Sangamo Weston. 2½in. circular, basic movement being 500-0-500 microamps. A really first-class centre zero meter for hundreds of uses. BRAND NEW IN MAKER'S CARTONS. ONLY **27/6.**

500 MICROAMPS METER. 2in. circular as used on British No. 19 Wireless Sets. Calibrated 0-15 and 0-600 volts, resistance 500 ohms. A very fine instrument, and A SNIP AT ONLY **15/-.**

MARCONI SIGNAL GENERATOR TF144G

Frequency coverage 85 kc/s. to 25 Mc/s., and known as a Laboratory Standard. For normal A.C. mains, and complete with all leads. Reconditioned. AS NEW ONLY **£75.**

MARCONI SIGNAL GENERATORS TF-390G

Frequency coverage 16-150 Mc/s. BRAND NEW IN MAKER'S ORIGINAL TRANSIT CASES, with instruction manual. For normal A.C. mains operation. A unique opportunity to acquire Laboratory Equipment at a fraction of original cost. ONLY **£27/10/-.**

MARCONI BAND III CRYSTAL CALIBRATORS

Frequency range 170-240 Mc/s. Incorporates 5 Mc/s. crystal for better than .001 per cent. accuracy. Directly calibrated dial, internal A.C. mains pack. Complete with spare set of valves and instruction manual in maker's transit cases. BRAND NEW. ONLY **£4/19/6.**

CLASS D WAVEMETER

Another purchase of this famous crystal-controlled wavemeter which has been repeatedly reviewed and recommended in the "R.S.G.B." Bulletin as being suitable for amateur transmitters. Covers 1.9-8.0 Mc/s., and is complete with 100/1,000 kc/s. crystal, 2 valves ECH35, two 6-volt vibrators and instruction manual. Designed for 6 v. D.C. operation, but simple mod. data for A.C. supplied. BRAND NEW IN MAKER'S TRANSIT CASES. ONLY **£5/19/6.** Transformer for A.C. modification, **7/6.** OR a few instruments less Crystal **£3/10/0.**

METERS

F.S.D.	SIZE	AND TYPE	PRICE
50 microamps D.C.	2½in.	Flush circular	59/6
100 microamps D.C.	2½in.	Flush circular	39/6
250 microamps D.C.	2in.	Proj. circular	30/-
500 microamps D.C	2in.	Flush square.....	27/6
1 m/a D.C.	2in.	Flush square.....	22/6
10 m/a. D.C.	2½in.	Flush circular (blank scale)	10/6
150 m/a D.C.	2in.	Flush square.....	7/6
200 m/a D.C.	2½in.	Flush circular	12/6
10 amps D.C.	3½in.	Proj circular	20/-
20 amps D.C	2in.	Proj. circular	7/6
40 amps D.C.	2in.	Proj. circular	7/6
15-0-15 amps D.C.	3½in.	Flush square.....	25/-
30-0-30 amps D.C.		Car type moving iron ...	5/-
15 volts A.C.	2½in.	Flush circular moving iron	8/6
300 volts D.C.	2in.	Flush square.....	10/6

WIRELESS SET NO. 19 MK. II The famous Army Tank Transmitter-Receiver Incorporates "A" set (TX/RX covering 2.0-8.0 mc/s., i.e., 37.5-150 metres); "B" Set (VHF TX/RX covering 230-240 mc/s., i.e., 1.2-1.3 meters), and Intercomm. Amplifier. Complete with 15 valves as follows: 6 of 6K7G, 2 of 6K8G, 2 of 6V6G, and 1 ea. 6B8G, 6H6, E1148, EF50, 807, and booklet giving circuits, notes, etc.

Size 17½in. x 8½in. x 12½in. Magnificently made by famous American firms.

IN BRAND NEW CONDITION. ONLY £4/19/6 (carriage, etc., 10/6).

AMERICAN COMMAND RECEIVERS. A few still available. Top band model (1.5-3.0 Mc/s.). Used, good condition. **65/-,** OR BRAND NEW IN CARTONS, **75/-.**

L.T. HEAVY DUTY TRANSFORMERS. Ex-Admiralty, with 230 v. 50 cycles primary. Secondaries 5, 10, 15, 20, 25, 30 volts at 5 amps. ONLY **29/6.** (Postage 2/9).

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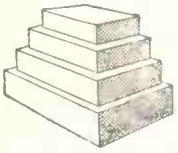

Aluminium Undrilled with Reinforced Corner. Available in the following sizes:

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SPECIAL OFFER BAND I-III TUNERS

Covering Channels 8-4 with provision for 10 more coil sets. 2 valves: Mazda 30L1 cascode r.f. amp., Mazda, 30C1 triode pentode f.c. Complete with power supplies for 200-250 v. A.C.1.F. output 16-19 Mc/s, easily modified to other outputs. Full circuit diagram supplied **£5.17.6**

THE NEW APEX MARK II BAND III CONVERTOR

- B.B.C. or Commercial Programmes at the touch off a switch.
- Built in power supply for 200/250 v. A.C.
- Variable fine tuner and gain control. Separate mains on/off switch.
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Retail Price £5/15/- complete.

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EX-GOVERNMENT HEATER TRANSFORMER. Universal Input. 2×6.3 volts windings at 1½ amps each. Price 7/6 each.

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Manufacturers Surplus Types.	each
945 ohms Zenith with taps	1/-
725 ohms Erie tap at 600 ohms	1/6
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Green Vitreous Mains Dropper 1,328 ohms, 2 taps, Midget Type	1/3
Zenith Mains Dropper 910 ohms	2/-
Dubilier Type HY, tapped 200-210 220-230, 240-250 ohms	1/9
Erie Two Section Dropper, 150 ohms and 1,340 ohms, with two taps	1/9
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REPANCO COILS

TRANSISTOR COILS AND COMPONENTS

	Each
Type OT1 combined IST IFT (315 Kc/s) and OSC Coil Medium and Pre-Set Long Wave	11/6
Type TT2 2nd if transferable 315 Kc/s	5/-
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Type TT5 Push Pull Output Transformer	8/-
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Type DRE2 Dual Range High Gain Coil	4/-

All are complete with circuits.

Co-axial Cable 75 ohms, top quality, 9d. yard.

Aerialite Co-axial plug, Part 166. 1/4 each.

Aerialite Back to Back Socket, Part 203, 1/6 each.

Aerialite Car Radio Aerial, Model 12, Mudguard or Vallance fitting, 35/- each.

Cyldon Turret Tele-Tuner, suitable for all Channels and most Receivers. Send for descriptive leaflet. £7/7/-.

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Wearite P Coils, Aerial, Oscillator and H.F. Coils. All types in stock, 3/- each.

J.B. Solid Dielectric Condensers 100pf, 200pf, 300pf and 500pf, 3/10 each.

100 resistors, mixed ½ ¼ and 1 watt. Popular values. Special offer of 100 for 12/6. Do not miss this Bargain, 12/6 pkt.

Television Electrolytics:—100 mfd. T.C.C. 450 v., 2/- each. 60-120 mfd. B.E.C. 300 v. 5/- each. 100-200 mfd. 275 v. B.E.C., 5/- each. 60-250 mfd. 275 v., 5/- each. 60-100 mfd. 275 v. B.E.C., 5/ each.

Vibrators:—4 pin U.X. types. Available for 12 or 6 volts by Oak, Mallory Plessey, etc., 8/6 each.

Pre-Set Controls. Available wire wound 1K and 10K ohms, 2K ohms, 30K ohms, available, carbon track 50K, 100K, ¼ meg., 1 meg., 2 Meg. 20K ohms, ½ Meg. ohms. Various makes and types. 150K ohms. 1/9 each.

*Control Knobs in Modern Styling. Tastefully and clearly engraved in gold. These Mouldings are available in two colours: Walnut and Ivory.
They are suitable for use with ¼in. spindles and are simply and firmly held by means of a grubscrew and locking nut.
Prices: Type "A" 1/6 each. Type "B," 1/2 each.

Line Card, 3 amp., 3 core .... 1/9 yard
Line Cord 2 amp., 3 core .... 1/9 yard
Electric Buzzers in Bakelite Case, Loud tone ..... 2/6 each
Epicyclic Friction Drive with Brass Drum. For use with steel Dial Drive Wire ..... 1/6 each

MISCELLANEOUS COMPONENTS

ROTARY SWITCH. 4 position, 30 amp., 3/- each.

SPINDLE COUPLERS. Brass, for ¼in. spindles, with two Grub Screws, 6½d. each.

IRON ELEMENTS. H.M.V. Replacement Element, 3/- each. Standard Elements will fit most makes, 1/8 each.

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RUBBER GROMMETS. Mixed Sizes. 6d. doz.

GRID CAPS. 1. Octal Push-on type, 6d. doz. British Screened type, 3d. each.

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2 Pin Mains Plug and Socket. 2/6 each. Pliers Side Cutters, 2/9 pair. Line Cord. .3 amp., 3 core, 1/9 yard. Line Cord, .2 amp., 3 core, 1/9 yard. Electric Buzzers in Bakelite case. Loud tone, 2/6 each. Epicyclic Friction Drive with Brass Drum. For use with Steel Dial Drive Wire, 1/6 each.

AMERICAN RELAY. 45 ohms Impedance with lead, No. AZ0545, 1/9 each.

IRON LEADS. Black and white flat iron leads, bonded ends, 1/3 each.

