Wireless World

ELECTRONICS, RADIO, TELEVISION

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In This Issue

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Transistors for the Experimenter

As in previous years, one of the Mullard contributions to the 1956 Radio Show is a stand supplying technical information to all those who use valves and other electronic devices—whether at work or for their hobby. These enthusiasts are often described generally as home constructors, but many professional engineers, dealers, service engineers, teachers, and students are included among their number. Our publication on transistors this year is called "Transistors for the Experimenter". Deliberately the rather vague term 'experimenter' has been introduced to cover a wide range of interests and requirements. The title does not mean that the booklet has a restricted appeal: on the contrary, nobody need feel left out.

Transistors give us all the opportunity to start afresh and to follow the subject through from its beginnings. A very large part of the booklet has therefore been devoted to the more instructional aspects of transistor applications. More important, many circuits are given in the later pages. Most of the circuits are new, and the text has been completely revised and made several times larger than that given in "Junction Transistors for the Home Constructor". Material which has appeared in earlier advertisements in this series has been included.

Particular interest this year centres round the low power output OC72 junction transistor. Two circuits for a 200mW amplifier are supplied, one for operation from a 6-volt supply and the other for 4.5V. The output and sensitivity are sufficient for small portable equipment such as gramophones and personal radio receivers. A crystal pick-up will drive the amplifier fully. A number of possible r.f. front-ends for the amplifier are described, though the sensitivity requirements of these r.f. circuits are such that in general the amplifier will not be driven to its full output.

Circuits are included which show how the personal receivers can be made in a form which feeds into an insert earpiece. Other new circuits are: a two-transistor R-C coupled sinusoidal oscillator; a symmetrical multivibrator; a bridge balance indicator; and a sensitive e.h.t. voltmeter.

Each circuit is accompanied by notes which show, for example, the possible uses and operating ranges of the equipment. An explanation of the mode of operation of the circuit is given to help the reader grasp the applicational information in the rest of the booklet.

After the circuit descriptions the remainder of the booklet is fairly general. The design of transistor circuits is by no means a hit-or-miss or empirical affair. Although reasonably full design procedure is described to show not only how it's done, but that it can be done, the more immediate and practical methods are not neglected.

Following some introductory notes on the circuit configurations etc., the most important new material comes under the following headings. *Small-signal a.f. stages* shows how small-signal parameters are applied to the earlier stages of amplifiers. *D.C. stabilising* gives a full treatment of this topic, including the preferred system using a potential divider and emitter resistor, and shows how production spreads are allowed for. *Large-signal a.f. stages* is devoted chiefly to Class B and the design of the output stage of the 200mW amplifier, with examples. Further sections indicate the problems encountered at *high frequencies* and in *oscillator* and *switching* circuits etc. *Transistor data* contains a discussion on the choice of limiting values.

"Transistors for the Experimenter" can be obtained at our Radio Show stand or after the show from the address below. No charge is made for this publication.

D2A

DEALERS: SERVICE ENGINEERS: HOME CONSTRUCTORS: You are invited to visit the Mullard technical information service in Demonstration Room D2A.

TAPE RECORDER ENTHUSIASTS: Circuits for recording and playback amplifiers are on view. Two circuits are described, with constructional information, in a free booklet "Circuits for Tape Recorders". One circuit is for a unit to feed into a high quality amplifier such as the '5-10'. The other unit is self-contained and gives an output of about 3 watts.

AMPLIFIER CONSTRUCTORS: Built-up amplifier circuits and the f.m. tuner unit are specially displayed. Constructional details of these circuits are given in "High Quality Sound Reproduction" (on sale, price 3s. 6d.). A supplement giving additional information is being issued free. The free leaflet on the 3-valve 3-watt amplifier is being re-issued and shows an improved and slightly modified circuit.

TRANSISTOR STUDENTS: Get your free copy of "Transistors for the Experimenter". Many circuits are described including miniature receivers, pre-amplifiers, and 4.5-volt and 6-volt versions of the 200mW amplifier.

Something for Everybody: Demonstration Room D2A is divided into two parts. General technical enquiries will be answered in an open 'forecourt'. Literature is distributed here, and there is also a display of non-working equipment built from Mullard circuits. Working models of the circuits are located in a demonstration room leading off the forecourt. Constructors can examine and compare the circuits and discuss problems with the engineers.

Mullard

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Wireless World

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Recording From the Telephone

EVERY telephone subscriber knows that the G.P.O. instrument in his home or office remains the property of the Postmaster-General, and must not be tampered with. But most of us probably believe that the P.M.G., if he does not officially approve, turns a blind eye on the use of telephone attachments depending entirely on acoustic or inductive couplings, and so involve no mechanical tampering or the making of metallic electrical connections.

Apparently that belief is wrong. In *Wireless World* for July we published a description of a simple telephone answering machine. It seemed to satisfy the "no tampering" rule, and the descriptive article carried an implication that the device would meet Post Office requirements. The G.P.O. now tells us that implication was incorrect. The device described in our article has not been submitted for approval; further, in the official view, a reliable answering/recording service can only be provided by a self-contained appliance directly wired to the telephone installation.

Any telephone answering machine of necessity makes use of a two-way coupling to the Post Office instrument and may also present other electrical and mechanical problems. Instead of commenting on the Post Office statement just quoted, we will consider a much simpler kind of telephone attachment—the tape recorder pick-up. This consists merely of an inductor for attachment (usually by a sucker) to the body of the telephone instrument in order to provide an inductive coupling with the built-in transformer, and thus to allow the recording of incoming messages. These pick-ups, in one form or another, are offered by several manufacturers of tape recorders and are in widespread use. But do they have the official blessing of the Post Office?

The relevant section of "The Telephone Regulations, 1954," reads:—

"A subscriber shall not, without the written consent of the Postmaster-General:—

(*a*) alter or remove an installation or any part thereof, or obliterate or deface any marks thereon;

(*b*) make any attachment to an installation, or place any thing in electrical connection therewith;

(*c*) place or use in any manner or position in relation to an installation any thing that may in the opinion of the Postmaster-General have a harmful effect on the installation or on its use for the purposes for which it is provided; or

(*d*) place or use any thing (unless provided for the purpose by the Postmaster-General) in such a manner or position in relation to an installation that it transmits or enables to be transmitted any message or other communication to or from the installation. . . ."

According to the strict letter of the Regulations there is little doubt that even a recorder pick-up would rank as an "attachment," though it might conceivably be admitted under paragraph (*c*) if it were considered to have no harmful effect. *Wireless World* has accordingly questioned the G.P.O. Engineering Department on that point, and finds the attitude to be distinctly frigid towards inductively coupled pick-ups. Only one tape recorder attachment has so far been approved, and that uses a directly wired connection, which is considered to be necessary. As to "harmful effects," the main trouble—and that admittedly is not common—is said to be due to the transfer of h.f. bias currents from the recorder to carrier circuits, with consequent heterodyning. Official objections to inductive pick-ups are apparently more concerned with their alleged ineffectiveness and the fear that their use may bring discredit on the telephone service. Incidentally, our experience tends to show such fears are unjustified, as good recordings can be made after very little practice.

Although we do not question the superiority of the direct electrical connection for regular use, to insist on it seems greatly to restrict the applications of recorders as telephone adjuncts. Those who have only an occasional need for recording messages will probably be unwilling to go to the trouble and expense of having a break-in point installed by Post Office mechanics, though that procedure would not deter regular users. The inductive method of coupling has the great advantage of simplicity and cheapness and it seems a pity that the Post Office should turn its face too resolutely against it until the possibilities of overcoming the deficiencies have been explored. Transfer of bias current to the telephone lines could surely be prevented quite easily; we should imagine that the number of modern recorders in which a significant h.f. voltage is developed across the input terminals must be very small.

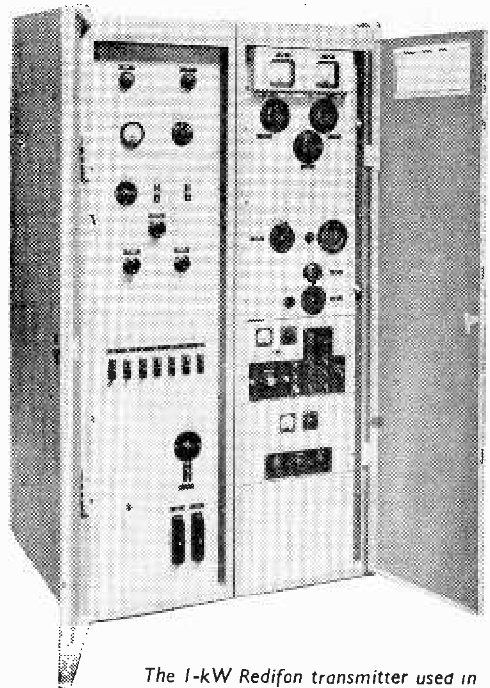
Communication via Meteors

LOW-POWER ALTERNATIVE TO IONOSPHERIC SCATTER

TELEGRAPHIC radio signals can be transmitted up to 1,000 miles by a new v.h.f. technique in which the waves are reflected from the ionized trails of meteors in the upper atmosphere. Developed by the Canadian Defence Research Board under the code name "Janet," the method is notable for requiring only a small radiated power and uses transmitters of about 1-kW output. It therefore offers a very economical alternative to the high-power ionospheric scatter system, with small, low-cost stations and simpler aerial arrays. Moreover, it appears to be unaffected by electrical and cosmic disturbances, while the spasmodic nature of the reflecting medium ensures a high degree of privacy. Reliability in transmitting messages is claimed to be 95%.

The meteors, which are about the size of pin-heads, plunge into our atmosphere in the region of 60 miles up at a speed of roughly 100,000 m.p.h. They are burnt up rapidly in this process and as a result leave behind trails of ionized particles up to six miles long. Radio astronomers have been using these trails as reflecting media to measure the speed of the meteors by radar methods since about 1946. It has been estimated that some 8,000 million of the meteors enter our atmosphere each day, and there are hundreds of usable trails formed every hour between any two fixed points at the right sort of altitude.

Nevertheless the meteors are essentially spasmodic in their appearance, and the equipment of "Janet" has to be specially designed to take advantage of them when they come. A complete communications circuit has two ground stations, each with a transmitter and a receiver and carefully aligned directional aerials. The transmitters and receivers are on continuously, but no messages are passed until a meteor forms a trail across the spot in the atmosphere at which the aerials are directed. When this happens and the path becomes "conductive," the two receivers pick up a signal and automatically switch on devices which feed tapes carrying telegraphic messages to their respective transmitters at very high speed.



The 1-kW Redifon transmitter used in "Janet" with doors open to show the controls.

Signal Strength

Actually, the signal received when there are no meteors is approximately 0.1 μV and this is just about enough to tune the equipment in readiness. When the waves are reflected by a meteor trail this signal increases by some 60-80 dB. The frequency of operation is in the range 30-60 Mc/s, while the aerials used so far have been Yagi types with a gain of 10-12 dB.

Because each meteor trail can only be used for a short period—varying from milliseconds to a few seconds—the messages have to be stored before transmission (by magnetic tape equipment) then sent in short, fast bursts. The ingoing speed of messages to the store is 40 words per minute, while the actual transmission speed in the bursts can be as high as 2,000 w.p.m.—which, taking into account the breaks between meteors, works out to an average speed of 40 w.p.m. At the receiving end the incoming bursts of messages are again recorded on magnetic tape (since the code characters are too fast for standard teleprinter equipment) and then printed at normal speed in the intervals between transmissions.

There is a danger, of course, that some meteor trails may prove of too short a duration for effective transmission and that the few code characters radiated in such bursts may not be properly received. Naturally, the equipment cannot "know" in advance how long the trails will be effective, so a device has been incorporated in the system which measures the duration of each burst and, if it proves to be unreasonably short, causes that part of the message to be repeated. In this way the high standard of reliability is maintained.

Transmitting Equipment

The 1-kW transmitters for use in "Janet" have been designed and built by Redifon (see photograph), and it is a notable achievement that they were in operation in Canada within six months of the date of the order being received in London. They are fairly conventional in design, having two crystal-controlled fixed frequencies available, normal drive circuits and Class-C push-pull output stages. The modulation is a high grade type of a.m., special precautions being taken to ensure that the short bursts of high-speed pulses are not mutilated by transient distortion. Further transmitters are being built for the Canadian and British governments and for N.A.T.O.

Low-power tests with "Janet" have been going on for some two or three years in Canada, and since August, 1955, the experimental transmissions have been on the relatively high power given by the 1-kW transmitters. Undoubtedly the system will bring considerable relief to the heavily overcrowded h.f. communications band. It is too early yet to say how many channels will become available, but the number should be quite large as the system occupies only a narrow bandwidth. Possible interference with television will, of course, have to be watched.

I.E.E. Awards To Authors

A LARGE number of the premiums awarded by the Institution of Electrical Engineers for papers read or accepted for publication during the 1955/1956 session will be received by authors of papers on radio and electronics.

The Kelvin premium (£25) is awarded jointly to A. Stott and P. E. Axon (B.B.C.) for their paper "The subjective discrimination of pitch and amplitude fluctuations in recording systems"; the Blumlein-Browne-Willans premium (£20) goes to R. S. Webley, H. G. Lubszynski and J. A. Lodge (E.M.I.) for "Some half-tone charge storage tubes"; the Fahie (£10) is shared by Captain C. F. Booth (G.P.O.) and B. N. MacLarty (Marconi's) for "The new h.f. transmitting station at Rugby"; the Heaviside (£10) to I. A. Harris (M.o.S.) for a paper on co-axial resistor mounts and the Webber (£10) to W. C. Bain (D.S.I.R.) for two papers on direction-finding systems.

Recipients of the Radio and Telecommunication Section premiums are L. R. F. Harris (G.P.O.) who receives the Duddell (£20) for his paper on electronic telephone switching; Professor A. L. Cullen and J. C. Parr the Ambrose Fleming (£10) for "A new perturbation method for measuring microwave fields in free space." £10 premiums also go to E. D. R. Shearman (D.S.I.R.) for two papers on ground back scatter and G. B. B. Chaplin (Harwell), R. E. Hayes and A. R. Owens (Manchester University) for a series of papers on transistor circuits. Three £5 section premiums were also awarded.

One of the £10 graduate and student premiums goes to G. A. Gibson (G.E.C.) for his paper on pulse circuitry.

BOOKS RECEIVED

Transistors in Radio and Television by Milton S. Kiver. Takes the reader in easy stages from electron theory through an elementary explanation of transistor physics to practical applications of transistors in sound and television receivers. Includes chapters on experiments designed to give familiarity with transistor behaviour and circuit servicing procedure. Pp. 324; Figs. 261. Price 37s 6d. McGraw Hill Publishing Co., Ltd., 95, Farringdon Street, London, E.C.4.

Einführung in die Siebschaltungstheorie der elektrischen Nachrichtentechnik by Richard Feldtkeller. Revised fourth edition of an introductory treatise on filter circuits for telecommunications. Pp. 199; Figs. 191. Price DM25.40. S. Hirzel Verlag, Birkenwaldstrasse 185, Stuttgart N.

Studien über Traveling-Wave Tubes by Dr. Gerhard E. Weibel. Mathematical exposition of travelling wave tube theory and a detailed description of a tube designed for experimental study and demonstration. Pp. 93; Figs. 25. Price 9.35 Swiss francs. Verlag Leemann Zurich, Arbenzstrasse 20, Postfach Zurich 34.

Servicing Record Changers by Harry Mileaf. Analysis with simplified diagrams of the basic functions of record changer mechanisms of various makes with hints on repair and adjustment. Pp. 224; Figs. 173. Price $2.90. Gernsback Library Inc., 154, West 14th Street, New York 11. Obtainable in this country through the Modern Book Company, 19-23, Praed Street, London, W.2. Price 23s.

Plastics Engineering by F. T. Barwell, Ph.D., D.I.C., B.Sc.(Eng.), M.I.Mech.E., A.M.I.E.E. Succinct introduction to the basic methods of fabricating plastics and to the standard tests for mechanical and electrical properties, being an extract (Chapt. XIX, Part I) from "Modern Workshop Technology." Pp. 43; Figs. 12. Price 3s 6d. Cleaver-Hume Press, Ltd., 31, Wrights Lane, London, W.8.

Observational Errors by E. W. Anderson and J. B. Parker. Explanation for the practical man of the language and methods of statistics as applied to the interpretation of navigational observations. Pp. 28; Figs. 23. Price 5s. John Murray, 50, Albemarle Street, London, W.1.

Mechanical Design for Electronic Engineers by R. H. Garner, B.Sc.(Eng.), A.M.I.E.E., A.M.I.Mech.E., A.M.Brit.I.R.E. Students guide to the methods and materials available for housing electronic equipment, with a chapter on codes of practice and standards specifications relevant to the subject. Pp.223 + vii; Figs. 130. Price 25s. George Newnes, Ltd., Southampton Street, London, W.C.2.

"Electronic Machine-Tool Control"

Correction.—On page 384, penultimate paragraph, of this article in the August issue, the E.M.I. control system was wrongly stated to be shown on the stand of W. H. Kearns and Co. This should actually be Wadkin, Ltd.

WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

V.H.F. Sound Broadcasting

A FURTHER six v.h.f. stations, bringing the total to sixteen, are to be built during the next two years by the B.B.C. With the introduction of these stations, the v.h.f. service will be within reach of 96% of the population.

The location of the new stations and the frequencies on which they will operate are given below. It is planned to have the first four in operation by the end of next year.

The Anglesey station will replace the temporary transmitter at Penmon at present radiating the Home Service on 94 Mc/s.

Only five of the original ten stations authorized are at present in full service—Wrotham, Pontop Pike, Divis, Meldrum and North Hessary Tor which came into service on August 7th on 88.1, 90.3 and 92.5 Mc/s. The B.B.C. plans to have the others, Norwich, Sutton Coldfield, Holme Moss, Blaen Plwy and Wenvoe (where a temporary transmitter is at present operating on 94.3 Mc/s), in service by the end of this year.

	Light (Mc/s)	Third (Mc/s)	Home (Mc/s)
Rowridge, Isle of Wight ...	88.5	90.7	92.9
Kirk o'Shotts, Lanarks.	89.9	92.1	94.3
Sandale, Cumberland	88.1	90.3	92 5 (North) 94.7 (Scottish)
Corwen, N. Wales	—	—	94.9
Anglesey	89.6	91.8	94.0
Rosemarkie, Moray Firth ...	89.3	91.5	93.7

Long-Distance Closed-Circuit TV

REMOTE control has frequently been employed to perform an opening ceremony, but not until this month has television been used in this country to enable the opener and the assembled guests to see the plant started and be "conducted" round the works whilst remaining some 200 miles away. The occasion was the official starting up by the Home Secretary of Britain's first "bulk" oxygen plant at Margam, near Swansea.

Television cameras, installed by Marconi's, at both the plant of the British Oxygen Co. and the works of the Steel Company of Wales, to which the oxygen is piped, were linked by radio to the G.P.O./B.B.C. cable from Wenvoe to London and fed to a number of monitors in the London office of the British Oxygen Company.

By fitting the television camera with "dark glasses" the interior of a furnace, into which oxygen was being injected, was clearly seen—a rigorous test for the camera; the contrast ratio of light-to-dark being of the order of 500:1 compared with a normal studio ratio of 20:1.

Sales at Home and Abroad

ALTHOUGH retail sales of sound and television receivers were higher in June than the previous month, the total sales for the first six months of the year were well below those of the same period in 1955. Television receiver sales were down 14%, sound receivers 19% and radiogramophones 40%. The comparable figures for the first half of each year are tabulated below:—

	Television		Sound		Radiograms	
	1956	1955	1956	1955	1956	1955
January...	85,000	103,000	66,000	98,000	18,000	35,000
February	81,000	98,000	66,000	99,000	15,000	33,000
March ...	71,000	85,000	72,000	95,000	13,000	24,000
April ...	62,000	75,000	65,000	79,000	14,000	16,000
May ...	53,000	62,000	70,000	75,000	11,000	15,000
June ...	61,000	58,000	80,000	74,000	11,000	13,000
	413,000	481,000	419,000	520,000	82,000	136,000

Whilst home sales decreased during the first six months of the year, overseas sales of sound and television receivers increased from £1.83M to £1.96M. The increased exports for the other main groups of the industry were even greater—sound reproducing equipment £3.67M (£2.57M); components £4.05M (£3.46M); valves £1.55M (£1.38M); capital goods £7.94m (£6.36m).

The overall total for the half-year was £19.17M compared with £15.6M for the same period last year.

PERSONALITIES

Sir Archibald Gill, K.B., B.Sc.(Eng.), M.I.E.E., engineer-in-chief of the Post Office until his retirement in 1951, has joined British Telecommunications Research Limited as director and general manager. Sir Archibald, who entered the Post Office engineering department as an assistant engineer in 1913, was for some time in charge of the radio experimental station at Dollis Hill. He will be responsible for the general administration of the research establishment at Taplow, Bucks, which was formed jointly by B.I. Callender's Cables Limited and the Automatic Telephone and Electric Company Limited ten years ago to promote telecommunications research and now has a staff of some 350.

F. E. Jones, M.B.E., B.Sc., Ph.D., A.M.I.E.E., who, as mentioned in our August issue, recently retired from Government service, has joined the board of Mullard Limited. Dr. Jones was on the staff of the Telecommunications Research Establishment from 1940 to 1952 and was appointed an M.B.E. in 1945 for his work on "Oboe," the wartime blind-bombing system. For the past four years he has been at the Royal Aircraft Establishment, Farnborough, where he was deputy director (equipment). Before entering Government service he held an appointment at King's College, London, where he graduated. He is 42.

J. D. Stephenson, M.Sc., Ph.D., M.I.E.E., a director of the Mullard Radio Valve Company and Mullard Blackburn Works Limited, has also been appointed to the board of the parent company—Mullard Limited. After four years' research work at Durham University, where he took degrees in physics, applied science and electrical engineering, Dr. Stephenson joined the Mullard organization in 1933 and for the past ten years has been in charge of valve manufacture for the group.

H. A. Lewis, M.B.E., T.D., B.Sc.(Eng.), A.C.G.I., M.I.E.E., has resigned from Marconi's Wireless Telegraph Co., where he was manager of the broadcasting division, and has joined Electric and Musical Industries as personal assistant to E. J. Emery, managing director of the domestic electronics division. He had been with Marconi's since 1948. After taking his degree at Imperial College, University of London, in 1933, Mr. Lewis, who is 43, joined the B.B.C. as a student apprentice and was subsequently appointed to the newly-formed television section of the station design and installation department. During the war he was responsible for the formation and expansion of the branch of R.E.M.E. concerned with the installation and maintenance of Army telecommunications and radar equipment.

D. G. Smee, M.B.E., Assoc.I.E.E., is the new manager of Marconi's broadcasting division in succession to H. A. Lewis. Prior to war service, first in Royal Signals and then in R.E.M.E. rising to the rank of major, he was for seven years in Marconi's research laboratories. He was appointed an M.B.E. in 1945 for his work in the Middle East and Italian theatres of war, where he was responsible for the maintenance and repair organization of Army telecommunications and radar equipment. Mr. Smee rejoined Marconi's in 1946 and has held various positions including that of assistant commercial manager since 1951.

G. E. Condliffe, O.B.E., B.Sc., M.I.E.E., has relinquished the position of managing director of E.M.I. Research Laboratories Limited, which he has held since 1951, to become research and technical consultant to J. F. Lockwood, the chairman and managing director of Electric and Musical Industries Limited. Mr. Condliffe, who graduated at Manchester University, joined the research laboratories of the Gramophone Company (now in the E.M.I. Group) in 1929 and during the war was concerned with Government radar projects. He was appointed to the technical subcommittee of the Television Advisory Committee in 1953.

Owing to the illness of **R. P. Browne,** O.B.E., B.Sc., secretary of the Radio Industry Council, who has been in hospital for the past two months, his deputy, **G. B. Campbell,** has been appointed acting secretary. Incidentally, during the Radio Show all R.I.C. business will be conducted from Earls Court.

Denis Taylor, M.Sc., Ph.D., F.Inst.P., the new chairman of the measurement and control section of the I.E.E., is head of the electronics and instrumentation division at the Atomic Energy Research Establishment, Harwell. He went to A.E.R.E. in 1946 after seven years' service at the Telecommunications Research Establishment, where he played a leading part in the development of radar. For his work as a member of Sir Robert Watson-Watt's team, and especially for the development of G.C.I. (ground controlled interception), he was awarded £2,400. Before joining the Watson-Watt team at Bawdsey in 1939, Dr. Taylor was a lecturer at Hull Technical College and at Croydon Polytechnic.

D. R. Parsons, M.I.E.E., M.Brit.I.R.E., who for the past eight years has been chief engineer of Rediffusion (North-East) Limited, has been transferred to Rediffusion (Merseyside) Limited as general manager. He was previously with Eddystone, Whiteley Electrical and the G.E.C.

R. H. Hammans (G2IG), president of the Radio Society of Great Britain, was elected to preside over the recent International Amateur Radio Union conference held at Stresa, Italy. This was the second triennial conference of I.A.R.U. Region 1 societies which was attended by representatives of seventeen countries. Mr. Hammans is chief engineer of Granada TV Network—one of the I.T.A. programme contractors. **H. A. M. Clark,** B.Sc.(Eng.), M.I.E.E., (G6OT), R.S.G.B. representative on the technical committee of the conference, was elected chairman of that committee.

OUR AUTHORS

John M. Beukers, contributor of the article in this issue describing a switch-tuned f.m. unit, is now in the advanced development laboratory of Standard Telephones and Cables, having served a two-year apprenticeship in the company's radio division. He studied at the Northampton Engineering College, London, where he obtained his B.Sc.(Eng.) degree and a college diploma. Mr. Beukers won this year's B.S.R.A. committee prize with a pre-tuned f.m. receiver and a gramophone pre-amplifier.

J. S. Belrose, the writer of the article on a selective band-pass i.f. amplifier, graduated from the University of British Columbia in 1950 with a B.A.Sc. degree. From 1951 to 1953 he was in the radio physics laboratory of the Defence Research Board in Ottawa, Canada, where he was concerned mainly with the design of transmitting and receiving aerials and equipment for f.s.k. teleprinter transmission. In 1953 Mr. Belrose came to this country and has since then been a research student at the Cavendish Laboratory, Cambridge, experimentally studying the reflection of long waves from the ionosphere at both steep and oblique incidence.

Dr. F. E. JONES.

Dr. J. D. STEPHENSON.

H. A. LEWIS.

D. G. SMEE

OBITUARY

L. H. Bainbridge-Bell, O.B.E., M.C., M.A., M.I.E.E., whose absorbing personal interest was the presentation of technical information, especially in relation to circuit diagrams on which he has contributed to *Wireless World* (sometimes under the nom-de-plume Symbol Simon) died on August 7th, aged 63. Since his retirement in 1953 from the Admiralty Signal and Radar Establishment, which he joined in 1939, he had been a committee secretary in the electrical section of British Standards Institution. From 1927 to 1936 he was at the Slough radio station developing the c.r. direction finder for atmospherics and ionosphere-sounding apparatus. During this period he was co-author with Watson-Watt and Herd of "The Cathode-Ray Oscillograph in Radio Research." For his "contributions to the development of radar installations" as a member of Sir Robert Watson-Watt's team, he was awarded £2,400.

IN BRIEF

Television licences must now exceed six million for during June, the last available figure, the total increased by 58,547 to 5,922,020. The Midland Region, like the London Region, now has more television than sound licences—1,021,171 compared with 1,011,463. The overall total of broadcast receiving licences at the end of June was 14,332,856.

Awards to Inventors.—The fourth and final report of the Royal Commission on Awards to Inventors (H.M.S.O. Cmd. 9744) lists 115 claims heard by the Commission since November, 1952. Among the radio claims not previously referred to in these pages is one for the disc-seal triode for which E. H. Ullrich, Dr. C. N. Smyth, S. G. Tomlin and J. Foster received £2,500. Awards of £750 for the development of Yagi aerials, £500 for a capacitance switch and phasing switch and £1,500 for parabolic reflector type aerials were shared by R. V. Alred, J. F. Coales, M. J. Jones, W. T. Davies, E. F. Daly, A. Dooley and K. R. Soar.

I.T.A. Increased Power.—The e.r.p. at both Croydon and Lichfield has been doubled by operating two transmitters in parallel. The Croydon station's e.r.p. is now 120 kW and Lichfield 100 kW. The e.r.p. of the Midland station will eventually be increased to 200 kW—probably in the autumn. The transmitters at Croydon were installed by Marconi's and at Lichfield by Pye.

Lifeboat Radio.—The Royal National Life-boat Institution is to install v.h.f. radio-telephones in 50 lifeboats to enable crews to keep in touch with pilots of helicopters and other search and rescue aircraft. At present communications have to pass through the G.P.O. coast stations or coastguards. The equipment, which will operate on the "search and rescue, scene of action" frequency (138.78 Mc/s) used by the Royal Naval Air Service and the R.A.F., is being supplied by the British Communications Corporation.

A two-day exhibition of their receivers is being held by Champion Electric Corporation in the ballroom at the Mayfair Hotel, London, W.1, on August 23rd and 24th. Complimentary tickets are obtainable from Champion at 8, Eccleston Street, London, S.W.1.

"Ferroresonant Computing Circuits."—The authors of this article in the July issue ask us to state that the following two references should be added to the bibliography: British Patent No. 749,383 (R. H. Baker: assigned to N.R.D.C.); British Patent Application 5828/56 (R. S. Arbon and G. Phylip-Jones).

"Broadcasting in the U.S.S.R."—In para. 4, p. 381, July issue, there was some confusion between cause and effect. In fact, films and O.Bs preponderate in Soviet television programmes *because* available studio space is at present small. Also, on p. 380, the frequency of the latest radio link should be 3,000 and not 300 Mc/s.

A memorial plaque bearing the inscription "John Logie Baird, A.R.T.C.—1888-1946. A former student of the college. This plaque was erected to commemorate his inventive genius and outstanding contributions to the development of television", was unveiled by the Postmaster General at the Royal Technical College, Glasgow, in July. It is the first of three memorials sponsored by the college; the others being a Baird lecture and a Baird prize to be awarded annually in the department of electrical engineering.

Brit. I.R.E.—The first London meeting of the session will be held at 6.30 on September 26th at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, when Dr. H. W. Loeb will read a paper on "Some aspects of transistor progress."

Teacher Training.—Garnett College, in the New Kent Road, London, S.E.1, still has a number of vacancies in the nine-months full-time course starting in September to train teachers of technical subjects for work in technical schools and colleges. It is stressed that it is a course of teacher training and does not deal with specific technical subjects, students being expected to possess the necessary engineering qualifications. The course leads to the teachers' certificate of the University of London Institute of Education.

Next year's **British Plastics Exhibition** (July 10th to 20th) is to become an international show. The exhibition and convention, organized by *British Plastics* in co-operation with the British Plastics Federation, will now occupy both the Grand and National halls at Olympia—an area of 250,000 square feet compared with 90,000 square feet at the last exhibition in 1955.

A programme has now been prepared for the **Air Traffic Control Convention** to be held at Southend-on-Sea on October 4th and 5th. Details can be obtained from the Guild of Air Traffic Control Officers, 118, Mount Street, Berkeley Square, London, W.1. The main objective of the convention is to bring together not only those who operate and use the air traffic control services but those who design and manufacture the equipment employed.

Amateur Television Convention.—This year's convention of the British Amateur Television Club will be held at the Bonnington Hotel, Southampton Row, London, W.C.1, from 10 a.m. to 7 p.m. on October 27th. It will include displays and demonstrations of members' equipment. Further particulars and admission tickets (price 5s) are obtainable from D. S. Reid, 4, Bishop Road, Chelmsford, Essex.

BUSINESS NOTES

Harbour radar is to be installed by **Decca** at the Southampton Harbour Board's Calshot Signal Station. The equipment (Type 32), which employs a beam of only ⅓rd degree and 1/20th microsecond pulse, will provide a radar picture of the Port of Southampton and its approaches.

Sound Equipment, Limited, of 5, Great Newport Street, London, W.1, which was a member of the Rank group, has become a wholly-owned subsidiary of the British Thomson-Houston Company and its name is to be changed to BTH Sound Equipment, Limited. The company will continue to supply and service cinema equipment and will also broaden the scope of its activities in this field.

As foreshadowed in our July issue, **McMichael Radio** has been taken over by Radio and Allied Industries, Limited, manufacturers of Sobell receivers. The McMichael office in the Strand, London, has been closed and the company's activities centred at Langley Park, Slough, Bucks. (Tel.: Slough 22201.) The service department will remain at The Plaza, Iver, Bucks. (Tel.: Iver 1171.)

Dagnall and Kendall, Limited, of Cranfield, near Bletchley, Bucks., have taken over the manufacture of the components previously made by the **Igranic Electric Company, Limited.** These include both 70° and 90° time-base components, deflection and focus coil assemblies for projection television and the complete range of Igranic wire-wound components. J. A. Field, who was in charge of the research and development section of Igranic's components division, has been appointed chief engineer of Dagnall and Kendall, and J. White, who was also in the division, is sales manager.

Atkins, Robertson and Whiteford, Limited, of Glasgow and London, manufacturers of components and industrial electronic equipment, have moved to a new factory on the Thornliebank Industrial Estate, Glasgow. (Tel.: Giffnock 1031/2.) Harry L. Ranson, formerly with the Furzehill Group, has been appointed general sales manager of the company.

Andec Limited is the new name adopted by Avis and Baggs, Limited, who have moved to larger premises in Bennet Road, Reading, Berks. During its seven years the firm has specialized in the application of electronics to industrial processes. It also undertakes batch or long-run production of transformers and fractional horse power electric motors.

The sales and service departments of **Staar Electronics Limited,** of 39, New Oxford Street, London, W.C.1 (manufacturers of the automatic record-playing equipment developed by Usines Gustave Staar, of Brussels), are now at 86, Palmerston Road, Walthamstow, London, E.17. (Tel.: Larkswood 5441/2.)

OVERSEAS TRADE

For the **Damascus Fair** (September 1st to 30th) Pye are setting up a complete television broadcasting station as they did for the Baghdad Fair in 1954. They will have a stand on which will be featured export sound and television receivers using printed circuits. The television transmitter will operate on 625 lines in the U.K. channel 8. Seven other receiver manufacturers—Bush, Cossor, Ekco, Ferguson, G.E.C., Kolster-Brandes and Regentone—are putting on a combined demonstration under the auspices of the British Radio Equipment Manufacturers' Association in the British Pavilion.

Iran.—A £300,000 contract has been awarded to Marconi's by the National Iranian Oil Company for the installation of a complete v.h.f. multi-channel radio-telephone system along the route of their new 600-mile oil pipeline from Abadan to Teheran. The order calls for the supply of 84 multi-channel equipments (Type HM181), together with a considerable quantity of telephone carrier equipment (to be supplied by the Telephone Manufacturing Company) and diesel electric power plant. The majority of the stations along the route will be unattended.

The equipment for the multi-channel v.h.f. radio-telephone system along the 200-mile route of the Sui to Multan gas pipeline in **West Pakistan** is being jointly manufactured by Pye, Limited, and Ericsson's Telephones, Limited.

Radio links, over which consumer demands will be transmitted to the electricity authority's headquarters for the automatic control of load shedding, are being supplied to **New Zealand** by Automatic Telephone & Electric Company, Limited. A supervisory and remote control system manufactured by A. T. & E. will be used to operate control equipment at one of the sub-stations. A. T. & E. are also supplying repeater equipment for the 80-mile coaxial cable (supplied by B. I. Callender's Cables), which will link Auckland and Hamilton, N.Z. It will initially provide 240 telephone circuits, but provision is made for this to be increased four-fold.

Switzerland.—A Marconi ST201 radar trainer is being modified by International Aeradio, Limited, for use by the Swiss air force.

International Aeradio, Limited, are to install and operate equipment to provide a communal radio-telephone service for six of the major oil companies prospecting in **North Africa.** The two main base stations will be set up at Benina and Tripoli, through which messages will be passed to and from the various mobile units operating in Libya.

Solartron, of Thames Ditton, Surrey, announce that they intend to establish an **American** sales and servicing company in the near future; to hold stocks at Philadelphia, Cleveland and Los Angeles; and to make nation-wide servicing arrangements through suitable agents. They have a team of engineers already in the States with headquarters at Western Instruments, Inc., Burbank, near Los Angeles, California.

Plessey Incorporated has been formed, with offices at 41, East 42nd Street, New York City, to represent and control the interests of the Plessey Company in the **United States.** The company's Chicago office is being closed.

R.C.A. Great Britain, Ltd., announce that their **high-fidelity equipment** produced in this country is now being exported to twenty-eight countries, including the U.S.A.

Malaya.—Three Malayan public services—police, customs and fire brigade—are to be supplied with v.h.f. mobile radio equipment by A. T. & E. (Bridgnorth), Limited. All the 43 sets are standard six-channel 10-watt equipment (Type RL).

Pye radio-telephone equipment has been installed by their Belgian agents, Semobel, in a fleet of taxis in **Brussels,** stated to be the first permanent radio taxi service in the country.

NEW "WIRELESS WORLD" BOOKS

Correcting Television Picture Faults.—Some 150 end-of-tube photographs illustrating a wide variety of receiver defects are included in this 76-page book, by John Cura and Leonard Stanley. Other photographs illustrate the effects of many different kinds of interference. The text explains the nature of the defects and indicates what action should be taken to correct them. The explanations are written in simple form for the layman and are supplemented by more technical information printed in smaller type. The book costs 3s 6d (postage 3d).

Guide to Broadcasting Stations, 1956/57.—The present chaos in the medium-wave band is emphasized by a glance at the medium-wave section of the latest edition of this book, from which it will be seen that some 50 per cent of the broadcasting stations in Europe are operating on "pirated" frequencies. Some 700 European stations operating on long and medium waves and nearly 2,000 short-wave broadcasting stations of the world are listed, both in order of frequency and geographically. The operating details—frequency, wavelength and power—have been checked against measurements made at the B.B.C. Receiving Centre, Tatsfield, Surrey. Within its eighty pages the book, which costs 2s 6d (postage 4d), also includes operating details of Europe's v.h.f. broadcasting stations, which now total nearly 400, and 170 television transmitters.

Radio Valve Data.—The 5th edition of this well-known manual has been revised and enlarged and includes characteristics of some 2,500 valves, transistors, metal rectifiers and cathode-ray tubes. An important feature is the improved presentation of the base connections, which are now given in diagrammatic form with the electrode connections marked against the appropriate pins. Price 4s 6d (postage 7d).

These books are issued for *Wireless World* by our Publishers, Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

National Radio Show

PREVIEW OF TECHNICAL EXHIBITS

WITH a preview for overseas visitors and invited guests on August 21st, the 23rd National Radio Show opens to the public at Earls Court on the 22nd.

A stand-to-stand survey of the technical exhibits, prepared from information provided by the exhibitors, is given in the following pages. For those attending the Show the report and the plan opposite should provide a useful guide to the stands. Although there are bound to be some last-minute introductions by manufacturers, it is hoped that for those unable to visit the exhibition this survey will give a useful overall picture, which will be supplemented by the review of this year's trends in sound and vision receivers to be included in our next issue.

The Show is first and foremost an exhibition of domestic sound and television receivers, components and ancillary equipment. Of the 117 exhibitors, some 85 are manufacturers and of this number about 40 are makers of domestic receivers. Television Avenue, which has been a feature of the Show for some years, is discontinued but to each stand both B.B.C. and I.T.A. television transmissions are being piped for demonstration purposes. Most of the demonstration rooms are being fed with the B.B.C. v.h.f. sound transmissions.

The sponsors of the Show, the Radio Industry Council, have again provided, with the assistance of colleges and manufacturers, a "careers" display. Among the exhibits included in the display are the electronic air speed timing equipment used for the record-breaking flight of the Fairey Delta, guided missile equipment, a computer which will do sums for visitors and a radar screen with a scanner on the roof which visitors can operate.

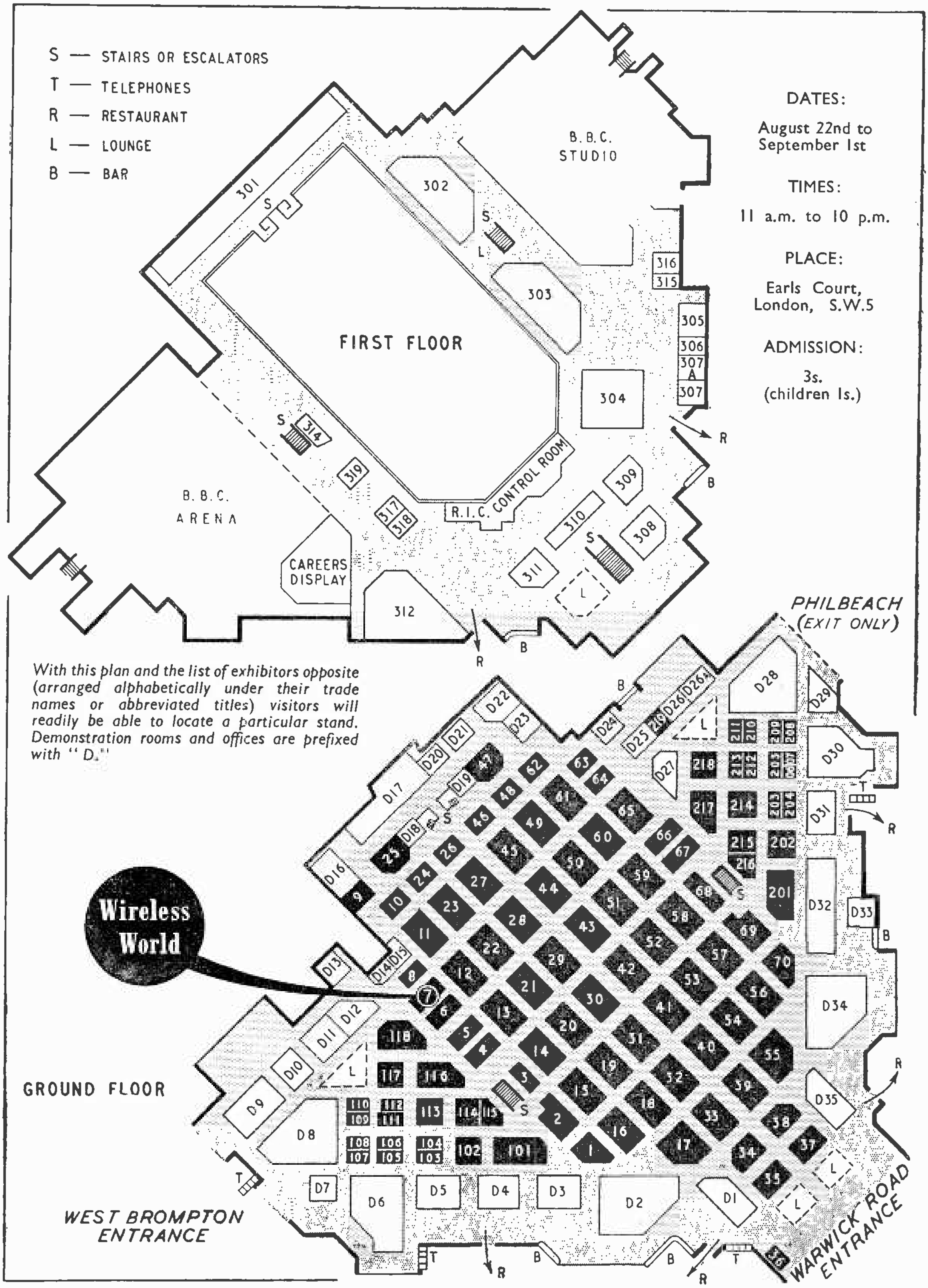
ALPHABETICAL LIST OF EXHIBITORS

	Stand
Acos	202
Aerialite	51
Airmec	212
Alba	61
Ambassador	43 (D23)*
Antiference	69
Argosy	219 (D26)
Army	302, 308
Assimil	307A
Avo	3
B.B.C.	301
Barclays Bank	118
Belling-Lee	49
Bernards	109
Bowmaker	208
Brimar	39
British Radio & Television	110
British Railways	114
Bulgin	26
Bush	17, 29
Channel	108
Collaro	21 (D3)
Cossor	57 (D35)
Cossor Instruments	206
Decca	58 (D30)
Defiant	35, 37
De La Rue	8
Domain	107
Dubilier	62
Dynatron	4
E.A.P.	215
E.A.R.	67
E.M.I.	16, 23 (D10, D11)
E.M.I. Institutes	307
Econasign	210
Ediswan-Siemens	19 (D5)
Ekco	24, 30 (D17)
Electrical & Radio Trading	112
English Electric	40 (D20)
Ever Ready	54

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

	Stand
Ferguson	12 (D12)
Ferranti	31, 68 (D1)
G.E.C.	53 (D34)
G.P.O.	304
Garrard	50
Goodmans	105 (D7)
H.M.V.	28 (D8)
Hart	209
Hobday	218
Hunt	25
I.T.A.	309, 310, 311
Invicta	65
J.B. Cabinets	115
J-Beam Aerials	1
K.B.	20
Keith Prowse	36
Kerry's	214
Labgear	203
Linguaphone	207
Lloyds Bank	217
McMichael	59
Marconiphone	23 (D9)
Masteradio	15
Midland Bank	101
Mullard	32 (D2, D32)
Multicore	10 (D15, D18)
Murphy	42 (D4)
National Provincial Bank	116
Navy	303
Nixa	5
Opperman	319
Pam	55 (D33)
Pamphonic	34
Peto Scott	14
Philco	22, 317 (D26A)
Philips	44, 45 (D28, D29)
Pilot	27

	Stand
Plessey	9 (D16)
Plus-a-Gram	216
Portogram	66
Practical Wireless	111
Price	306
Pye	13 (D6)
R.A.F.	312
R.C.A.	103 (D14)
R.G.D.	52 (D31)
R.S.G.B.	305
R.T.R.A.	201 (D24)
Regentone	60
Roberts	48
Rola Celestion	6 (D13)
S.T.C.	117
Simon	46
Slingsby	104
Sobell	33 (D22)
Spectone	316
Spencer-West	211
The Star	318
Stella	56
T.C.C.	64 (D27)
Tape Recorders	38
Taylor	106
Telequipment	63
Telerection	18
Thompson, Diamond & Butcher	70
Ultra	41
United Appeal for the Blind	314
Valradio	213
Vidor	11 (D25)
Waveforms	205
Westinghouse	102
Westminster Bank	113
Whiteley Electrical	47 (D19, D21)
Wireless & Electrical Trader	204
Wireless World and *Wireless Engineer*	7
Wolsey	2
Wood & Metal Industries	315



With this plan and the list of exhibitors opposite (arranged alphabetically under their trade names or abbreviated titles) visitors will readily be able to locate a particular stand. Demonstration rooms and offices are prefixed with "D."

NATIONAL RADIO SHOW

Guide to the Stands

ACOS (202)

Pickup replacement cartridges designed to give accurate groove tracing at high lateral accelerations ("Hi-g") are available to fit most record players and changers with removable heads. For use in extreme tropical conditions, a turnover head with ceramic pickup element (GP61-1) is now being produced.

The exhibit will include a range of piezo-electric microphones ranging from the inexpensive MIC35 to the MIC16 sound-cell type for studio use.

Cosmocord Ltd., Eleanor Cross Road, Waltham Cross, Herts.

AERIALITE (51)

Wide spacing of elements in Band III aerials is advocated by Aerialite as a means of obtaining a wide bandwidth and less disturbance of characteristics in proximity to buildings. Models are shown with up to 11 elements.

Additions to the range of twin-band aerials include two new "Unilead" models, so called because the interconnection between the two systems is effected in the factory and only a single downlead has to be fitted on erection.

Three Band III convertors are now available: Model TC2 gives a single channel only; TCD, giving two channels at high sensitivity, has an r.f. stage, and MC continuous coverage. All three have Band I/Band III switching.

Aerialite, Ltd., Castle Works, Stalybridge, Cheshire

AIRMEC (212)

Two interesting test equipments, one for servicing television sets and the other for sound receivers are to be shown this year. The former is the Televet Type 877 and is complete self-contained portable test room comprising pattern generator. oscilloscope, wobbulator, a.m. signal generator, a.f. oscillator and valve voltmeter.

The other is for a.m. and f.m. receiver testing and again is a self-contained and comprehensive item of equipment. It embodies a signal generator covering 100 kc/s to 15 Mc/s and 85 to 100 Mc/s, an oscilloscope, wobbulator and an a.f. oscillator. Both are mains operated.

Airmec, Ltd., High Wycombe, Bucks.

ALBA (61)

Separate sensitivity controls on Bands I and II enable programmes to be switched rapidly in the new T641 and T644 table model television receivers, which have 14-in and 17-in tubes respectively. Both models are fully screened against radiation. Two 17-in and two 21-in consoles, complete the television range.

There is a choice of four table-model sound broadcast receivers, six radio-gramophones and two portable record reproducers among which the Model 202 a.c./d.c./battery portable, Model C116 midget receiver, and Models 880 and 881 record reproducers are new.

A. J. Balcombe, Ltd., 52-58, Tabernacle Street, London, E.C.2.

AMBASSADOR (43)

Television receivers with 17-in and 21-in tubes are to be shown. They have turret tuning and vision-channel a.g.c. The 17-in is available as a table model, but the 21-in is in console form. The console form of the 17-in is unusual in being roughly triangular in plan so that it will fit closely into the corner of a room.

A sound broadcast receiver covers the medium- and long-wave a.m. bands and the f.m. band, for which there is a built-in v.h.f. dipole aerial.

Ambassador Radio & Television Ltd., Princess Works, Brighouse, Yorks.

ANTIFERENCE (69)

The "Hil-O" range of dual-band television aerials is based on what is described as "electronic coupling"; the Band III signal is transferred to the feeder only by the proximity of the Band III dipole to the Band I element. The range has been extended and now includes no fewer than 17 different models.

A new one-piece coaxial plug has been introduced which simplifies the fitting of the cables. No loose outer grip is employed, the cable being firmly gripped by squeezing the sides of the body of the plug on to the woven copper sheath of the cable. The centre conductor is soldered in place. The plug is fully insulated by means of a Neoprene sheath.

Antiference. Ltd., Bicester Road, Aylesbury, Bucks.

ARGOSY (219)

Radiograms equipped for v.h.f. reception and with 4-speed record players are among the completely new ranges of domestic equipment to be shown this year. Television receivers designed for long-range reception will be featured, and also automatic record players with the latest 4-speed motors. In external design of cabinets the "contemporary" style will be predominant.

Argosy Radiovision, Ltd., Abbey Road, Barking, Essex.

ARMY (302, 308)

A feature of the Army's exhibit, which is manned by the Royal Corps of Signals, is a demonstration of the complete cycle of training in a trade in the Corps. Examples of ancient and modern radio equipment are compared and the Army's present-day communications system is traced through division and brigade H.Q. installations down to the latest "walkie-talkie" equipment.

The War Office, Whitehall, London, S.W.1.

ASSIMIL (307A)

A system of language instruction by gramophone records is offered by this firm, who have a preliminary course of eight double-sided 78-r.p.m. records, including text-book and tuition service, and an advanced course consisting of a further 12 records and tuition. The complete range of courses in Russian, French, German, Italian, Spanish and Dutch will be available for private listening on the stand.

E.M.I. Institutes, Ltd., 10, Pembridge Square, London, W.2.

AVO (3)

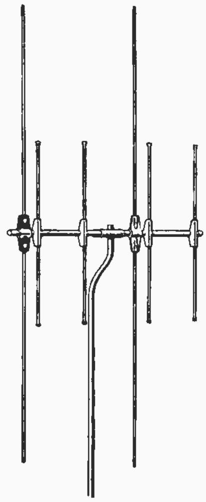
Some items of test equipment hitherto shown as prototypes are now available as production models; these include the two signal generators covering Bands I, II and III. "Mark III" covers 150 kc/s to 220 Mc/s with internal amplitude modulation. The other is the "Wide Band AM/FM Signal Generator" providing amplitude modulation from 5 to 225 Mc/s and f.m. from 60 to 120 Mc/s with deviation up to ±150 kc/s. Provision is made for checking the frequency and adjusting the scale cursor when necessary.

Another interesting Avo instrument is the "Universal Measuring Bridge Type 1" for resistance, capacitance and inductance measurements. In addition there is a full range of the well-known Avometers.

Automatic Coil Winder and Electrical Equipment Co. Ltd., Douglas Street, London, S.W 1.

B.B.C. (301)

Continuing the campaign to popularize v.h.f. sound broadcasting, the B.B.C.'s stand includes a demonstration theatre where visitors can compare direct reception of a programme on v.h.f., on medium or



Antiference HL402/4K combined television aerial utilizing the "electronic coupling" principle.

long waves or by line from Broadcasting House.

Among various methods of instruction devised by the Engineering Training Department which can be seen on the stand are demonstrations showing the operation of the cathode follower and the diode detector and experiments in geometric optics. An automatic monitor for checking transmitter performance shows the type of equipment being installed by the Corporation to eliminate uninteresting routine jobs.

British Broadcasting Corporation, Broadcasting House, London, W.1.

BELLING-LEE (49)

Although aerials are to be the prominent feature of this firm's display, Belling-Lee produce also a wide range of small parts such as fuses, terminals, thermal-operated switches, valveholders and a variety of plug and socket connectors.

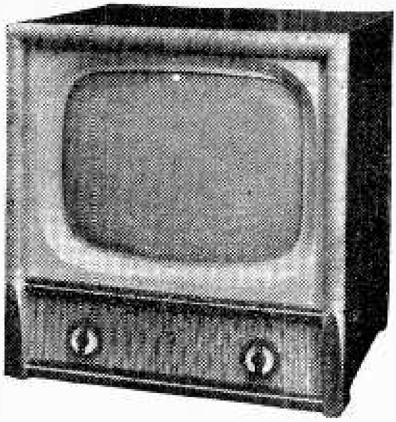
The latest developments in aerials are the collapsible Band III models designed for more convenient transport but just as effective in use as the factory assembled models. Combined Band I/Band III aerials cover a very wide range, from a simple "Loftrod" (indoor type) to an "H" with two 6-element Band III Yagis arranged to form a broadside array. This type of fringe-area aerial is suitable for use where both B.B.C. and I.T.A. stations are co-sited. For use elsewhere separately orientated systems are available.

Aerial accessories shown include cable outlet sockets, aerial amplifiers, Band I/Band III filters and a comprehensive range of interference suppressors.

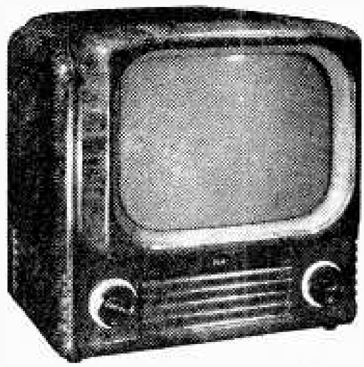
Belling and Lee, Ltd., Great Cambridge Road, Enfield, Middlesex.

BRIMAR (39)

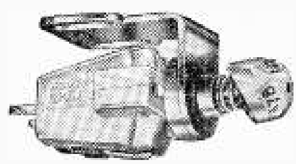
A reasonable size of television set cabinet, combined with a big picture,



Alba Model T644.



Bush TV 62 with 14-in tube in Bakelite cabinet.



Acos ceramic pickup cartridge (GP61)

is made possible by the new C21KM 21-in c.r. tube to be shown, which has a 90° deflection angle. A range of valves suitable for the time bases of such 90° tubes will also be seen.

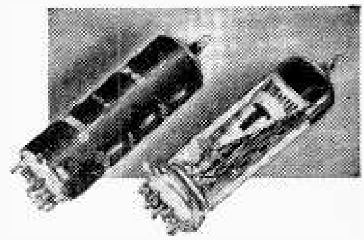
Among the special-quality valves will be flying-lead types assembled with close-fitting cooling cans and mounted on nylon-loaded PTFE bases.

Transistors will include the comparatively new TS series (*p.n.p.* junction types) which are approximately half the size of their predecessors (TP and TJ series) and are hermetically sealed in metal cans.

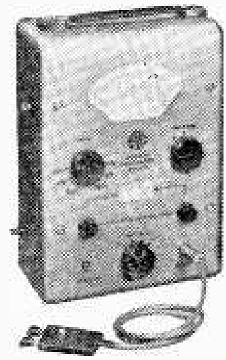
Standard Telephones and Cables Ltd. Footscray, Sidcup, Kent.

BULGIN (26)

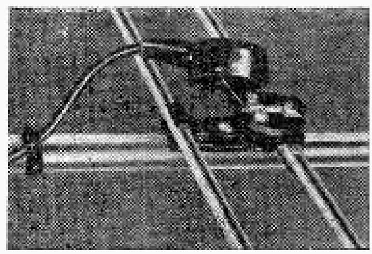
This firm specialize in the manufacture of signal lamps, switches, knobs, connectors and a host of small, but important, parts used in the radio and electronic industries.



Brimar mounted flying-lead valves.



Avo signal generator Type III covering 150 kc/s to 220 Mc/s.



New style centre insulator fitted to Belling-Lee Band III aerials.

New items shown this year include a pillar-type signal lamp, rather like a lighthouse with a 30° side window and with or without a transparent top. There is also an inexpensive type of key switch available in several styles, such as locking both sides or locking one side and spring-loaded the other, or spring-loaded both sides. Various contact combinations are available.

A toggle-action micro-switch and an ultra-lightweight version of the Lilliputian model shown last year, but operating with under 5 oz pressure, are also new.

A. F. Bulgin and Co. Ltd., By-Pass Road, Barking, Essex.

BUSH (17, 29)

Television receivers manufactured by this firm retain the form of station-selector mechanism introduced last year. Tuning is by a method which gives basically continuous tuning in each band but which is operated by a control moving it in steps and so giving the effect of a switch selector. The 14-in tube model is available in two styles of table cabinet, one of moulded Bakelite and the other of wood, and there is a larger type with a 17-in tube which is basically the same electrically.

Among the sound receivers the models including a v.h.f. band now outnumber the purely a.m. sets. The VHF 90, for example, has a double-triode for the v.h.f. "front-end." It is a two-band set covering v.h.f. and medium waves and it has a built-in dipole for v.h.f. and a ferrite-rod aerial for medium waves. Provision is made for the use of an external v.h.f. aerial.

Bush Radio Ltd., Power Road, London, W.4.

CHANNEL (108)

New equipment shown this year includes two general-purpose power supply units. One, the Type PS12, gives a stabilized output variable from 200 to 400 V d.c. and an unstabilized d.c. output of 550 V with an output impedance of less than one ohm. There is also an improved version of the Type T3 pattern generator which covers both television bands.

Channel Electronic Industries Ltd., Dunstan Road, Burnham-on-Sea, Somerset.

COLLARO (21)

Four-speed turntable drives (including 16⅔-r.p.m.) are now available in three new gramophone units—the AC4/564 single-record player, RC456 record changer and 4T-200 transcription unit. All these units are fitted with the "Studio" crystal pickup cartridge and the record changer can be switched to be operated manually for single discs.

A pre-amplifier and power pack are now available for use with the "Tape Transcriptor" magnetic recording mechanism. This employs four heads and both top and bottom tracks can be recorded and played back without changing over spools. Tape speeds of 3¾, 7½ and 15in/sec can be used according to the frequency range required for the material to be recorded.

Collaro Ltd., By-Pass Road, Barking, Essex.

COSSOR (57)

Outstanding in the new range of television sets on show will be a 21-in table receiver, model 947. With a chassis layout and cabinet designed to facilitate easy servicing, it has 15 valves, an aluminized tube, self-centring flywheel sync and automatic contrast control. Ease of servicing is also a feature of the 17-in model 942 console receiver, in which the screen safety glass can be easily detached for cleaning the tube face. Another 17-in console (with full-length cabinet doors) will be on view, also a low-cost 14-in table set for areas of good signal strength, together with a long-range version, and finally a 17-in table receiver.

A v.h.f. waveband is included in the latest addition to the well-known range of "Melody Maker" sound broadcast receivers and also in the new model 529 radiogram, which has three speakers with a crossover network.

Printed circuit technique will be seen in the new "Melody Portable," which is a 4-valve battery superhet for long and medium waves with a ferrite rod aerial and a 5-in loudspeaker. With the batteries it weighs 6lb.

A. C. Cossor Ltd., Cossor House, Highbury Grove, London, N.5.

COSSOR INSTRUMENTS (206)

Construction kits for two instruments—the first of a series—will be introduced this year, one being a valve voltmeter and the other an oscilloscope. Also on show will be the model 1322 "Telecheck" and marker generator for Bands I and III—a frequency-modulated alignment oscillator with internal crystal-controlled frequency markers. In addition, there will be a Band-III convertor for extending the frequency range of an earlier "Telecheck" and an f.m. receiver alignment generator having a carrier frequency generator modulated by the sawtooth waveform of the display c.r.o. to provide the sweep. The display will be completed by a range of oscilloscopes and c.r. tubes.

Cossor Instruments Ltd., Cossor House, Highbury Grove, London, N.5.

DECCA (58)

Choice of seven television receivers is offered with tube sizes ranging from 14 to 21in. The recently introduced table model DM4 (17in) and its console version DM4/C are fitted with tambour (folding) doors to cover the tube face when not in use. Models DM4/C, DMC/D18 and DMC/D21 incorporate a sound broadcast receiver for the v.h.f. service with switched selection of alternative programmes. Model 444 provides television, v.h.f., short, medium and long wave reception and includes a three-speed record changer.

There are three radio-gramophones with four-waveband receivers (including v.h.f) and combined moving-coil and electrostatic loudspeaker systems in each case.

The "Panatrope" console record reproducer, "Portrola" portable radio-gramophone and "Deccalian" and "Deccamatic II" portable gramophones are continued.

Decca Record Co. Ltd., 1-3, Brixton Road, London, S.W.9.

DEFIANT (35, 37)

Television receivers with 14-in, 17-in and 21-in tubes are being shown. Turret tuners are used and flywheel sync is provided. Sound receivers include models covering the v.h.f. band as well as the long, medium and short wavebands.

There is also a portable record reproducer which includes a 4-speed automatic record changer.

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

DE LA RUE (8)

The "Delaron" division of this firm is represented by a wide variety of laminated plastics including Delaron Copper Clad for printed (etched) circuits. A recent development is Delaron Neoprene Clad in which the synthetic rubber functions as a seal for the ends of electrolytic capacitors.

Thomas De La Rue and Co. Ltd., 84-86, Regent Street, London, W.1.

DOMAIN (107)

This stand is devoted to a display of tables for television sets and trolleys for apparatus, such as oscilloscopes.

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

DUBILIER (62)

This firm caters for the diversified requirements of the radio industry in respect to capacitors, resistors and volume controls of one kind or another. Among their latest additions are some sub-miniature electrolytic capacitors, plastic film dielectric tubular capacitors, encapsulated pulse-forming networks and a small 7-ampere choke for suppressing electrical equipment causing interference to television. This last item is an addition to the existing range of television and other types of suppressors produced for use with domestic electrical appliances.

Capacitors, resistors and volume controls are being produced with special terminations and connections for use in printed circuits.

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

DYNATRON (4)

A pre-tuned switch-controlled v.h.f. tuner is to be exhibited in which a.f.c. is employed and provides four channels with an output at audio. Save for the audio side, it is virtually a complete receiver and it forms the heart of the RG10 radio-gramophone. Here it is accompanied by an a.f. amplifier and a tone-control unit and a bass-reflex loudspeaker.

Television sets have 17-in or 21-in tubes. The latter has provision for f.m. sound reception.

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

E.A.P. (215)

The new "Elizabethan de luxe" tape recorder incorporates the Collaro "Transcriptor" and has facilities for mixing microphone and gramophone inputs, headphone monitoring and a voltage output for feeding an external amplifier. The internal amplifier is rated at 3½ watts and the loudspeaker is a 9in × 5in elliptical type.

The "Elizabethan" portable recorded has been redesigned and will be known as the "Elizabethan—56."

E.A.P. (Tape Recorders) Ltd., 9, Field Place, St. John Street, London, E.C.1.

E.A.R. (67)

Electric gramophones include the "1960" range with both portable and "Chairside" versions, the latter designed to serve also as a table for a television or sound broadcast receiver. A transistor portable gramophone will also be shown.

A new series of amplifiers with outputs from 4 watts includes the "Three-Nine-Five" for which the distortion at 20 watts is rated at 0.05 per cent.

Electric Audio Reproducers Ltd., The Square, Isleworth, Middlesex.

E.M.I. (16, 23)

Tape records of the "Stereosonic" kind will be seen amongst the comprehensive display of records from all the E.M.I. group on stand 16. Here there will also be a technical bureau with staff to answer questions about sound recording and reproduction.

Professional tape recording equipment to be shown on stand 23 will include a new and versatile recorder, the TR90, which is available in three versions—in two carrying cases, in rack-mounted chassis and in a glass-topped console. The latest 8¼in spools, giving increased recording capacity, will be seen in the new TR51 transportable machine. An accessory pack for tape jointing (including leader strips) will also be displayed.

Electric and Musical Industries Ltd., Hayes, Middlesex.

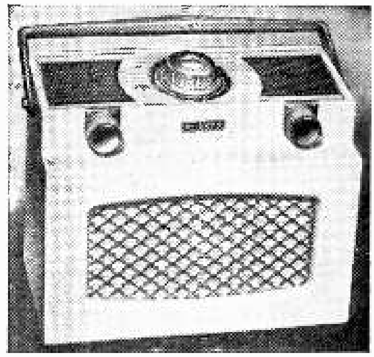
E.M.I. INSTITUTES (307)

A method of practical training by post in radio and electronics is provided by this institute, which is part of the well-known industrial organization. On display will be examples of the equipment which the student builds and studies at home alongside the theoretical instruction. Facilities will be available for private interviews.

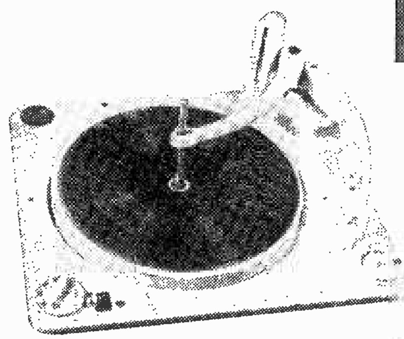
E.M.I. Institutes, Grove Park Road, London, W.4.

EDISWAN-SIEMENS (19)

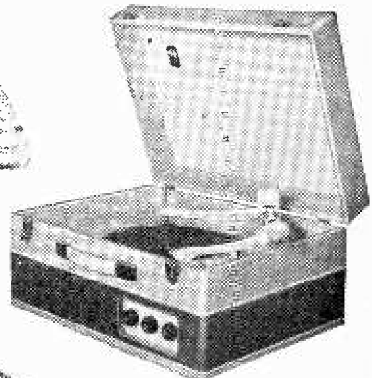
Two double-cone loudspeakers, 10in and 12in, with built-in mechanical cross-over networks will be among the new exhibits on this stand. Asso-



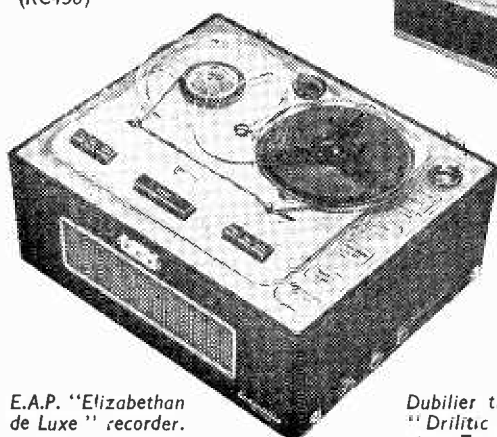
Cossor "Melody Portable" with printed circuit.



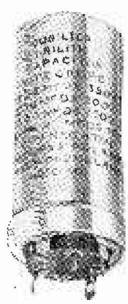
Collaro four-speed record changer (RC456)



E.A.R. "1960" portable gramophone.

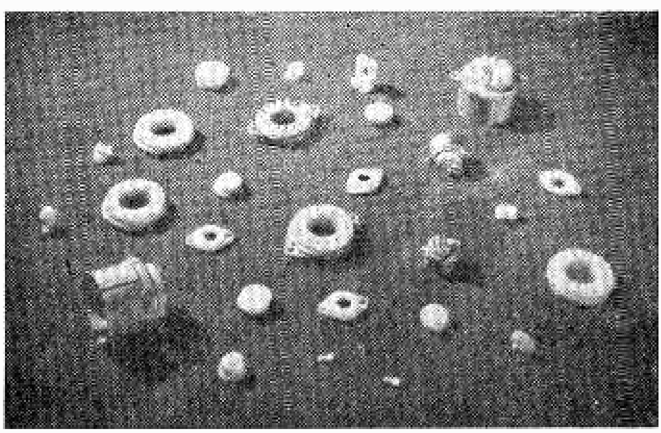


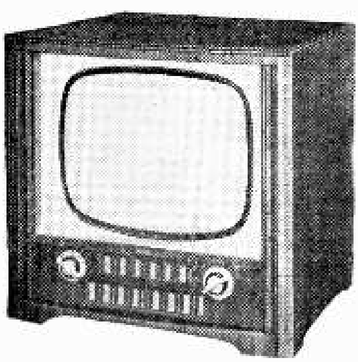
E.A.P. "Elizabethan de Luxe" recorder.



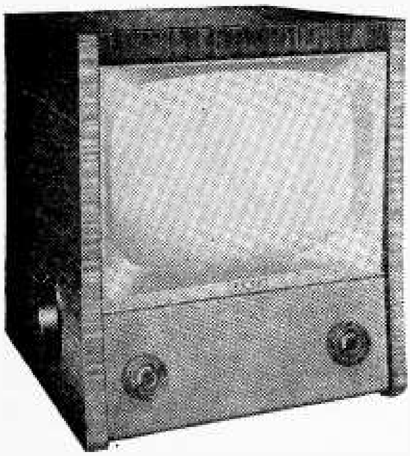
Dubilier triple unit "Drilitic" capacitor, Type CRE/PC, for printed circuits.

Ediswan Clix radio components manufactured from fluorocarbons.

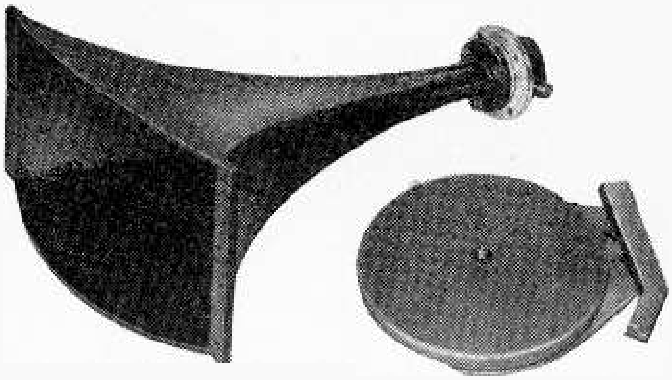




Decca DM4 television receiver.



Ekco model T284 with 17-in tube.



Goodmans "Midax" mid-frequency unit.

Garrard BA1 battery record player.

ciated amplifiers will also be shown. Other electronic apparatus will include marine radio equipment.

Valves for f.m. and Band-III television will be displayed and c.r. tubes will include a new 24-in rectangular type. Industrial valves will be represented by a new vapour-cooled type ESV.1002, while at the other end of the size scale will be miniature diodes for electronic instruments.

Clix radio components will be on view and also an extensive display of high-performance fluorocarbon resins and components incorporating PTFE.

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

EKCO (24, 30)

Among the television receivers to be shown by this firm are new 14-in and 17-in tube models, the T283 and T284. They have turret tuning and flywheel sync, automatic bandwidth control and automatic interference inverter. They are both table models. The T293 is similar to the T284, but has provision for the reception of Band II f.m. sound transmissions.

Sound receivers covering the v.h.f. band only are made and the new types include the A277 table model and the C273 console. A double-triode frequency-changer is used and there are two i.f. stages feeding a ratio detector. Two loudspeakers are used and provision is made for connecting a tape recorder and for using a record player.