POTENTIOMETER PANEL. Four Potentiometers on Panel. 50K ohms SPS; 750 ohms W/W; 25K ohms Carbon; 5K ohms W/W. All with long spindle, with leads of different colours terminating in an 11 pin plug. 7/6 each. Wavox choke, max. current 100 m/a D.C., resistance 125 ohms, 6/- each. Westinghouse 1 m/a Rectifier, wire ends, 9d. each. 6 volt Vibrator Pack, complete with 4-pin Vibrator, 17/6 each. Morphy Richards Type Replacement Iron Elements, 3/9 each.

INDICATOR LAMPS. Spring fixing type, 9d. each. "Aerovox" Condenser Clips. 1d. each. Pencil Rectifiers. Type J10, 2/- each. Amplion Volume Controls, 2 meg. S.P.S., 3/6 each. Extension Speaker Volume Controls, 1/3 each. Vibrator Clips (Standard), 5d. each.

NINE-INCH TUBE MASKS. White (Soiled Condition), 4/9 each. Tri-Sol 3-Core Solder. Nett weight 1lb. 16 S.W.G. 60/40 alloy, per carton, 6/6. 0-100 mA Meter Panel Mounting, 7/6 each.

SURPLUS GEAR PARCELS. We have found, from time to time, stocks of components stripped from ex-Government equipment, along with discontinued lines, etc. These are in small quantities and therefore unprofitable to advertise. To make room for new items we offer at less than cost parcels of these components at 10/- each.

JUNCTION BOXES. Type 5X/2234. 20 way 1/6 each.

RECORDING TAPE. 1,200 feet. "Puretone," 12/6 each.

NEEDLE CUPS. For Gram. Needles (Bakelite), 1d. each.

CRYSTAL DIODES. Wire Ends, plastic case, 1/- each. Bulgin 7-pin Plug and Socket, 1/6 each. Insulated Coupler, 2in. dia., for standard ¼in. spindles, ceramic insulation, 9d. each. Pairs of Instrument Handles, 5½in. between centres, 1½in. back to front, 1/3 pair. Speaker Cones, 6A8P is 8in. cone with 1in. cone piece, 4/6 each. 6A6P is 6½in. cone with 1in. pole piece, 4/6 each. A Low-High Impedance Matching Unit for Headphones to be inserted in the cord, 3/9 each. Mains Transformer, Standard Type Primary Windings with a Secondary 325-0-325 20 m/a. 6.3 v. .3 amp., 11/6 each. Bulgin Indicator Lamp, single hold fixing for standard MES bulb, red lens, 3/3 each. Tubular Condenser (Metal Boss) Sprague 4 mfd. 600 v., 4/- each. Sprague Block Condenser, 2×.1 mfd. 2,000 volts, 3/- each. Paper Block Condenser, 2 mfd. 250 volts, 9d. each. Kettle Elements, 1,000 watts for 200/210 volts or 230/250 volts, 17/6 each. Relay Valve CV271, in Holder. 3/9 each.

BELL TRANSFORMER "CONCORDIA." 3 v., 5 v., 8 v., 1 amp. fused. In bakelite case, 8/6 each.

SELF TAPPING SCREWS (PK). No. 4, ¼in. long, 3½d. doz.

"CLEM" TRAVELLING IRON with ASBESTOS STAND. Size: 4in. × 2in. × 2½in., including handle, complete with lead and switch to enable it to be used on any voltage between 110 and 250 v. A.B.C. adaptor is fitted on the lead. (Colour as available: Blue, Green, etc.). 21/- each.

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CARRYING CASE. Suitable for use as a projector or recording case, size 15in. × 9½in. × 13in. Internal dimensions: 14in. long, 11½in. deep, 5½in. front H.T., 8½in. rear H.T. With black rexine finish. Weight 9½lb., 13/6 each. Post and Packing 2/6.

B7G MINIATURE VALVE PIN STRAIGHTENER. This is an American manufactured tool at a price everyone can afford Complete with plug, 2/6 each.

10 WATT WIRE WOUND RESISTORS BY DAGOLE. Special purchase of following sizes at 1/- each. 250 ohms, 700 ohms, 600 ohms, 225 ohms, 750 ohms, 500 ohms, 300 ohms, 175 ohms 150 ohms, 200 ohms, 350 ohms, 400 ohms.

TV SLIDER PANEL. Welwyn panel of 3 resistors, values 1 Meg. ohms, 150K ohms, 250K ohms, with black screw type locking knobs. Total size: 3⅛in. × 3in. Price 1/9 each.

ALL DRY BATTERY PLUGS AND SOCKETS All types available. Two popular types of plug, 2-pin and 3-pin, 4d. each part. Bulgin Type P322 Anode Cap. Insulated for high voltage, 6d. each. Terminal Block. Ref. No. 5X/2234. 20-way. 6 yards Top Quality Maroon Flex, 2in. core, twisted with 2in. pin plug, 2/9. Marconi Dropper, resistance 1,000 ohms, 3 voltage taps 195/215, 216/235, 236/255, 1/- each. Crocodile Clips, plated, strong jaws, 3d. each. Toggle Switches, various assorted, 12/- doz. 4B.A Terminals, red and black. Suitable for Battery Chargers, etc., 1/6 each.

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HIGH QUALITY SOUND REPRODUCTION.
Includes 20 watt amplifier. P.M. Tuner. Pre-Amplifiers, etc. ..... 3/6 each

C.R.T. ISOLATION TRANSFORMERS.
Type NR20. New "Competition" transformers. Input has one tap which increases output by 25%. Three types available to cover 2, 4 and 6.3 volt CR Tubes.
NR20/A. Input 200/250 volts. Output: 2 volts. NR20/B. Input 200/250 volts Output 4 volts. NR20/C. Input 200/250 volts. Output 6.3 volts. (All with optional 25% boost).
With tag board primary. Flying lead secondary. All types. All 10/6 each.

2 pin Mains Plug and Socket 2/6 each. Pliers Side Cutters 2/9 pair.

HEATER TRANSFORMERS	Each
230 v. Input 2 volt .5 amp.	5/-
230 v. Input 2 volt 3.0 amp.	8/3
230 v. Input 4 volt 1.5 amp.	5/6
230 v. Input 4 volt 3.0 amp.	10/-
230 v. Input 5 volt 2.0 amp.	10/-
230 v. Input 6.3 volt .5 amp.	5/6
230 v. Input 6.3 volt 1.5 amp.	6/9
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230 v. Input 12 volt .75 amp.	5/9

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C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit for C.R. Tubes with falling emission.
Type A. Low leakage windings. Ratio 1:1.25 giving a 25% boost on Secondary.

2 volt	10/6 each	
4 volt	10/6 each	with Tag
6.3 volt	10/6 each	Panel and
10.8 volt	10/6 each	Solder Tags
13.3 volt	10/6 each	
Ditto with mains primaries	12/6 each	

Type B. Mains input 220/240 volts. Low Capacity. Multi Output 2, 4, 6.3, 7.3, 10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for all Cathode Ray Tubes. With Tag Panel 21/- each.
Type C. Low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 220/240 volts. Output 2-2½-2½-2½-3 volts at 2 amps. With Tag Panel 17/6 each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE:—It is essential to use mains primary types with T.V. receivers having series connected heaters.

RESISTORS. All values. 10 ohms to 10 meg., ½ w. 4d.; ¼ w., 6d.; 1 w., 8d.; 2 w., 1/-.
HIGH STABILITY. ½ w. 1%, 2/-. All preferred values 100 ohms to 10 meg.
5 watt, 10 watt, 15 watt } WIRE-WOUND RESISTORS 25 ohms—10,000 ohms ..... { 1/3 1/6 2/-
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WIRE-WOUND POTS. 3 WATT LAB. COLVERN, ETC.
Pre-set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 Meg., 3/-.
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L.F. CHOKES 15/10 H. 60/65 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H., 120/150 mA., 12/6; 5 H. 250 mA., 15/-.
MAINS TRANS. 350-0-350, 80 mA., 6.3 v. tapped 4 v. 4 a, 5 v. tapped 4 v. 2 a., ditto 250-0-250 80 mA., etc., 21/-. Bargain 300-0-300 v. 65 mA., 6 v. 4 a., 4 v. 2 a., 15/-.

I.F. TRANSFORMERS 7/6 pair

465 Kc/s Slug tuning Miniature Can 2½ × 1 × 1in. High Q and good band width. By Pye Radio. Data sheet supplied.
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ALADDIN FORMERS and cores. ½in., 8d.; ¾in., 10d. .3in. FORMERS 5937/8 and Cans TV1/2. ¾in. sq. × 2½in. and ¾in. sq. × 1¾in., 2/- complete with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYANA. Midget Soldering Iron. 200/220 v. or 230/250 v., 16/9. SOLON INSTRUMENT IRON. 25 w., 24/-.
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LINE CORD. .3 amp., 60 ohms, per foot, .2 amp., 100 ohms, per foot, 2 way, 6d. per foot, 3 way, 7d. per foot.

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Precision engineered. Size only 1¼ × 3/16in. Bargain. Price 6/6. No transformer required.

MIKE TRANSF. Ratio 50 : 1, 3/9 ea.; 1 0 : 1, 10/6.
LOUDSPEAKERS P.M. 3 OHM. 2¼in. square 17/6
5in. R.A. 17/6 7in. × 4in. Goodmans 21/-
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CRYSTAL DIODE. G.E.C., 2/-. GEX34, 4/-. 40 Circuits, 3/-.
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Miniature size 2½ × 2½ × 1½in. High Q dust cored coils. SHORT, MED., LONG. GRAM switching with connection diagram and 5 valve circuit. 465 Kc/s I.F.