E. K. Cole Ltd., Ekco Works, Southend-on-Sea, Essex.

ENGLISH ELECTRIC (40)

Television receivers with 17-in and 21-in tubes are being exhibited. They are available in two forms, with and without provision for f.m. sound reception on Band II, the price difference being of the order of £5. All models cover Bands I and III.

English Electric activities in other fields are illustrated by photographs and models.

The English Electric Co. Ltd., Marconi House, Strand, London, W.C.2.

EVER-READY (54)

The weights of the two new battery portables to be shown by this firm, "Sky Princess" and "Sky Baby," are only 6½lb and 6¾lb respectively. They are 4-valve superhets using low-consumption valves, and are designed in flat carrying cases with hinged lids on the "personal" principle. The "Sky King" is another new battery set of larger and more conventional design. All have high sensitivity speakers and long and medium wavebands.

Among export receivers a new and improved version of the "Saucepan Special" will be shown. A stout metal cabinet is used and the components of the 4-valve superhet circuit are tropicalized.

A subsidiary company, Berec Radio, Ltd., will also be exhibiting a complete range of portable receivers, the "Calypso," "Ballerina" and "Jester" being solely battery sets while the "Fiesta" is a mains/battery model. Ferrite rod aerials are used in all but the "Jester."

As usual there will be a comprehensive display of dry batteries, including the compact layer types.

The Ever Ready Co. (Great Britain) Ltd., Hercules Place, London, N.7.

FERGUSON (12)

A range of television sets, sound receivers and radio-gramophones is to be shown on this stand. Sound receivers include types covering the v.h.f. band as well as medium and long waves, and this applies also to the radio-gramophones.

New television models have 17-in and 21-in tubes. Among the latter is a table model, the 308T.

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

FERRANTI (31, 68)

This firm has now introduced v.h.f. reception into its radiograms. Three models will be shown: the 6-valve 355 with a 10-in speaker, the 8-valve 455 with push-pull output into twin 8-in speakers and the 12-valve 1055 with a short-wave band, separate bass and treble controls, and a push-pull output handled by 7-in and 12-in speakers. All models have three-speed record changers.

In television the latest introduction is a 20-in table projection receiver, model 20T6, which incorporates a paraphase video circuit to permit a large contrast range. There will also be a 24-in console projection receiver and, in direct-viewing sets, 14-in, 17-in and 21-in models.

Among the valves and cathode-ray tubes an outstanding exhibit will be a range of silicon power rectifiers. These are hermetically sealed junction types with very low reverse currents and an ability to work at high temperatures.

Ferranti Ltd., Hollinwood, Lancs.

G.E.C. (53)

To meet the requirements of extreme fringe areas, a complete range of 14-in and 17-in television receivers fitted with flywheel sync will be shown. For those who prefer larger pictures there will be a new 21-in table model and a 21-in console model. A range of Band-III convertors for use with earlier G.E.C. receivers will also be displayed.

In sound broadcast receivers there will be two new table models covering the v.h.f. transmissions, while three radiograms having the same facility will be exhibited.

The display of valves and c.r. tubes will include a new audio output beam pentode, KT88, xenon-filled rectifiers, silicon junction rectifiers, industrial c.r. tubes and valves for r.f. heating and radar. A model of a 2-W transistor a.f. amplifier will be shown, and demonstrations will be given (in room D34) of high-quality sound reproduction equipment.

The General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2.

G.P.O. (304)

A speech synthesizer developed as part of a programme of research into ways of transmitting speech more economically is being demonstrated. It consists of a pulse generator of variable repetition rate to represent the voice excitation, a random noise hiss generator, and three adjustable electrical resonant circuits to impose the "formant" frequencies on the spectrum of the combined output of these two sources. For demonstration purposes a special control unit is being used so that simple words can be produced.

Other exhibits include an electronic sorter, electronic telephone switching, the prototype of the latest quartz-crystal controlled speaking clock and ERNIE, the Premium Bond "wheel of fortune," described on page 440.

General Post Office, St. Martins-le-Grand, London, E.C.I.

GARRARD (50)

A new "transcription" pickup arm with many adjustments not normally provided, and a 45-r.p.m. battery-operated turntable (BA1) for use in miniature valve or transistor portable gramophones are likely to be centres of interest on this stand. The backbone of the exhibit will, as in previous years, be the range of multi-speed gramophone turntables and record changers which includes the RC120/4 and RC121/4 which are designed to occupy the minimum of cabinet space.

Pickup heads include a ceramic type (GCE4) and a moving coil of new design. The Garrard stylus pressure gauge has been redesigned and now includes a spirit level for checking the turntable.

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

GOODMANS (105)

The introduction of "pressure" units into the range of loudspeakers designed for high-quality reproduction is a new departure for Goodmans. In the "Midax" unit covering middle frequencies the horn is of rectangular section and the recommended cross-over frequencies are 750 c/s and 6 kc/s. The "Trebax" unit covers 5 kc/s to 16 kc/s and has a short built-in horn. Cross-over filters are available for coupling the two pressure units and for adding a low-frequency direct radiator cone unit for frequencies below 750 c/s.

A new cabinet ("Viscount") designed for use with the majority of Goodmans cone loudspeakers includes the recently developed acoustical resistance unit.

Goodmans Industries Ltd., Axiom Works, Wembley.

H.M.V. (28)

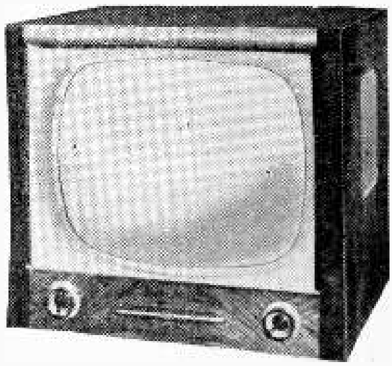
A new range of tape record reproducers to be shown by this firm include the 3031 table model with pre-amplifier and equalizer, giving an output suitable for high quality amplifiers, and the 3032, a console version with tape storage space. Model 3033 is a complete reproducer incorporating a 10-watt amplifier and a dual speaker system, while Model 3034 is for playing "Stereosonic" dual-channel tapes. Model 3035 is a stereophonic tape deck.

Six speaker units, including an electrostatic ribbon type, cover the a.f. ranges in the 3052 high quality disc reproducer to be shown. The 18-watt amplifier has a response of 20 c/s to 30 kc/s. The associated pre-amplifier, incorporating tone control, equalization, etc., is a separate unit with remote control.

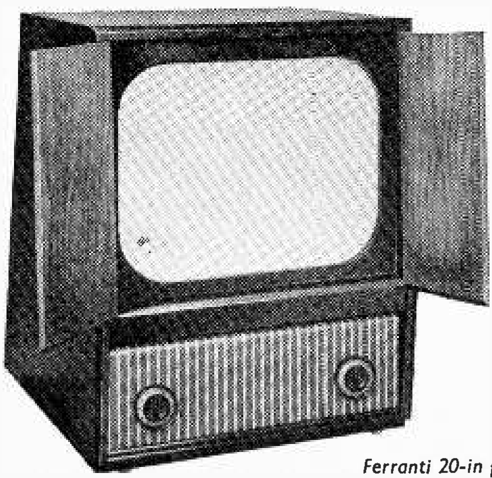
New radiograms incorporating v.h.f. reception will be exhibited, one having an ultra-linear amplifier and four speaker units in an acoustically loaded enclosure.

To compensate automatically for

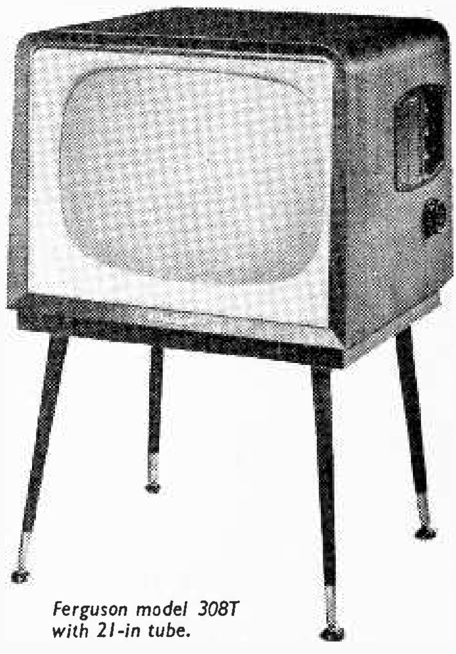
Berec "Ballerina" portable receiver.



G.E.C. 21-inch receiver, BT3251.



Ferranti 20-in projection receiver, 20T6.



Ferguson model 308T with 21-in tube.

differences in strength between Band-I and Band-III signals a new 21-in television receiver incorporates an improved vision a.g.c. system. The sound receiver has a dual speaker system comprising a $10\frac{1}{2}$-in bass unit, which can be moved to either side of the cabinet, and a front-facing tweeter. Table (1847) and console (1848) versions will be on show.

The Gramophone Co. Ltd., Blyth Road, Hayes, Middx.

HART (209)

Several additions have been made to the range of radio cabinets in which this firm specialize. A novel design is the "Hartique Stayrite" television table which can be erected or dismantled in a few seconds. The top when assembled measures 23 × 21in and it is 23in high; castors are fitted.

Alfred Hart and Co. Ltd., 243-249, Upper Street, Highbury Corner, Islington, London, N.1.

HUNT (25)

The manufacture of fixed capacitors of all kinds for the radio and electronics industries comprises the main activity of this firm. Their products include paper, ceramic and synthetic film dielectric varieties, as well as types designed for use in printed circuits.

Among the latest additions is a range of "Duolectric Supermold-seal" capacitors, so called because they are constructed of metallized paper with synthetic film interleave and encapsulated by a cast resin technique providing a tough, heat- and water-resisting casing which withstands temperature changes of from −40°C to +100°C. This form of encapsulation is used for several other ranges.

A. H. Hunt (Capacitors) Ltd., Bendon Valley, Garratt Lane, Wandsworth, London, S.W.18.

I.T.A. (309, 310, 311)

This is the first time that the sponsors of the alternative television service have participated in the Radio Show. The I.T.A.'s stand, which is shared with the two London programme contractors—Associated Rediffusion and Associated Television, naturally stresses the growth of the alternative service in its first year. Part of the stand is devoted to a "conversion centre" where members of the Radio and Television Retailers' Association give advice to viewers on the conversion of their sets.

Independent Television Authority, 14, Princes Gate, London, S.W.7.

INVICTA (65)

Two radiograms incorporating v.h.f. reception will be exhibited on this stand—the Model 59 console with a 3-speed automatic record changer and the Model 60, incorporating the latest type of 4-speed record changer. V.H.F. is also obtainable on the 6-valve sound broadcast receiver, Model 38. Notable for their light weight of under 7lb will be two portable sets, the all-battery Model 26 and mains/battery, Model 27.

Television receivers to be shown will include a 14-in and two 17-in table models, two 17-in consoles and a 21-in console.

Invicta Radio Ltd., 100, Gt. Portland Street, London, W.1.

J. B. CABINETS (115)

This firm specialise in the production of radio, radiogram and television cabinets for the trade. An interesting feature of their display is a selection of cabinets made especially for the American market.

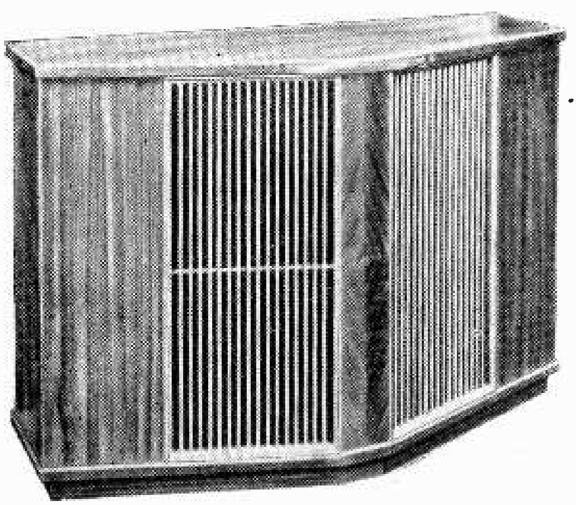
J. B. Manufacturing Co. (Cabinets) Ltd., Howard Way, Harlow, Essex.

J-BEAM AERIALS (1)

Pioneers of the skeleton-slot aerial, J-Beam has now introduced a skeleton-horn aerial for Band III, which, combined with a vertical dipole for Band I, has been named the "Hornbeam." Two models are made, one with reflector and one without. The Band III gain, relative to a dipole, is 7 to 9 dB and the bandwidth 170 to 230 Mc/s.

A wide range of individual Band I and Band III aerials, the latter embodying skeleton slots in multi-element systems, is also to be shown.

J-Beam Aerials Ltd., Westonia, Weston Favell, Northampton.



H.M.V. 3052 reproducer with six loudspeakers and amplifier.

K.B. (20)

A newcomer to the range of sound receivers is the NR30, which covers medium and long waves as well as the v.h.f. band, with internal aerials. Three loudspeakers are included to improve the sound distribution.

Among the existing models which are being continued is the FB10FM, an f.m. receiver which can also be used as an f.m. adaptor with existing a.m. receivers.

Television sets have pictures in the three standard sizes of 14-in, 17-in and 21-in. All models have turret tuners and a form of automatic gain control.

Kolster-Brandes Ltd., Footscray, Kent.

LABGEAR (203)

Two new indoor television aerials make their appearance this year. One is a dual-band type consisting of a Band III dipole with a compressed Band I aerial wound spirally around it. The centre insulator is common to both systems and can be plugged directly into the aerial socket on the television set. Alternatively it can be mounted elsewhere and a 75-ohm feeder used. This is known as the "Spiral" aerial.

The other indoor aerial is for Band I only and is intended for erecting in the loft. Described as the "Bi-Square" it is said to give a good performance up to 40 or 50 miles. The "Spiral" is for use at about 10 miles.

Aerial interference suppressors and cross-over filters are shown also.

Labgear (Cambridge) Ltd., Willow Place, Cambridge.

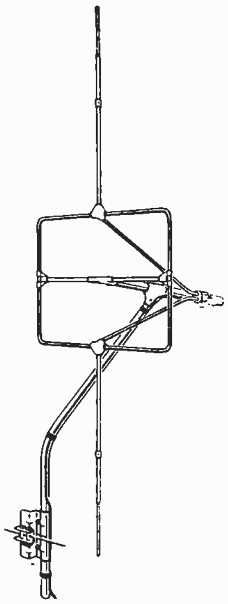
LINGUAPHONE (207)

Courses of instruction in foreign languages through the medium of gramophone records and books are offered by this company. Altogether 32 courses are available, the most recent additions being in South-American Spanish and Icelandic.

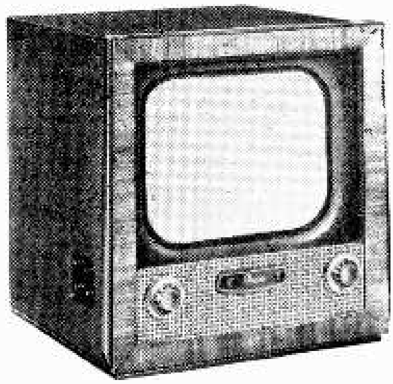
Linguaphone Institute Ltd., 207-209, Regent Street, London, W.1.

McMICHAEL (59)

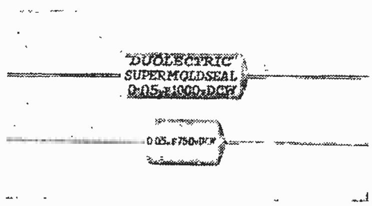
Several of the new television sets now embody a "black spotter," a circuit feature which blanks out the white spots on the screen produced by severe ignition and similar inter-



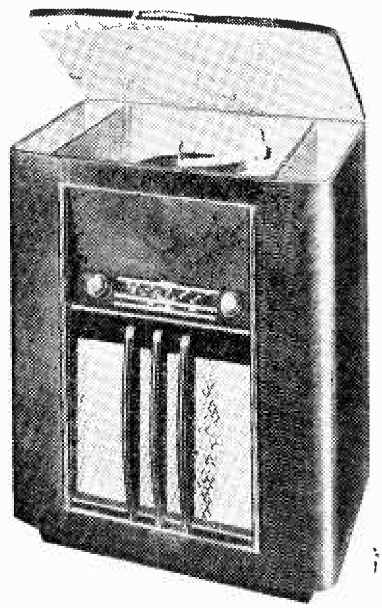
J-Beam "Hornbeam I" dual-band aerial.



Marconiphone 14-in receiver, VT150.



Hunt "Duolectric Supermoldseal" capacitors for 750V and 1,000V d.c. working.



Invicta 60 radiogram with 4-speed record changer.

ference. This is generally far worse in fringe areas. The new sets offer the choice of 14, 17 and 21-in tubes and multi-channel tuners.

A 3-waveband a.m./f.m. chassis is included in the Model C417FM combined television and broadcast receiver. It has provision for a gramophone input and extension loudspeakers.

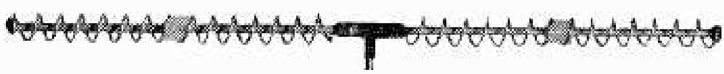
The majority of the new sound only sets have an f.m. range and built-in aerials for all bands are common, but there is provision for external aerials. One radiogram, M101RG, actually has push-button station selection operative on f.m. and a 4-speed automatic record changer.

McMichael Radio Ltd., Slough, Bucks.

MARCONIPHONE (23)

Electrostatic focusing is used in the 14-in c.r. tube of the new VT150 table television receiver to be shown, and is claimed to give an exceptionally sharp picture with accurate focusing over the whole screen. High sensitivity circuits are used, with extra gain on Band III channels. Another new set, model VC152, has the large screen size of 21in and has special circuit features to counteract fading, aircraft flutter and variations in signal strength between Band I and Band III stations.

Among radiograms the new "Studio" model, ARG49A, is notable for its modern styling and low-level cabinet with a Warerite table top. It has a 6-valve a.m./f.m. circuit with a 3-speed automatic record changer, and this combination



Labgear "Spiral" dual-band indoor aerial for direct connection to the receiver.

appears in several other radiograms to be shown.

The Marconiphone Co. Ltd., Blyth Road, Hayes, Middx.

MASTERADIO (15)

Complete home entertainment in a single unit seems to have been the aim of the designer of the TRG366, which combines the facilities of a 17-in television set, a radiogram and a tape recorder. Several other new television sets are shown with tubes ranging in size from 14 to 21in.

There is a range of sound broadcast receivers, some of which include the f.m. band and one the trawler band.

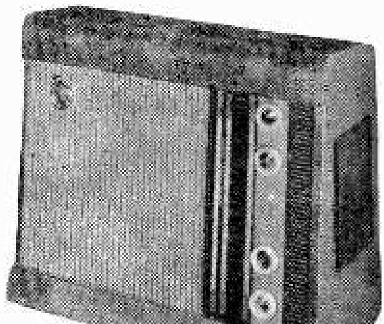
Cabinet styles employed include portable, table, console and bureau, the last-mentioned for radiograms.

Masteradio Ltd., Fitzroy Place, London, N.W.1.

MULLARD (32)

Applications of electronics in communications, navigation, medicine, industry and commerce will be illustrated by photographs, typical Mullard products and various working devices and demonstrations. There will also be an historical display of radio valves.

For the amateur constructor there will be a special demonstration room, D2A, containing examples of equipment built to Mullard circuits and



Kolster-Brandes NR30 a.m./f.m. receiver.

free technical literature. Technical representatives will be available to answer queries.

Mullard Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

MULTICORE (10)

A new solder alloy produced by this firm is said to prolong the life of the soldering bit by preventing the absorption of copper from the bit into the solder. The alloy contains a small percentage of copper. The main feature of the stand will be a demonstration of the new alloy being used in the wiring and soldering of Alba midget sound receivers.

Other exhibits will include home constructors' solder for printed circuits, a solder thermometer and a magnetic tape splicer. The well-known BIB wire stripper and cutter will also be shown, with the new feature of 4 B.A. and 6 B.A. spanner holes in the handles.

Multicore Solders Ltd., Maylands Avenue, Hemel Hempstead, Herts.

MURPHY (42)

Television sets with tubes up to 21in and sound broadcast receivers are to be exhibited. The basic 17in models are the V280 (table) and V280C (console) and they are electrically similar to the 14in V270, but not identical. They have turret tuners and vision-channel a.g.c. The V280A (table) and V280CA (console) and V280AD (console with doors) are fringe-area models which differ in having an extra i.f. stage and flywheel sync.

Sound broadcast receivers include the v.h.f. band in their coverage. A v.h.f. mobile radio telephone is also being shown. It is crystal-controlled on both transmit and receive and can be obtained for the bands 60-90 Mc/s, 100-133 Mc/s or 133-174 Mc/s. The receiver is of the double superheterodyne type.

Murphy Radio Ltd., Welwyn Garden City, Herts.

NAVY (303)

A Sea Hawk naval fighter, complete with radio-communication equipment and navigational aids, is the dominant feature of the stand. The Admiralty Signal and Radar Establishment has provided a demonstration showing the use of ferrites in the development of radar and other electronic equipment.

Among examples of marine radio-communication equipment to be seen on this stand is the gear supplied to members of the Royal Naval Volunteer (Wireless) Reserve for use at home and also a complete Royal Marine beach signal station. There is also a section devoted to radio aids to navigation.

The Admiralty, Whitehall, London, S.W.1.

NIXA (5)

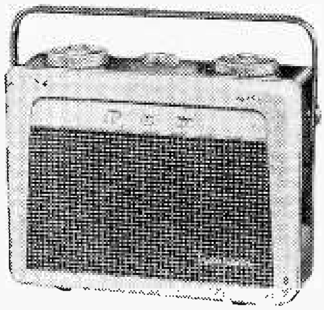
Gramophone discs under this name, and Mercury, Vanguard and Emarcy records which are also marketed by Pye Ltd., will be featured on this stand.

Nixa Record Co. Ltd., 66, Haymarket, London, S.W.1.

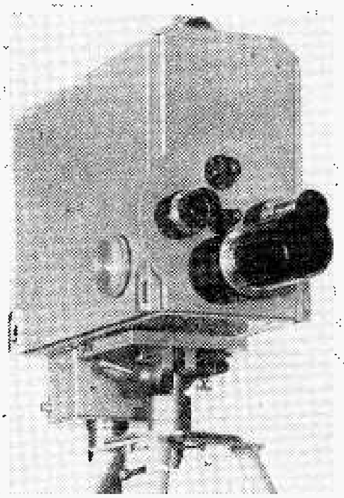
OPPERMAN (319)

The Stirling single-valve Band I/III convertor, from which, it is claimed, there is no radiation, is to be shown by this company, whose main business is the manufacture of aircraft parts.

S E. Opperman Limited, Sterling Corner, Boreham Wood, Herts.



Pam "Transistor" portable.



Peto Scott television camera.

PAM (55)

A superheterodyne portable receiver using transistors throughout will be regarded by many people as being technically the most interesting exhibit on this stand. It covers medium and long waves, has an intermediate frequency of 310 kc/s and consumes only 35 mA from a 6-volt battery. It is built by the printed circuit technique and the push-pull output transistors feed the loudspeaker moving coil directly without a transformer.

A new radio-gramophone (Model 715 RG) incorporates the Collaro four-speed record changer and provides for reception of v.h.f. as well as medium- and long-wave stations.

Pam (Radio and Television) Ltd., 295 Regent Street, London, W.1.

PAMPHONIC (34)

Sound reproduction and reinforcement in all its aspects is represented by the products of this firm which include popular record reproducers, high-quality amplifiers, tuners and loudspeakers, and complete sound reinforcement systems based on the delay principle for use in large auditoria.

A prominent exhibit on this stand will be a 10-kW amplifier for vibration testing made by W. Bryan Savage, Ltd., an associated company.

Pamphonic Reproducers Ltd., 17, Stratton Street, London, W.1.

PETO SCOTT (14)

A feature of the television sets exhibited by this firm is the provision of pre-set r.f. gain and contrast controls for the two bands selected by the band-switching. This is done to obviate the need for adjusting controls when changing from one station to another. Both 14-in and 17-in models are shown.

A television camera is also on view.

Peto Scott Electrical Instruments Ltd., Addlestone Road, Weybridge, Surrey.

PHILCO (22, 317)

Fully transistorized sound receivers, radiograms and record players will be a feature of this stand. The more conventional equipment will include v.h.f. receivers, a three-waveband "torch" receiver, car radios with push-button short-wave converters for use in various parts of the world, and a range of television receivers with screen sizes from 14in to 21in.

An electronic device for use in training electronics technicians will also be displayed, while in the high-fidelity demonstration room D26a there will be a two-channel, four-speaker equipment for high-quality reproduction of gramophone records.

Philco (Great Britain) Ltd., Romford Road, Chigwell, Essex.

PHILIPS (44, 45)

Built-in dipole aerials for v.h.f. will be a feature of several of the a.m./f.m. receivers to be displayed, with ferrite rod aerials for medium and long waves. Also on show will be a 5-valve superhet clock radio and an "easy-to-fit" car receiver, for 6-V or 12-V operation, with a separate 5-in loudspeaker.

Automatic gain control on both sound and vision will be found in most of the television receivers, which range from a 14-in table model to a 23-in console projection set, while flywheel sync is used in the fringe-area models.

The 10-W "Novosonic" high-quality sound reproduction equipment will be demonstrated, and there will be a comprehensive display of radiograms, record players and automatic record changers.

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

PILOT (27)

A new model amongst the range of television sets on show will be the 17-in TV107 table receiver, which has a.g.c. on vision, flywheel sync, flyback blanking and a front-facing loudspeaker. Other receivers will range from 14in to 21in.

Sound receivers will include a new

(*Continued on page* 421)

version of the "Little Maestro" a.c./d.c. 4-valve superhet with a ferrite rod aerial. Also on view will be a.m./f.m. receivers, one of them having a short-wave band, with an alternative version offering the trawler band instead.

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

PLESSEY (9)

The activities of this firm are devoted largely to the production of components, accessories and complete assemblies for the radio industry. This year is displayed a production model, the Type D15, of a loudspeaker working on the novel principle described in the *Wireless World* of January, 1952. Known as the "Ionophone" it has no recognisable moving parts as it functions by direct modulation of ionized air. Its only frequency limitations are those of the horn used with it.

This loudspeaker is particularly suitable as the "high frequency" reproducer in a multi-loudspeaker system, for which application a 2,000 c/s cross-over filter is advised.

Plessey Co. Ltd., Ilford, Essex.

PLUS-A-GRAM (216)

This firm is showing Dansette gramophones. The Minor has a three-speed motor and crystal pick-up and is of the portable type.

J. & A. Margolin Ltd., 112-116 Old Street, London, E.C.1.

PORTOGRAM (66)

Twin elliptical loudspeakers are used in the new "Symphony Four" console record reproducer which incorporates the Collaro RC/456 four-speed changer unit and is designed for the small living room.

Other new models are the "Auto-4-Gram" and "Babygram" portable record reproducers.

The Model HF63 console with omnidirectional sound distribution and the TR100 high-quality reproducer, with alternative combinations of record-player, tape recorder and f.m. tuner, are continued.

Portogram Radio Electrical Industries Ltd., Preil Works, St. Rule Street, London, S.W.8.

PYE (13)

Demonstrations of amplifiers, loudspeakers, a.m./f.m. tuners and record reproducers will be given in room D6, entrance tickets for which will be available on the stand.

A comprehensive range of television receivers, from 14-in to 21-in, will be shown, together with a.m./f.m. sets, portables and radiograms. Also on view will be the "Talk Box" intercommunication system which operates over the electric mains wiring.

Pye Ltd., Cambridge.

R.A.F. (312)

Guided missiles and their associated electronic control and telemetering equipment are to be seen on this stand. The equipment shown in the section devoted to rockets includes a v.h.f. direction finder, u.h.f. gear and teleprinter systems. The training of radio apprentices is also featured.

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

R.C.A. (103)

Sound reproducing equipment, built to the highest performance standards, and termed "New Orthophonic," will be shown and demonstrated. The basic units are a 20-watt amplifier and pre-amplifier to which may be coupled an f.m. tuner incorporating automatic frequency control and the new 6AL7 tuning indicator.

For record reproduction a transcription turntable is available with a choice of electro-magnetic pickups working on the 8-pole balanced armature principle and sealed against dust by a plastic moulding.

A three-unit cross-over loudspeaker system is housed in a cabinet of similar design to that used for the R.C.A.-Olson loudspeaker.

R.C.A. Great Britain Ltd., Lincoln Way, Windmill Road, Sunbury-on-Thames, Middlesex.

R.G.D. (52)

In the latest radio-gramophone introduced by this firm four loudspeaker units (two 8in × 5in elliptical, one 10in and one small cone "tweeter") are arranged to give wide sound distribution. The radio receiver includes a v.h.f. range, and the record changer has four speeds.

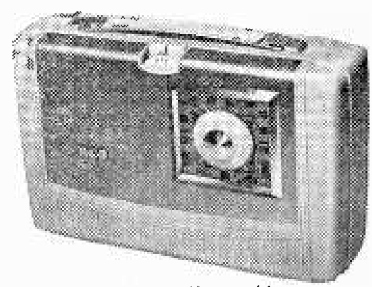
Another new product is the "B Fifty Five" small portable for mains or battery operation with push-button wavelength selection.

The R.G.D. programme includes four television receivers and five other sound receivers and radio-gramophones.

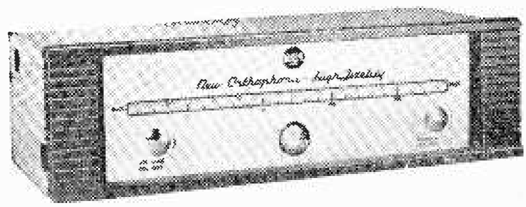
Radio Gramophone Development Co. Ltd., Eastern Avenue, Romford, Essex.

R.S.G.B. (305)

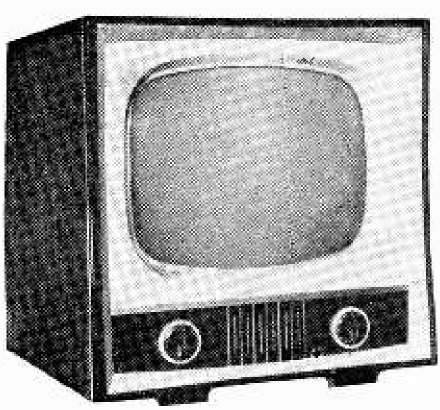
The theme of this stand is "An introduction to amateur radio" and



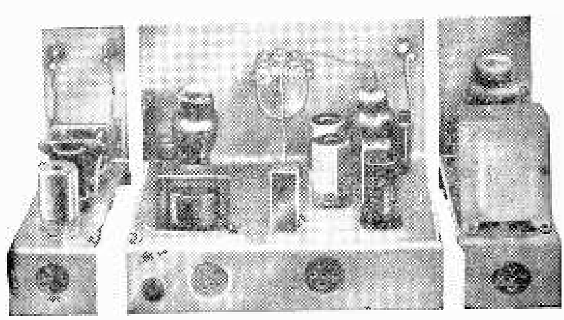
R.G.D. "B Fifty-Five" portable.



R.C.A. f.m. tuner unit.



Pilot 17-in receiver TV107.



Home-constructed communications receiver exhibited by R.S.G.B.

this is emphasized by a short film "A guide to amateur radio." Among the exhibits is a complete amateur transmitting station including home-constructed transmitting, receiving and frequency measuring equipment. On the stand will also be found other examples of home-constructed equipment including a single side-band transmitter for 144 Mc/s and a communications receiver.

Radio Society of Great Britain, New Ruskin House, 28/30 Little Russell Street, London, W.C.1.

R.T.R.A. (201)

Telesurance—the receiver maintenance and insurance scheme operated by members of the Association—is the main feature of this stand. The scheme, for which the charges vary according to the size of the tube, provides for replacement of defective components, servicing and insurance against burglary, fire and accidental damage.

Radio and Television Retailers' Association, 15/17 Goodge Street, London, W.1.

REGENTONE (60)

A choice of no fewer than 22 models (four television, six sound receivers, seven radio-gramophones and five portable electric gramophones) is offered this year.

The principal new model is the "Continental" radio-gramophone with four-speed record changer, long, medium, short and v.h.f. sound receiver and a three-unit omnidirectional loudspeaker system.

Three other new radio-gramophones include a table model (FM109) with provision for v.h.f. reception.

Two new a.c./d.c. portables (DP2 and DW1) are shown and a "handbag" portable ("Double Two") which operates either from batteries or mains.

Regentone Radio and Television Ltd., Eastern Avenue, Romford, Essex.

ROBERTS (48)

This firm continues to specialize in the production of high-grade portable receivers and this year has produced a new compact lightweight model (R66) for a.c. mains or battery operation covering medium and long waves. A ball-bearing turntable is fitted so that the directional properties of the self-contained aerial can be effectively exploited.

Roberts Radio Co. Ltd., Creek Road, East Molesey, Surrey.

ROLA CELESTION (6)

The exhibit is designed to emphasize the wide range of loudspeaker types, both domestic and public address, which are made by this firm. Four new models have been introduced for the domestic market. C10A is a 10-in unit designed to give a smooth response from 65c/s to 10kc/s and may be used in conjunction with the 4-in C4A high-frequency unit (5 to 15kc/s). C8A gives the unusually wide frequency average, for an 8-in unit, of 50c/s to 12kc/s. C68A is an elliptical unit to meet the demands of modern cabinet designs and has a range of 70c/s-12kc/s.

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

S.T.C. (117)

The ability of silicon rectifiers to work successfully over a wide range of temperatures will be demonstrated by an apparatus which plunges the rectifiers cyclically into chambers at $-40°C$ and $100°C$ respectively.

Improved performance for a given size is shown by a range of selenium rectifiers, Series 400, the plates of which are coated by a new vacuum evaporation process. Changes in design offer improved mounting and connecting facilities. Selenium is also used in a new range of rectifiers, designed for a.c./d.c. portables, which are notable for their compactness and novel construction.

Standard Telephones and Cables Ltd., Connaught House, Aldwych, London, W.C.2.

SIMON (46)

Tape speeds of $3\frac{3}{4}$in/sec and 7in/sec are provided in the Model SP/2 magnetic tape recorder. The frequency responses claimed for these speeds are 50-7,000c/s $\pm$3dB and 50-12,000c/s $\pm$3dB. Spools up to $8\frac{1}{2}$-in diameter can be used, and the amplifier, which can be used separately, has an output of 10 watts.

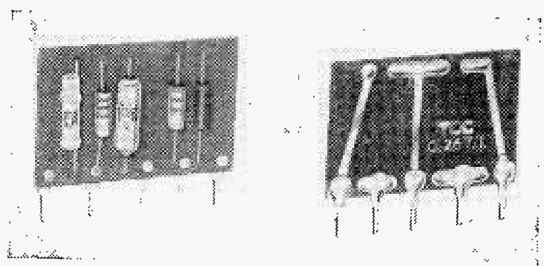
Accessories include a matching v.h.f. tuner unit and a new pressure microphone.

Simon Sound Services Ltd., 48, George Street, London, W.1.

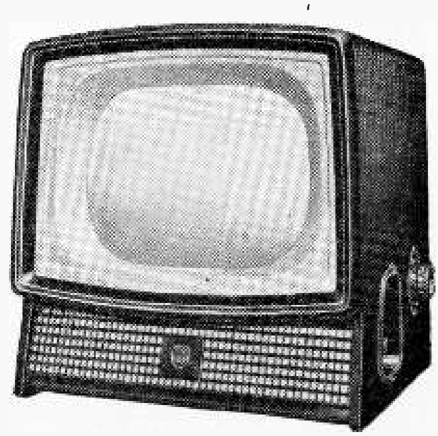
SOBELL (33)

Both 17-in and 21-in table television receivers are shown in table and console styles. Turret tuning and fly-

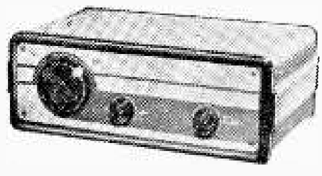
Simon Model SP/2 tape recorder.



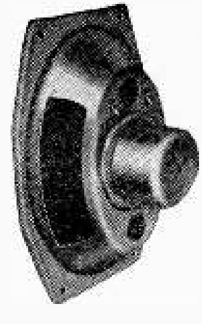
Printed circuit sub-assembly shown by T.C.C.