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WAVECHANGE SWITCHES.
2 p. 2-way 3 p. 2-way, short spindle 2/6
5 p. 4-way 2 wafer, long spindle 6/6
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Wave change "MAKITS," 1 wafer 8/6; 2 wafer 12/6; 3 wafer 16/-; 4 wafer 19/6; 5 wafer 23/-; 6 wafer 26/6.
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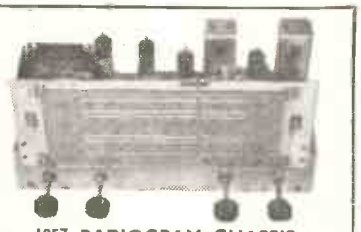

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FIVE VALVES LATEST MULLARD ECH42, EF41, EBC41. EL41, ELZ40
12 month Guarantee. A.C. 200/250 v., 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative feedback. 4.2 watts. Chassis 13½in. × 5½in. × 2½in. Glass Dial 10 × 4½in. horizontal or vertical available. 2 Pilot Lamps. Four Knobs, Walnut or Ivory, aligned and calibrated. Chassis isolated from mains.

BRAND NEW £10.10.0 Carr. 4/6.

TERMS: Deposit £5/5/- and 6 monthly payments of £1.
MATCHED SPEAKERS FOR ABOVE CHASSIS: 8in., 17/6; 10in., 25/-; 12in., 30/-.

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★ R.C.S. SCOOP ★
HIGH FIDELITY AUTOCHANGER
1957 MODEL RC456
For 7", 10", 12" Records 16, 33, 45, 78 r.p.m.
4 SPEEDS — 10 RECORDS
WITH STUDIO "O" PICK-UP
BRAND NEW IN MAKER'S BOXES
OUR PRICE **£9.15.0** Post free.
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SUITABLE PLAYER CABINETS 49/6
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B.S.R. MONARCH
4-SPEED AUTOMATIC RECORD CHANGERS
1957 MODELS
Brand new and fully guaranteed 12 months.
NOT JOB LINE REJECT STOCK
Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in., 12in. Lightweight Xtal pick-up, turnover head, two separate sapphire styli, for Standard and L.P. Each plays 2,000 records. Voltage 200/250 A.C.
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SUITABLE PLAYER CABINETS 49/6
AMPLIFIER PLAYER CABINETS 63/-

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FAMOUS MAKE 4-speed Motor and Turntable with selecting switch for 16, 33, 45 and 78 r.p.m. records 200/250v. A.C. 50 c.p.s. Also Lightweight pick-up with Xtal turnover head, separate Sapphire stylus for L.P. and standard records. SPECIAL OFFER. THE TWO 24/12/6, post 2/6. 14 × 12½in. Cut Out board 6/-.

AMPLIFIER/PORTABLE RECORD PLAYER CABINET Size 17½ × 13½ × 7in. Motor Board 16½" × 12½" SPACE FOR ANY SINGLE RECORD PLAYER, TWIN SPEAKERS and AMPLIFIER etc.
BARGAIN PRICE 45/-
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4-WATT GRAM. AMPLIFIER. For 200-250 v. 50 c.p.s. A.C. mains. Chassis fully isolated. Fitted vol. (with mains switch) and Tone Control. Designed for use with any kind of single player or record changing unit. With 6½in. loudspeaker and output transformer. Fits our portable cabinet without modification. **£4-15-0**

CHAMPION VHF (FM) TUNER 88 to 96 mc/s. 5 Mullard Valves and Superhet Tuning Heart. Maroon and Cream Receiver styled cabinet 6 × 12 × 6in.
Features: This is a self powered 200/250 v. A.C. VHF (FM) Adaptor with operating and servicing data and a screened lead for connection to pick-up sockets of Any Radio, Radiogram or Amplifier.
Brand new with 12 months guarantee. List price 16 gns. Our Price 10 gns., carr. 4/6.

TELETRON BAND III CONVERTER

For London, Midland and Northern I.T.A. Suitable all T.V. makes, T.R.F. or Superhet. Coils, valves, components, chassis, wiring plans. COMPLETE KIT for mains operation 200-250 v. A.C., £3/10/-. As ABOVE less POWER PACK. Requires 200 v. 20 mA. H.T., 6.3 v., 6 a. L.T. £2/5/-. Mark II cascode £1 extra each Kit.

Volume Controls

Midget size
Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg.
No. Sw. S.P.Sw. D.P.Sw.
3/- 4/- 4/9
Lin or Log Tracks

80 ohm CABLE Coaxial

Semi-air spaced Polythene insulated ¼in. dia. Stranded core. Ideal Band III. 9d. yd. Losses out 50%.
STANDARD QUALITY ¼in. Coaxial ..... 8d. yd.

COAXIAL PLUGS 1/- DOUBLE SOCKET 1/3
SOCKETS 1/- OUTLET BOXES 4/6
BALANCED TWIN FEEDER per yd., 6d. 80Ω or 300Ω.
TWIN SCREENED BALANCED FEEDER 1/- yd., 80 ohms.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Philips 1/- ea.

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

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1,200 ft. on standard fitting 7" Plastic reels. Brand new, boxed, 12/6.
Spare Spools 5" metal, 1/6, 7" Metal 2/3

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TELETRON. L. & Med. T.R.F., with reaction, 3/6.
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CERAMIC CONDS. 500 v., .3 pf. to .01 mfd., 10d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3. DITTO 1% 1.5 pf. to 500 pf. 1/9; 515 pf. to 5,000 pf., 2/-.

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TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	100/25 v.	3/-	8+16/450 v.	5/-
2/450 v.	2/3	8+8/500 v.	4/6	16+16/500 v.	6/-
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8/450 v.	2/3	CAN TYPES		32+32/350 v.	4/6
8/500 v.	2/9	Clips	3d.	32+32/450 v.	6/6
16/450 v.	3/6	16/450 v.	3/6	64+120/275 v.	7/6
16/500 v.	4/-	32/350 v.	4/-	60+100/350 v.	11/6
32/450 v.	5/6	64/350 v.	5/6	100+200/257 v.	12/6
25/25 v.	1/9	100/275 v.	5/6		
50/25 v.	1/9	50+50/350 v.	7/-	1,000+1,000/6 v.	6/6.
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1S5	8/6	6L6	10/6	EB91	6/6	E1148	1/6
1T4	8/6	6Q7	10/6	EBC33	8/6	HABC80	12/6
3S4	8/6	6SA7	7/6	EBC41	10/6	HVR2A	7/6
3V4	8/6	6SN7	8/6	EBF80	8/6	MU14	10/6
5U4	8/6	6V6G	7/6	ECC84	12/6	PC084	12/6
5Y3	8/6	6V6GT	8/6	ECF80	10/6	PCF80	10/6
5Z4	10/6	6X4	7/6	ECF82	10/6	PCF82	10/6
6AM6	8/6	6X5	7/6	ECH42	10/6	PCL82	10/6
6B8	5/6	7S7	8/6	ECL80	8/6	PEN25	6/6
6BE6	7/6	12A6	7/6	ECL82	12/6	PL82	10/6
6BH6	10/6	12AH8	10/6	EF39	7/6	PY80	10/6
6BW6	8/6	12AT7	10/6	EF41	10/6	PY81	10/6
6BW7	8/6	12AU7	10/6	EF50	5/6	PY82	10/6
6CH6	10/6	12AX7	10/6	Equip.		8P61	5/6
6D6	7/6	12BE6	10/6	EF50	8/6	UBC41	8/6
6F6	7/6	12BH7	10/6	Sylv.		UCH42	8/6
6H6	3/6	12K7	8/6	EF80	10/6	UF41	8/6
6J5	6/6	12Q7	8/6	EF92	5/6	UL41	8/6
6J6	7/6	3524	10/6	EL32	5/6	UY41	8/6
6J7	8/6	80	8/6	EL84	10/6	U22	10/6
6K6	6/6	954	1/6	EY51	11/6	U25	11/6
6K7	5/6	EA50	1/6	EZ40	10/6	X79	10/6

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I.F. Transformers, 1st, 2nd, 3rd and 4th	12/6 each
Set of four	£2 0 0
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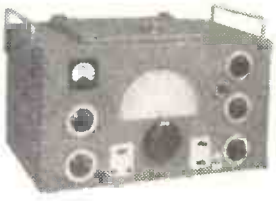
Marconi CR-150 Communication Receivers, range 2 to 60 mc/s, dual superhet, fully overhauled and guaranteed £50 0 0
Power Supply Unit for the above £10 0 0

EDDYSTONE 358X COMMUNICATION RECEIVERS



40 kc/s to 31 mc/s with ten plug-in coils.

PRICE: Aerial Tested, complete with ten coils £12 10 0
Fully overhauled and guaranteed, complete with mains power pack £25 0 0

ALSO, for the first time we have available separately coils in sets of ten or individually, at 17/6 each or £6/10/- per set of ten.

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500 volts £12 10 0
250 volts £11 10 0
Evershed 500 v. Meggers, 40 megohms £22 10 0
Evershed 1,000 v. Meggers, 100 megohms £27 10 0
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These can also be supplied fully rebuilt and guaranteed, price on application.

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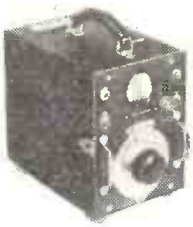

Frequency Meter (Absorption) BC-906-D, range 150-235 mc/s.

Test Oscillator 1-196, portable, battery operated; frequency range 150-235 mc/s.

Test Receiver BC-1066, 150 to 235 mc/s, battery operated; contains one valve 1D8GT and two Valves 957.

Range Calibrator BC-949; contains a resonating circuit that can be switched to produce signals from 8 to 81 kc/s. Valves: one each 6SL7GT and 6H6.

Indicator BC-936; contains a diode rectifier circuit (957) to rectify received pulsed RF signals. The output can be supplied to a C.R. Oscilloscope.

PRICE: £5 . 10 . 0 per set. **CARRIAGE: £1 . 0 . 0 extra.**

ECHO BOX TS-61/AP

Hand Tuned Echo Box, having a frequency range of 3140 to 3360 mc/s. Accuracy ± 10 mc/s; Microammeter for measuring relative power and resonance indication. PRICE, each ... £7 10 0

KLYSTRONS AND MAGNETRONS AT SPECIAL PRICES: QK59, QK-60, QK-61, QK-62, 417A, 5J29, 5J30. All brand new and guaranteed at £2 each.

AMPLIFIER ALIGNMENT UNIT TS-92/AP. Superhet Receiver having a range of 15 to 500 mc/s, accurate to ± .125 mc; Low pass filter adjustable from .5 to 7 mc bandwidth. Selectivity 3 db down at 50 kc from resonance Sensitivity 100 mA for ½-scale deflection of the meter.
PRICE, each £12 10 0

HALLICRAFTER S-27C UHF RECEIVER, 130 to 210 mc/s, FM/AM Detectors, for 115 V. A.C. operation, fully overhauled and guaranteed £50.

FREQUENCY METERS
BC-221 Frequency Meter, 125 kc-20 mc/s. LM Series Frequency Meters, Naval Version of the above.
MARCONI TF-643 Absorption Frequency Meters.

SIGNAL GENERATORS
Marconi TF-144G, 85 kc to 25 mc.
Marconi TF-390G, 16 to 150 mc/s and other ranges.
Marconi TF-517F, 18-58 and 150-300 mc/s or 130-260 mc.
R.C.A. type 710 UHF Signal Generator 370-560 mc.

MARCONI TF-340 OUTPUT METERS. Fully overhauled and guaranteed £32/10/-.

We buy good American Communication, Test and Aircraft Equipment such as: BC-312, BC-342, BC-348, ARC-1, ARC-3, ART-13, ARN-6, ARN-7, etc.

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Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee: Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

LEWIS RADIO for the right price and best selection.—See page 68 [0341

BUY direct from the makers; we can now supply our R/G chassis and feeder units at keen prices; Model A/F834 an 8-valve AM/FM chassis, 4 watts output; Model A/F73 a 7-valve AM/FM feeder; 2½d stamp for full details and literature; trade enquiries invited.—Bayly Bros., 46, Pavilion Drive, Leigh-on-Sea, Essex. [7351

SHIRLEY LABORATORIES, Ltd., 3, Prospect Place, Worthing, Sussex. Tel. 30536 THE TWA/1515 stereosonic tape recording and replay amplifier, separate meter monitoring on record and playback on both channels, 13watts O/P each channel, 96gns; TWA/15 tape recording and reproducing amplifier, 13watts O/P, for Wearite and Collaro decks, 45gns; TW/PA recording and replay pre-amplifier, 30gns; both with valve voltmeter monitoring; type SB/1-15E high-fidelity amplifier, exceptionally wide tone-control system, 40mv sensitivity, 20gns; with two inputs and 3-position gram filter, 22gns; specialized amplifiers for the musical and scientific industries including the Mullard 20watt. [0095

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

GRAMPION 506 amplifier and radio unit combined, unused; list price £32/13/6; one only, £20.—S.E.S., Ltd., 429, Staniforth Rd., Sheffield, 9. [7341

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

"WIRELESS WORLD" 7-valve F.M. tuner, unused with cathode follower, magic eye and power supply for use on 200-250 volts A.C., fitted with latest type F.M. components of highest grade including specific temperature compensating capacitors, price £14/15 including 7 valves, accurately aligned and tested ready for use; approx. half original price, exceptionally good reproduction, ideal for use with all high fidelity amplifiers and recorders, as above but including high-grade cabinet, £18/10, limited number, bargain; above are despatched by passenger train in boxes lined with foam rubber to ensure safety in transit. Also few unused 12in high-fidelity dual speakers with frequency range 25-20,000 c/s available at half usual prices including cross over units.—Box 0866. [7865

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

1500 cycles alternators 2KVA, 80v.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [7205

TEST EQUIPMENT—SURPLUS AND SECONDHAND

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

NEW COMPONENTS

TRANSISTOR P.P. amplifier, 4 transistors, complete kit, 75/-; transistor superhet portable, latest, circuit, etc., 1/6.—Osmabet, Ltd., 14, Hillside Rd., Tottenham, London, N.15. [0020

CRYSTAL microphone inserts (cosmocord mic 6/4), in steady demand by hams and sound engineers, guaranteed newly made and boxed; 15/6 post free.—Radio-Aids, Ltd., 29 Market St., Watford, Herts. [0170

COMPONENTS—SURPLUS AND SECONDHAND

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COMPONENTS—SURPLUS AND SECONDHAND

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport St., London, W.C.2. See our displayed advertisement page 174.

ILLUSTRATED Catalogue No. 13 containing over 450 items of Government surplus and model radio control equipment, 2/2, refunded on purchase of goods, 2/6 overseas sea mail.—Arthur Sallis Radio Control, Ltd., Department W.W., 93 North Rd., Brighton. [0193

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. MAINS transformers, pri. 110v, 200-240v, sec. 300-0-300v, 4v 2amp, 6.3v 2.5amp, 11/-; 2-gang condenser, .0005, var. size, 2¼in×2in×1¾in, ⅜in spindle, 4/-. P.M. focus rings.
WIDE-ANGLE tetrode tube, fully adjustable, 7/6; T.V. metal rectifiers, 250v 250ma, size 2¼in×4in, 12/6; C.T.V. I.F.S. 34mc/s, 2nd, 3rd, 4th vision cans, 1¾in×1¾in×1¾in×2¼in, slug tuned, set of 3, 5/6; 2-gang var. 15pf, size 2¼in×1¼in×1¼in, 2/-.
VIBRATORS, 6v synchronous, 7-pin, 7/6; vibrator trans., 6v, 7/6.
WIRE-WOUND pot., 100Ω, 1in spindle, 2/6; speakers, P.M., 5in 5Ω speech coil, 16/6; sheet aluminium, large variety of sizes in stock.
SUB-MINIATURE electrolytics for transistor circuits, 6mfd, 8mfd, 3v and 6v, size ⅛in×7/16in, 2/9; 16mfd, 30mfd, 3v and 6v, size 9/16in×½in. 2/9.
ELECTROLYTICS, capacity, voltage, size, type of mounting: 50mfd, 25v, 1¾in×½in, tag, 1/6; 100mfd, 12v, 1¾in×½in, tag, 1/6; 500mfd, 12v, 1¾in×¾in, tag, 2/-; 10mfd, 25v, ¼in×½in, W/E, 1/3; 4mfd, 150v, 1½in×⅝in, tag, 1/3; 8mfd, 150v, 1½in×⅝in, tag, 1/3; 8mfd, 350v, 2in×⅝in, tag, 1/9; 8mfd, 500v, 3in×1⅜in, clip, 2/6; 16mfd, 350v, 2in×⅝in, prong, 1/9; 20mfd, 450v, 2in×7/8in, clip, 2/-; 24mfd, 275-350v, 2in×7/8in, clip, 2/-; 32mfd, 275-350v, 2in×1in, 2/-; 32mfd, 350v, 2in×1in, clip, 2/6; 32mfd, 450v, 2in×1in, W/E, 2/9; 40mfd, 150v, 2in×1in, prong, 1/6; 40mfd, 350v, 2in×1in, prong, 2/-; 40mfd, 450-525v, 2in×1in, 2/9; 50mfd, 350v, 2in×1in, W/E, 3/-; 100mfd, 270-350v, 2in×1½in, clip, 3/3; 100mfd, 350-425v, 3in×1⅝in, prong, 3/6; 125mfd, 350-425v, 3in×1⅝in, prong, 3/6; 200mfd, 35v, 1½in×1in., tag, 1/-; 200mfd, 250-325v, 3in×1⅜in, 2/6; 200mfd, 275-350v, 3in×1⅜in, prong, 3/-; 250mfd, 25v, 2⅜in×1⅜in, 1/-; 250mfd, 150v, 3in×1⅜in, prong, 2/-; 500mfd, 6v, 2in×1in, clip, 1/3; 500mfd, 25v, 2in×1in, clip, 2/6; 1,000mfd, 6v, 2in×1in, clip, 2/-; 1,000mfd, 25v, 3in×1in, clip, 1/6; 2,000mfd, 12v, 2in×1⅝in, W/E, 3/6; 2,000mfd, 25v, 3in×1⅜in, clip, 3/6; 2,000mfd, 50v, 4½in×2in, clip, 5/-; 2,500mfd, 50v, 4½in×1¾in, clip, 5/6; 3,000mfd, 25v, 4½in×1¾in, clip, 5/-; 4,000mfd, 6v, 3in×1⅜in, clip 5,000mfd, 25v, 4½in×1¾in, clip, 5/6;8+8mfd. 450v, 2in×1in, W/E, 4/-; 15+15mfd, 450v+20mfd, 25v, 3in×1in, prong, 4/-; 16+16mfd, 275v, 2in×1in, clip, 3/-; 20+10mfd, 450-525v, 3in×1in, clip, 3/6, 20+20mfd, 350-425v, 2in×1in, prong, 4/-; 20+20mfd, 150v, 2in×1in, clip, 2/-; 20+20mfd, 150v, 2in×1in, W/E, 2/3; 20+20mfd, 350-425v, 2in×1in, W/E, 3/9; 20+20mfd, 450v, 3in×1in, prong, 3/9; 30+30mfd, 150v, 2in×1in, clip, 2/6; 32+16mfd, 200v, 2in×1in, prong, 1/6; 32+16mfd, 275-350v, 2in×1in, clip, 3/-; 32+32mfd, 275-350v, 3in×1in, prong, 3/9; 32+32mfd, 350-425v+50mfd, 25v, 2in×1⅜in, prong, 4/3; 40+40mfd, 150v, 2in×1in, clip, 2/6; 40+40mfd, 350v, 3in×1in, clip, 3/6; 40+40mfd, 450v, 3in×1⅜in, prong, 4/-; 50+20mfd, 150v, 2in×1in, clip, 2/-; 50+30mfd, 450-525v, 3in×1⅜in, clip, 4/6; 50+50mfd, 150v, 2in×1½in, W/E, 2/6; 50+50mfd, 275-350v, 3in×1⅜in, clip, 3/6; 50+50mfd, 300-350v, 2in×1⅜in, clip, 4/-; 50+50mfd, 350-425v, 3in×1⅜in, prong, 5/-; 60+100mfd, 275-350v, 3in×1⅜in, clip, 4/6; 60+200mfd, 275-350v, 4½in×1⅜in, clip 5/-; 60+250mfd, 250-325v, 4½in×1⅜in, clip 4/6; 60+250mfd, 275-350v, 4½in×1½in, clip, 5/-; 100+65mfd, 250-325v, 3in×1⅜in, prong, 4/6; 100+200mfd, 250-325v, 4½in×1⅜in clip 5/6; 150+200mfd, 350-425v, 4½in×1⅜in clip 7/-; 200+100mfd, 275-350v, 4½in×1½in, clip, 6/6, 200+200mfd, 275-350v, 4½in×1¾in, clip, 7/6; 1,000mfd+1,000mfd, 6v, 3in×1in, clip, 3/6; 12+12+24mfd, 275-350v, 2in×1in prong, 3/6; 16+8+4mfd, 275-350v, 2in×1in, prong, 3/6; 16+24+8mfd, 2in×1⅜in, clip, 5/-; 20+20+10mfd, 275-350v, 2in×1in, prong, 3/6; 20+20+20mfd, 150v, 2in×1in, prong, 2/9; 30+25+20mfd, 150v, 2in×1⅜in, clip, 2/9; 32+32+2mfd, 275-350v, 3/-; 32+32+8mfd, 275-350v 2in×1⅜in, clip, 3/-; 32+32+8mfd, 350-425v, 2in×1⅜in, clip, 3/6; 40+30+20mfd, 275-350v, 3in×1in, prong, 3/6; 40+30+20mfd, 275-350v+25mfd 25v, 3in×1⅜in, prong, 4/-; 50+50+8mfd, 275-350v, 3in×1⅜in, prong 4/6; 50+50+50mfd, 350v, 3in×1⅜in, prong, 5/6; 200+250+250mfd, 275-350v, 4½in×2in, clip, 8/-; 40+20+10+10mfd, 350-425v, 2in×1⅜in, clip 5/-.
ALL prices include packing and postage.
RADIO CLEARANCE, LTD., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188.