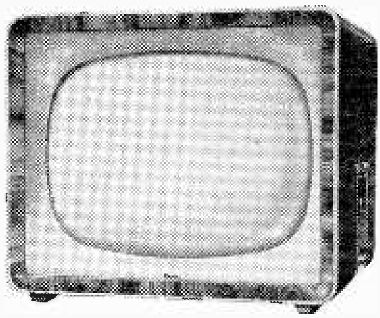
Ultra V 15—60 table model with 14-in tube.



Spencer-West Band III convertor.



Celestion elliptical loudspeaker (C/68/A).



Sobell T21 table model with 21-in tube. Side controls are fitted.

wheel sync are employed. There is also one 14-in model.

Sound receivers include the 636WF which covers the f.m. band as well as medium and long waves. A receiver of similar basic form is available with an automatic record player in radio-gramophone form.

Radio & Allied Industries Ltd., Langley Park, Slough.

SPECTONE (316)

A stereophonic magnetic tape reproducer (Model 123) is the main item on this stand. It is built to reproduce tapes recorded to C.C.I.R. standards and incorporates a "Reflectograph" mechanism and two amplifiers based on the Mullard "5-10" design. Model 127 is a smaller version designed to operate with external main amplifiers.

The Spectone "Five Fifteen" range of amplifiers, similar to those used in the magnetic tape reproducer, are available with separate or built-in controls.

Specto Ltd., Vale Road, Windsor, Berks.

SPENCER-WEST (211)

In addition to a range of aerial distribution amplifiers, this firm is to show a Band III pre-amplifier using a double-triode, one stage acting as an earthed-grid amplifier and the other, neutralized, as an earthed cathode.

Several Band III convertors are to be displayed. The Type 66 has a printed circuit. The Type 50 includes a cascode pre-amplifier which is operative on Band I as well as Band III. Other exhibits include a variable aerial attenuator and a pattern eliminator.

A television receiver, Model 1956, has a 9-in tube and is intended rather as an "occasional" set for the nursery or sick-room.

Spencer-West Ltd., Quay Works, Great Yarmouth, Norfolk,

STELLA (56)

The television receivers on view will include a new 17-in table model ST2717U. It has a.g.c. on sound and vision, while the turret tuner covers B.B.C. Channels 1-5 and I.T.A. Channels 8-10.

Reception of v.h.f. programmes is provided for in the new ST24A table sound broadcast receiver and also in the ST238A a.m./f.m. radiogram, which has a 3-speed automatic record changer and an 8-in dual-cone loudspeaker. Both of these models have built-in aerials for a.m. and f.m. A mains/battery portable, another table receiver and a portable record-player will also be on show.

Stella Radio and Television Co. Ltd., Oxford House, 9-15, Oxford Street, London W.1.

T.C.C. (64)

While this firm are primarily manufacturers of fixed capacitors and small ceramic trimmers, an important subsidiary activity is the production of printed circuits for the radio and electronic industries. A new development in this field is the use of printed circuit sub-assemblies in conjunction with the main printed circuitry and several examples, principally of capacitor banks, are shown. Printed circuit plates for wafer-switches is also a new development and those made by T.C.C. have either silver- or rhodium-plated contacts.

There is a new range of "Hi-K" (high dielectric constant) miniature lead-through and stand-off ceramic capacitors for use in v.h.f. and u.h.f. tuners, also some "Low-K" trimmers of limited coverage for the same application.

Telegraph Condenser Co. Ltd. Wales Farm Road, North Acton, London, W.3.

TAPE RECORDERS (38)

Modifications to existing models include facilities for mixing inputs and monitoring in the "Editor" tape recorder as well as the "Hi-Fi Editor Super."

A new recorder, to be known as the "Sound" is based on the Collaro "Transcriptor" tape mechanism.

Tape Recorders (Electronics) Ltd., 784-788, High Road, Tottenham, London, N.17.

TAYLOR (106)

Apart from the introduction of several new pieces of test equipment a number of improvements have been effected to the existing range of test sets. Multi-range meters Types 77A and 88A have resistance ranges now extending to 50 MΩ with self-contained batteries, while the Taylor Junior (Model 120A) now has a 5A current range. The electronic test meter, Model 171A, is modified for f.m. discriminator measurements.

Among the newer models is the 94A, a comprehensive television test set embodying an a.m. and f.m. signal generator covering 4 to 230 Mc/s, a pattern generator and a wobbulator. There is a new Model 33A miniature oscilloscope with a 2¾in tube.

Taylor Electrical Instruments Ltd., Montrose Avenue, Slough, Bucks.

TELEQUIPMENT (63)

In addition to the Type WG44 television pattern generator this firm are showing factory-type test equipment and a new Type 4A oscilloscope for checking G.P.O. television lines and terminal equipment. A modified version of this is available for television research applications where a wide-band, high-gain oscilloscope is required.

Telequipment Ltd., 313, Chase Road, Southgate, London, N.14.

TELERECTION (18)

Delta matching of the feeder to the aerial, a principle which obviates the need to use a centre insulator and split dipole, has always been the distinguishing feature of all this firm's television and v.h.f. sound aerials. They also introduced the tilted aerial and still include the feature in some of the multi-element Band I systems.

The most recent addition is a "Double Delta" Band III series of aerials for use in fringe and difficult close-in areas.

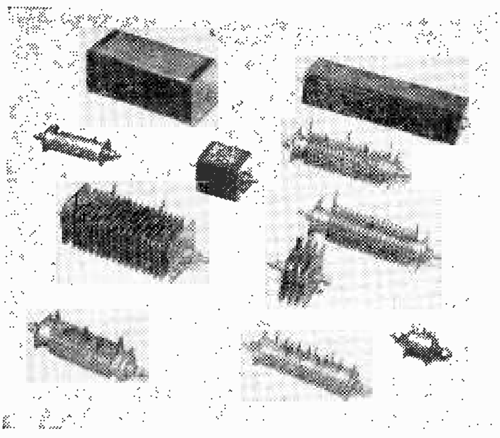
Telerection Ltd., Antenna Works, St. Pauls, Cheltenham.

ULTRA (41)

The range of television receivers includes 14-in, 17-in and 21-in tube models. The tuner is of the 13-channel permeability type and includes coils for all channels. Flywheel sync is used and a phase-corrected i.f. amplifier.

The sound broadcast receivers include an a.c./d.c./battery portable and an a.m./f.m. receiver of the a.c./d.c. type. This is also available in radio-gramophone form with a three-speed record changer.

Ultra Electric Ltd., Western Avenue, London, W.3.



Westinghouse potted and normal rectifiers.

Waveforms television oscilloscope, type 301.

UNITED APPEAL FOR THE BLIND (314)

A number of radio factories employ blind people on assembly work; among them are Pye's, whose subsidiary, TV Construction, Ltd., Lowestoft, have provided the demonstration on this stand. Blind operators can be seen producing sub-assemblies for television receivers (Pam 500) and inspecting magslip pillars. For the latter operation Braille-adapted micrometers and gauges are used.

Examples of Braille wiring diagrams on plastic sheeting, a new Braille Avometer and other aids for the blind to work alongside their sighted colleagues are to be seen.

United Appeal for the Blind, 28 Manchester Street, London, W.1.

VALRADIO (213)

For operating television receivers, tape recorders and radiograms from d.c. mains or battery supplies a range of d.c.-to-a.c. converters will be exhibited. Also on view will be heavy-duty vibrators for operation from 6V to 250V.

In the field of television there will be 10-, 11-, 12- and 13-channel tuners for home and overseas transmissions, and a range of viewing screens for front-projection television receivers.

Valradio Ltd., Browells Lane, Feltham, Middlesex.

VIDOR (11)

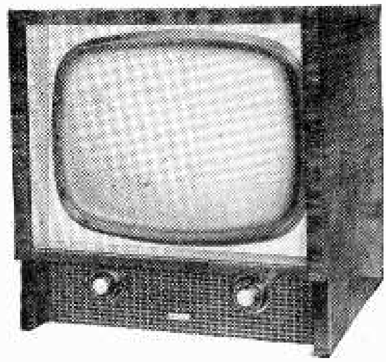
Two new portables make their appearance this year, the "Lady Margaret de Luxe" and the "Vanguard" an a.m./f.m. model. There is also a 45-r.p.m. battery portable record player known as the "Jamboree."

The Model CN4231 table model television set is also new; this has a turret tuner, 17 valves plus two crystal diodes and a metal rectifier and a 17-in rectangular tube with ion trap. A 7×4in elliptical loudspeaker is fitted.

In addition to receivers, Vidor make a very wide range of dry batteries, including hearing-aid types.

Vidor Ltd., Erith, Kent.

Whiteley Electrical loudspeaker (HF 1514).



Vidor Model CN4231 turret-tuned television receiver with 17-in tube.

WAVEFORMS (205)

The Radar 301 oscilloscope is intended for television work and has a signal amplifier with a 3-dB bandwidth up to 6 Mc/s and a calibrated and frequency-compensated attenuator. It has a Miller timebase with trace expansion to 20 cm. The maximum sweep is 0.5 μsec/cm.

Television signal generators, a c.r.-tube reactivator and an e.h.t. measuring device are among the other exhibits.

Waveforms Ltd., Radar Works, Truro Road, London, N.22.

WESTINGHOUSE (102)

High-temperature lightweight rectifiers, designed to operate at ambient temperatures up to 85°C, will be a feature of this stand. Constructed of aluminium, with cooling fins eliminated to reduce bulk, these units are very light and compact compared with ordinary h.t. rectifiers.

Contact-cooled rectifiers, where the heat is dissipated by chassis conduction rather than convection, will be displayed, and also tubular double- and quadruple-voltage rectifiers in normal and sealed types. The quadruple-voltage units are suitable for e.h.t. supplies in television receivers. Germanium diodes for radio circuit applications will again be featured.

Westinghouse Brake and Signal Company Ltd., 82, York Way, King's Cross, London, N.1.

WHITELEY ELECTRICAL (47)

An unusually wide range of choice in loudspeaker units for high-quality reproduction is offered by this firm, including many with a unique form of cambric cone. A new model, shown for the first time, is a combination of the moving-coil and electrostatic principles.

Cabinets designed to complement the characteristics of the various loudspeaker units are available and are supplied packed flat ready for home assembly with a screwdriver.

The WB12 quality amplifier and pre-amplifier appears in improved form and is now supplemented by a v.h.f. tuner unit.

A large part of the stand is devoted to examples of the versatility of Whiteley Electrical's manufacturing facilities for making components and instruments, such as the meteorological "radio sonde," for the Services, science and industry.

Whiteley Electrical Radio Co. Ltd., Victoria Street, Mansfield, Notts.

WOLSEY (2)

A new Band III aerial for loft mounting is introduced this year; it has a ball joint cross-arm fitting enabling the aerial to be mounted on sloping beams yet having the elements vertical or horizontal and oriented as required. Three- and five-element models and a full range of outdoor types will be shown.

A special display is made of combined aerials embodying "arrowhead" style Band III elements. These are intended for use where the B.B.C. and I.T.A. stations are co-sited or virtually so.

A Band III convertor with turret tuning for the oscillator is now available. A cascode r.f. stage is used and the gain is 20 dB.

Accessories include cross-over networks, 75 to 300Ω balun couplers and a solderless cable plug.

Wolsey Television Ltd., 43-45, Knight's Hill, West Norwood, London, S.E.27.

WOOD & METAL INDUSTRIES (315)

A spring-loaded castor is to be exhibited on this stand. The weight is taken by a thrust ball bearing against a spring so that, in addition to the normal action of a castor, there is a buffering action against shocks in the vertical plane.

Wood & Metal Industries Ltd., Seymour Road, Leyton, London, E.10.

LETTERS TO THE EDITOR

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

Noise in Carbon Resistors

THE article on "Characteristics of Fixed Resistors," by G. W. A. Dummer (*Wireless World*, June, 1956, p. 263), has probably suffered through being over-compressed from the author's book, but the note on the frequency spectrum of current noise calls for comment. Whereas Dummer refers to the spectrum of current noise "from below about 10 c/s", experiments on carbon composition resistors (Rollin and Templeton, *Proc. Phys. Soc. B*, 1953, vol. 66, p. 259) have shown that the inverse frequency power spectrum continues to as low a frequency as can be measured, which is so far a frequency of the order of a thousandth of a cycle per second. For carbon the spectrum follows very closely the law $E^2 \propto \Delta f/f$ where Δf is a narrow pass-band centred on f. The noise in equipment of considerable bandwidth from f_1 to f_2 then has squared voltage proportional to the *logarithm* of the ratio f_1/f_2, not to the direct ratio as stated in the article.

The figures given in Table 3 are, of course, arbitrary acceptance limits, and related to the physical mechanism only empirically if at all. I have not a copy of RCS specifications to hand, so could the author please tell us what is the formula now used for the maximum acceptable noise from cracked-carbon resistors, in place of the rule of 0.5μV/V which was employed a year or two ago?

I assume that the + and − signs in Fig. 6 have been copied from Fig. 5 by mistake, since R_{rf} will not become negative. But why is it stated categorically (No. 3 of the conclusions) that a resistor for use at radio frequency should be of the film type when a rule has previously been given for the behaviour of *composition* resistors up to 1500 Mc/s?

To continue dotting i's and crossing t's, may I say to "Cathode Ray" that there is no harm in using a composition resistor across the input of a high-gain amplifier *provided there is no steady current in it.* I have often used composition resistors as a source of standard noise levels for the calibration of high-gain amplifiers, and all measurements show that at zero mean current the composition resistor produces good honest Johnson noise.

D. A. BELL.

Electrical Engineering Department,
The University, Birmingham 15.

Technical Training

YOUR correspondent, S. J. Coe (issue of May, 1956), has apparently been misled into believing that City and Guilds certificates in Telecommunications Engineering can be gained only by those students who attend recognized technical college courses. This is not so.

The City and Guilds of London Institute, whilst strongly recommending attendance at a technical college wherever possible, has always recognized that there will be many students for whom no courses are available. This is particularly true in the case of the more advanced levels where the small numbers often preclude the establishment of appropriate college courses. The Institute has accordingly made special provision in its Regulations for the acceptance of such students as external examination candidates, and the Intermediate, Final and Full Technological Certificates in Telecommunications Engineering are available equally to internal and external entrants.

A perusal of the Institute's Regulations would have revealed to Mr. Coe that he could have made an entry to the examinations as an external candidate merely by applying to the authorities of the nearest technical college in February, seeking accommodation for the tests which take place in May.

CYRIL LLOYD.
Director, City and Guilds of London Institute.

Television Film Quality

YOUR Editorial on broadcasting from recordings (June issue) has stimulated me to comment upon the use of film in television. There are two aspects of this, the technical and the artistic, and I must say that very many of the films recently televised can only be considered thoroughly bad on both counts.

Good films are technically possible on television and as instances I may cite the old B.B.C. newsreels and many of the Peter Scott wild-life pictures. All too often, however, the picture is so lacking in tone gradation that a man in a dark suit is little more than a silhouette, while the sound quality is of the kind generally known as 90 per cent distorted.

Artistically, many of these films fail because they have been produced to suit the conditions of mass reaction which exists in the cinema but not in the television audience. Quite a different style of production is needed for television, but even then it can only compare unfavourably with "live" television. If anyone doubts this statement he has only to watch one of those programmes which is a mixture of "live" scenes and of film. It is very instructive to notice how the film breaks up the continuity of the programme and destroys the illusion of reality. The effect on the viewer is exactly the opposite to what the producer obviously intends.

It may be objected that the viewer cannot distinguish film from "live" television when the film is good. He may sometimes be deceived into thinking it is a "live" show with rather a poor camera. But there is no disguising the horrible jerky motion in horizontal panning shots which is a peculiarity of film and which is as evident in the cinema as in televised films.

W. TUSTING.

Measurement of Rise-time

IN the February, 1955, issue of *Wireless World*, E. G. Dann described a method of measuring rise-time by replacing the normal timebase of an oscilloscope by an r.f. generator. However, he does not give the order of recurrent frequency of the square waves which may be measured by this method. Owing to the great difference in the frequency of the square waves, and that of the r.f. waves required to display several cycles during rise-time, there can never be sufficient constancy of frequency in practice to obtain a steady trace.

The problem is solved, however, if a multivibrator is locked on to the r.f. generator and the output from the "multi" used to trigger the square wave generator at its fundamental frequency. A rock-steady display is then readily obtained. Since a "multi" will lock quite positively as far as its tenth harmonic, by employing several in series, rise-times of the order of millimicro-seconds may be measured for pulses or square waves where recurrent frequency is as low as a few cycles per second.

London, N.2. VICTOR DUMERT.

Music Stations?

IN the Editorial of the August issue you say the B.B.C.'s v.h.f. service must be used mainly to reinforce transmissions on the normal wavebands, and cannot be conducted entirely, or even mainly, for those whose principal interest is in high-quality reproduction of music.

I suggest there are good reasons why at least one channel in each region might be devoted to items whose value is most dependent on high-quality reproduction; i.e., to music, more or less exclusively. The increase in interference on the a.m. bands has surely diminished their value for music transmissions very much more than for speech.

Hampton Hill, Middx. J. S. PRESTON

Grandfather Clock Effect

WHEN the I.T.A. got going one of my colleagues made the necessary alteration to his receiver and sat back to enjoy the programme. At once he noticed a cyclic disturbance, slight on the picture, and more pronounced on the sound. As this effect was always present on the I.T.A. transmission and never on the B.B.C. he concluded that the trouble came from their end, so, with his faith in private enterprise slightly shaken, he just left it at that.

One day the penny dropped, so to speak, and he noticed the disturbance was exactly in phase with the pendulum of his grandfather clock. Stopping the clock stopped the interference, and vice versa.

This phenomenon is less obscure than the "Bournemouth Effect" described by your contributor "Diallist" and the cure is obvious, but so far my advice to re-orient the clock, and/or fit it with a non-metallic pendulum, has aroused no enthusiasm.

Although this case may not be unique, it is certainly the first time I have heard of a weight-driven clock causing radio interference!

London, S.E.9. A. L. HUTTON.

Morse Information

IT must surely have been a slip of "Free Grid's" usually accurate pen which led him to say (August issue) that letters in most frequent use convey most information. The opposite it true; they convey least.

The more unexpected a signal is, the more information it conveys. In the absence of any special indications the most likely letter is E, we are not surprised when we receive it and when we have received it we have not increased our total information by much. In a good code, therefore, it should not occupy much time. By the same argument we do not expect to receive Z very frequently in the English language, and hence it conveys a lot of information and justifies a long signal.

Brentwood, Essex. W. D. H. BLACKMAN.

Aerial Cross-over Network

THE formulæ quoted by L. S. King (June issue) for a prototype half-section are not correct and should be:—

$$L_1 = L_2 = \frac{R_o}{2\pi f_c} \quad (1)$$

$$C_1 = C_2 = \frac{1}{2\pi f_c R_o} \quad (2)$$

(See Appendix, page 295)

Hence for f_c = 95 Mc/s (cross-over point)

$L_1 = L_2 = 0.126\,\mu$H and $C_1 = C_2 = 22$ pF

I would also like to know how Mr. King obtained different values for L_1 and L_2, and C_1 and C_2 which according to (1) and (2) should have been the same.

London, N.W.2. J. KASON.

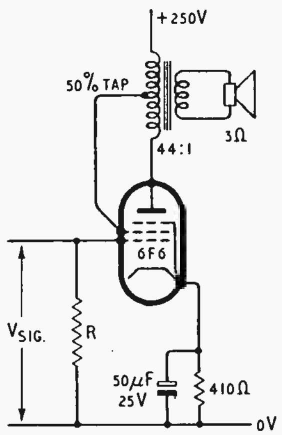
The Author Replies

J. KASON is, of course, correct in his criticism of the formulæ in the Appendix to my article. I quoted the usual formulæ for *full*-sections and inadvertently said that they were for half-sections. The formulæ were used correctly in determining the filter constants quoted and the error affects nothing in the body of the article.

L. S. KING.

VL Amplifiers

IT may not be generally appreciated that the benefits of the "ultralinear" circuit for pentodes and tetrodes are not confined to the pushpull case. Having the data available I worked out the figures for a 6F6 valve and the results looked very promising for 30%, 40% and 50% taps. It was most convenient to test the 50% tap using a small multi-ratio push-pull output transformer which presented a 5,800-ohm load to the valve, the optimum being estimated as 6,000 ohms. The values used are shown in the diagram. R may be of any value between 220kΩ and 560kΩ. This value, together with the coupling capacitor to the previous stage may be chosen for the desired bass characteristic.



Audible results are very satisfactory. The small transformer does not cope with bass tones so a deliberate cut is introduced from a turnover of 180 c/s. The middle and top registers are level and clean, and only sustained bass notes suffer by comparison; e.g., organ diapason and the low strings. As might be expected from the estimated distortion the individual instruments of an ensemble retain their identity. 10 dB feedback over two stages has very little "cleaning-up" effect but is valuable for damping the cone excursion at bass resonance.

The power output drops from 3W at 4 to 6% distortion to 2W with less than 0.3%. The 1.7 dB loss is negligible and if the straight pentode connection is reduced to 2W the distortion is still 3 to 4%.

London, S.E.4. W. GRANT.

Switched-Tuned F.M. Unit

Automatic Frequency Correction by Means of a Reactance Valve

By JOHN M. BEUKERS, B.Sc., (Eng.), Grad. I.E.E.

WHEN an f.m. receiver incorporating a ratio detector or a discriminator of the Foster-Seely type is tuned through an f.m. transmission there are three points at which detection occurs and two where severe distortion sets in; this phenomenon is due to the S-shaped characteristic of the detector which is illustrated in Fig. 1a.

The correct portion of the response curve for detection to take place is that lying between the two peaks (C, D, on Fig. 1a), and for minimum distortion this should be as straight as possible. It is usual to make the "peak separation" considerably more than the maximum peak-to-peak frequency deviation to be expected of the carrier to which the receiver is to be tuned; for example, 100% modulation of a B.B.C. carrier corresponds to a frequency deviation of ± 75 kc/s or 150 kc/s peak-to-peak, the peak separation of the discriminator would be some 300 to 400 kc/s.

The sensitivity of the detector is defined by the slope of the centre portion of the curve and since the latter is substantially straight the sensitivity remains constant over some 200 to 300 kc/s; in other words the audio output level remains constant while tuning over the useful portion of the curve. Thus if a receiver using this form of detector is tuned by ear the unsatisfactory situation may arise where the carrier is centred at one end of the working portion of the characteristic. The result is that normal distortion-free reception is obtained when the modulation is at low level but modulation peaks may be severely distorted.

Tuning indicators, if used, should work from voltages developed by the discriminator and not be peak-carrier indicators, since if the i.f. amplifier and discriminator are not exactly in alignment the receiver will be tuned to the centre of the i.f. pass-band (or if the coils are over-coupled, to one of the peaks in the pass-band) and not to the centre of the discriminator characteristic. Of the two zero frequency voltages available from the discriminator, one is constant (V_{ab} Fig. 1b) over the pass-band and the other is zero when the receiver is in tune (V_0 Fig. 1b)[6]; this makes the design of suitable indicators a little troublesome. Two tuning indicators suitable for f.m. receivers have been described in *Wireless World*[1, 2].

The two discriminators mentioned give maximum a.m. rejection at the centre of their characteristics. It is therefore possible to tune the receiver for minimum background noise, but this is often difficult because the noise is masked by the programme.

Switch tuning removes the difficulties of manual tuning and makes a tuning indicator superfluous; as far as non-technical users are concerned pre-set tuning of an f.m. carrier is a blessing and whilst there are only the three B.B.C. programmes on Band II the writer feels there is much to be said for the system.

Some Problems.—For a switch-tuned system to

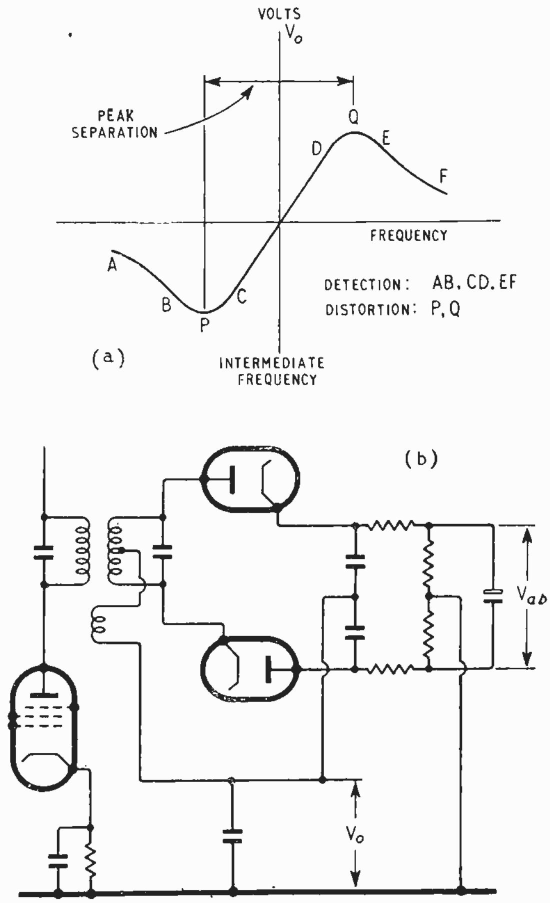


Fig. 1. (a) response characteristic of the discriminator: (b) the circuit arrangement.

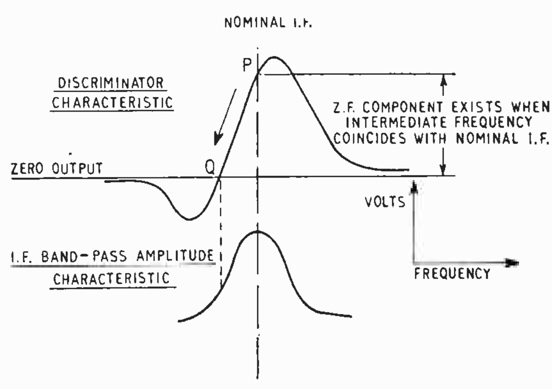


Fig. 2. A.F.C. will shift the i.f. from the nominal point P on discriminator characteristic to point Q.

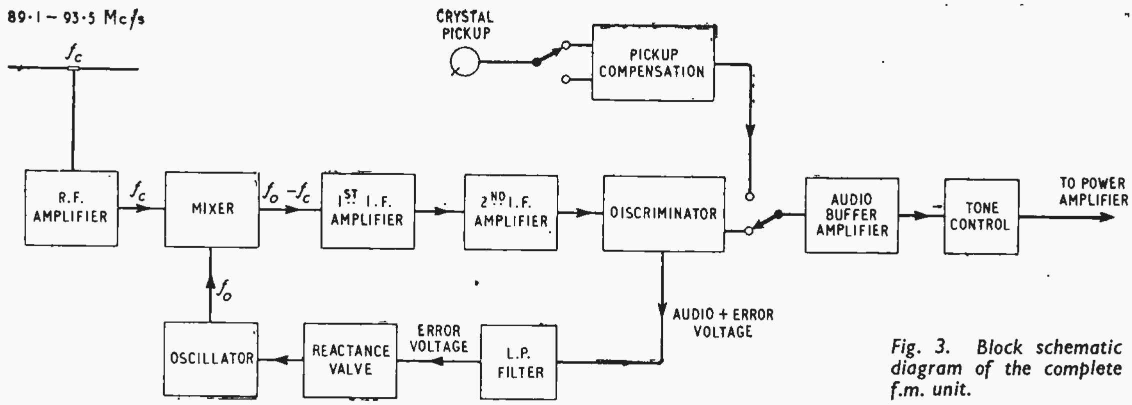


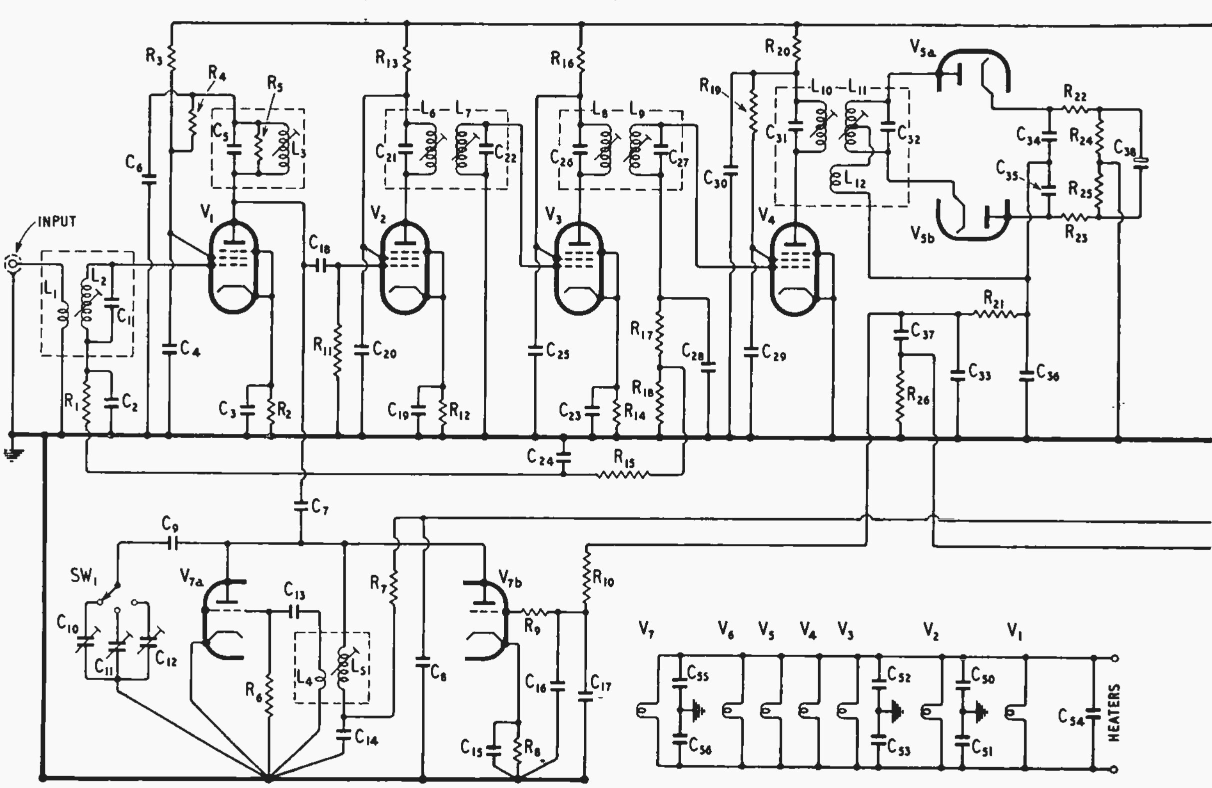
Fig. 3. Block schematic diagram of the complete f.m. unit.

operate satisfactorily the stability of the oscillator must be such that when the receiver is switched on from cold the intermediate frequency produced by mixing the oscillator frequency with the desired carrier lies not far from the centre of the discriminator characteristic; as the receiver warms up drift of the oscillator should shift the intermediate frequency to the centre of the detector characteristic.

Receivers for use on Band II will in general have their oscillators running at about 100-110 Mc/s and at this frequency it is virtually impossible to obtain a simple lumped LC oscillator of the required stability. Negative temperature coefficient capacitors can be used giving an improvement, but drift during the first two or three minutes while the oscillator valve is warming up cannot be entirely overcome. The use of crystal oscillators, one crystal for each programme is one solution[3]; another is to use automatic frequency correction. A.F.C. may be applied in a number of ways, one of which was described in this journal recently[4]. The present receiver uses a reactance valve and derives the necessary error voltage from the discriminator.

It is not possible to obtain perfect correction using this method of a.f.c. for the following reason. When the intermediate frequency is shifted by the reactance valve towards the centre of the discriminator characteristic the zero frequency error voltage is reduced and thus a point of equilibrium will be reached somewhere between the centre frequency and the uncorrected frequency. The more "sensitive" the reactance valve the more perfect the correction; in the present design the off-tune error is reduced by between seven and ten times.

Fig. 4. Theoretical circuit diagram of the f.m. unit.



LIST OF PARTS

Resistors*

R_1, R_{29}.	10 kΩ
R_2, R_{12}, R_{14}.	180 Ω, 10%
R_3, R_4, R_{13}, R_{16}, R_{20}, R_{22}, R_{23}, R_{34}.	1 kΩ (R_{22}, R_{23} to be 10%)
R_5.	1.8 kΩ
R_6.	33 kΩ
R_7.	2.2 kΩ
R_8.	680 Ω, 10%
R_9.	100 Ω, 10%
R_{10}, R_{26}, R_{39}, R_{41}, R_{43}.	2.2 MΩ
R_{11}, R_{15}, R_{40}.	1 MΩ
R_{17}, R_{18}, R_{19}, R_{21}, R_{31}, R_{33}, R_{35}.	100 kΩ (R_{31}, R_{33} to be 10%)
R_{24}, R_{25}.	6.8 kΩ, 2%
R_{27}, R_{32}.	470 kΩ
R_{28}.	4.7 kΩ, 10%
R_{30}.	82 kΩ
R_{36}.	22 kΩ
R_{37}.	3.3 kΩ, 10%
R_{38}.	wirewound (value to suit h.t. supply)
R_{42}.	1.5 MΩ
R_{44}.	150 kΩ
RV_1.	1 MΩ pot, linear law
RV_2.	500kΩ pot, with centre tap (Dubilier).

Resistors (continued)

RV_3.	500 kΩ pot, log law

Capacitors†

C_1.	4.7 pF, 10% (Erie Ceramicon, N750)
C_2, C_3, C_4, C_6, C_{14}.	0.001 μF ceramic
C_5.	10 pF ceramic
C_7.	2.2 pF, ±½ pF (Erie Ceramicon, P100)
C_8, C_{15}, C_{16}, C_{55}, C_{56}.	0.0015 μF lead-through ceramic
C_9.	15 pF (Erie Ceramicon, N750).
C_{10}, C_{11}, C_{12}.	2 to 10 pF trimmer
C_{13}.	33 pF, 10% (Erie Ceramicon, N750)
C_{17}.	0.25 μF, metallized paper
C_{18}.	47 pF, 10% (Erie Ceramicon, N750)
C_{19}, C_{20}, C_{23}, C_{25}, C_{29}, C_{30}, C_{50}, C_{51}, C_{52}, C_{53}, C_{54}.	0.005 μF, Ceramic
C_{21}, C_{22}, C_{26}, C_{27}.	50 pF, 5%, silvered mica (see text)

Capacitors (continued)

C_{24}, C_{37}.	0.1 μF, 150V wkg., metallized paper
C_{28}.	22 pF, 10% (Erie Ceramicon, N750)
C_{31}.	10 pF, ±½ pF, (Erie Ceramicon, N750)
C_{32}.	39 pF, 5% (Erie Ceramicon N330)
C_{33}.	470 pF, 10%, silvered mica
C_{34}, C_{35}, C_{36}.	330 pF, 10%, silvered mica
C_{38}.	12 μF, electrolytic, 50V wkg.
C_{39}.	2 μF, electrolytic
C_{40}, C_{44}.	0.1 μF paper
C_{41}, C_{42}.	0.005 μF, 10% matched, paper
C_{43}, C_{47}.	100 pF, 10% silvered mica
C_{45}, C_{46}.	8 μF, electrolytic
C_{48}.	0.001 μF, 10%, silvered mica
C_{49}.	250 pF, 10%, silvered mica

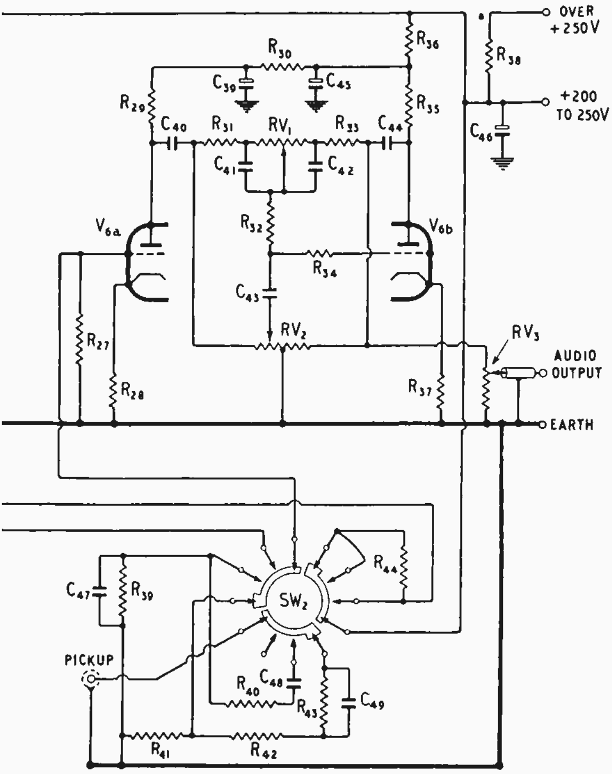
Valves

V_1–V_4.	6AM6
V_5.	6AL5
V_6.	12AX7
V_7.	12AT7.