CATHODE ray tubes, used but in good working order, with 3 months' written guarantee, £4/10 plus 12/6 carriage, etc., 12in to 17in, Mullard and Mazda, and equivalent types only.—Enquiries and orders in writing only to B.H.P. Distributors, 379, Staines Rd., Hounslow, Middx. [7230

NEW GRAMOPHONE AND SOUND EQUIPMENT

LEWIS RADIO for the right price and best selection.—See page 68. [0340

NEW GRAMOPHONE AND SOUND EQUIPMENT

GLASGOW.—Recorders bought, sold, exchanged, cameras, etc. exchanged for recorders or vice versa.—Victor Morris, 406, Argyle St., Glasgow, C.2. [0201

TRUE Hi-fidelity: have you heard Vortexion tape recording equipment in use with the latest Wharfedale and Goodman's Hi-Fi speakers? Why not arrange a personal demonstration, when we can give you our undivided attention and help you with your Hi-Fi problems? Write or 'phone for appointment. GRIFFITHS HANSEN (RECORDINGS), Ltd., 32-3, Gosfield St., Langham St., W.1. Mus. 2771/0642. [0293

TAPE Recorders, Ferrograph, 76gns; Reflectograph, £87; Brenell, 48 gns; tape decks, Wearite, Collaro, Truvox; microphones, Reslo, S.T.C., Acos; amplifiers, Leak, 27gns; Quad, £42; hire purchase facilities available; high fidelity tape to disc service.—Lambda Record Co., 4, Kimberley Ave., Liverpool, 23. [6884

OLD-ESTABLISHED studio offers you benefit of years of experience recording for broadcasting, TV, films, theatre, etc., in choosing your professional or domestic T.R.; Leevers-Rich, Ferrograph, M.S.S. Brenell Mk. IV, mics., tapes, speakers, etc., special tape bargains, tape/disc service, mobile and studio recording.
"EROICA" Recording Studios (1949), Peel St., Eccles, M/c. Eccles 1624. Director, Thurlow Smith, A.R.M.C.M. [0122

ATTENTION! The famous Sonomag "Adaptatape" pre-amplifier is now fitted to the Collaro Mk. IV tape deck and now incorporates push-pull oscillator, complete with power pack; 38gns. Easy terms and full specification on request.—Sound Tape Vision, the tape recorder and Hi-Fi specialists, 71, Praed St., London, W.2. Pad. 2807. [7355

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

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECONDHAND

FERROGRAPH 3 A/N as new, also accessories, tapes available; £74.—Box 8829. [0199

BIB tape splicers, with base, 13/6, without, fix direct to tape-recorder, 11/- including post.—44, Shipman Rd., Forest Hill, S.E.23. [7314

LEEVERS-RICH recorder, 11½in spools, 15 ips, timing clock, variable spooling, etc., £300, perfect condition; Vortexion 4-channel mixer, £15; Sugden Connoisseur m/c cutter head, £15.—Box 1089. [7297

CABINETS

LEWIS RADIO have the best selection and finest finish.—See page 68. [0224

CABINETS, radiogram and television, 25 models.—157, Bromsgrove St., B'ham. Mid. 1054. [7140

VALVES WANTED

ALL types of valves British or American, transmitting and receiving; keenest cash prices paid. What have you to offer?—Write or call Lowe Bros., 9a, Diana Place, Euston Rd., N.W.1. [6985

WANTED, EXCHANGE, ETC.

WANTED Mullard valve tester, cheap.—44, Shipman Rd., Forest Hill, S.E.23. For. 5513. [7313

WANTED Voigt Corner Horn with or without drive unit.—Parker, 17, Kingsley Park Ave., Sheffield, 7. [7309

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

VALVES (new), tape recorders, test equipment, any quantity.—Stan Willetts, 43, Spon Lane, West Bromwich, Staffs. Tel. Wes. 2392. [7079

LEE ELECTRONICS.—For all leading makes of high-fidelity equipment, tape recorders, tuners, amplifiers, speaker enclosures; bought, sold, exchanged.—400, Edgware Rd., Pad. 5521. [7283

URGENTLY required, scrap platinum wire, contacts, etc.; spot cash for any quantity; £27 per oz troy.—The Scientific Metal Co., 50, Old Brompton Rd., London, S.W.7. Tel. Kni. 2534. [7235

CASH on the spot for second-hand tape recorders, amplifiers and Hi-Fi equipment, top prices paid.—Sound Tape Vision (Dept. W.W.), 71, Praed St., London, W.2. Paddington 2807.

WANTED, BC610 Hallicrafters, E.T.4336 transmitters, BC312 receivers, BC221 frequency meters and spare parts for all above; best cash prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

WANTED, EXCHANGE, ETC.

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Gerrard 2504. [6993

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estb. 18 years.—Call, send or 'phone Ger. 4638, Miller's Radio, 38a, Newport Court, Leicester Sq., W.C.2. [7074

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

REPAIRS AND SERVICE

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

TRANSFORMERS rewound or built to specification, up to 8KVA, singly or in quantities; 12 months' guarantee.
NOTTINGHAM TRANSFORMER SERVICE, 179, Wollaton St., Nottm. Tel. 41992. [7260

USE Jefco coil winder, cheapest machine on the market.—Details, 170, London Rd., Southend-on-Sea. [0174

MAINS transformers, E.H.T.s, chokes, field coils, etc., promptly and efficiently rewound or manufactured to any specification.
LADBROKE REWIND SERVICE, Ltd., 320a, Harrow Rd., London, N.W.10. [0222

WE have in stock 1,000s and 1,000s of service sheets for sale or hire; these are the actual ones used by the trade; please send s.a.e. with enquiries.—M. Foy, 6, Wykebeck Gardens, Leeds, 9. [7208

D. C. BOULTON for repairs to any loudspeaker: specialists on heavy and P.A. types; cone assemblies, field coils, repair accessories, pressure units, microphones; transformers rewound and to specifications; motor rewinds.—134, Thornton Rd., Bradford, 1. Tel. 22838. [0171

PAINTS, CELLULOSE, ETC.