* (20% tolerance, ¼W unless otherwise stated)

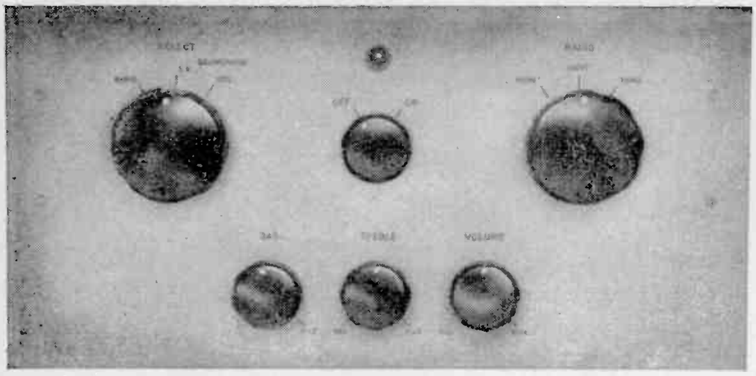
† (20% tolerance, 350V wkg. unless otherwise stated)

The application of a.f.c. immediately raises a problem, that of frequency stability of the i.f. and discriminator tuned circuits with changes of temperature. If the discriminator characteristic is not symmetrical about the nominal intermediate frequency employed then a zero frequency voltage exists when the intermediate frequency lies in the centre of the i.f. pass-band. The voltage will be fed back to the reactance valve (or any other device producing a.f.c.) which will shift the oscillator frequency thus bringing the intermediate frequency to one side of the i.f. pass-band as illustrated in Fig. 2. This may lead to deeply modulated signals being distorted due to working on the non-linear portion of (a) the discriminator characteristic and (b) the phase/frequency characteristic of the i.f. tuned circuits. To minimise drift of these circuits with temperature the positive temperature coefficient of the coil should be compensated by negative temperature coefficient capacitors.



The Receiver.—This is based on a design by Amos and Johnstone published in *Wireless World* last year;[1] those sections that have been modified are described in detail in this article. The reader is, however, referred to the original article for more information on the points not discussed.

The block diagram and the circuit are shown in Figs. 3 and 4 respectively. The received signal f_c is fed into a tuned circuit designed to give a fair match between the aerial and the grid impedance of the r.f. amplifier. The local oscillator, which operates at a frequency above the received signal, is mixed with the output of the r.f. amplifier to produce an intermediate frequency f_0-f_c. V_3 and V_4 comprise the i.f. amplifier, V_3 being a straightforward amplifier working at full gain and V_4 a high-level limiter the output of which feeds a ratio detector. To complete the unit a tone control has been incorporated and provision made to take the output from a crystal pickup. To make this possible a double triode is included, one half of which is used as an RC coupled amplifier and the remaining half the tone control to a design by P. J. Baxandall.[5]



Front panel layout of the unit.

The pickup is provided with a simple RC compensation for standard and long playing records, switching being effected from the front panel. The output level from the audio stages with the tone controls set to their mid positions is approximately one volt r.m.s. on both radio and gramophone.

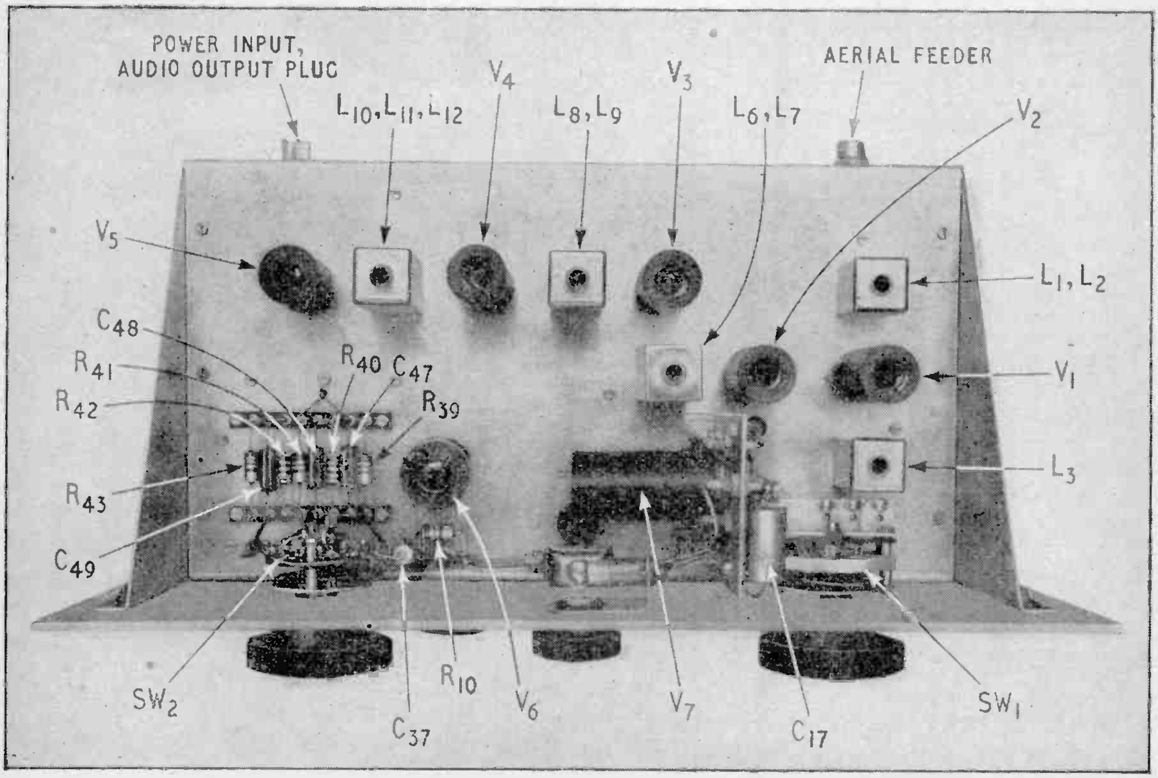
The R.F. Stage.—The transmissions of the Home, Light and Third programmes on Band II from any one transmitter are spaced by 2.2 Mc/s and thus cover a band of 4.4 Mc/s. In the r.f. stage tuning of both grid and anode circuits is fixed and peaked to the middle of the band; this means that the bandwidth to the 3-dB points of the r.f. stage must not be less than 4.4 Mc/s in order that the sensitivity of the receiver on the three programmes remains substantially constant.

The grid circuit will unavoidably be of low impedance and low Q due to the input resistance of the valve and the loading of the aerial. Assuming a grid circuit Q of about 5 the anode circuit Q should be approximately 18. The natural coil Q will be very much higher than this value and therefore the coil must be damped down to give the required value of Q; this is effected by R_5.

I.F. Coils.—The spacing between the windings in the i.f. coils is very critical as has previously been pointed out[1] and this cannot be too greatly stressed. It must be remembered that unlike the reception of an a.m. transmission where insufficient bandwidth, or a distorted pass-band (amplitude) results in a poor frequency response, an f.m. transmission could suffer harmonic distortion which is far less tolerable. A method of achieving maximum phase linearity from the i.f. amplifier and discriminator tuned circuits is outlined in the alignment procedure.

For optimum results from the a.f.c. the i.f. coils should be temperature compensated; to do this the 50-pF silver-mica tuning capacitors should be replaced by two capacitors one with a positive and one with a negative temperature coefficient. The method for determining the values of these capacitors is given in the Appendix. In general a single layer inductor at the frequency employed for the i.f. will have a temperature coefficient of about plus 40 parts/million/°C, to compensate for this the combination

Layout of the top of the chassis of the pre-tuned f.m. unit. The annotation shows location of the principal parts.



of the two capacitors should have a negative temperature coefficient of the same value.

The Detector.—The ratio detector provides an output voltage which can be readily used for a.f.c. It has already been shown (Fig. 1a and b) that at the centre frequency (the frequency to which the i.f. coils and discriminator are tuned) the output voltage V_0 from the discriminator is zero, and that if there is a frequency shift in either direction from the centre frequency a zero frequency voltage will be produced which will increase either positively or negatively with frequency depending upon the orientation of the diodes. A reactance valve when fed with this voltage can be used to change the frequency of the oscillator such that the intermediate frequency is shifted towards the centre of the discriminator characteristic. It is essential to wire the diodes correctly; if they are wired the wrong way round the zero frequency voltage fed back will tend to shift the oscillator frequency such that the intermediate frequency is moved away from the centre of the discriminator characteristic. It will be quite obvious if the diodes are the wrong way round since it will be impossible to tune the receiver to a carrier.

Low-Pass Filter.—When the receiver is tuned to a modulated carrier and the intermediate frequency is not quite coincident with the centre of the discriminator characteristic the output from the discriminator will contain two components (a) the zero frequency error voltage and (b) the audio output; normally the zero frequency component is blocked off with a capacitor and the audio is fed to further audio stages. To use the output from the discriminator for a.f.c. it is necessary to separate the zero frequency component from the audio, this is done in a low-pass filter consisting of R_{10}, 2.2 MΩ, and C_{17}, 0.25 μF.

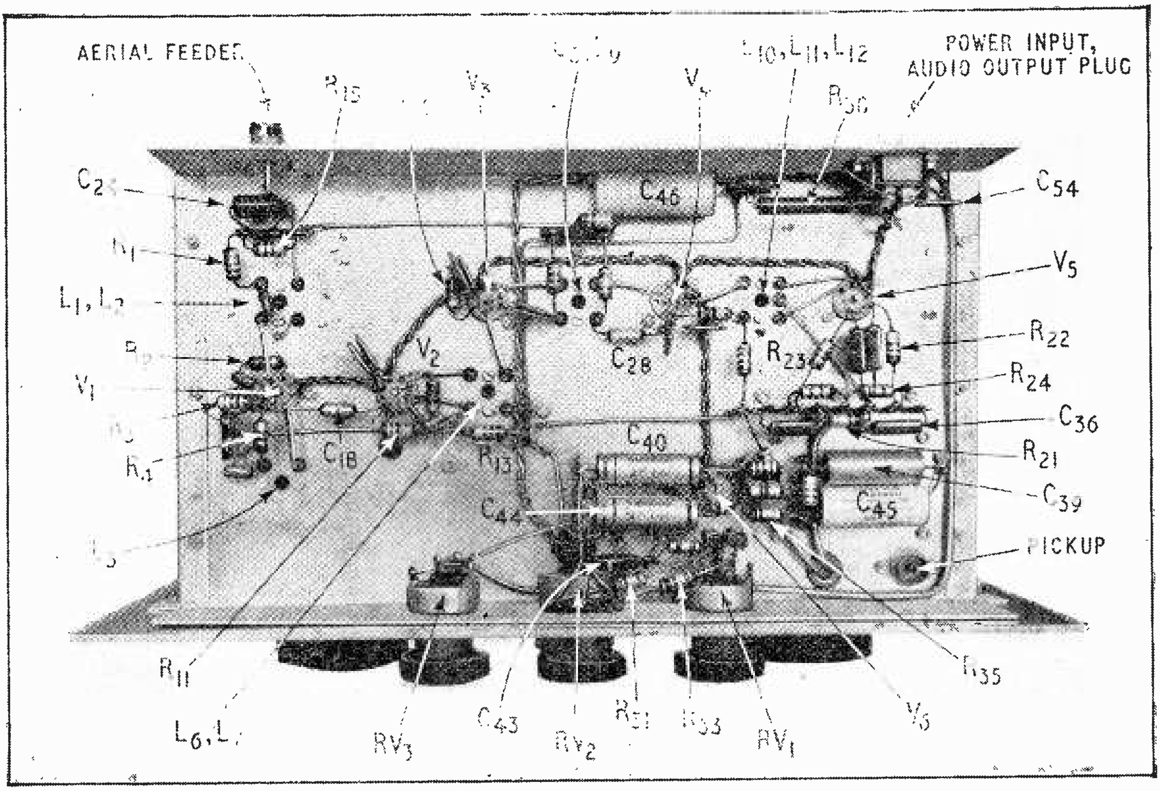
Applying the audio to the reactance valve is a form of negative feedback since the reactance valve adjusts the oscillator so as to oppose any output voltage from the discriminator. It is interesting to note the possibilities of putting the de-emphasis network in the feedback path so that top cut is produced by reducing the deviation of the transmission at the higher frequencies.

Reactance Valve And Oscillator.—The reactance valve and oscillator is perhaps the most interesting section in the unit and for this reason a a fair amount of detail is given, both electrical and mechanical. At the oscillator working frequency (around 100 Mc/s) the size, type, quality, placing of the components and position of wiring are of significance, for this reason it is unadvisable to change the layout and/or components without considering the effect of the change of distributed elements of the circuit. (By which is meant lead inductance, stray capacity and chassis r.f. resistance).

It may not be obvious from the circuit diagram how the reactance valve changes the oscillator frequency. A clearer picture may be obtained from Fig. 5 which depicts the reactance valve with only those components responsible for the working of the device.

C_{ag} and R_p form a phase-shift network such that at 110 Mc/s the grid voltage (V_g) is out of phase with the anode voltage (V_a) and thus the valve draws a current I_r having two components, one resistive which damps the oscillator tank circuit and one reactive which has the effect of altering the total reactance present, this in turn changes the oscillator

Underside view of the chassis. Note the twisted a.c. heater leads and that the components form the bulk of the wiring.



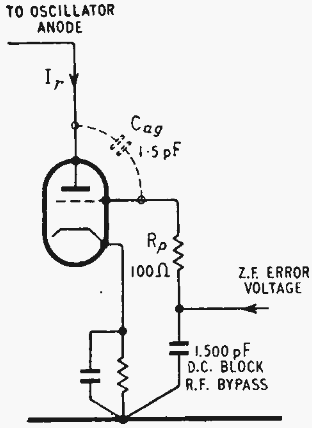


Fig. 5. Details of the reactance stage.

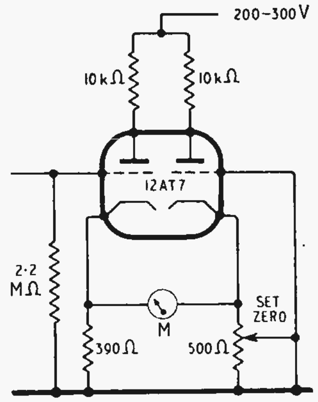
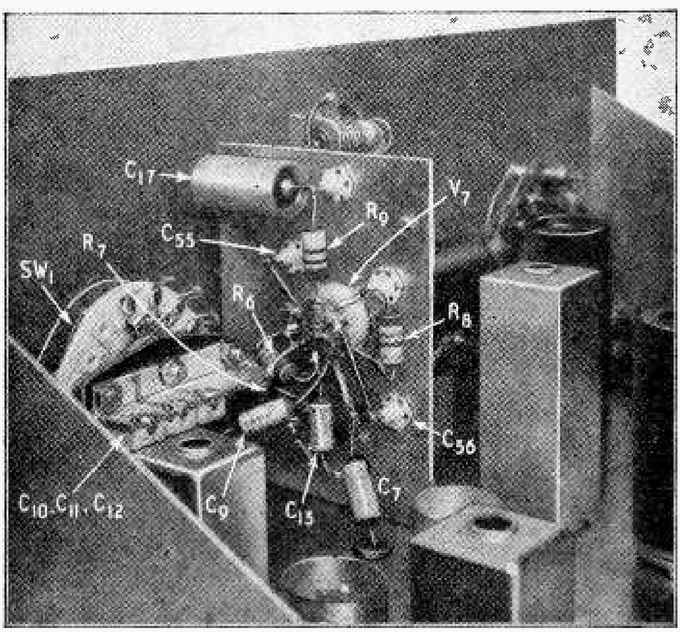


Fig. 6. Suggested circuit for a simple valve voltmeter.



Details of the oscillator sub-assembly and select switch.

frequency. To increase or decrease I_r it is only necessary to vary the bias (and hence *gm*) on the reactance valve, this is done by the zero frequency component from the discriminator.

If the grid potential of the reactance valve is raised the frequency of the oscillator is lowered and this at once fixes the orientation of the diodes in the discriminator. The discriminator must be wired so that if the intermediate frequency increases, a positive voltage is fed back to the reactance valve which will tend to lower the oscillator frequency.

The design of the oscillator is quite conventional, but there are one or two points to mention. There is no physical capacitor across the anode coil, the tuning capacitance is made up of the valve electrode capacitance, the wiring and the trimmers. In order to make the a.f.c. reasonably sensitive the total tuning capacitance should be kept small, this should be borne in mind when aligning the receiver. The oscillator coil consists of an anode winding and a grid feedback winding; the anode winding is of No. 18 s.w.g. tinned copper wire and the grid winding is of No. 20 or 22 s.w.g. polythene covered wire if available. Polythene insulant is preferable because it is not so lossy as PVC and thus damps the tuned circuit to a lesser extent.

The three trimmers C_{10}, C_{11} and C_{12} are mounted on a brass bracket which is fixed to the back of a three-position rotary switch. This switch should be in good condition and of robust design; it will be appreciated that the trimmers are across the tuned circuit of the oscillator and therefore the contacts of the switch have to pass appreciable r.f. current. It is desirable although not mandatory that the switch wafer be ceramic. The switch and trimmers are shown on this page.

Cathode Poisoning.—When the unit is switched to gramophone the r.f. stage and i.f. stages are left connected direct to the h.t. supply and a resistor (R_{44} 150 kΩ) is inserted into the oscillator feed. The reason for this is as follows: if certain valves are left for a period of time with their heaters on but with no h.t. the cathode becomes poisoned due to the building up of an interface on the cathode. So long as the valve is passing a small current the rate of build-up of this interface is slow.

Alignment.—Two methods of alignment are given, the first using a minimum of test gear and the second a somewhat more complicated procedure but one that will show up any discrepancies in the i.f. amplifier and discriminator and will also enable the receiver to be aligned more accurately. The latter is most important since for satisfactory operation it is necessary that the zero frequency voltage output from the discriminator be zero when the intermediate frequency lies in the centre of the i.f. passband.

For the first method a signal generator covering 10.7 Mc/s is required, also some form of valve voltmeter. There is no substitute for the generator but for those who do not possess a valve voltmeter the circuit shown in Fig. 6 will serve.

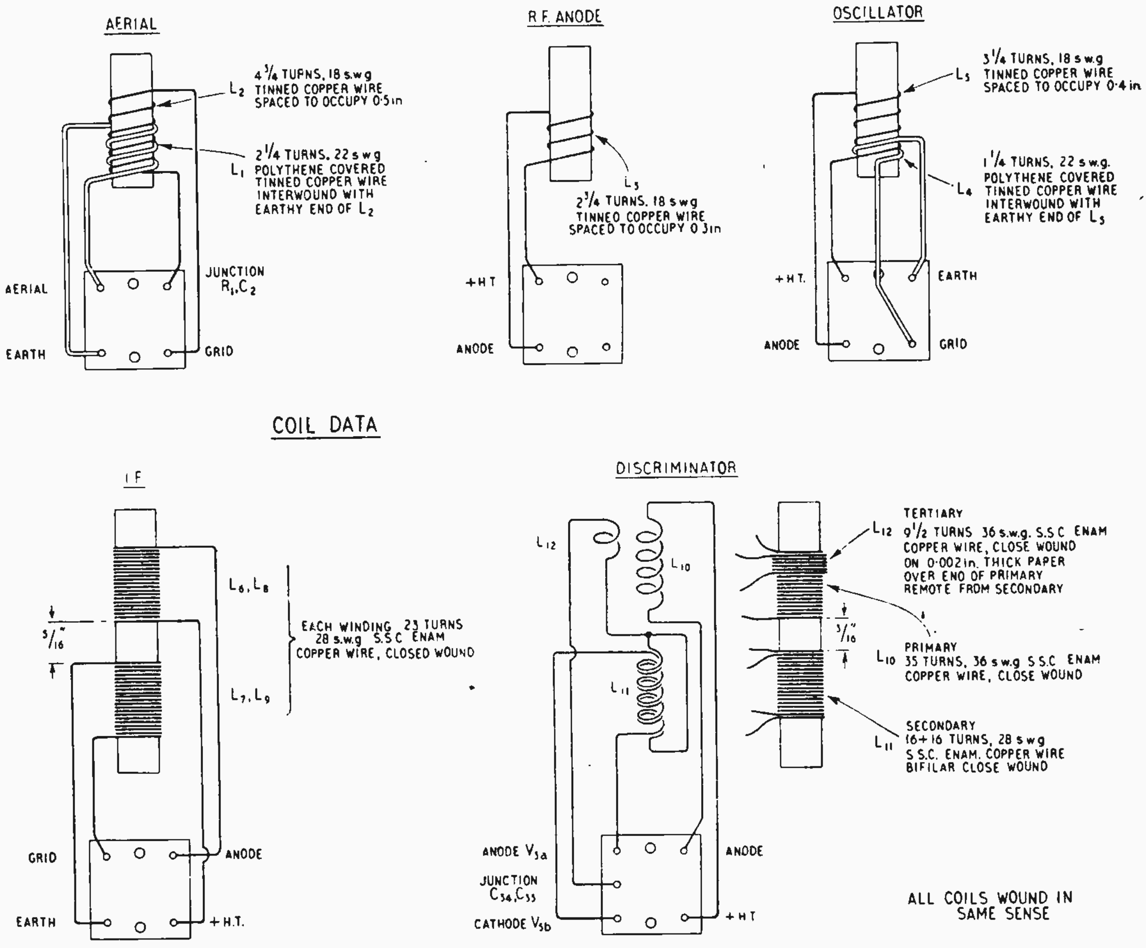
Switch on the receiver at least fifteen minutes before aligning, make sure that all the valves are drawing current and that the oscillator is oscillating. (If the oscillator is working correctly momentarily shorting its grid to ground will cause the valve to draw more current.) Join the junction of R_9, R_{10}, C_{16}, C_{17} to chassis, this will make the reactance valve inoperative.

The alignment may now be carried out. Set the signal generator to 10.7 Mc/s and connect it to the grid of V_4, adjust the output to about 0.1 volt. Connect the valve voltmeter to one side of the secondary of the discriminator and adjust L_{10} for maximum deflection. Disconnect the generator and connect it to the grid of V_3, adjust L_8 and L_9 for maximum deflection. As the coils come into tune it will be necessary to reduce the output from the generator, adjust this output to maintain approximately the same deflection obtained previously.

Disconnect the generator and reconnect it to the grid of V_2, adjust L_6 and L_7, turning down the output from the generator to maintain approximately the original deflection on the valve voltmeter. Now transfer the meter to the junction of R_{21} and C_{34} and adjust L_{11}; as the core is screwed into the coil the meter should first deflect in one direction, come down to zero and then deflect in the opposite direction. The correct position for the core is when the meter passes through zero. The i.f. and discriminator should now be aligned to 10.7 Mc/s.

Next connect an aerial (or the signal generator if it covers Band II) to the aerial input socket and the audio output to a power amplifier. Set the trimmer corresponding to the Home service so that about 5° of the vanes are meshing, turn the station select switch to "Home" and adjust the oscillator coil L_4, L_5 until the Home service is received. (The Home service is transmitted on the highest frequency from Wrotham, the frequencies of the three transmissions being: Home 93.5, Light 89.1 and Third 91.3 Mc/s.) Now set the station select switch to "Third" and adjust the corresponding trimmer until the Third programme is received. Connect the valve voltmeter between R_{17} and R_{18} and adjust the aerial coil L_1, L_2 and the anode coil L_3 for maximum deflection. It may be necessary to make small adjustments to the Third programme trimmer during this operation since tuning the r.f. stage affects the oscillator frequency. Having completed this, turn the station select switch to "Light" and adjust the corresponding trimmer until the Light programme is received. Finally with the valve voltmeter connected to the junction of R_{21},C_{34} adjust each of the trimmers for zero output (again the correct point is when the meter deflection passes through zero).

It now only remains to put the reactance valve into service but before doing so it is advisable to check that the error voltage developed from the discrimator goes positive with increase and negative with decrease of the intermediate frequency. To carry out this check connect the valve voltmeter to the junction of R_{21}, C_{34} and tune into a carrier, there should be zero reading on the meter. If now the hand is brought near to the oscillator circuit (adding capacity) the oscillator frequency will drop and this will result in a lower intermediate frequency; (the oscillator is working above the carrier) the valve voltmeter must register a *negative* voltage. Should a positive voltage be indicated the connections between the secondary of the discriminator



Winding details of the r.f. and i.f. coils used in the f.m. unit. L_1, L_2 and L_3 are wound on Aladdin formers Type PP5938 and enclosed in John Dale cans Type TV2. The i.f. and discriminator transformers are wound on Aladdin formers Type PP5937 and enclosed in Dale cans Type TV1. Cores: "purple" for L_1, L_2 and L_3, and "grey" for i.f. and discriminator.

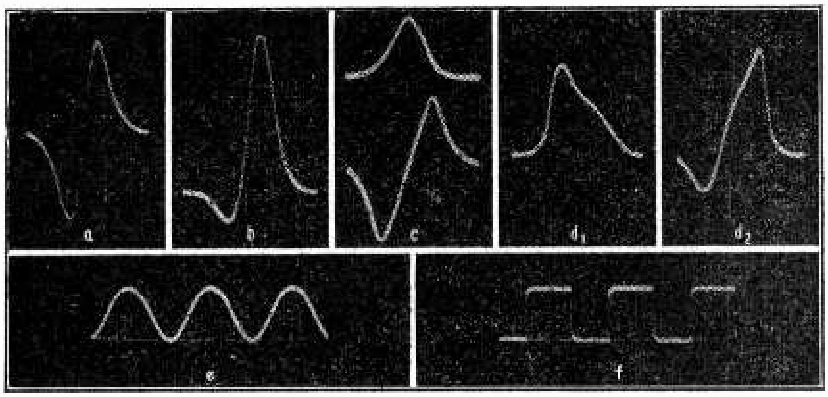


Fig. 7. Discriminator and i.f. amplifier oscillograms. (a) discriminator characteristic with 20 μV signal input to receiver: (b) with discriminator mistuned by $\frac{1}{4}$ turn of core: (c) discriminator and i.f. characteristics using double-beam oscilloscope: d_1 and d_2 effect of phase irregularities in i.f. amplifier: (e) and (f) discriminator output as a result of modulating oscillator by means of reactance valve and modulating frequency of 1,000 c/s, ±100 c/s deviation approximately, using sine and square-wave modulation.

and the two diodes should be reversed. Having performed this check the link connecting R_9, R_{10}, C_{16}, C_{17} may be removed, the reactance valve is now in operation.

The second method of alignment requires a signal generator covering 10.7 Mc/s and 87 Mc/s to 95 Mc/s, a valve voltmeter, an audio frequency generator and a single or double beam oscilloscope. Although not quite so convenient a B.B.C. carrier can be used for the signal in the 87 Mc/s to 95 Mc/s band and the 50-c/s heater supply can be used in place of the audio generator. The principle involved in this method is to use the audio source and the reactance valve to frequency modulate the input signal; the detected output from the discriminator and the modulation can then be applied to an oscilloscope in such a way as to display the combination of the i.f. phase/frequency and the discriminator amplitude/frequency characteristics. In addition the i.f. band-pass amplitude characteristic can also be displayed.

The variation of effective reactance with zero frequency input voltage to the reactance valve is reasonably linear over at least 500 kc/s and so an audio frequency sinusoidal voltage applied to the valve will produce a sinusoidal frequency modulation of the oscillator with peak deviation as great as ±250 kc/s with little distortion. Fig. 7e and f are actual oscillograms of the detected output from the discriminator as a result of modulating the oscillator by means of the reactance valve; the modulating frequency is 1,000 c/s and the peak-to-peak frequency deviation of the oscillator running at 100 Mc/s is about ±100 kc/s. The source of audio frequency is ideally an a.f. signal generator, but if this is not available the 6.3V heater supply, suitably attenuated, can be used. An audio voltage of between 100 and 300 mV is required.

To display these characteristics the zero frequency error voltage and the low-pass filter (R_{10}, C_{17}) are removed from the reactance valve and the audio source connected in their place, the source should have a d.c. path to chassis for the grid of the reactance valve. Temporarily disconnect C_{38}. If the oscillator is tuned to f_o and there is a carrier present of frequency f_c an intermediate frequency f_0-f_c will be produced which is frequency modulated by the audio source. (It does not matter if the carrier is already modulated). Applying the a.f. output to the Y-amplifier of an oscilloscope and using the audio source as the X sweep Fig. 7a will be displayed which is the overall i.f. phase/frequency and the discriminator amplitude/frequency characteristic. It may be necessary to place a simple r.c. phasing network in one of the two audio paths to correct for phase differences in these two paths.

Valve V_4 has no grid bias and so in the presence of a signal grid current will flow producing a voltage across the grid resistors R_{17} and R_{18}, this voltage is an indication of signal level and if applied to the Y-amplifier of the oscilloscope instead of the a.f. output the display produced will be the band-pass amplitude characteristic of the i.f. amplifier. Where a double-beam oscilloscope is available both the discriminator characteristic and the i.f. band-pass characteristic can be delineated at the same time, such a display is shown in Fig. 7c. This display will enable the discriminator to be accurately aligned and will also show up any phase irregularities within the i.f. amplifier (see Fig. 7d_1 and d_2).

If the receiver is carefully aligned the performance will be such that when switched on from cold the programme selected tunes in not far from the centre of the discriminator characteristic; drift, whilst the receiver is warming up, is small and is in any case directed towards the centre of the characteristic.

Appendix

Let C_p be a capacitor having a positive temperature coefficient of α_p.

Let C_n be a capacitor having a negative temperature coefficient of α_n

Now $C_p + C_n = 50$ pF

It can be shown

$$\frac{C_p\,\alpha_p + C_n\,\alpha_n}{C_p + C_n} = \alpha_t$$

where α_t is the required temperature coefficient.

Using a P100 capacitor ($\alpha_p = +100$ parts/million/°C) and an N740 capacitor ($\alpha_n = -470$ parts/million/°C)

C_n becomes 10.4 pF say 10 pF

C_p becomes 39.6 pF say 39 pF

So that the 50 pF tuning capacitor would become 10 pF P100 in parallel with 39 pF N470. The capacitors should be mounted inside the coil cans; the Erie non-insulated Ceramicons will be found small enough for this purpose.

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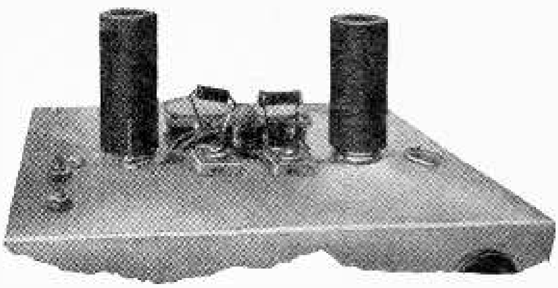
Selective Bandpass I.F. Amplifiers

Use of "Ferroxcube" Pot Cores in Conjunction with Negative Feedback

By J. S. BELROSE

The purpose of this article is to introduce designers to the use of "Ferroxcube" pot cores in selective bandpass filters. Designs have previously been described[1] for very narrow bandwidths and the author now gives details of filters suitable for radio telephone working in congested wavebands.



Experimental bandpass i.f. amplifier using Ferroxcube cores.

FOR a radio-telephone system a bandwidth of 3 kc/s is near to optimum. A receiver having this bandwidth would be suitable for the reception of single-sideband speech, or for reception of only one sideband of an ordinary double-sideband, amplitude-modulated carrier when adjacent channel interference is particularly severe. This article discusses the application of high-Q "Ferroxcube" pot cores in the design of a bandpass filter of bandwidth 3 kc/s. The response of the circuit approaches the ideal square-edged frequency response and will give performance superior to that of any circuit at present in use in communication receivers, other than the symmetrical bandpass crystal filter[2] and the electro-mechanical filter[3].

The method used here, to give a level pass-band frequency response and to sharpen the attenuation outside this range is to use frequency-selective negative feedback[4, 5]. Two parallel-tuned circuits are included in series between the cathode and earth, one tuned to the low side and one to the high side of the centre frequency of the pass band. These circuits provide negative feedback with considerable attenuation at the two resonate frequencies. Such a circuit is shown in Fig. 1.

Suppose the cathode circuits are designed to attenuate frequencies f_1 and f_2, which are symmetrically centred about f_0 the centre frequency of the pass band. The frequency response due to the feedback circuits is shown in Fig. 2. If overcoupled circuits are used in the anode of the anode of the amplifier, then, by proper design, the feedback response can be made to neutralize exactly the trough due the overcoupled circuits, and so a flat-topped response can be obtained with very steep "skirts."

Simplified Design Procedure—We will follow the procedure outlined by Sturley[5] and use his generalized selectivity curves for the cathode feedback and for the overcoupled circuit responses. For a flat overall pass band the shape of the cathode feedback curve must be the reverse of the coupled circuit curve, and the former should fit exactly over the latter in the pass band.

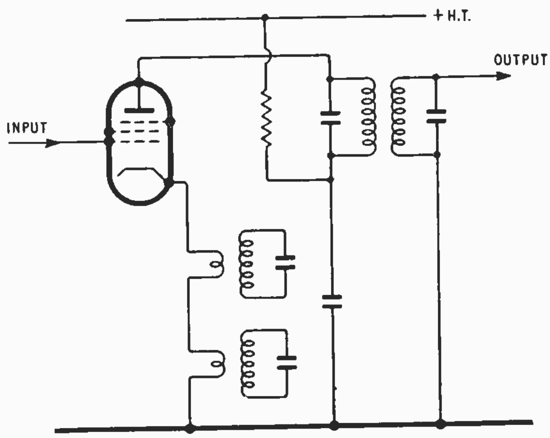
In our case we choose f_0 = 100 kc/s and we want a total bandwidth of 3 kc/s. Using Sturley's notation $\triangle f$ = 1.5 kc/s (half the bandwidth). Suppose we design the maximum attenuation of the feedback circuits to be $\pm$ 3 kc/s about 100 kc/s (i.e., f_1 = 97 kc/s and f_2 = 103 kc/s). Our experience indicates that the maximum operating coil Q-factor we can easily obtain at 100 kc/s is about 180. We will design for this coil Q for the cathode coils.

To use the generalized curves of Sturley we need to calculate the parameter

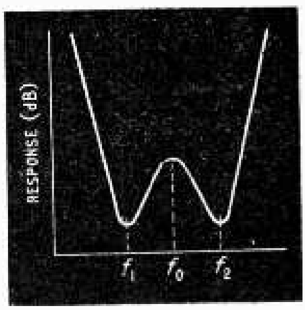
$$(Q\,F_1)^2 = \left[\frac{180 \times 2 \times 3}{100}\right]^2 = 117$$

$$\text{since } F_1 = \frac{2\triangle f_1}{f_0} = \frac{2(f_0 - f_1)}{f_0}$$

The response curve for $(Q\,F_1)^2$ = 117 is therefore



Above:—Fig. 1. I.F. amplifier with cathode feedback.



Right:—Fig. 2. Frequency response due to feedback circuits.