PANL, recognised for many years as the unique one-coat black crackle finish, brush applied, no baking; available by post in 1/8th pint cans at 3/6 from: G. A. Miller, 244, Nether St., London, N.3. [0260

MISCELLANEOUS

TAPE to disc; 12/6.—Mobile Recording Services, 5, New Brown St., Manchester. [6555

COIL winding machines, as new, and small stock of wire; Birmingham area.—Box 1516. [7347

REWINDS, all types of transformers rewound as original or new types supplied to your specification.
MANUFACTURERS of the "Meltronic Series" of quality transformers and chokes.
MELTON ELECTRONICS, LTD., 42, Towngate St., Poole, Dorset. Tel. Poole 2044-5. [7343

FOR sale 50 chimney brackets; brand new with corner plates/hooks. £12 10s. carriage forward.—Box 1184. [7312

REFRIGERATOR spares of every description.—Farron Refrigeration, Station Approach, Sanderstead. Tel. 3655. [7221

TAPE to disc, Queensway Recording Studios, 123, Queensway, W.2. Bay. 4992. Recorders serviced and for hire. [6994

TAPESPONDING.—Exchange your recorded messages with tape pals home/overseas.—Ewart, 87, Terrace, Torquay. [7320

HAVE your tape recordings transferred to discs; quick service.—Supertone Radio, 29, King St., W.3. Acorn 2594. [0195

RENDEZVOUS RECORDS offer comprehensive size 78/LP tape to disc recording facilities. Leaflet from: 19, Blackfriars St., Manchester 3. [7249

PLAIN white valve cartons, best quality board, 4 sizes available from miniature to large G; list on request.—R.H.S., Ltd., 155, Swan Arcade, Bradford. [0195

TOROIDAL inductors, considerable stocks held of wound coils up to 1Hy.; Toroidal winding to order.—Bel Sound Products Co., Marlborough Yard, London, N.19. [0182

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

TAPE to disc recording—LP (30 mins.), 25/-; 78's 12/-; 48-hour service; s.a.e. leaflet.—Marsh, Little Place, Moss Delph Lane, Aughton Ormskirk, Lancs. Aug. 3102. [6907

MISCELLANEOUS

USE Britain's oldest full-time tape/disc transfer service for LPs and Mark 78s (still 1952 rates).—Sound News Productions, 59, Bryanston St., London, W.1. Amb. 0091. [0192

HEAVY duty auto-transformers (ZA22917) input and output 100/120v, 150/170v, 200/250v, 40/60 cycles, 500 watts approx., all brand new in makers' boxes. 49/6, part cost packing and carriage 7/6. Brand new electric motors, 1/6th h.p., standard ½in shaft, continuous 1,400rpm rating, made by Hoover, Compton Parkinson, etc., 120-125 volt a.c. 50-cycle single-phase, or 110-120v a.c. 50-cycle single-phase, 59/6; 220-230v d.c., 55/-; 200-220v a.c. single-phase 79/6; part cost packing and carriage 7/6 in each case.
WALTON'S WIRELESS STORES, 48, Stafford St., Wolverhampton. [0145

NOTICES

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

AGENTS WANTED

ADVERTISERS wish to enter into a mutual arrangement for representation by gentleman at present calling upon manufacturers of equipment employing electronic units or devices: please write in strictest confidence.—Box 0750. [7245

BUSINESS AND PROPERTY

DRURY Lane, W.C.—Light workshop available, suitable TV servicing, light and phone. —Holborn 8622. [7284

BUSINESS AND PROPERTY WANTED

PREMISES central London sought by small private recording service, sharing partnership consid.—Box 8828. [0194

BUSINESS OPPORTUNITIES

ANGLO-AMERICAN house in New York seeks exclusive franchise for U.S.A., Latin America or Canada for British tape recorder mechanisms, record changers or Hi-Fi speaking units; also interested in manufacturing licenses.—Box 1340. [7340

WELL-KNOWN firm of precision engineers and instrument makers (London area) are desirous of entering into a licence agreement or purchasing outright, patents relating to electrical and/or mechanical devices of a precision instrument character, or of a consumer goods nature; adequate capital and production facilities are available to develop, produce and market suitable devices.—Communications should be addressed, in the first instance, to Box 7247. [7146

CAPACITY AVAILABLE

CHASSIS work, instrument cases, embossed panels, in all usual metals. Special groundboards in S.R.B.P., etc. Long or short runs. Precision work at keen prices. Extensive range of stock tools for radio and electronics industry: special tooling at favourable rates.—Metalwork Dept., Unitelex (London), Ltd., Pagnell St. London, S.E.14. Tideway 5842. [0200

WORK WANTED

ELECTRONIC apparatus wiring and subassembly work wanted.—Please write E. G. C. Rawson, 47, Morley Crescent West, Stanmore, Middlesex. [7220

SUB-ASSEMBLY work invited by specialising company; excellent capacity for longish runs; increased output for you at reduced costs. —Box 1016. [7295

SITUATIONS VACANT

HER Majesty's Overseas Civil Service

A VACANCY exists for an Assistant Superintendent of Police (Signals Officer) in Tanganyika.
CANDIDATES, preferably under 30 years, must have sound knowledge and practical experience of the installation and maintenance of all types of H/F and V.H.F. equipment including erection of masts used in Police fixed and mobile radio communication or similar services and should have good knowledge of the maintenance and repair of petrol and diesel generating sets.
APPOINTMENT is permanent and pensionable with salary including inducement pay in the scale £879—£1,422 per annum. Outfit allowance £15 on first appointment. Free initial issue of uniform and an annual allowance of £25 towards its upkeep. Free passages for officer, wife and children up to cost of three adult passages. Government quarters when available at low rent. Taxation at low local rates. Generous leave.
SUMMARY of personal particulars, qualifications and experience to the Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD55/8/09. [7354

SERVICE technician with experience of television and V.H.F. required; Dublin firm; state qualifications, experience, salary expected. —Box 1468. [7344

SITUATIONS VACANT

TV TECHNICAL SALES.
A VACANCY has arisen in the TV Technical Sales Department of Pye, Ltd., for an Assistant, whose duties include the preparation of quotations and the handling of orders, correspondence and enquiries relating to the sale of television transmission equipment at home and overseas.
PREVIOUS experience in this work is not essential although a knowledge of television equipment would be an asset. Important qualifications are ability to deal with customers at all levels and to work on own initiative.
APPLICATIONS should be addressed to the Chief Engineer, Pye, Ltd., Cambridge, quoting "ATS." [7331

INSTRUCTOR, Grade I, required by POSTS and Telegraphs Department, Nigeria Federal Government, for one tour of 12-24 months in first instance. Salary scale (including inducement addition) £1,536 rising to £1,674 a year. Disturbance allowance £200-£250. Gratuity at rate of £150 a year. Commencing salary according to experience. Free passages for officer and wife. Assistance towards children's passages and grant up to £150 annually towards maintenance in U.K. Liberal leave on full salary. Candidates, preferably under 40 years of age, should have had experience in the installation or maintenance of Multi-channel radio telephone systems and be conversant with V.H.F. and F.M. techniques. They must have had not less than three years' teaching experience and should possess C. & G. Certs. in Telecomms. Principles III and Radio III or equivalent.—Write to the Crown Agents, 4, Millbank, London, S.W.1 State age, name in block letters, full qualifications and experience and quote M2C/42120/WF. [7330

SENIOR Electronic and Mechanical Engineers. ARE required by Pye, Ltd., of Cambridge, for an expanding TELEVISION programme for home and export markets.
OPPORTUNITIES exist for suitably qualified and experienced engineers to join the design and development teams of one of the counntry's leading T/V manufacturers in the following fields:
1. T/V Receivers.
2. T/V Transmitters, medium and high power.
3. T/V Terminal equipment, including studio and O.B. equipment.
4. INDUSTRIAL T/V.
5. T/V Flats Distribution Systems.
ALTHOUGH desirable, previous T/V experience is not essential, and applications will be welcomed from engineers with several years' design and development experience in other branches of the electronics industry.
APPLICATIONS should be addressed to the Chief Engineer, Pye, Ltd., St. Andrew's Rd., Cambridge, quoting "STE." [7318

APPLICATIONS are invited for pensionable posts as EXAMINERS in the PATENT Office.
TO undertake the official scientific, technical and legal work in connection with Patent applications.
AGE at least 21 and under 35 years on 1st January, 1957, with extension for regular Forces' service.
CANDIDATES must have (or obtain in 1957) 1st or 2nd Class Honours in Physics, Organic or Inorganic Chemistry, Mechanical or Electrical Engineering or in Mathematics, or an equivalent qualification, or have achieved a professional qualification, e.g., A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C. For a limited number of vacancies candidates with 1st or 2nd Class Honours degrees in other subjects—scientific or otherwise—will be considered. Exceptionally candidates otherwise qualified by high professional attainments will be considered.
STARTING pay for 5-day week of 42 hours in London between £605 and £1,120 (men), according to post-graduate (or equivalent) experience and National Service. Maximum of scale £1,345. This salary scale is being increased by approximately 5%. Women's pay above £605 slightly lower but is being raised to reach equality with men's in 1961. Good prospects of promotion to Senior Examiner rising to £2,000 (under review) and reasonable expectation of further promotion to Principal Examiner.
APPLICATION form and further particulars from Civil Service Commission, Scientific Branch, 30, Old Burlington St., London, W.1. quoting S 128/57 and stating date of birth.
INTERVIEW Boards will sit at intervals, as required. Early application is advised. [7300

BRITISH COMMUNICATIONS CORPORATION, Ltd., Exhibition Grounds, Wembley, have vacancies for the following:—
(1) PROCESS planning engineer with experience of methods to produce electronic telephone and similar equipment.
(2) DRAWING office clerk to prepare material schedules from drawings
(3) DESIGNER draughtsmen.
ALL progressive, pensionable appointments.
APPLY, with details of qualifications and experience, to Personnel Officer. [7352

HI-FI.—Vacancy for sales assistant with good technical and practical knowledge of all modern Hi-Fi equipment.—Berry's Radio, 25, High Holborn, W.C.1. [7223

SITUATIONS VACANT

CHIEF engineer, telecommunications department, Mauritius.
TO be responsible for the engineering branch, particularly for the installation and maintenance of C.B. and automatic exchanges, training of technical staff and as necessary to take charge of the department.
PERMANENT and pensionable appointment or contract appointment for 3 years. Salary £1,327/10 p.a., plus cost-of-living allowance. Contract gratuity—£50 for each 3 months' resident service. Free passages for officer, wife and up to 3 children. Quarters, if available. Generous leave.
CANDIDATES must be A.M.I.E.E. or be exempted from the Institution's examinations, and have considerable practical experience in maintenance and installation of telecommunications equipment, particularly automatic exchanges.
WRITE Director of Recruitment, Colonial Office, London, S.W.1, giving age, qualifications and experience, quoting BCD 133/52/01. [7293

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY.
RESEARCH Assistant required to work on a project concerned with electronic equipment for the control of machine tools. The project is sponsored by the National Research Development Corporation.
THE successful applicant will be expected to lay out, construct and test such equipment according to the requirements and specifications supplied by research engineers. Experience of similar work is essential. Salary according to experience.
APPLICATIONS in writing, stating experience, qualifications, salary requirements, etc., should be addressed to the Registrar, The Manchester College of Science and Technology, Sackville Street, Manchester, within fourteen days of the appearance of this advertisement. [7346

PETO SCOTT ELECTRICAL INSTRUMENTS, Ltd., Addlestone Rd., Weybridge, Surrey.
SENIOR and Junior Development Engineers are required for the design of domestic television equipment, employing printed circuit techniques.
DEVELOPMENT Engineers are also required for application and design of transistorised equipment of various types.
LABORATORY Technicians and Wirers for employment on television transmission equipment and electronic instruments.
EXCELLENT rates of pay, and ideal working conditions in modern, well-equipped laboratory will be available to successful applicants.
THERE are new housing estates in the vicinity and the area is well served by train and bus services to most parts of London.—Apply: Chief Engineer. [7305

ASSISTANTS (Scientific).—The Civil Service Commissioners invite applications for pensionable posts.
AGE at least 17½ and under 26 years of age on January 1st, 1957, with extension for regular service in H.M. Forces, but candidates over 26 with specialised experience may be admitted.
CANDIDATES must produce evidence of having reached a prescribed standard of education, particularly in a science or mathematical subject. At least two years' experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces essential in one of the following groups of scientific subjects:—
(i) ENGINEERING and physical sciences.
(ii) CHEMISTRY, bio-chemistry and metallurgy.
(iii) BIOLOGICAL Sciences.
(iv) GENERAL (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).
STARTING pay £355 (at 18) up to £485 (women £454) at 25. Men's scale maximum £665; women's scale being raised to reach equality with men's by 1961; somewhat less in provinnces; opportuninties for promotion and for further education; 5-day week, generally.
FURTHER particulars, from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S59/57.
INTERVIEW Boards sit at intervals, as required: early application is advised. [7319

REQUIRED for interesting research development work on electro-acoustic devices, an Engineer up to B.Sc. standard.—Apply Box 8273. [0099

ENGINEER required, experienced in television and radio, able to drive; good salary.—Ritz Radio & Electrical Co., 306, Neasden Lane, N.W.10. Gladstone 4983. [7299

SEVERAL attractive and senio positions are offered in the development and industrial application of modern non-destructive testing techniques; the positions will be in the following fields:—
(1) ELECTRONIC Circuit Development.
(2) PROPERTIES of Materials.
(3) PHYSICAL Investigation and Measurement.
They offer good scope to men of initiative and experience in the above fields; salaries will be commensurate with the candidate's qualifications and experience.
Applications should be made in writing in the first instance, giving full details of qualifications, previous experience, age and salary required and be addressed to:—
PERSONNEL Department,
KELVIN & HUGHES, Ltd., New North Rd., Barkingside, Essex. [7209

SITUATIONS VACANT

AUDIO and television engineer required by leading manufacturer, applicants to submit full details of qualifications and experience; all applications treated as strictly confidential.—Box 0303. [7187

RADIO Mechanics wanted immediately, workshop and aircraft experience essential: pay according to ability.—Apply: Chief Radio Engineer, Dan-Air Engineering, Lasham Airfield, Nr. Alton, Hants [7257

RADIO/TELEVISION.—Service engineer, capable man required, ability to drive an advantage, permanent and progressive position, half-day Saturday.—Apply, Staff Manager, Gamages of Holborn. [7321

RADIO repairmen required to repair navigational radio equipment, applicants should have good basic knowledge of radio.—Please apply: Ref. RFB, Decca Radar, Ltd., Brixton Rd., S.W.9. [7306

TELEVISION service engineer; good position and prospects for keen man with high standards of service; able to drive; write, stating age and details of experience.—Drazin, Ltd., 59, Heath St., Hampstead, N.W.3. [7349

AUDIO engineers required for progressive positions in expanding organisation; men with experience of development test and service work apply to Personnel Manager, E.A.R., Ltd., The Square, Isleworth. Tel. Hou. 6256. [7239

SUPERVISOR required by leading manufacturer of high quality loudspeakers and microphones, experience in this field and ability to control female staff essential; full particulars and wages required.—Box 1413. [7328

PERSONAL assistant required by owner of London retail radio and electrical business of good standing; congenial position and good prospects for capable and conscientious person; state age and full details of career.—Box 1517. [7348

SUPERVISOR is required for department associated with assembly and test of high-grade transformers; considerable experience of this class of work is necessary, and electrical qualifications are desirable; ability to control female labour is essential.
GOOD salary and prospects; pension scheme, sports club, etc.
APPLY by letter, setting out qualifications and experience, to Personnel Manager, R. B. Pullin & Co., Ltd., Phœnix Works, Great West Road, Brentford, Middx. [7326

TELEVISION Engineer.—Large Cardiff house require experienced engineer, must have experience on all leading makes, good comfortable permanent job with excellent wages and prospects; new flat available if required.—Full particulars to Box 1100. [7302

EXPERIENCED electrical engineer required for development laboratory to work on electro mechanical and electronic instruments; degree or similar qualification essential; housing available.—K.D.G. Instruments, Ltd., Manor Royal, Crawley. [7350

TECHNICAL writers required for writing radar technical manuals, applicants should have previous experience in writing and good knowledge of radio and radar techniques.—Please apply: Ref. RFB, Decca Radar, Ltd., 1-3, Brixton Rd., S.W.9. [7307

ELECTRONIC engineer required for development work on saturable reactor devices and power transformers; H.N.C. or equivalent standard, with design experience in this field.—Apply in writing to Hirst Electronic, Ltd., Gatwick Rd., Crawley, Sussex. [7294

INSTALLATION and service engineers required by Decca Radar Ltd., applicants must have sound knowledge of both radio and radar, marine experience an advantage but not essential.—Applicants please apply in writing: Ref. RFB, 1-3, Brixton Rd., S.W.9. [7308

FARADAY ELECTRONIC INSTRUMENTS, Ltd., 245, Brixton Rd., S.W.9, have vacancies for young men in the test and inspection department which could lead to development work for the right type of man; further education is encouraged.—Apply in writing to the Chief Engineer. [7296

MCMICHAEL RADIO, Ltd., Slough, require a radio development engineer with experience in F.M./A.M. design and progressive ideas; good pay and prospects with an expanding and progressive company; pension scheme.—Apply to Personnel Officer, McMichael Radio, Ltd., Wexham Rd., Slough. [7323

TESTER-Inspector. A leading firm in audio equipment require several young men with electronic test experience and technical knowledge. 44-hour week and overtime, canteen, good rate and prospects. West London region. Please state age, details of training and experience.—Box 1457. [7342

LABORATORY technician required for development of prototype electronic equipment. City and Guilds or National Certificate qualification desirable, but practical experience essential; salary in accordance with qualifications and experience.—Apply in writing to the Director of Research, Research Laboratories, The British Aluminium Co., Ltd., Chalfont Park, Gerrards Cross, Bucks [7353

SITUATIONS VACANT

INSPECTOR required for electronic equipment and components, good remuneration and excellent prospects for advancement in expanding company.—Rivlin Instruments, Ltd., Doman Rd., Yorktown Industrial Estate, Camberley, Surrey. Telephone Camberley 2507-8. [7334

VACANCY exists for electrical engineer or physicist, interested in the design of selenium metal rectifiers; applicant would be expected to work in close liaison with design and sales sections and be prepared to undertake original work; good salary for competent person. Automat, Moorside Rd., Swinton. Tel. Swinton 4242. [7322

THE Medical Research Council have a vacancy for an operator to be trained in the running of their 45in cyclotron at Hammersmith Hospital; duties will include supervision of the production of radioactive isotopes on the cyclotron and co-operation with workers using the machine for medical and biological research.
CANDIDATES must be adaptable and willing to learn cyclotron techniques; some knowledge of electronics, including R.F. is essential.
SALARY according to age, experience and qualifications.—Write, stating age and give full personal details, to the Senior Cyclotron Engineer, Medical Research Council, Hammersmith Hospital, Ducane Rd., W.12. [7335

RADAR Technician, experience in Third Line Maintenance and servicing of Ground and Air Radar equipment preferred. Would suit ex-R.A.F. radar fitter or mechanic. Staff appointment.—Write, giving details of experience, qualifications, age, etc., to Personnel Department (E44), Murphy Radio, Ltd., Welwyn Garden City, Herts. [7345

OVERSEAS. Electronic technicians to maintain & operate equipment on seismic field crews. Academic qualifications to H.N.C. or equivalent or genuine practical experience to this standard. Liberal home leave. Permanent career for men prepared to accept responsibility & work in camp conditions in all parts of the world.—Box 1239. [0188

ABLE electronic engineers required for varied and interesting work in rapidly expanding research department, experience of pulse techniques / ultrasonics desirable but not as essential as initiative and capability.—Write giving details of qualifications, experience, age and salary required to Ultrasonoscope Co. (London), Ltd., Sudbourne Rd., London, S.W.2. [7248

SKILLED radio mechanics. A large organisation has vacancies for men who are prepared to travel and work anywhere in the world. Periods abroad from 6-24 months. Salary £75 per month plus all found; candidates must be single, medically fit and have a good knowledge of radio theory and practice. Write Box WD.360 c/o 191, Gresham House, E.C.2. [7311

RADIO mechanics. Skyways Limited require the following experienced radio mechanics at Stansted Airport for employment in workshops and on maintenance of equipment in aircraft. Applicants must be fully experienced particularly in workshop practice; good rates of pay and conditions of service; apply with full details to Personnel Manager, Skyways Limited, Stansted Airport, Essex.