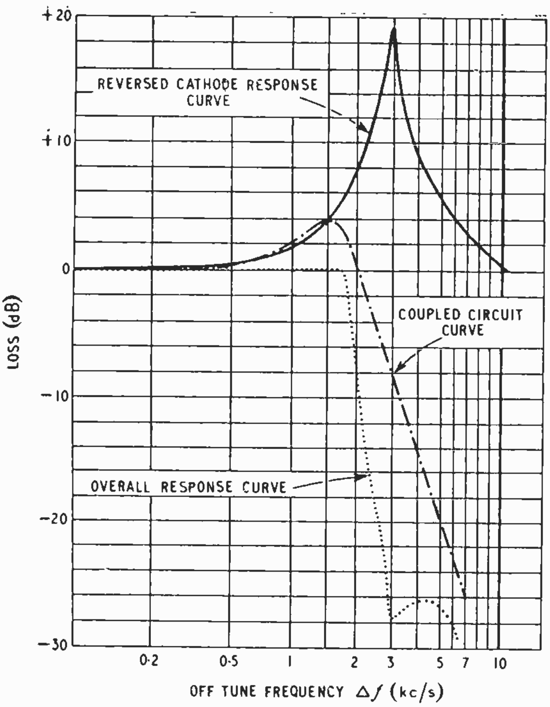


Fig. 3. Overall response for cathode feedback compensation.

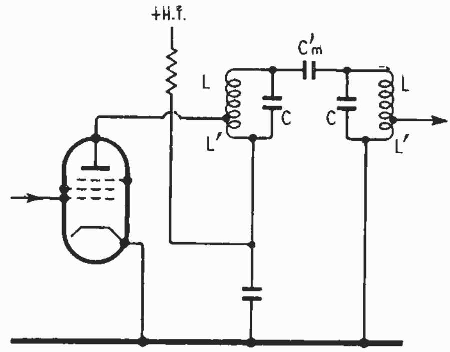
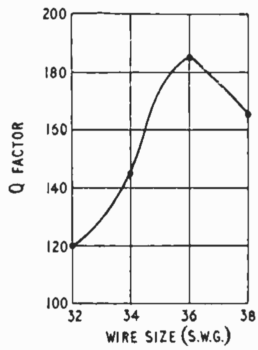


Fig. 5. Anode circuit.

Fig. 6. Variation of Q-factor with wire size.



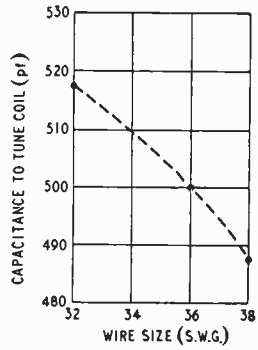


Fig. 7. Capacitance required to tune coil to 100 kc/s.

redrawn on tracing paper from Sturley's Fig. 7.47, p. 540 with the correct frequency scale but with the loss reversed. This curve which is given in Fig. 3 is placed on top of the set of generalized selectivity curves for overcoupled circuits (Sturley's Fig. 7.8, p. 453) and is moved along until it fits as nearly as possible over the coupled curve out to 1.5 kc/s. The most suitable curve is for $Qk = 3$ and we find that $\Delta f = 1$ intersects the coupled graph at $Q F = 2$. This fixes Q and k. For $QF = 2$ at $\Delta f = 1$, $Q = 100$ and $Qk = 3$, so $k = 0.03$

The overall response is obtained by plotting the difference (a dB scale) between the two curves. This is plotted also in Fig. 3.

Cathode Circuit.—The constants for the cathode circuit are given by

$$R_D = \frac{0.414\,(1 + Q^2F_1^2)}{2\,g_m}$$

For $g_m = 5.5$ mA/V, $R_D = 4440$ ohms.

The cathode tuned circuits are transformer coupled. For Ferroxcube pot cores $k \approx 1$, and so

Fig. 8. Complete circuit diagram of i.f. stage. With Mullard Type LA3 pot core, winding data are as follows:—Cathode transformers: primary 16 turns, secondary 191 turns, 36 s.w.g. enamelled wire, Q = 185. Anode transformers: 191 turns tapped at 88 turns, 36 s.w.g. enamelled wire, Q (shunted by 2 MΩ) = 125.

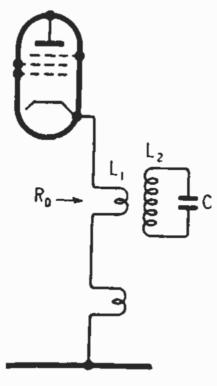
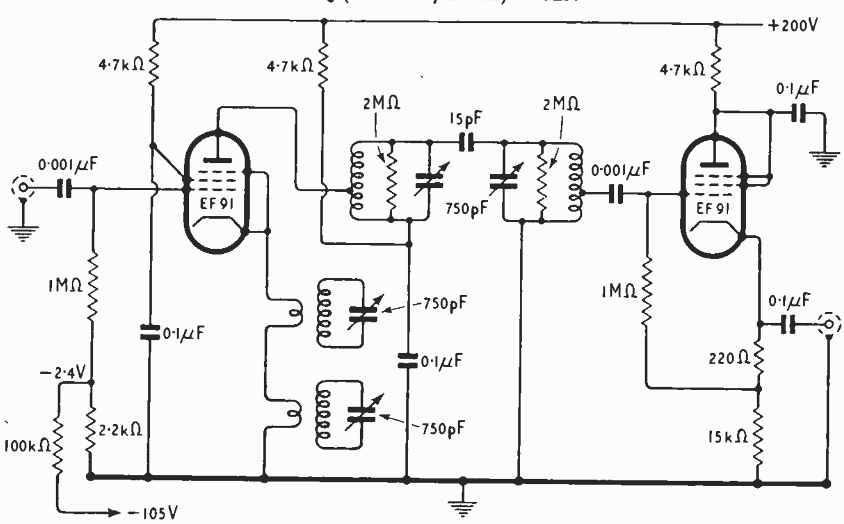


Fig. 4. Cathode circuit.



$R_D = 2\pi f_0 \, Q \, L_1$ where L_1 = primary inductance, and the Q of the circuit is assumed to be that of the tuned secondary.

$$\text{Therefore } L_1 = \frac{4440}{2\pi \times 100 \times 10^3 \times 180} = 39.3\mu\text{H}$$

The secondary coil L_2 is arbitrarily chosen so that it will tune to 100 kc/s with 500 pF. Hence L_2 = 5.06 mH.

Ferroxcube pot cores type LA3 are recommended.* For these cores $n = 85\sqrt{L}$, where L = inductance (mH) and n = number of turns.

The cathode transformers then should have 191-turn secondaries with 17 turns primary wound over the secondary turns.

Anode Circuit.—The stage gain of the amplifier shown in Fig. 5 is

$$G = \left(\frac{L'}{L}\right) \frac{g_m k 2\pi f_0 L}{k^2 + \frac{1}{Q^2}}$$

where L′ = inductance of the tapped portion of the coil, L = total inductance, and the coupling between L′ and L is unity.

If G = 110, g_m = 5.5 mA/V, k = 0.03, Q = 100, then L′ = 1.08 mH.

Choose L = 5.06 mH, and the coils should have 191 turns tapped at 88 turns. The coupling capacitor $C'_m \approx kC$ = 15 pF.

Complete Circuit.—It is important to choose the correct wire size for optimum Q-factor. Several wire sizes were tried in order to obtain the desired Q-factors. Test coils of 191 turns were wound. The variation with wire size of the Q-factor, and the capacitance required to resonate the coil to 100 kc/s are shown in Figs. 6 and 7. There is clearly an optimum wire size for maximum Q. The coils used in the test amplifier built by the author were wound with 36 s.w.g. enamelled wire (do not use silk-covered wire, for the losses are considerably higher).

The circuit which was built for test is shown in Fig. 8. A cathode-follower output stage was used for convenience in testing. A Mullard EF91 valve was used and so biased that its g_m would be about 5.5 mA/V.

Method of Adjustment.—The circuit was aligned with a signal generator and a valve voltmeter. More elaborate instrumentation would allow the optimum response to be more easily obtained (i.e., a panoramic type of display with an oscilloscope and a sweep frequency signal generator).

With the cathode earthed, the anode circuits should be peaked at 101.5 kc/s. The other peak should be found about 98.5 kc/s. Trim until a symmetrical response is obtained, centred on 100 kc/s. Remove

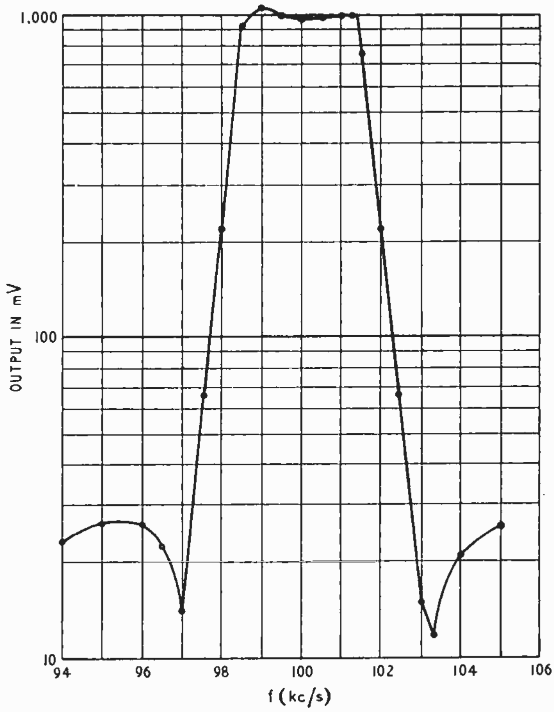


Fig. 9. Measured frequency response for cathode-feedback amplifier.

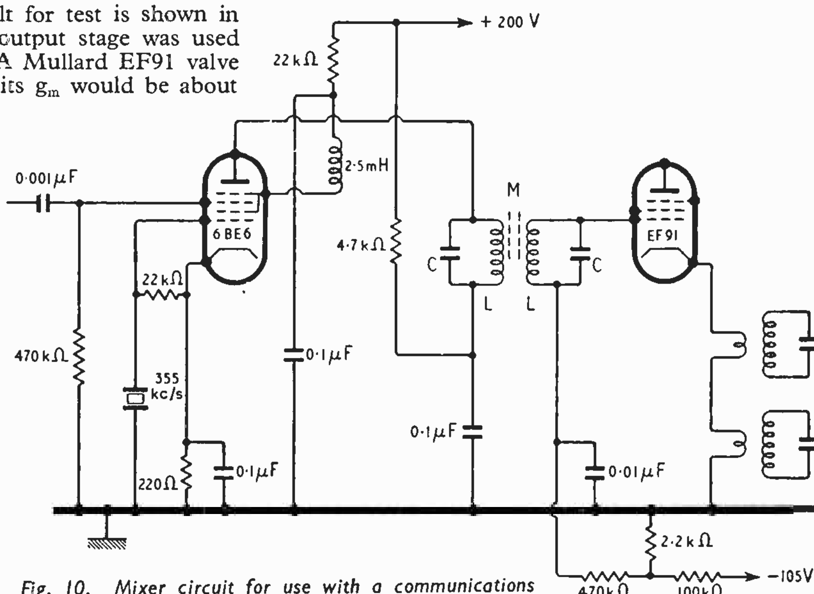


Fig. 10. Mixer circuit for use with a communications receiver with 455-kc/s i.f. Transformer details: L = 2.12 mH, Q ≈ 17, k ≈ 0.057 (pie-wound on moulded coil formers fitted with threaded iron-dust cores), C = 1200 pF.

*Manufactured by Philips' Industries, Eindhoven, and Ferroxcube Corporation of America. Obtainable in Great Britain through Mullard Components Division, in Canada through Rogers Majestic (Toronto) and in U.S.A. through Ferroxcube Corporation of America. The above is Mullard's type number. Philips' type number is D-25/17,5-10,50-IIIB3 (i.e. type 25 pot core, total height 17.5 mm, air gap 1 mm since the length of the ring is 11.5 mm, of Ferroxcube IIIB3 material). The Philips' type pot cores type D-25/17,5 have been superseded by D-25/16 and D-25/12 (i.e. the total height of the assembly is 16 and 12 mm rather than 17.5 mm). The advantage of these new pot cores for our application is that larger air gaps are available, 1.8 and 1.25 mm respectively for the IIIB3 types, and so a slightly improved temperature stability. The author has not used these new types. No doubt satisfactory Q-factors can be obtained with optimum wire-size/turns ratio.

the earth connection to the cathode. Adjust the cathode circuits for maximum rejection of 103 and 97 kc/s. Take a frequency response of the circuit. If the response is not symmetrical with a flat top the tuning procedure must be repeated, perhaps slightly juggling the two rejection frequencies, until the desired response is obtained.

The response curve obtained with the circuit of Fig. 8 is shown in Fig. 9. The circuit is critical to adjust and must be carefully tuned if the curve shown in Fig. 9 is to be achieved. The response as shown was for an input of approximately 10 mV, so the voltage gain in the pass band is about 100. The anode coils were shunted, as shown, with 2 MΩ and the coil Q was 125, that is slightly higher than calculated. With the cathode earthed the gain at the centre frequency is 110 peaking to + 6.3 dB at the two peak frequencies. That is because of the higher Q's the circuit is more over-coupled than we calculated, but by carefully juggling the positions of the two reject frequencies a satisfactory response was obtained. The Q of the cathode transformers was not measured with the cathode current flowing through the primary turns. The Q of the secondary was 185.

Sturley[5] suggests that if a.g.c. is applied to the selective amplifier the circuit will function as an automatic variable bandwidth filter. With the circuit described here, however, it is absolutely necessary that the amplifier be operated at fixed bias, since any change in g_m or cathode current upsets the shape of the response. It is quite easy to obtain ridiculous lop-sided, lop-eared response curves.

Use of the Amplifier with a Conventional Receiver.—The circuitry necessary to use the amplifier in conjunction with a standard receiver of, say, 455 kc/s i.f. is straightforward. One point of warning, however, which should be obvious but can be overlooked: the mixer anode circuit should have a wide bandwidth so as not to spoil the flat top of the pass band amplifier. If commercially manufactured 100 kc/s transformers are used they will most certainly have to be modified, i.e., shunted with resistors and the coupling increased to give a bandwidth which is quite flat to 3 kc/s. A suggested circuit is given in Fig. 10. The values given for the anode transformer are suitable if home-constructed coils are used, they are designed for a bandwidth of 8 kc/s. The overall gain of the circuit as shown is about 500, so only a few millivolts of 455 kc/s signal is needed.

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CLUB NEWS

Barnsley.—The first meeting of the Barnsley and District Amateur Radio Club, after the summer recess, will be the annual general meeting on September 14th. On the 28th W. Lee (G6LZ) will "review modern receivers." Meetings are held at 7.0 at the King George Hotel, Peel Street. Sec.: P. Carbutt (G2AFV), 33 Woodstock Road, Barnsley.

Birmingham.—At the meeting of the Slade Radio Society on August 31st, R. G. Hackel, of Joseph Lucas, Limited, will deal with the diagnosis, measurement and possible cures of interference from car electrical systems. On September 14th P. Huggins, of T.I. (Group Services), Limited, will speak on automation. Meetings are held at 7.45 at The Church House, High Street, Erdington, Birmingham 23. Sec.: C. N. Smart, 110 Woolmore Road, Erdington.

Birmingham.—The meetings of the Midlands Group of the British Amateur Television Club will restart on September 13th at 7.45 at the White Swan Inn, Edmund Street, Birmingham, and will meet on the second Thursday of each month. Sec.: F. J. Rawle (G3FHZ), 16 Kings Road, New Oscott, Sutton Coldfield, Warwicks.

Bournemouth.—The Bournemouth Amateur Radio Society is organizing a mobile/portable rally for September 16th at Stoney Cross Aerodrome, 7½ miles west of Southampton. Three control stations will be operating from 10.30—G2HIF on 2m, G3GYK on 80m and G3KYU on 160m. Those wishing to participate can obtain further details from the secretary. The Society meets on the first Friday of each month at 7.45 at the Cricketers' Arms Hotel, Windham Road, Bournemouth. Sec.: J. Ashford (G3KYU), 119 Petersfield Road, Boscombe East.

Newbury.—The Astronomer Royal, Dr. R. v. d. R. Woolley, will read a paper on "Astronomy and Cosmology" at the meeting of the Newbury and District Amateur Radio Society at 7.30 on September 28th at Elliot's Canteen, West Street, Newbury, Berks. Applications for tickets, which are free, should be sent to N.A.D.A.R.S., 83 Newtown Road, Newbury, Berks., enclosing a stamped addressed envelope.

South Shields.—At the town's annual flower show (August 24th to 26th) the South Shields and District Amateur Radio Club will operate a transmitter using the call GB3SFS. Reception reports will be welcome and certificates will be issued to the transmitter making the most contacts and the listener sending the most comprehensive report. The club meets regularly at Trinity House Social Centre, 134 Laygate Lane; the main meeting being on the last Wednesday of each month. Sec.: W. Dennell (G3ATA), 12 South Frederick Street, South Shields.

West Ruislip.—A radio club has been formed by the members of No. 114 Squadron, Air Training Corps, West Ruislip, Middlesex. Its transmitter, using the calls G3LAF and G4GB/A, will be on the air in the 40- and 80-metre bands on Sundays from 10.30 a.m. for two hours and on Tuesdays and Thursdays between 7.30 p.m. and 9.30 p.m. using phone and c.w. Reports will be welcome. Sec.: A. Morris, No. 114 Sqdn. A.T.C., No. 4 Maintenance Unit, West Ruislip, Middx.

Worthing.—The annual general meeting of the Worthing and District Amateur Radio Club will be held at 8.0 on September 10th at the Adult Education Centre, Union Place. Sec.: J. F. Wells, 37 Salvington Gardens, Worthing, Sussex.

Too Old At — ?

AGE, HEARING AND "HI-FI"

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

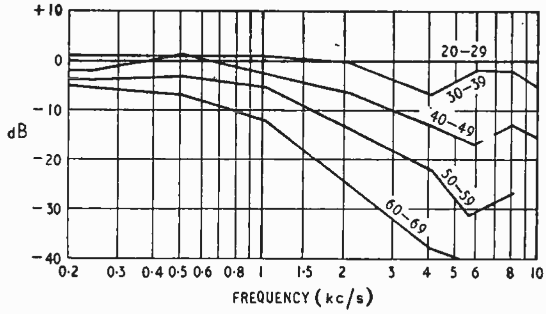

Fig. 1. Audiometer tests of various age groups.

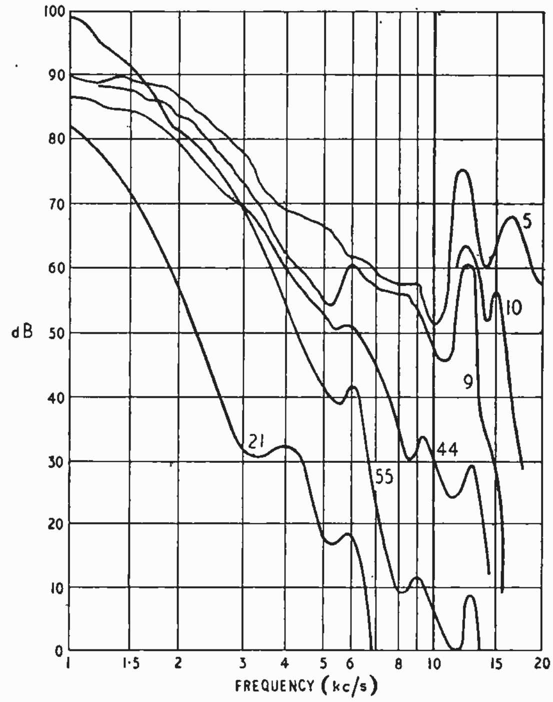

Fig. 2. Results of hearing tests made by the author on persons between 5 and 55 years of age. All except the 21-year-old were believed to have normal hearing.

HAVING for some time enjoyed the marvels of "ultra-linear" amplification, we may expect any time now to learn that the new electrostatic loudspeakers have brought us into the era of "ultrasonic hi-fi." Those of us who are not so young as we were, however, may be wondering why we should spend a lot of money on equipment for reproducing frequencies we cannot hear.

The fact that high frequencies are lost at an age when hearing is still good often dawns first when some member of the family complains of the loud 9-kc/s whistle that is now the normal accompaniment to medium-wave broadcast programmes after dark, and another cannot understand what he is talking about, being totally unable to hear it.

Fig. 1 shows the results of audiometer tests by C. C. Bunch on 353 hospital patients divided into age groups containing roughly equal numbers. The youngest group appears to have been taken as the reference level (0 dB). In the book "Hearing" by Stevens and Davis, from which this graph was taken, the authors mention that tests by H. C. Montgomery showed rather smaller losses with age—a discrepancy they attribute to hospital patients as a class being likely to suffer additional hearing loss as by-products of their ailments.

It occurred to me to compare these data with some measurements I had made on a few individuals (Fig. 2). They had been taken with a constant-output audio oscillator connected to moving-coil headphones through an attenuator having 5-dB steps. The victim was placed where the operator could not be seen, and asked to indicate by hand whether the signal was or was not heard. In this way guessing was eliminated. Care was taken, of course, to ensure that the switching was not only invisible but also silent—acoustically and electrically. The results were compensated for normal differences in acuity with frequency by means of the threshold-level Fletcher-Munson curve. Headphone characteristics were not compensated—a resonance is noticeable at 13 kc/s, for instance—but being the same for all a comparison of the curves is valid. The dB zero is quite arbitrary.

The numbers against the curves are the ages of the people tested. All had, as far as was known, normal hearing except the one aged 21, who had suffered an illness affecting the ear and—as might be expected from the graph—has some difficulty in following ordinary conversation. The measurements extended down to 40 c/s, but as there were no significant differences below 1 kc/s in any of the individuals—even the 21-year-old—those readings have been omitted.

Apart from the one clearly abnormal curve, these results illustrate again the steady decline of high-frequency hearing with age. They might give the impression that Fig. 1 by no means overstates the decline, but the number of people represented by Fig. 2 is too small to tell; actually only two come within the age groups included in Fig. 1. The really interesting features of Fig. 2 are what it shows regarding the younger ages and higher frequencies—absent from all published data that have been seen. It appears that substantial loss of high-frequency hearing occurs in quite early childhood. And that this loss at first takes the form of a lowering of a sharp cut-off frequency rather than the increasingly downward slope above 1 kc/s that characterizes ages above 20.

The statements made elsewhere suggesting that loss begins in the late teens may have resulted from not extending tests to sufficiently early ages and high frequencies. I was fortunate in happening upon a

5-year-old sufficiently intelligent and co-operative for the purpose; and in view of the precautions against fraud was frankly astonished to find no signs of cut-off even at 20 kc/s—well into the r.f. communication band!—and greatly regretted the absence of a quickly available extension of facilities to higher frequencies.

I still more deeply regret inability to possess once again hearing of this kind, for assessing the value of reproducers that work up to 20 kc/s or so. Unfortunately they seem to offer no advantage beyond the listener's cut-off, unless anyone is prepared to argue that the beating of supersonic components in the non-linearity of the ear produces audible components that add something worthwhile to fidelity. Personally I suspect that if anything does drop down in this way through the ceiling of audition it is more likely to reintroduce some non-linearity distortion that we would otherwise have been spared. But one has only to express almost any opinion on high-fidelity to provoke contradiction, so I expectantly leave it at that.

PICKING THE WINNERS

Random Number Generator for Premium Bonds

On view at the Radio Show this year will be a version of the electronic machine known as ERNIE (Electronic Random Number Indicator Equipment) which is responsible for selecting the prize-winning numbers in the Government's new Premium Savings Bonds scheme. Its function is, of course, equivalent to the traditional method of drawing numbered counterfoils from a drum by hand. The numbers concerned will be made up of 9 digits and each of these digits will be generated separately by an independent piece of circuitry. This will safeguard the randomness of the numbers, in one respect, by ensuring that there is no correlation between individual digits of the 9-digit number.

Actually the second and third digits of the numbers will be alphabetical characters, but this merely means selecting randomly from a scale which is greater than the ten numerical characters. (That is, in the second digit position, where 23 alphabetical characters will be available; in the third position only ten characters will be used—the same as for numbers.) At the Radio Show the demonstration equipment will be generating only two of the digits.

The basic component of each digit-circuit is a cold-cathode gas discharge tube giving out a random noise waveform. This is followed by a clipping circuit which removes the low-amplitude fluctuations and leaves the remainder to be amplified and squared, giving an output of well-shaped pulses of constant amplitude. About 3,000 pulses are produced a second. The pulses are passed to a decade counter, which is started and stopped at regular intervals by a master timing pulse generator in such a way that the counting is done in periods of 160 milliseconds with gaps in between. At the end of each 160-msec period the number of pulses counted is read. This number might amount to something like, say, 487, and it is the digit in the units column, the 7, which is actually selected and indicated.

The counter is always started from the point at which it was left at the end of the previous 160-msec period. This gives a series of different starting points and ensures that the output digits will be more random (that is, equally likely to occur) than if, say, the counter were started from zero each time.

To guard against possible equipment failures each digit generator is duplicated. The two outputs from a pair of such circuits, each giving a different digit, are passed into a combining circuit which performs the *logical* operation of multiplying one by the other (but not actual *arithmetical* multiplication). This is done to avoid the possibility of a bias of periodicity appearing in a series of generated digits as a result of a fault in one of the gas discharge tubes. Multiplying a periodic series (from the bad tube) by a random series (from the good tube) always gives a random series as the product.

The digit outputs from the 9 combining circuits are transferred to stores, from which they are assembled, scanned and passed to teleprinters, together with fixed codes needed for the actual operation of the teleprinters—figure shift, letter shift, line feed, carriage return and spaces. The starting and stopping of the teleprinters (which are also duplicated) is done by the same master pulse generator which controls the counters. Circuits are incorporated for inhibiting random numbers above certain values, corresponding to ranges of Bonds not yet offered for sale, and these can be set before each draw. The equipment will also examine the first two digits of each number for the purpose of routing the numbers to appropriate teleprinter stations—each station being associated with a numerical register of a particular range of Bonds.

Amateur Television Book

"SELF-HELP" is the philosophy which seems to have inspired the amateur television transmitting enthusiasts throughout their difficult career. It has now been taken a stage further by Michael Barlow, a member of their organization*, in acting as his own publisher to produce his own book on amateur television. The work may not be up to the usual standards of professional publishing, but it contains a great deal of specialized information which certainly could not be obtained from any other single source: Starting off with a chapter on fundamentals, it passes on to the construction of flying-spot scanning apparatus, for both transparent and opaque subjects, then to mixers and modulators and finally to r.f. equipment. It also includes items on the B.A.T.C.*, their agreed transmission standards and the Post Office amateur television licence. A list of useful references is provided for those who wish to pursue the subject farther.

"An Introduction To Amateur Television Transmission," which contains 30 pages, can be obtained from Mr. Barlow at 10, Baddow Place Avenue, Gt. Baddow, Essex, price 3s 6d.

* The British Amateur Television Club.

Improved Slide-back Valve Voltmeter

BY O. E. DZIERZYNSKI

Applications in Test and Control Apparatus

Conventional slide-back valve voltmeters are not much used nowadays for routine laboratory measurements in spite of their low input loss and independence of supply voltage variations. The reason is that two meters are required and concentration and skill are needed for accurate "zero" adjustment. The author shows how these disadvantages may be overcome and suggests uses for the improved design in test and control equipment.

AT least two indicating elements must be employed when taking measurements with, say, a bridge or a slide-back voltmeter; namely, an adjustable calibrated variable resistor, condenser or inductance, and a balance indicator. Let us see what sort of indicators are available: (1) moving-coil, (2) "magic eye," (3) neon indicator, (4) lamp or similar device actuated by a relay. Each of these indicators has some advantages and disadvantages, but as the instrument to be described had to be used for industrial control as well as measurement, a relay as indicator was chosen. Regarding the circuit itself, a slide-back voltmeter combined with a d.c. amplifier and output relay or neon indicator was developed. Before considering this circuit in detail, we will refresh our memory of the working of the slide-back valve voltmeter (s.b.v.) and explain why it is considered necessary to employ a d.c. amplifier.

Principle of the Conventional S.B.V.—In the circuit of Fig. 1 the d.c. bias is adjusted by the potential divider to obtain the same anode current with and without a.c. input; then providing that the voltage to be measured is high enough and the valve has a sharp enough cut-off, the measured positive peak voltage has a value v-v_0 when v and v_0 are the corresponding readings of the d.c. voltmeter, V.

The conventional s.b.v. measures the peak value of the signal, whereas we are generally interested in the mean or r.m.s. value. Other disadvantages are that two meters are required, and the accuracy is to some extent dependent on the valve cut-off characteristic and on the signal level.

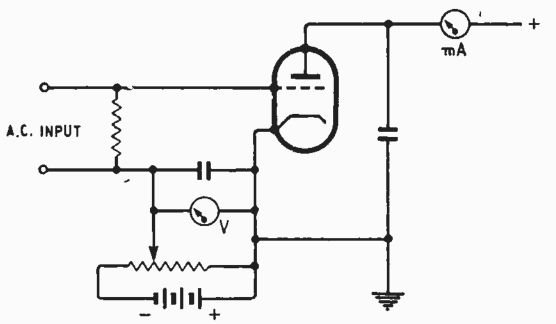

Fig. 1. Conventional slide-back valve voltmeter.

Basic Circuit for Improved S.B.V.—In redesigning the voltmeter the first decision was to rectify the signal first and to derive a direct voltage representing its mean value. The next step was to replace the d.c. voltmeter, V, by a calibrated potentiometer supplied from a d.c. stabilized source V_1. In this way the actual bias voltage can be read directly from the potentiometer setting. Finally, the milliammeter in the anode circuit was replaced by a relay which is actuated from a certain threshold current upwards. The initial bias and the relay itself can be adjusted to cause movement of the armature from a given current upwards and with a determinable degree of accuracy.

Fig. 2 is a skeleton circuit of these new arrangements and it will be seen that a d.c. amplifier has been inserted between the input circuit and the relay. The need for this can be explained as follows. Relay RL has to indicate exactly the same total grid bias voltage before and after the signal is applied. Now if we assume that our smallest measured signal is, say, 1 volt (d.c.) and the required accuracy is ±5%, this would correspond to a change of anode

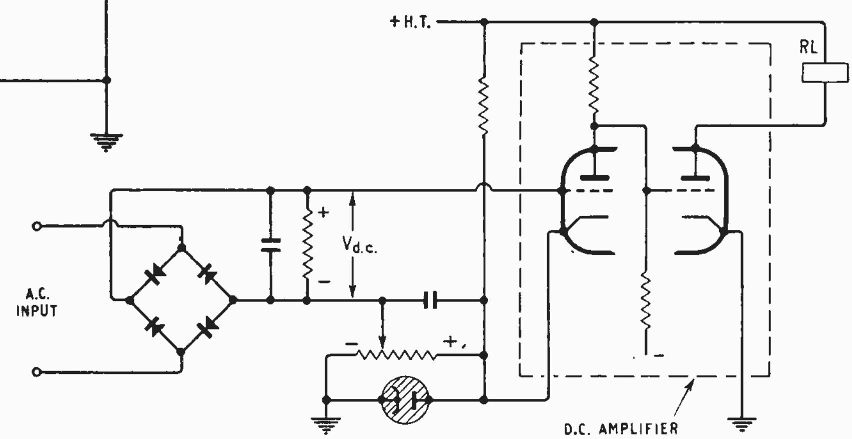

Fig. 2. With separate rectification and a d.c. amplifier a relay can be used as an accurate indicator.

current of say 2mA±100μA—if only one triode is employed, without d.c. amplification. Consequently, if the relay has an initial current of, say, 4mA, the sensitivity of the armature going "on" and "off" has to be within limits ±100μA which represents only 2½% of 4mA. Unfortunately, in an ordinary relay this tolerance is much larger, and limits can be expected as high as ±10-30%.

Another factor to be taken into account is that relays usually have different "pull" and "release" currents and without certain circuitry modifications the figures quoted above might well be increased up to 60%.

The conclusion here is, that by amplification of the d.c. input signal all problems can be solved. Assuming that one stage of d.c. amplification would give us a gain of 20, we now have instead of ±100μA a change of ±2mA which represents ±50% of the initial relay current of 4mA. This means that 1 volt d.c. input can be measured within limits of accuracy of ±5%. Obviously, with larger signals the situation would improve—as 50mV (representing 5% of 1 volt) remains constant (as far as accuracy is concerned) for every signal. For instance, when applying −10 V d.c. to the grid and "sliding back" the potentiometer until the armature moves again, the accuracy of measurement would be 10 V ±50mV=10V±0.5%.

Circuit Stability and Accuracy.—Fig. 3 gives the final circuit. Before going into details it is important to analyse additional factors having influence on the stability and accuracy of measurements.

For reliable operation the current (given previously as 4mA) must remain constant within certain limits. Any drift from 4mA would involve additional error. Setting the limit for this error at, say, ±1% (total allowed ±6% of 1 V input), the permissible anode current drift would be 2/5=0.4mA.

Reducing drift of standing current is not a simple problem, as drift could result from several factors, as (a) variation of working voltage of stabilizer, (b) changing emission of both triodes, due to ageing, (c) fluctuation of emission (first triode particularly) due to heater voltage variations, (d) changing emission of each triode occurring very slowly during first 1-2 hours after switching on.

Let us analyse these factors. (a) Reference tubes types 85A1 and 150B2 were used, connected in series. 85A1 provides 85 volts, forming the negative part of the bias, V2; and also the positive and negative portions of the bias for V1 (developed across r_1, r_2 and r_3 respectively). Maximum percentage fluctuation of working voltage in this valve is 0.2%, i.e., 170 mV, and it can be calculated from the ECC81 characteristics that this would affect anode current up to approximately 0.35 MA. On the other hand, every change of the stabilized 85V would affect simultaneously the grid bias of V1 which is of total value about −1.2V (negative value in cathode −2.2V

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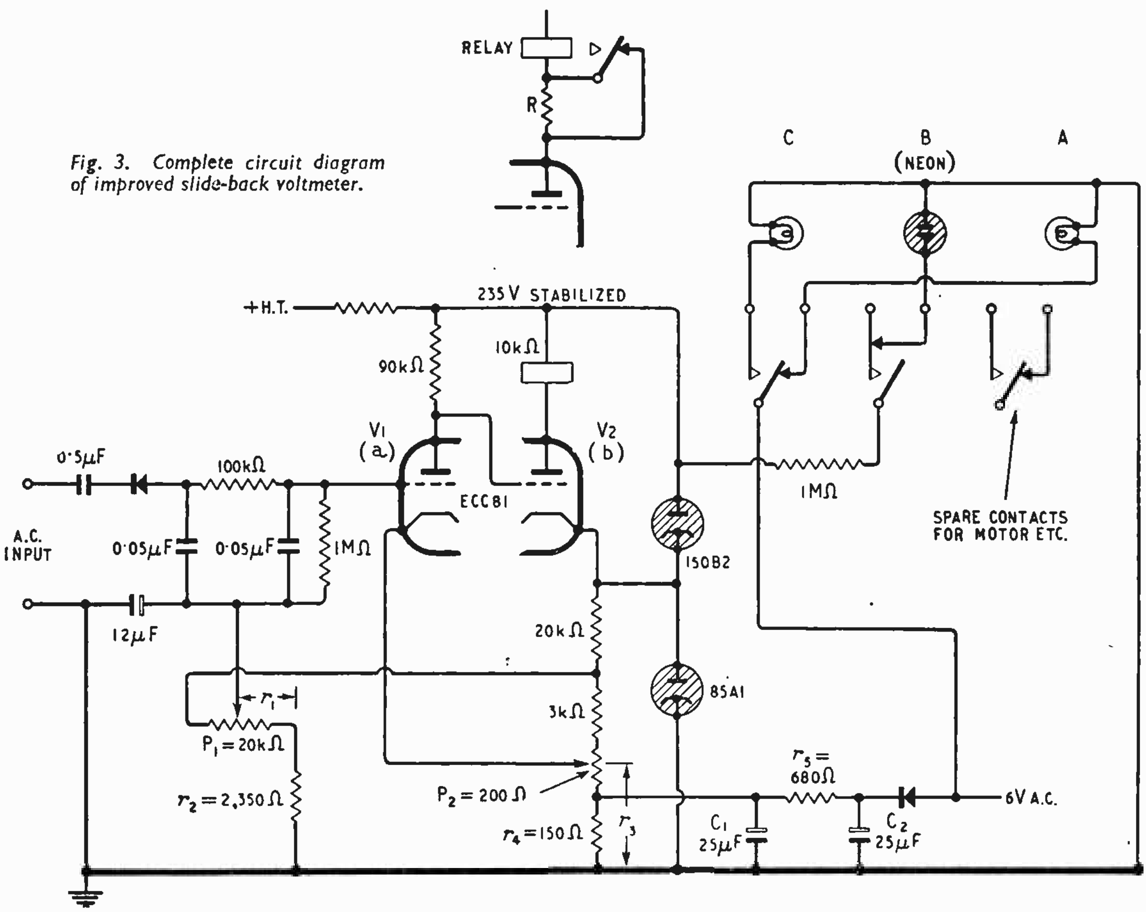


Fig. 3. Complete circuit diagram of improved slide-back voltmeter.

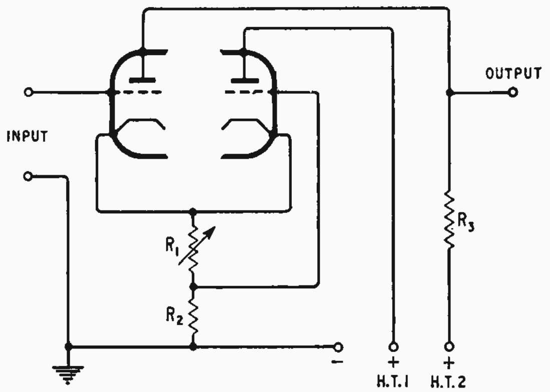


Fig. 4. Circuit for compensating long-term drift of emission.

opposed by positive portion on r_1, r_2 which is 1V). Corresponding fluctuation would be $\frac{1.2}{85}\times 170 = 2.4$ mV, and this after amplification, say 20 times, would produce 48 mV to the grid V2 in opposite sense to the 170 mV. As a result, the grid of V2 will receive 170-48=122 mV and the current change would be only $0.35 \times \frac{122}{170} = 0.25$ mA.

We must remember here that all this is assuming no-signal conditions. With the presence of a signal, say −10V, after balancing relay to a current of 4 mA, the positive portion of V1 bias would be 10-1.2=8.8V. This 8.8V could vary from stabilizer fluctuation by $170 \times \frac{8.8}{85} = 17.6$ mV, and to the grid V2 could be delivered as a total of $-(17.6 \times 20) + 170 = -80$ mV. In effect the current change would be only $0.35 \times \frac{80}{170} = 0.16$ mA. From this it is apparent that working voltage fluctuations affect accuracy most when the smallest signal is being measured; with increasing signal level error is reduced until the balance condition between positive and negative biasing voltages in the grid circuits of V1 and V2 respectively is obtained.

Anode current fluctuations are here 0.25-0 mA and well within the required limits 0.4 mA.

(b) Changing emission of triodes has an obvious effect on the anode current drift, but this occurs gradually and accuracy of measurement is not affected if, every time the instrument is used, the initial current conditions are checked and adjusted (potr. P_2).

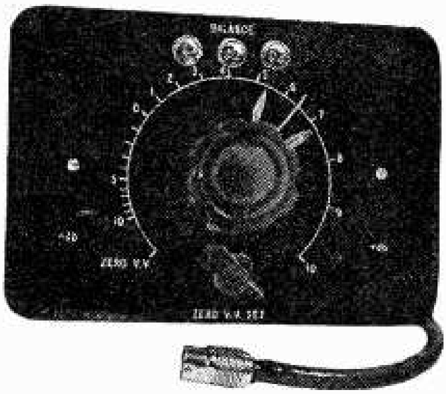
(c) Fluctuation of emission due to heater voltage variation has the largest effect on anode current drift. It was found that current changes proportionally to mains voltage at a rate of 1.5 mA per volt a.c. To minimize this effect two alternative methods could be used: to stabilize heater voltage or to design compensating methods by applying additional bias varying proportionately to mains variations and with amplitude and phase properly chosen. To stabilize heater voltage, constant-voltage transformers could be employed or heaters connected in series with conventional barretters. Special transformers are rather expensive and barretters are not recommended on account of the excessive heat developed in a normal-sized cabinet.

The compensating method was found very effective, simple and not expensive. A fraction of the negative portion of the bias of V1 ($r_4 = 150\Omega$) is derived from the heater supply through a small rectifier. The output is so adjusted, that any change of heater voltage produces an additional bias voltage in the grid circuit of V1, entirely compensating any change of anode current in V2 due to varying emission. Rather large smoothing condensers C_1, C_2 are chosen to make the time constant of the rectified output large, as variations of current due to mains fluctuation do not occur rapidly but with a certain delay. With proper adjustment of the ratio r_4/r_5, compensation can be made very accurate and mains voltage variations between 200-250V did not cause drift of more than ±2% (of 4 mA).

(d) Slow drift of emission is of the order of 50μA in valve ECC81, consequently the anode voltage drift in the first section of the valve will be around 400 mV, which is equivalent to a drift of 15 mV in the input circuit, representing only 1.5% of minimum measured voltage (1V). Obviously the effect of (d) can be disregarded in our circuit. However, if any reader would like to reduce this drift to improve accuracy, the circuit of Fig. 4 could be employed. In this case the first section of the ECC81 (V1) has to be replaced by a double triode with identical characteristics and a value of R_2 equal to $1/g_2$ where g_2 is the mutual conductance of the right-hand half.

Output Relay Circuit.—The output relay, giving indication of identical voltage (and current) conditions in the circuit, has to fulfil certain requirements regarding winding and type of contacts to be employed. Before measurement, the current should be checked, by adjusting P_2, to set for the moment when the armature of the relay is on the point of moving. Depending now on which direction the potentiometer is moved, some backlash effect will be experienced. This can be reduced by inserting a resistor R (Fig. 3) in series with the winding, R being short-circuited when the relay is "off" and opened while it is "on." In this way the actuating currents for pull and release are compensated. Another way to improve this action is to adjust the gap between armature and core.

The next problem concerns the indicator itself. Three indicating lights are employed. Lamp A signals when the relay is "off," B when the relay armature is in motion, and C when it is in the "on" position. Most important for our purposes is the neon indicator B, which produces only a flash of light. Indicators A and C (pilot bulbs) are helpful in determining the setting of the slide-back potentiometer P_1. For example, let us assume that a certain measurement has to be taken. After switching on the instrument and allowing a few seconds for "warming up," one of the indicators A or C will be on; by adjusting P_2 a change-over from A to C (or *vice versa*) will be found, and P_2 must be left in a position close to this change-over, i.e., to the flash in B. After applying the unknown voltage to the input terminal, indicator C will be "on" and we have to turn P_1 now in a clockwise direction until the change-over from C to A occurs (indicated by flash in B). A reading of the input voltage can then be taken from the calibrated scale of P_1.



Improved slide-back voltmeter with scale calibrated in dB for use as an a.f. level indicator

Indicating System without Relay.—If the instrument is to be used only for measuring purposes and no further actuating action is necessary (such as switching heavy-duty mechanical contacts, etc.), it could be advantageous to dispense with the relay. This could be achieved by employing an additional double triode in a supplementary output circuit (Fig. 5 (a)). Here three neon indicators are used. Neon B is inserted between the two anodes of output triodes V3 and V4 and lights up only for given biasing conditions. This is a result of the fact that irrespectively of the signal d.c. voltage applied to the grids the biasing voltages of each section are opposed to each other for approximately 2 V (batteries b_1, b_2).

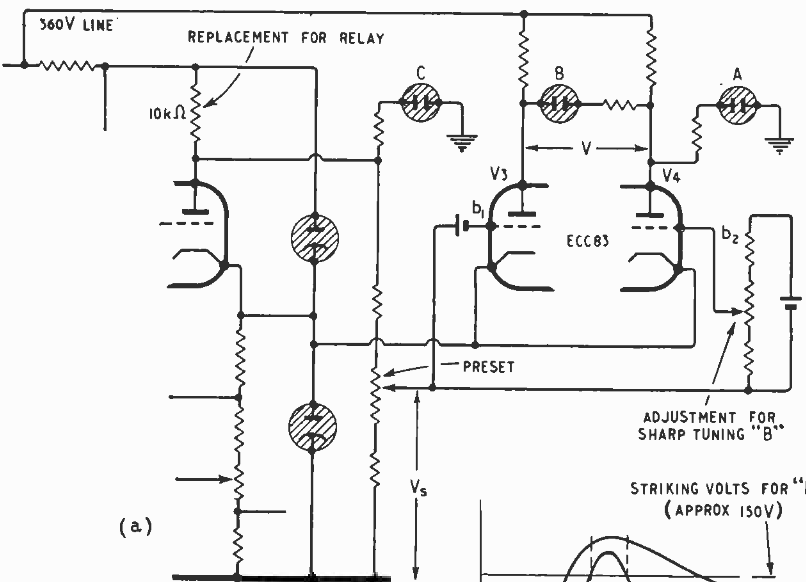
While increasing signal voltage V_s (positive), valve V3, having the grid more positive, will start to conduct before V4 and a difference of potential will appear between the anodes of V3 and V4 lighting up the neon. Still further increasing the positive signal, this difference will reach a maximum and then decrease, as now valve V4 will start to conduct as well. Fig. 5 (b) shows how the d.c. voltage V depends on the positive signal on grid V for different biasing conditions. A bias difference of 2 V gives optimum conditions when the neon is lit up quite firmly and discrimination of output signal amplitude is within ±2 V. Neons A and C indicate voltages respectively higher and lower than the voltage setting of the slide-back potentiometer.

Applications

Level Indicator.—The most important use of the complete instrument is in replacing the conventional d.c. microammeter bridge rectifier employed in a sensitive valve voltmeter. The photograph shows a level indicator in which the potentiometer scale is calibrated in decibels as in this case the differences in certain a.f. levels had to be measured and registered.

For this purpose two addition "limit" pointers are employed. Several frequencies are played back from a tape recorder and their relative response should be within, say, 6 dB (±3 dB). When the reference frequency (1,000 c/s) is first reproduced, the s.b.v. control with all three pointers closed together is set to, say, 0 dB level and the latter is adjusted by the volume control in the tape recorder ("balance" neon on). Other frequencies might give different levels which have to be followed by turning the s.b.v. knob to keep the "balance" neon alight. While doing so, the right-hand loose pointer would be setting limits for higher levels and the left would be doing so for lower. Finally, when all frequencies are played back these two limiting pointers, by indicating maximum and minimum of level, tell us if the response is within required limits (6 dB). Using an ordinary meter indicator, these readings must be memorized, but here maximum and minimum of levels are recorded. Accuracy of setting can be improved considerably by replacing manual control by automatic setting. In this case the potentiometer can be driven by a small reversible motor actuated from the relay described before, and the neon indicators in such a system would have only auxiliary importance.

Supply Voltage Controllers.—The basic circuit of an electronic supply voltage regulator is given in Fig. 6 (a) in which a very similar circuit to the s.b.v. is employed. Unit A has



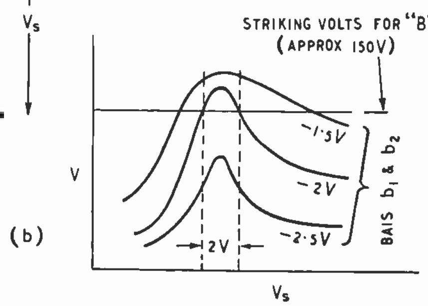


Fig. 5. (a) Alternative indicating circuit dispensing with relay. (b) Relationship between input signal V_s and voltage V across neon B for different bias conditions.

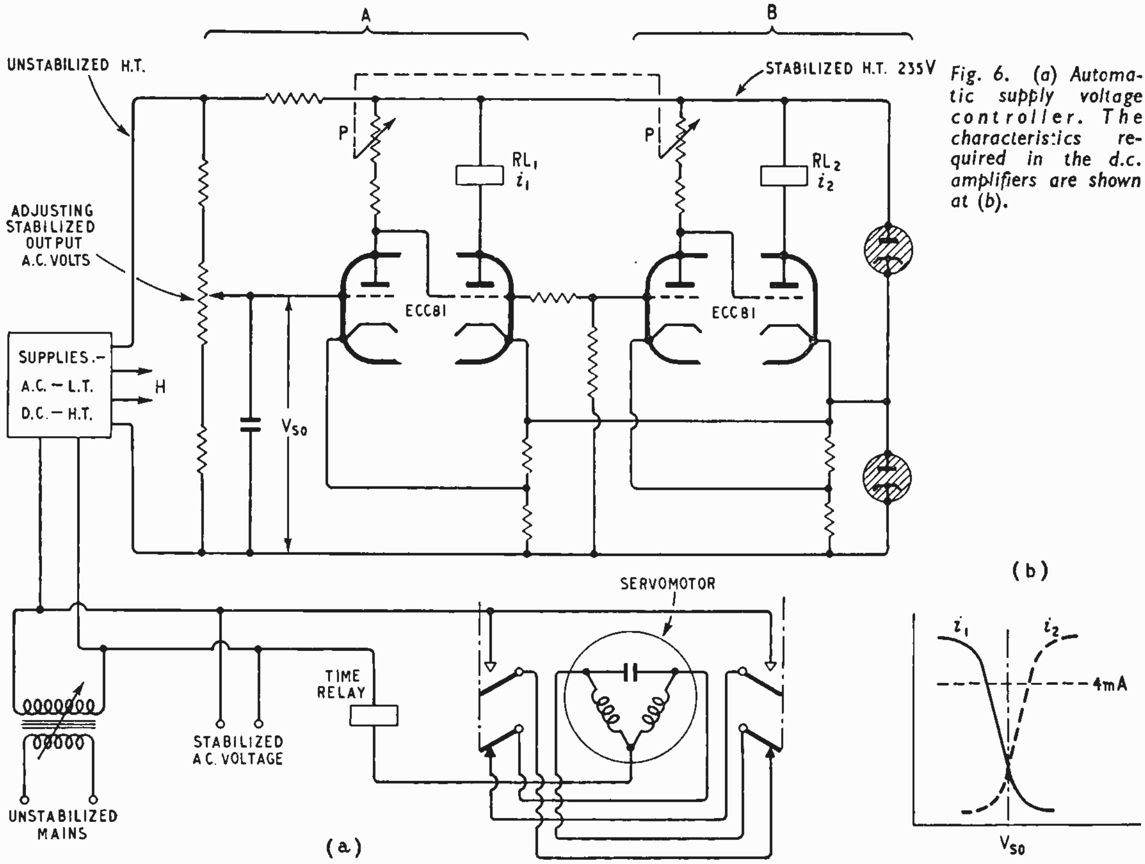


Fig. 6. (a) Automatic supply voltage controller. The characteristics required in the d.c. amplifiers are shown at (b).

a d.c. amplifier characteristic as shown in the full-line curve at (b) and unit B must have a similar characteristic but with reversed phase. Biasing conditions and anode voltages of the left-hand sections of the double triodes are so adjusted that for only one input voltage V_{s0} are the anode currents in both relays low enough not to actuate the armatures. Every change of V_{s0} outside limits ± 1 per cent will actuate RL_1 or RL_2 and would switch on the reversible servomotor which rotates the control of the supplying "Variac" transformer. If the mains voltage rises (V_{s0} would rise, RL_2 actuate; curve i_2) the servomotor will turn the "Variac" in the direction to reduce output voltage—and *vice versa.*

By setting the control P, different a.c. mains outputs can be obtained, ranging between 190 and 260 V.

Selective Calling for Ground-to-Air Communication

A SELECTIVE calling device for use with long-range pilot-operated h.f. radio-telephone equipment now in use for air-to-ground communication has been developed by Motorola. Known as Secal, its purpose is to relieve the pilot of the need for maintaining a continuous radio watch.

Calling the aircraft is effected by a ground-station unit which applies coded audio tones of short duration to the transmitter. In the aircraft these tones are fed into the airborne Secal unit which responds only to the particular combination for which it is set up and then sets in operation a flashing light and chiming sound to attract the pilot's attention.

Some changes in existing ground-station procedure may be necessary as with Secal in use only Secal-equipped ground stations can call an aircraft direct and those not fitted may have either to make contact through a station so fitted or by previously arranged schedules.

As for technical details of the system, 12 different tones between 312.6 c/s and 922.2 c/s, with tolerances held at $\pm 0.15\%$ are used. Each call consists of two tones transmitted simultaneously for one second with an interval of 0.2 sec followed by a further two tones for one second. Each Secal-fitted aircraft is allotted a permanent four-letter (equivalent to four tone) call.

The ground-station Secal equipment consists of a small control unit having four twelve-position switches each marked "A" to "M" (I being omitted) and on these the code letters of the aircraft to be called is set up by the ground controller.

A push button then initiates the call and a lamp is illuminated which is repeated on other control units at the ground station to warn other operators that the Secal equipment is in use on any particular channel. It is usual to provide as many Secal control units as there are radio channels likely to be used simultaneously at any one ground station.

It is stated in the May, 1956, issue of the *I.A.L. News*, the magazine of International Airadio from which this description is taken, that a Secal-equipped aircraft can often be contacted by a ground station much quicker than would otherwise be possible, for when signals are weak the call might be difficult to hear on a busy channel whereas the calling device will respond immediately.

Wide-Band Linear R.F. Amplifier

Results of Tests to Check Performance of Amplifier and Filter

By B. F. DAVIES,* A.M.I.E.E.

(Concluded from page 378 of the previous issue)

SUMMARY OF AMPLIFIER CHARACTERISTICS		
Nominal Gain: 15 dB		
Frequency Coverage: 150 kc/s to to 25 Mc/s.		
Band-stop Filters: 400–535 kc/s: 1.6–3.8 Mc/s.		
Inlet: 75Ω coaxial.		
Outlets: 4 x 75Ω coaxial.		
Cross-modulation Limit:	0.35 V	Input
1st I.M. Criterion:	50 mV	Input
2nd I.M. Criterion:	25 mV	Input

Linearity of a high order is necessary in an amplifier covering all broadcast bands, if inter- and cross-modulation products are to be kept down. This article gives the results of measurements on an amplifier (described in the previous issue) which was designed as part of a ship's communal aerial system. The filter used to suppress currents induced by the ship's transmitter must also meet a stringent specification

MEASURED between 75-Ω impedances, the actual gain of the amplifier from input to any output was 14.6 dB, while the frequency response, which includes that of the filter, was as given in Fig. 9. Without the anode corrector coils in circuit, the 25-Mc/s response would have been some 6 dB down.

To make measurements utilizing two signals, the test circuit of Fig. 10 was set up. It was found necessary to have the isolating resistances in each signal-generator output in order to minimize reaction between the generators. Tests were commenced by first checking that, with the amplifier omitted and the generators delivering levels greater than that required for actual measurements, no unwanted inter- or cross-modulation effects could be detected on the receiver. The amplifier was then inserted, together with an attenuator to bring the voltage at the receiver back to the same level, and the measurement carried out.

The basis of the cross-modulation (X.M.) test was to find the level of a 30% modulated signal at the input that would produce modulation, 20 dB down (3% modulation level), on a small unmodulated carrier. A reference signal of 5μV at 1.4 Mc/s, 30% modulated, was applied to the input (the necessary allowance being made in all cases for the input test circuit loss), the receiver was tuned in and a reference output noted. The modulation was then switched off and the carrier increased to 50μV (+20 dB). The level of the other generator, 30% modulated, was then increased until the same reference output was read on the receiver output meter. The large interfering signal was, of course, kept off 1.4 Mc/s. From the results quoted, an input signal of 0.35 V could be handled. This means that if a filter is used which has an attenuation of 40 dB, the aerial input volts within the M.F. and I.F. bands could be as high as 35 volts.

At high frequencies the maximum input level falls about 3 dB but at 20 to 25 Mc/s high voltages on the aerial are likely to be a rare occurrence and, from available statistics, do not exceed 5 V when the ship's transmitter is working in the 22-Mc/s band. Should an H.F. band filter be used in the installation, the attenuation requirements would therefore not be so stringent as for the filters for the M.F. and I.F. bands. It should be remembered, however, that in the short-wave broadcast bands H.F. transmissions are made by other ships which will induce voltages into the aerial which will pass unattenuated to the amplifier input. The H.F. band filtering unit could not be relied upon to rectify this, as in practice it would only be switched into the aerial circuit by the radio operator during his own H.F. transmissions. The main reason for keeping the H.F. band filter out of circuit as often as possible is to avoid attenuation of some broadcasting bands, which conflict with the communication bands and also to avoid introducing a general insertion loss into the aerial circuit, which would be the case if several conventional-type filters were permanently inserted. Nevertheless, induced voltages greater than 0.35 V, caused by such transmissions from neighbouring ships, are extremely unlikely and immunity from cross modulation on all carriers can largely be guaranteed.

Test Requirements

When we come to testing for both forms of intermodulation, we must first consider how the test results will be interpreted. The 1st I.M. has been shown to be proportional to the product of the two carrier strengths, pq. As the same result could be obtained with carriers of equal strength ($p = q$) or with one very strong carrier ($p \gg q$), it is evident that the total input voltage applied to the amplifier ($p + q$) will not be indicative of the signal-handling capabilities where intermodulation is concerned. Fig. 11 shows how for a constant pq (neither carrier being considered modulated) the total voltage, as

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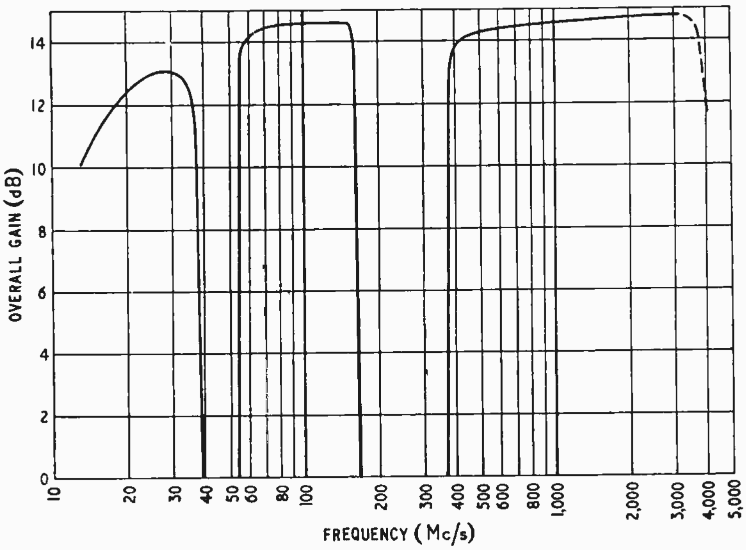


Fig. 9. Measured response of amplifier and filter.

would be measured on a peak reading r.f. voltmeter, varies with p. To establish a criterion, we can use $\sqrt{pq}$, which for two equal carriers will be equal to the level of each individual carrier. If, now, the tests are carried out by injecting the two signals simultaneously at the same level, we need only quote the signal level of either carrier entering the amplifier to ascertain the I.M. handling capabilities. With two equal carriers ($p = q$) for a given I.M. criterion voltage, the input level will be twice the criterion voltage. With only one carrier of high level (p), the total voltage level that can be accepted by the amplifier can, to a good approximation, exceed the criterion figure by the amount that the next highest carrier (q) is below the criterion figure.

The tests were based on ascertaining the I.M. criterion level at which the intermodulation product at ($\alpha + \beta$) or ($\alpha - \beta$) was equal to a carrier level of 5μV, a level which for entertainment purposes on a broadcast receiver would be considered an insignificant signal. It should be remembered that the noise field in the close vicinity of a ship, due to electrical machinery, is if possible kept down to 5μV/metre which demands signal strengths of 50μV/metre to obtain signal to noise ratios of 20 dB. On test a 5μV signal from one signal generator at 1.4 Mc/s, 30% modulated, was injected into the amplifier and the receiver set to a given reference output. The two generators, one of which was modulated 30%, were then set to 0.65 Mc/s and 0.75 Mc/s so that ($\alpha + \beta$) would correspond to 1.4 Mc/s and the levels increased simultaneously until the same reference output was obtained again. The push-pull balance control in this instance is used to obtain optimum results as it is capable of minimizing the 2nd harmonic distortion. Figures obtained for the I.M. criterion ranged from 50mV to 100mV according to the valves used. At 20 Mc/s and above, the results deteriorate due to the reduction in the linearization factor. For ($\alpha - \beta$) = 1.4 Mc/s where $\beta = 22$ Mc/s and $\alpha = 23.4$ Mc/s, the criterion figure was 25 mV. The question arises as to what happens when, say, α is at 22 Mc/s and β at 13 Mc/s, and the I.M. product is at 9 Mc/s. A series of tests have shown that, providing one of the carriers in question is at a sufficiently high frequency for the linearization factor to suffer, the I.M. criterion figure will be affected. Tables II and III show that 1st I.M. products, derived from frequencies in the common s.w. broadcast bands, can in some cases fall within the same s.w. bands. The greatest liability to I.M. from such causes

TABLE II

S.W. Broadcasting Bands				
49 m	5.95	—	6.20 Mc/s	a
41 m	7.15	—	7.30 ,,	b
31 m	9.50	—	9.775 ,,	c
25 m	11.70	—	11.975 ,,	d
19 m	15.10	—	15.45 ,,	e
16 m	17.70	—	17.90 ,,	f
13 m	21.45	—	21.75 ,,	g

TABLE III

(1)	(2)
a + d	f
a + e	g
c + d	g
b − a	M.W.
d − a	a
e − c	a
f − a	d
g − e	a
g − d	e

(1) Bands containing interfering signals.
(2) Band in which 1st I.M. product falls.

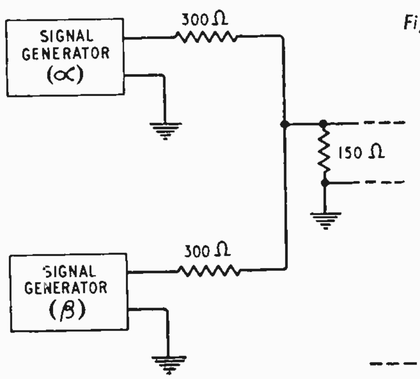
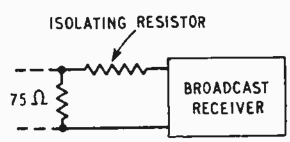
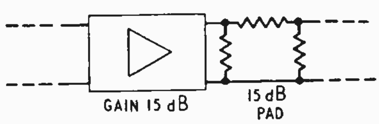


Fig. 10. Test arrangement for two-signal tests.





arises when there is a strong signal in the 13-metre band. Such interference from s.w. broadcasting bands is by no means the only interference due to 1st I.M. that could exist, there being many high-powered transmissions on communication frequencies, but such a consideration does serve to illustrate the possibilities of interference.

Second-order Intermodulation

When we come to the question of the 2nd order I.M., we must remember that the intermodulation term is proportional to p^2q or pq^2. Fig 12 shows how the total input level $(p + q)$ will vary as p is varied for a constant value of the product term. It will be seen that for the I.M. terms $(2\alpha + \beta)$ and $(2\alpha - \beta)$, where $k = p^2q$, the signal handling capacity $(p + q)$ rises more steeply below a certain minimum value: for $(2\beta + \alpha)$ and $(2\beta - \alpha)$ when $k = pq^2$, the rise below the minimum value is less. The converse case will apply for variations of q. Now in the 1st I.M. tests the criterion level corresponded to the minimum value of $(p + q)$, but in this case we can see from the graph that if we have $p = q$, it does not give a minimum for either sum of the 2nd I.M. terms. Actually, taking p^2q or $pq^2 = 1$, the two minima shown, for $p = 0.63$ or 1.26, give $(p + q) = 1.89$, while if $p = 1$, $(p + q) = 2$; a

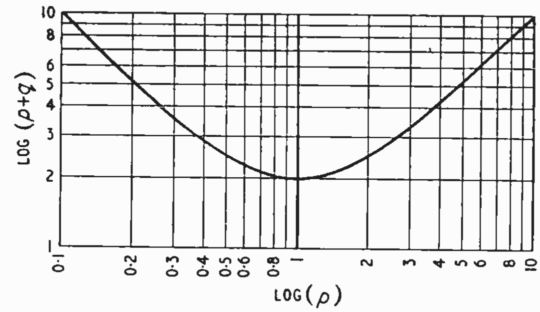


Fig. 11. Variation, for a given 1st I.M. product, of total peak input voltage (p + q) with p for the condition pq = 1.

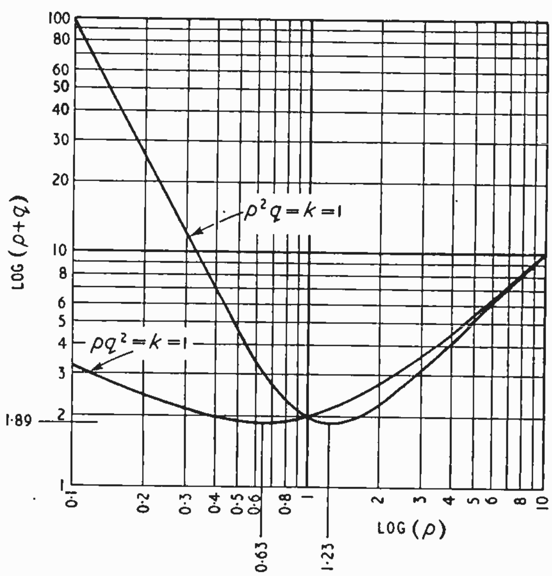


Fig. 12. Total input level for a given 2nd I.M. product.

difference of only 6%. We can, therefore, adopt the same method of expressing a 2nd I.M. criterion value for the input handling capacity as we used before with very little error, namely applying p and q of the same amplitude during test.

The other point that has to be considered is that if the 30% modulation is applied to the p carrier, for I.M. terms proportional to p^2q, we will have twice the modulation detected by the receiver on the I.M. carrier compared with having 30% modulation on the q carrier. By taking the worst possibility, we must ensure that the carrier representing p^2 or q^2 on test, is the one that is modulated.

The 2nd I.M. criterion level was found to be 50 mV, falling off only slightly above 20 Mc/s. Throughout the test, the reference frequency of 1.4 Mc/s was used for convenience, but there is no reason why other frequencies cannot be used, when similar results would again be obtained.

A point worthy of note is that 2nd I.M. products derived from $(2\alpha - \beta)$ can be important if α and β are close together, as would be the case of two signals in the same s.w. broadcast band. The $(2\alpha - \beta)$ product would then probably fall within the same band. This also applies to the M.W. band and in Table IV a few cases in the European area are shown where two signals could interfere with a third. On the practical side, the case of two 50 mV signals is hardly worth considering, since it is likely to arise only in some districts lying inland between transmitters.

Another interesting point concerning inter-modulation arises when one high-level input signal is present which is just at the cross-modulation level. From the final amplifier characteristics it is evident that the cross-modulation limit is 17 dB and 23 dB above the 1st and 2nd I.M. criterion limits respectively. Now, for the 1st I.M. case, if $\sqrt{pq} = 50$ mV and p is + 17 dB on 50 mV, then q is −17 dB on 50 mV, or 7.1 mV, and with no other signals above this figure no 1st I.M. would be present. In practice, a few signals, especially when near port, may exceed this figure. For the 2nd I.M. case, we will have two figures, using the criterion level of 25 mV for the

TABLE IV
2nd I.M. PRODUCTS IN THE M.W. BROADCAST BAND

Interfering Stations		Station Experiencing Interference
(kc/s)	(kc/s)	(kc/s)
1376 Lille	1439 Luxembourg	1313 Stavanger
1151 B.B.C. Stagshaw	1088 B.B.C. Droitwich	1214 B.B.C. Brookman's Park
1007 Hilversum	926 Brussels	1088 B.B.C. Droitwich
908 B.B.C. Brookman's Park	1070 Paris	746 Hilversum
908 B.B.C. Brookman's Park	692 B.B.C. Moorside Edge	1124 Brussels
863 Paris	620 Brussels	1124 Brussels
746 Hilversum	620 Brussels	872 A.F.N. W. Germany

level of the smaller signal. When the input signal of 0.35 V corresponds to p^2, the small signal q must be $-$ 34dB on 25 mV, or 0.5 mV, but when the small signal corresponds to q^2 it need only be $-$ 8.5 dB on 25 mV or 9.4mV, to prevent 2nd I.M. occurring under these conditions.

Conclusion

The main requirement of an aerial amplifier and its associated distribution network is that it should operate with the minimum of attention and to all intents and purposes should be as reliable as the proverbial "piece of wire." Freedom from cross-modulation not only minimizes interference but ensures that secrecy is maintained in the transmission of messages from the ship. No aerial distribution system can be considered satisfactory if passengers' radio telephone calls are to be heard on every station on the cabin receivers!

The wide-band amplifier that has been developed has necessarily been a compromise, but experience has already indicated that it is meeting all requirements.

TRANSISTORS

AN INTRODUCTION FOR BEGINNERS

BY "CATHODE RAY"

To obtain, as it were, a transfer ticket from valves to transistors one must get to know something about their differences. The currents in valves are made of electrons emitted from a heated cathode and are controlled in a clear space made of vacuum. In transistors, the counterpart of the vacuum is a crystal of germanium or silicon, which is certainly not a clear space but a sort of latticework of atoms joined together by co-valent bonds.* However, there is any amount of room throughout this latticework for currents to flow, just as there is in solid metal. But ideally there are no currents, because all the electrons are busy holding the crystal structure together. Free electrons can be introduced into the crystal by mixing with it a very small proportion of an element such as antimony that has one electron per atom too many to employ in the structure. These loose electrons make the crystal conduct; but because the "impurity" atoms are comparatively few the free electrons are far less numerous than in a metal and so the material (called *n*-type because the free electrons are negative charges) is only a semi-conductor. However, the resistance of the pieces that are commonly used is quite small because they are short and fat.

If on the other hand the crystal contains an impurity element such as indium, with one electron per atom too few, the shortage of an electron constitutes a "hole," which appears to move from place to place by successively borrowing electrons from other atoms. Because a hole is equivalent to a positive charge, material with holes is called *p*-type.

Crystal rectifiers and transistors—or at least those classified as junction types—are made up of pieces of crystal divided into *n* and *p* regions.

We saw last month how it is that a simple *p-n* junction works as a rectifier. If you were new to it you may have found the explanation rather complicated even though in fact it was simplified by leaving out some of the details. If so, you may be glad of a still simpler way of looking at it. Fig. 1(a) shows how current can consist either of negative charges flowing from $-$ to $+$ or positive charges from $+$ to $-$. Or, of course, both at once. When a thermionic diode is connected as at (b), current can flow because the heated cathode is an emitter of electrons, which are negative charges. But when connected as at (c) there is no current, because the anode does not emit electrons; neither does the cathode emit positive charges. But in a *p-n* junction connected *p* to $+$ (d) current flows because the *n* region is an emitter of electrons *and* the *p* region an emitter of holes, which are positive charges. When reversed (e) both regions emit the wrong charges, so there is no current.

One of the complications, which we did go into in some detail, is intrinsic conduction. The crystalline elements germanium and silicon in which *p* and *n* regions can be formed by impurities are also liable to have their own atoms broken up by heat or light into hole and electron pairs. Since their own atoms predominate in both *p* and *n* regions, these hole and electron pairs are formed regardless of *p* and *n* distinctions, and so there is two-way current through the material regardless of polarity. This effect, as regards a *p-n* rectifier, can be represented as a conductor shunted across it, which is generally a nuisance. Light can easily be excluded by an opaque covering, but unfortunately the amount of heat at ordinary temperatures is sufficient to give germanium an appreciable amount of intrinsic conductivity, and at the sort of temperature one can easily get in electronic equipment it is enough to reduce the efficiency very seriously. This is the chief snag about germanium devices, and the reason why research departments are pressing on with silicon, which can go to a considerably higher

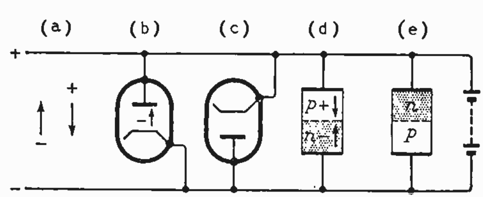


Fig. 1. Current can flow as electrons to positive and/or "holes" to negative (a). In a thermionic valve the cathode emits electrons, so current can flow if it is negative (b) but not if it is positive (c). A p-n junction emits both electrons and holes simultaneously and current can flow if it is connected as at (d) but not if as at (e).