TEST engineer required for testing prototype aircraft and allied instruments by light engineering company in south-west Essex locality; applicants should have a sound knowledge of electronics and some experience of aircraft instrumentation; experience of radio interference suppression an advantage; the work is of an interesting and varied nature requiring a methodical approach to the testing and subsequent reports of the best results.—Write, giving full details, to Box 1425. [7333

A VACANCY exists in the Electronics Laboratory in a section engaged upon the design of special purpose television receiving equipment. Several design projects are currently in hand offering interesting work in the industrial and other fields. Applications are invited from candidates possessing experience in the design of domestic television receivers, giving details of experience and qualifications, and should be addressed to Personnel Department (E.43), Murphy Radio, Ltd., Welwyn Garden City, Herts. [7338

MEDICAL RESEARCH COUNCIL Experimental Radiopathology Research Unit, Hammersmith Hospital, Ducane Road, London, W.12, require an electronics technician to work in a laboratory engaged in construction and maintenance of a wide variety of apparatus; previous electronic experience necessary; adv. level G.C.E., O.N.C. or equivalent preferable; age limit 25; salary in scale £515-£630 plus London weighting; prospects of promotion.—Apply in writing, giving two referees, to the Director. [7327

AMBASSADOR RADIO & TELEVISION, Ltd., have vacancies for development engineers in their television and radio laboratories. Men of degree standard or its equivalent are preferred, but lack of recognised qualifications will not exclude, providing the applicant has a keen technical interest and possesses initiative; previous experience of this class of work is an advantage, but is not essential.—Write, in first instance, giving details and salary required to Technical Director, Princess Works, Brighouse, Yorkshire. [7332

SITUATIONS VACANT

TEST-Engineers.—Vacancies exist for experienced engineers, applications are invited from test engineers with previous industrial experience of testing radio communication or similar electronic equipment; the work of the test laboratory of this expanding company is varied and includes the testing to specification of prototype and small batch production of the following types of equipment:—
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(c) MARINE installations including automatic alarms and d.f. equipment.
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(e) AUDIO amplifiers (2w-2kw).
THE positions are permanent and progressive and the salaries offered will be commensurate with qualifications and experience.—Apply, giving full details to Personnel Officer, Redifon, Ltd., Broomhill Rd., S.W.18. [7336

ENGINEER required to assist on sales and demonstration of VHF radio-telephone equipment; this is an interesting appointment for a young engineer with some general experience of VHF systems and with a presentable manner.—Please write, giving details of past experience, qualifications, age and salary required, to Personnel Department (E41), Murphy Radio, Ltd., Welwyn Garden City, Herts. [7303

RADIO technicians of all grades are invited to supply for interesting and varied positions in car radio servicing, installation and development. Vacancies occur from time to time for our dealers at all parts of the country; a high standard of practical and theoretical knowledge of radio technology is required.—Apply in the first instance to: Personnel Officer, S. Smith & Sons (Radiomobile), Ltd., North Circular Rd., London, N.W.2. [0270

INSTRUCTOR in marine radio required by the College of I.M.R. Commns., Overseas House, Brooks' Bar, Manchester, 16; technical standard equal to C. & G. Radio III with Telecomms.: Principles II desirable; P.M.G. 1st class certificate and lecturing experience in radio an advantage; salary based on Burnham Scale with pension scheme for man of proved ability.—Write Principal (Ref. "Staff"), giving full particulars in confidence. [7316

RADIO technicians required by International Aeradio, Ltd., for overseas service; permanent pensionable positions; inclusive salary from £845 per annum to £1,616 per annum, tax free, according to marital status; child allowances; free accommodation, free insurance, kit allowance, free air passages, generous U.K. leave; qualified candidates to whom replies only will be sent please write, quoting R.T., to—Personnel Officer, 40, Park St., W.1. [0262

NUCLEONIC and Electronic Development Engineer required by manufacturers who have pioneered development and production in this field; the successful applicant will be responsible for complete electrical development of instruments; there are first-class facilities available in new laboratories; the salary offered will be in the range £850-£1,100 p.a. and there is an attractive pension scheme in operation.—Apply, stating qualifications and experience, to Chief Engineer, Dynatron Radio, Ltd., St. Peters Rd., Furze Platt, Maidenhead, Berks. [7325

SECTION leader is required by A. V. Roe & Co., Ltd., for the environmental test laboratory of the Weapons Research Division (Guided Weapons) at Woodford, Cheshire. This laboratory is equipped to carry out a wide range of vibration and climatic tests on electronic and electro-mechanical components. Applicants should be of degree standard and possess experience of electronic development work and light engineering practice. Replies should be addressed to The Chief Engineer, A. V. Roe & Co., Ltd., Weapons Research Division, Woodford, Cheshire, quoting Ref. No. SL/R.23/W. [7339

STANDARD TELEPHONES & CABLES, Ltd., North Woolwich, London, require qualified electronic engineers for test apparatus laboratory. The work covers the development of a wide range of high-frequency testing equipment associated with the design of telephone and television cables. Practical experience in electronics is essential, with qualifications to H.N.C. level. Applicants will work in a well-equipped laboratory with access to all facilities of a large organization. Non-contributory pension, life insurance and many other facilities.—Please write experience and career to date to Personnel Manager, North Woolwich, London, E.16. [7337

ELECTRONIC Engineer required for Technical Advisory Laboratory of Design Department; the work involves research into suitability of all components and materials for inclusion in new designs of radio and television, and affords a practical graduate engineer a fine opportunity of broadening experience in an interesting branch of work; a further vacancy exists in the same type of work suitable for an applicant of H.N.C. standard; Welwyn Garden City is well situated in pleasant countryside within easy reach of London, and applicants from the London area would become eligible for housing; applications giving full details of experience, age, qualifications, salary expected should be forwarded initially to—Personnel Department (R.10), Murphy Radio, Ltd., Welwyn Garden City, Herts. [7227

SITUATIONS VACANT

THE General Post Office has vacancies for radio operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster-General's first-class certificate of proficiency in radiotelegraphy or an equivalent certificate issued by an administration of the Commonwealth or of the Irish Republic: selected candidates will be considered later for permanent pensionable posts. Application should be made to the Inspector of Wireless Telegraphy, Radio Services Department, Wireless Telegraphy Section, Union House, St. Martins-le-Grand, London, E.C.1. [7317

HIGH DUTY ALLOYS, Ltd., Research Division, Slough, Bucks, invite applications for an appointment in the Physics Laboratory; candidates should preferably be either physicists with a good degree and have some knowledge of electronics, or electronic engineers to the standard Grad. I.E.E. with an interest in applied physics; the successful candidate will have an opportunity of developing a knowledge of special applications of X-ray diffraction and non-destructive methods of determining the condition of metals and alloys; the salary will be in accordance with qualifications and experience and there is a pension scheme in operation; applications, giving full details, should be sent to —The Staff Manager, address as above. [7221

TELECOMMUNICATIONS Inspector required by British Railways at York; applicant must have wide practical experience including theoretical knowledge of electronic equipment including V.H.F. radio, line transmission overhead line and cable construction, carrier telephone and automatic telephone exchange systems. Applicant will be required to test all types of telecommunications apparatus and instruct personnel in the maintenance of equipment throughout the North Eastern Region. A technical standard of Higher National Certificate or equivalent is desirable, but consideration will be given to an otherwise suitable applicant. Pension scheme, free travel facilities; salary £775 to £832 per annum; apply in writing to Signal Engineer, British Railways, York, giving full details of experience, qualifications and age etc. [7510

SITUATIONS WANTED

RADIO electronics technician, 36, wide experience, seeks post in Australia.—Box 1431. [7329

PORTUGUESE ex-officer, 27, single, experienced assembly and repairs, radar and other electronic equipment, fairly fluent English, some knowledge French; suggestions welcomed.—M. Soares Rodrigues, Rua Nova da Trindade, 1-3-D, Lisbon, Portugal. [7304

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PERSONAL

MORBEY.—If Robert Morbey who formerly resided in the Welwyn Garden City area and who at one time worked for Murphy Radio, Ltd., will communicate with Messrs. Wild & Hewitson, Solicitors, 4, Market Hill, Saffron Walden, Essex, he may hear something to his advantage. [7324

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