* For the information of newcomers to whom these bonds are less familiar than the premium kind, see the last two instalments, on "Semi-Conductors."

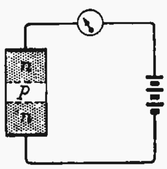


Fig. 2. Because one junction is bound to be in reverse, a double junction cannot pass much current either way.

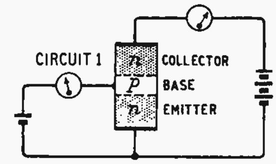


Fig. 3. But if electrons are brought into the p region thus, they are readily attracted further by a positive potential.

temperature before its intrinsic conductivity becomes comparable with its impurity conductivity. (Silicon, however, has its own particular snags.)

Those were the main findings of the last two months, leading to crystal rectification. Germanium and silicon rectifiers are still making tremendous progress for both signals and power. And not only up our particular street; the future policy of British Railways has been based largely on the extremely high efficiency of crystal rectifiers.

But transistors are our concern, so let us go right on to triple combinations of *p* and *n* materials, or double junctions if you prefer. There are two varieties, corresponding to the two varieties of sandwich chocolate provided by a well-known maker—milk-plain-milk or plain-milk-plain. They are—the semi-conductor junctions, I mean; not the chocolate—designated *n-p-n* and *p-n-p*. The chocolate analogy is quite a good one, for it too is a single slab containing three regions of essentially the same material but differing in the proportions of ingredients. The differences in the germanium are however too small to detect by chemical analysis, let alone visual inspection. So one must take the maker's word for it, or investigate electrically. Most if not all of the junction transistors obtainable in this country are *p-n-p* type, but except for a reversal of sign the *n-p-n* type is the same in principle and rather easier to compare with a triode valve.

If an e.m.f. is applied from end to end, as in Fig. 2, the circuit consists of two rectifiers in series opposition, and it is obvious that except for the (normally small) " leakage " current due to intrinsic conduction no current can flow whatever the polarity of the e.m.f. A quick glance back at Fig. 1 tells us that when connected as shown nearly the whole of the total potential difference between the ends occurs across the boundary between the upper *n* region and the *p*, for those two regions make a rectifier in reverse and therefore a very high resistance, whereas the *p* and lower *n* are a forward rectifier, with a very low resistance.

So far the utility of the arrangement is not conspicuous. The next step (Fig. 3) is to give the *p* layer a small positive bias. This biases the lower rectifier in the forward direction and allows current to flow in circuit 1. That is precisely what one would expect, but what would hardly have been expected is that (A) the amount of current is much less than if only that circuit had been present, and (B) a relatively large current flows in circuit 2.

The resemblance between this *n-p-n* junction transistor and a triode valve now begins to appear. The chief difference is that the transistor is basically a current amplifier rather than a voltage amplifier. The upper *n* region is analogous to a triode's anode; the lower *n* region to the cathode; and the *p* region to the grid-controlled space in between. But they are not called by these names. Instead of the anode there is the *collector*; and instead of the cathode, the *emitter*. Both these names would be quite appropriate in a triode. But the middle electrode in the transistor is called the *base*, which seems curiously inappropriate. The reason for it, which will appear later, is historical rather than functional.

Before going on to consider the behaviour of this type of transistor in more detail, you are entitled to expect some explanation for the surprising outcome of the Fig. 3 experiment. How is it that current can flow freely the " wrong " way through the upper rectifier? The answer to this question comes if we recall why it is that current doesn't normally flow this way through a *p-n* junction. It is because the only free current carriers present in substantial quantities in a *p* region are holes, which are repelled rather than attracted by a positive potential on the *n* region—the collector in this case. But the emitter, which is purposely made a high-impurity *n* region, has vast numbers of free electrons, and when the base is made positive they swarm across the frontier into it. In other words, the emitter emits electrons into an electron vacuum. There, they naturally respond to the attraction of the positive collector, much as electrons emitted into the vacuum of a valve by the cathode go to the anode.

Transistor Characteristics

If the grid of a valve were made positive like the base in this transistor, some of the electrons would be attracted to it, causing grid current. And so it is in the transistor. But the proportion that does so is relatively small because the base is made very thin —only one or two thousandths of an inch, or even less. In a transistor there is a third alternative for the electrons: they can combine with the holes in the base and so disappear. But because of the thinness of the base, and also because the number of holes in it is further restricted by making it of low-impurity material, the proportion lost in this way is very small.

The voltage amplification in a valve is related to the amplification factor μ, which is the change of anode voltage caused in a constant-current anode circuit by one volt change of grid potential. In a transistor the ratio of change of collector current (at constant voltage) to the change of base current causing it is denoted by α_{cb} or α', and may be anything from 10 to 100 or more according to type.

For an explanation of the *p-n-p* transistor, the same treatise will do again if " negative " and " positive " are interchanged, and also " holes " and " electrons."

There is no corresponding inverted kind of valve, with a hole-emitter as the anode, so in push-pull circuits it is necessary to use phase-reversing transformers or other devices at input and output. This is not necessary with transistors if matched-characteristic *n-p-n* and *p-n-p* types are available. The fact that transistors of either polarity can be produced is a unique feature which could come in very useful.

Although the picture of an *n-p-n* junction transistor

(*Continued on page 451*)

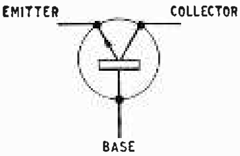


Fig. 4. This now well-known transistor symbol replaces that in Figs. 2 and 3 in circuit diagrams. It indicates a n-p-n *type; for a* p-n-p *type the arrow is reversed. The circular envelope is optional.*

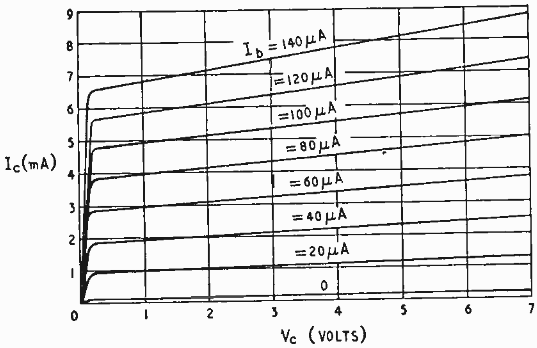


Fig. 5. Collector characteristic curves for n-p-n *junction transistor in earthed-emitter arrangement, with base current as parameter.*

in Figs. 2 and 3 could be used for circuit diagrams generally, in fact it is not. A great many different symbols have been suggested—as regular *Wireless World* readers must have noticed—but the only one that is generally used is shown in Fig. 4. The direction of the arrow head marking the emitter indicates the direction of current flow (which according to convention is opposite to the direction of electron flow) so Fig. 4 represents a *n-p-n* transistor. With the arrow reversed it would signify *p-n-p*.

Of the various valve characteristic curves that can be drawn, the most generally useful are those relating anode current to anode voltage for various values of grid voltage. The corresponding transistor curves are those relating collector current to collector voltage for various values of base *current*. Fig. 5 shows a typical set of these for a *n-p-n* transistor, which is easier to compare with a valve than a *p-n-p* transistor because the polarities are the same; but to tell the truth the curves actually belong to a Mullard OC71 which is a *p-n-p* type, and have been adapted simply by reversing the signs.

The most immediately obvious feature about the curves is that they are "pentode type." The rapid rise from zero, followed by an almost horizontal main run indicating high output resistance, is typical. But when one examines them more closely, the differences are no less striking than the superficial resemblance. Perhaps the biggest surprise is the voltage scale. Whereas a pentode may still be straightening out at 100 anode volts, the transistor is right on the job at 0.2 V! So efficient working is possible with only a single dry cell (1.4 V) as "h.t." A thermionic valve begins by needing at the very least 35 mW to heat the cathode (even in the latest and most economical sub-miniature types) before it starts to do any work, whereas a transistor can give back in useful work a substantial proportion of a power supply totalling a fraction of a milliwatt.

Next, the linearity of the curves compares favourably with that of pentodes, and the evenness of their spacing right down to cut-off compares more than favourably with the tendency of pentode curves to close up steadily as the grid bias is increased. The transistor linearity is admittedly somewhat marred by the tendency for the slopes of the lines to vary, so that a load line drawn athwart them cuts them at unequal intervals, but it still looks better than a pentode. While the voltage scale is so much smaller, the output current scale is not unlike that for low-power pentodes, so the near-flatness of the lines doesn't mean such a high output resistance as for pentodes. The resistance represented by the steep rise is phenomenally small—of the order of 20 Ω.

Lastly, instead of the control being exercised by grid voltages from zero downwards it is by base currents from zero upwards. The idea of current input takes a little getting used to, but the fact that the zero-bias line more or less coincides with cut-off is rather convenient. The input impedance—as one would expect, seeing that it is a forward rectifier—is very non-linear, and, since input current control is as linear as Fig. 5 shows, it follows that input voltage control would be non-linear.

High-Frequency Effect

As we all know, the performance of a valve falls off at very high frequencies, for several reasons. One is that the interelectrode capacitances form a low-impedance shunt across the couplings. Another is that the time taken by the electrons to cross the space inside the valve is not negligible in comparison with a signal cycle, and the phase shift so introduced causes loss. Both these effects have their counterparts in transistors. Although the boundary area between base and collector in the low-power junction transistors now available is smaller than the electrode areas in valves, the thickness is less still, so the capacitance is usually somewhat greater. And although the distance across the base is very small, the speed of the electrons is far slower than in a valve, and holes are slower still. Junction transistors, in

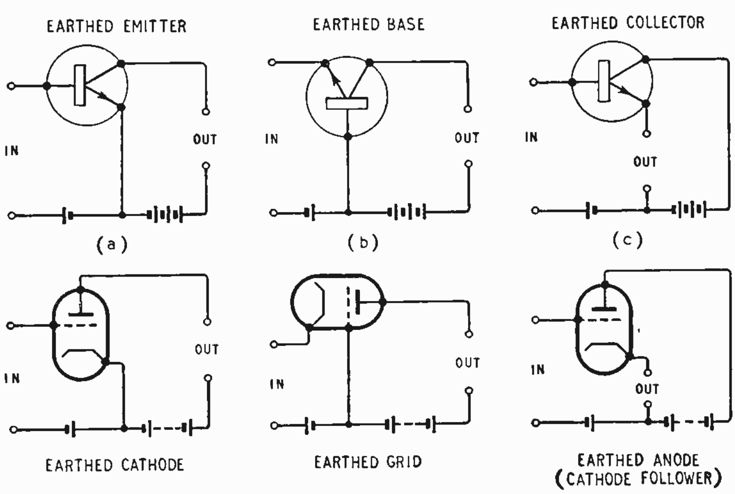


Fig. 6. The three basic transistor arrangements, with their valve analogues.

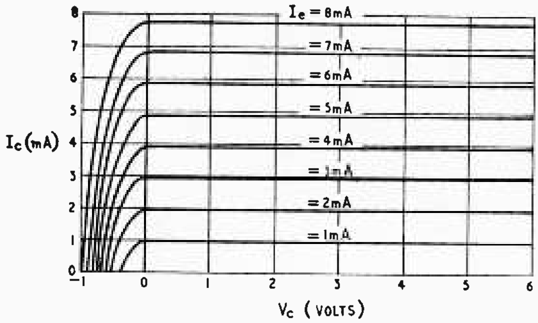


Fig. 7. Collector characteristic curves for same transistor as Fig. 5 in earthed-base arrangement, with emitter current as parameter.

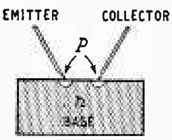


Fig. 8. Construction of point-contact transistor, which is obviously the basis for the standard circuit-diagram symbol for a transistor, Fig. 4.

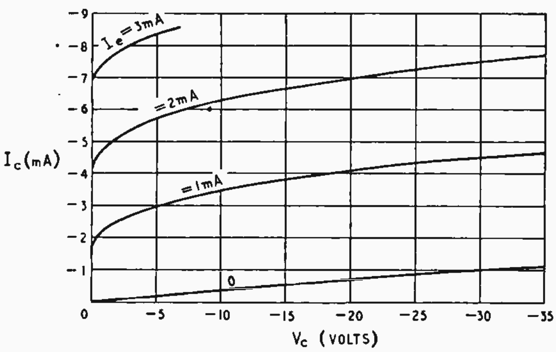


Fig. 9. Collector characteristic curves of point-contact transistor, corresponding to those of Fig. 7 for junction type.

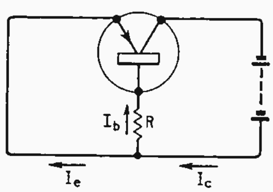


Fig. 10. The use of a base resistor in a point transistor circuit is liable to cause trouble unless precautions are taken to limit collector current.

fact, are for the most part pretty poor at even moderately high frequencies, and at present are used almost entirely for audio.

Although the usual method of using valves is from grid to anode, with cathode common to both and more or less earthed, there are two other schemes: earthed grid, and earthed anode (usually known as cathode follower). Similarly, there are two transistor schemes besides the earthed-emitter one already suggested by Figs. 3 and 5; they are of course the earthed base and earthed collector (Fig. 6). The valve analogy runs through them all. For instance, the earthed-collector transistor has (like the cathode follower) the highest input resistance and lowest output resistance of the three, and its voltage gain is just short of 1. And the earthed-base (like the earthed-grid valve) has a very low input resistance, and—though for rather different reasons—is suitable for amplifying at higher frequencies than the earthed emitter or cathode. Its performance is also rather less dependent on the somewhat wide variations of characteristics for which unfortunately transistors are noted.

For comparison with Fig. 5, Fig. 7 shows the output characteristics of the same transistor with emitter input (i.e., earthed base). Note the really high output resistance; the collector current is almost entirely unaffected by collector voltage from zero upwards, and a small negative voltage is needed to stop it. Then there is the comparatively high emitter current needed to control the output current; this means a low input resistance. The change of I_c caused by each milliamp change in I_e is in fact rather less than 1 mA, and the ratio of the two (which is the current amplification of this transistor arrangement) has been given the symbol α. It is easy to find the relationship between α' and α from the fact that $I_e = I_c + I_b$. Let a small change in any of the currents be denoted by small i. Then

$$\alpha = \frac{i_c}{i_e} = \frac{i_c}{i_c + i_b} = \frac{i_c/i_b}{i_c/i_b + i_b/i_b} = \frac{\alpha'}{\alpha' + 1}$$

This fractional current amplification looks as if it would strongly discourage use of earthed-base transistors, unless one remembers that the input resistance of this arrangement (being a forward-biased rectifier) is only a few ohms whereas Fig. 7 shows that the output resistance is vast—actually it is of the order of a megohm. So the voltage amplification—and hence the power gain—can be quite large, though not so large as with the earthed-emitter arrangement. But at high frequencies it may well overtake it.

You may be thinking there is something fishy about beginning with a quantity α' and then discovering α. And you would be right. Because people first started using valves in earthed-cathode circuits, they didn't have to start using transistors in earthed-emitter circuits. As it happened, for a reason that will become clearer in a moment or two, they started with earthed-base, invented α, then discovered that transistors could be used with earthed emitters, and hence the need for another amplification symbol, which became α'.

Another fishy feature (in my order of presentation) is the circuit symbol, Fig. 4, which by no stretch of imagination resembles a junction transistor. That, of course, is because the original transistor was not a junction transistor but a thing that really did (and still does) resemble Fig. 4—the point-contact transistor. It is simply a small block of germanium, usually *n* type, with two fine wire points pressing on it a few thousandths of an inch apart. I have introduced transistors out of historical order for the reason that, whereas a plausible explanation of how the junction type works is available, even the latest expositions of the point-contact type seem to me to be elaborate ways of saying that how it works is unknown.

However a few things can be said. A point-contact transistor has to be "formed" by passing pulses of current through the contacts. It seems that this converts the *n*-type material around the points into *p*-type (Fig. 8), which is in accordance with the fact that the thing has the polarity of a *p-n-p* transistor. One can understand the need for the points to be very close together—about the same distance as the thickness of the base in a junction type, and for the same reason. And one would expect the "inter-electrode capacitance" to be much less than in the junction type with its relatively large area of contact. This is indeed so, and at least partly accounts for the higher frequencies at which point transistors can work. The fact that electric field intensity close to a sharp point is much larger than around flat or gently curved electrodes (which is why sharp points are avoided in high-tension apparatus, except for discharge purposes) accounts for the lower back voltage at which a point-contact rectifier breaks down. The small contact area would also suggest a relatively low-power-handling capacity.

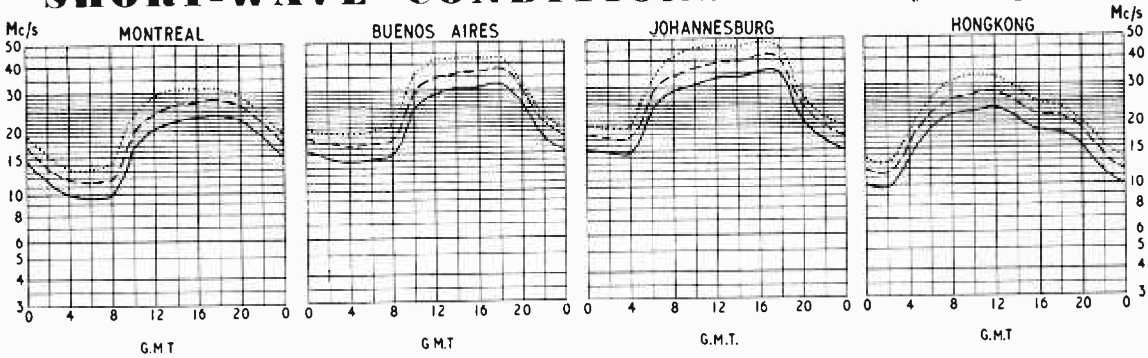
But none of these things might instantly lead one to predict that point transistors are far more noisy than junction transistors (which in their turn are somewhat more noisy than valves). Or—even more important—that their α should, unlike that of the junction types, be greater than 1. Yet such is the fact. And not merely just greater than 1; a typical figure is 2.5. Fig. 9 shows some earthed-base characteristic curves, which should be compared with Fig. 7. First, one notices their curvature and their less perfectly even spacing. And then the higher scale of collector voltage. And perhaps last of all the fact that each milliamp change in emitter current increases the collector current by two or three milliamps.

Much has been written by the scientists to explain this. But so far the only conclusion the observer on the side lines is able to draw with any large amount of confidence is that the *p-n-p* description just given is an over-simplification. Some authorities, for instance, show several layers around the point. And much is said about "trapping" and other effects I have spared you. Pending the results of further research we may just have to accept the >1 value of α as a fact.

It is an exceptionally important fact to remember, because it means that unless one uses a point transistor very carefully it may go into saturation or oscillation and destroy itself by excessive current quicker than one can think. It would be very unwise, for example, to make the connections to collector and emitter prior to that for the base (as in Fig. 2). Any current flowing through the e-b contact would (as Fig. 9 shows) cause a greater current to flow through the b-c contact, but that increased current would flow also through the e-b contact, which would increase the current still more . . . and so on until something went bust. Even a circuit based on the innocent-looking Fig. 10 is not safe. Here, following valve practice, R is being used as a substitute for the emitter bias battery in Fig. 6(b). Fig. 9 shows that the directions of the currents will be as indicated by the arrows in Fig. 10, and I_b through R will bias the emitter positive, which is correct for a transistor with *p-n-p* polarity. But, whereas a cathode resistor in a valve causes negative feedback which tends to stabilize things, a base resistor in a point transistor causes positive feedback and possibly instability, as can be seen by considering Fig. 10 with the aid of Fig. 9 to show what happens when current is increased, say from zero on switching on. Remember that quite a small increase in emitter voltage causes a substantial increase in emitter current, for it is a forward-biased rectifier.

At the present time point-contact transistors are needed in spite of their disadvantages, because their high α is convenient for trigger circuits in computers, etc., and because available junction types are more or less ineffective at the higher radio frequencies. The high-frequency shortcomings having been already largely overcome in the laboratory, it is presumably only a matter of time for junction transistors to displace the point type almost if not entirely.

SHORT-WAVE CONDITIONS *Predictions for September*



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

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

.... 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

More Lines or Colour?

Though it is generally believed that the next major step in television will be to add colour, the alternative of higher definition has had some support. In this article a studio producer gives his views

By IAN ATKINS*

COLOUR will not wait. When it is ready we shall get it, but that will not be until it is possible to make a good, stable receiver at a moderate cost. In my view, given the receiver, colour will be with us whether we like it or not. The alternatives we may expect surely are colour on 405 lines or colour with a higher standard of definition. "More lines or colour?" is an academic question. I shall give it a most unacademic answer.

From the purely selfish and personal point of view of the studio producer the key to the answer lies in another question. What do we want to present on the television screen? Television can now do some things well and others less well. Do we want to do even better the things we now do well? Or do we want as it were to balance things up and improve in the respects in which we are now lacking?

This "intimate, domestic medium," excels at present in the realistic. Actualities, outside broadcasts, travel programmes and other similar features are well served by the present standards of definition. The great popularity of the dramatized documentary programme is further proof of the success of realism on the television screen.

Writing in *Wireless World* for May, 1956, Dr. D. A. Bell said:

"The great advantage of the higher definition is that large-scale effects can be presented with adequate detail—e.g., a display of massed folk dancing—and solo artists are normally presented as three-quarter-length or full-length portraits, not head and shoulders only. It liberates television from the state of being a specialized art having limited effects at its disposal in order to *represent* some form of entertainment and makes it as free as the black and white film to *reproduce* visual entertainments where so desired, or use more natural "shots" if the moving picture is regarded as an artistic work." (Dr. Bell's italics.)

Dr. Bell is saying that higher definition will, above all, improve television's ability to report; he adds, by way of afterthought, that "if the moving picture is regarded as an artistic work" there will be some advantage in this direction also. This "liberation" is pretty cold comfort to the studio producer who sees television's task as in part to report, to reproduce and, equally important, in part to move towards establishing itself as an art form—in fact, to represent. The cinema is most memorable when, for all the freedom of its higher definition, it most uncompromisingly demonstrates that it is a specialized art. The picture is not, I am sure, as depressing as Dr. Bell paints it. Higher definition would provide advantages to the creative worker in television—not because he could eliminate the close-up, eschew all the potentialities of the camera to select and emphasize, show all his characters in threequarter or full-length figure and turn the viewer's screen into a miniature proscenium arch, but because the effects at the disposal of his specialized art would be less limited. He could work in general with his cameras a little farther away from the scene. In particular, he would not be in the present predicament of fearing that, if a character's hands are on the screen, his head may be too small for subtle facial expression to be seen clearly in the average home. He could also view the steady increase in the size of viewers' screens with equanimity.

But, and a very big "but," given reasonable definition picture "quality" is what really matters. I must not try to become technical, but is not this "quality" a matter of tonal gradation, a function of noise, contrast range, gamma and so on? These are factors not inherent in the standards of definition of a system. A picture with the whites crushed and spurious modelling apparent on the faces must be just as horrible on 819 lines as on 405.

Higher definition will enable me to show a room on the screen more clearly, but will it help me to create more successfully that room's "atmosphere"? I think not. To capture that atmosphere must we view in a new "dimension"? Is colour that dimension?

Monochrome Limitations

Television programmes cover a vastly wider range of type and style than the commercial cinema in its monochrome period. If the successes of the film documentary and *avant-garde* groups are added this disparity is perhaps not so great, but what is significant is that the areas in which television is, and black-and-white films were, less successful show a marked degree of identity. No really satisfactory way of presenting the dance on the black-and-white screen has been evolved; realism succeeds, the unrealistic, the stylized is a much more chancy business; the black and white screen can be made to glitter, but it does not often glow.

It is in this realm of the un-realistic that I believe colour will open up vast new possibilities. Fussy detail and overcrowded background will give place to simplicity, but a warm and satisfying simplicity; neither cold grey emptiness nor hard black void.

Of course, we shall make mistakes with colour. We shall at first think of it for its own sake and not as a means to an end. People will say, as they say about any new technical advance in any medium that colour has "put television back twenty years." But we shall hope to make these mistakes during an experimental period. Where we shall be lucky is in the fact that, for obvious reasons, the introduction of full-scale colour programmes will be a gradual process. We shall be able to present in colour those programmes which manifestly gain from it and to

* British Broadcasting Corporation.

take time to learn why in others the gain appears to be a minus quantity.

This literally rosy prospect will, however, be conditioned by one factor; whether colour is introduced on present standards or at higher definition. Whether "compatibility" in the strictly technical sense is a requirement of the system or not, a monochrome picture will undoubtedly be derived from the colour programme and that monochrome picture will have to be good. A considerable proportion of the experimental period will have to be spent in establishing the studio conditions necessary to give both good colour and good black-and-white.

The purely personal, selfish and parochial view of one studio producer, then, is "colour first and higher definition afterwards."

Does a less selfish and more forward-looking consideration alter this view? Is colour on 405 lines really good enough? Does it yield pictures as good as the present black-and-white picture? Are we right in hoping that the introduction of colour will not reduce the apparent definition? (May not, in fact, the addition of colour enable the viewer to pick out details by differences in hue, whereas on a monochrome picture he can distinguish only between different shades of grey?) Is the compatible picture on a monochrome receiver up to the requisite standard? Is the "reverse compatible" black and white picture on a colour receiver up to the requisite standard? There is at present, I believe, sufficient diversity of view among the experts on the answers to these questions to frighten into silence the most foolhardy of the in-expert who cannot know whether a present defect is due to the system or standards in use on the one hand or to a particular piece of apparatus, a link in the electronic chain to-day, but due to be superseded to-morrow. We must trust the experts to make the right decisions. They have not let us down in the past.

More lines instead of colour, then? Surely to discuss the introduction of a higher standard of definition in the present Bands I and III is wishful thinking. Higher definition must mean, in this country, going to Bands IV and V. To do this without also introducing colour might be easier, but would it not also be lamentably un-courageous?

Wired-in Valves

REASONS FOR USING THEM

By E. G. ROWE, M.Sc., D.I.C., B.Sc. (Hons.), A.C.G.I., M.I.E.E.*

IN the past the valve as a component has taken the blame for 50% of all equipment failures—if it is fair to blame something for failing to stand up to conditions for which it was not designed. The Special Quality valve, however, has been designed to work under arduous conditions, and with such valves the basic reliability of this component has improved vastly. With this position established, and an assurance that if valves are used correctly and conservatively there will be a very low failure rate up to the normal length of life, then there is a good case for wiring-in valves in the same manner as other circuit components.

The major difficulty here is that of custom, and it is hard to change the mentality of the servicing technician whose first approach to the diagnosis of an unusable equipment is to pull out the valves. This tendency is overcome by making this instinctive action not possible and results in many advantages. Some 30-50% of the valves so removed are perfectly satisfactory when tested, whilst many modern equipments are so compact that the removal of valves often results in mechanical damage to them. Then again, the use of soldered-in valves highlights the importance of giving the earliest consideration to methods of fault diagnosis and makes it necessary for the equipment designer to supply detailed procedures that will enable the real faulty component to be removed—this will improve the "unreliability record" of the valve to a surprising extent!

At the same time, it will give emphasis to the value of marginal checking techniques. Valves must die eventually of general deterioration of characteristics, but by routine diagnosis of the equipment performance it is possible to forecast potential failures and thereby increase equipment reliability by a whole order or more.

Next, by making valves with flexible leads instead of pins the valve manufacturer is able to produce a stronger glass article, and because there is no

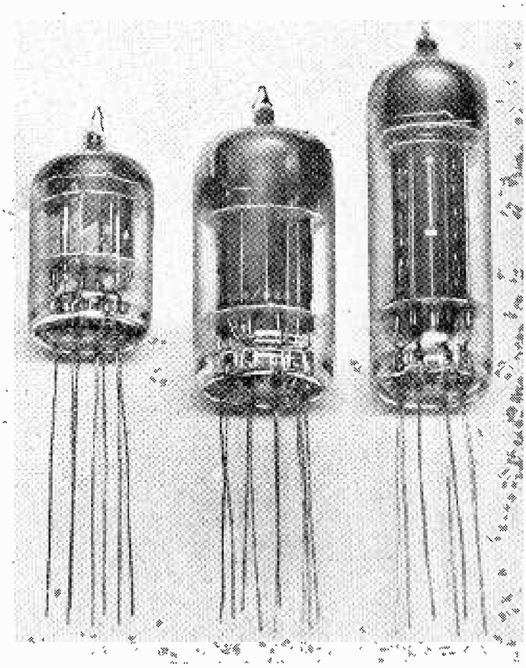


Fig. 1. Examples of flying-lead valves suitable for direct wiring-in and clamping by the user.

* Standard Telephones and Cables.

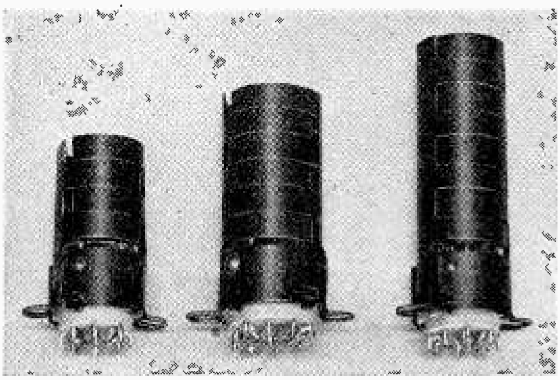


Fig. 2. *Flying-lead valves already mounted in cooling cans and connected to soldering tags corresponding to conventional valveholders.*

mechanical incompatibility between the valve pin spacings and the valveholder contacts there is no risk of strains being set up that will result in broken and leaky valves in service.

Finally, by dispensing with the conventional valveholder it is easier to provide satisfactory intimate metallic contact to the glass envelope and thus achieve greater cooling. The question of bulb temperature is now being studied extensively, and it is established that the life of a valve is very dependent on this temperature. Reducing it by 50-60°C can increase the life in many cases by four or five times. By using black metallic clamps specially designed to touch the bulb at as many places as possible the hot spots are evened out over the bulb surface, and then by secure fastening of the clamps to the chassis the heat is conducted away efficiently.

Many users purchase flying-lead valves in the form shown in Fig. 1 and design their own clamps to fasten the valves horizontally on the chassis. The ordinary U-shaped saddle, with the metal band situated at the hot spot of the glass envelope, is one of the simplest methods. Other users prefer to maintain their present circuit techniques and mount the valve in the usual vertical position. To suit such requirements a range of Special Quality valves is available in which the user is supplied with a "valve component" as shown in Fig. 2. This is a flexible-lead valve with its own cooling shield and with soldering tags in the conventional pin positions. The can has two lugs with normal hole fixings and thus the "valve component" replaces the usual arrangement of valveholder, valve and shielding can or springs.

The time has now arrived when the adoption of such wired-in valves, used conservatively and correctly with approved maintenance and marginal checking procedures, will produce equipment reliabilities very much in excess of those at present being achieved.

COMMERCIAL LITERATURE

High Quality Amplifier, 5-watt (No. 1 "Symphony," Mark III) with flexible tone control for treble, middle and bass. Negative feedback and scratch-cut are incorporated and also tape "record" and "play-back" sockets. Other amplifiers, tuners (a.m., f.m. and a.m./f.m.), radiogram chassis and loudspeaker cabinets and baffles. Illustrated catalogue (C.24) with price list from Northern Radio Services, 11 and 16, King's College Road, Swiss Cottage, London, N.W.3.

Atomic Power Stations; a booklet with sketch illustrations briefly outlining future plans and explaining the activities of the Atomic Energy Group formed by G.E.C. and Simon-Carves. From The General Electric Company, Fraser and Chalmers Engineering Works, Erith, Kent.

Electronic Measuring Instruments by well-known makers. A current price list of the equipments supplied and maintained by F. C. Robinson and Partners, 122, Seymour Grove, Old Trafford, Manchester, 16.

Precious Metals for electronic and electrical engineering and other purposes. A well-produced booklet, "An Industry Within Industry," consisting of large photographs and extended captions describing the activities of Johnson Matthey and Co. From their head offices, Hatton Garden, London, E.C.1.

American-Type Valves (Western Electric type numbers) manufactured by AB Svenska Elektronror, a subsidiary of Ericsson, of Stockholm, Sweden. Catalogue with full data and characteristics from the representatives for U.S.A., Canada and export, State Labs Inc., 649, Broadway, New York 12, N.Y., U.S.A.

Cable Eccentricity Gauge, electronic, working on comparison of capacitances between conductor or sheath of the cable and two external self-aligning electrodes. Sensitivity to 0.5 per cent of wall thickness. Description in a leaflet from the Addison Electric Company, 10-12, Bosworth Road, London, W.10.

Mobile Radio Systems; v.h.f. transmitters and receivers for fixed stations, transmitter-receivers for motor cycles and larger vehicles, h.f. and v.h.f. pack sets. Descriptive leaflets with detailed technical specifications in a folder from the British Communications Corporation, Second Way, Exhibition Grounds, Wembley, Middlesex.

Nickel-Cadmium Hermetically Sealed Cells, rechargeable like conventional accumulators. An article describing the use of the Perma-Seal types of the German Edison Accumulator Company for the l.t. supplies of battery and mains/battery portables; arrangements for trickle charging, economy operation and vibrator h.t. supplies are outlined. Obtainable from A. M. Allen, of G. A. Stanley Palmer, Maxwell House, Arundel Street, London, W.C.2, agents for the cells.

Components and Accessories; an illustrated catalogue for August, 1956, from Radiospares, 4-8, Maple Street, London, W.1.

Stabilized A.C. Power Supply, giving 200 watts at 2.4 kc/s (also models for 400 c/s, 1 kc/s and 1.6 kc/s). Voltage, 115V r.m.s.; regulation, less than 1 per cent change in output voltage from zero to full load; distortion less than 2 per cent. Descriptive leaflet from Shandon Automation and Electronics, 6, Cromwell Place, London, S.W.7.

Television Replacement Parts. Servicing hints on various commercial receivers and details of a transformer rewinding service are included in the latest illustrated catalogue from Direct TV Replacements, 134-136, Lewisham Way, New Cross, London, S.E.14. The price is 1s including postage.

Glass-Sealed Resistors (by Victoreen Instrument Co., U.S.A.), notable for high accuracy and long-term stability under extremes of temperature and humidity. Values 100Ω-10^{14}Ω, tolerances 1-20 per cent, power ratings 0.5-10W, max. temperatures 100-200°C, temperature coefficients mainly negative. Leaflet from the U.K. agents, Anglo-Netherland Technical Exchange, 3, Tower Hill, London, E.C.3. Also a leaflet on Victoreen voltage regulator tubes.

Broadcast Transmitter, 5-kW, for 535-1,620 kc/s (as ordered), in three cubicles. Frequency stability ±5 c/s, audio response 50 c/s-10 kc/s ±2 dB at 95 per cent modulation. Power consumption, 13 kW for average programme, claimed to be unusually low. Specification on a leaflet from Gates Radio Company, 13, East 40th Street, New York 16, N.Y., U.S.A.

Rotary Rheostats; three new models for replacing slider resistors in industrial controls. Values, 3-15,000Ω; current ratings between 173 mA and 12.9 A. Leaflet from The British Electric Resistance Co., Queensway, Enfield, Middlesex.

Further Education

WITH the opening of the scholastic year we have received details of a considerable number of special courses from which a selection is given below.

Microwave Techniques.—A series of thirty lectures on techniques and measurements at microwave frequencies will be given by Dr. D. R. Workman at Battersea Polytechnic, London, S.W.11, on Wednesday afternoons (3.0 to 5.0) commencing on October 10th. The first twenty lectures (Part I) will cover the general practical techniques used at these frequencies and Part II will deal with some of the applications of microwave techniques. The course is suitable for physicists and electrical engineers with a general knowledge of electrical and electronic principles. The fee for the course (or Part I only) is £2. Dr. Workman is also giving a parallel course on the theory of microwave circuits for graduates in physics, mathematics or electrical engineering, on Wednesdays at 6.30. (Fee £2.)

Colour Television.—The Television Society has arranged for a course of five lectures on colour television to be given during September by P. S. Carnt, of the G.E.C. Research Laboratories, in the Assembly Hall, Institute of Education, Malet Street, London, W.C.2. The lectures, which cover the fundamentals of transmission and reception of the N.T.S.C. system, will be given on four consecutive Mondays, beginning September 3rd, and on Friday, September 28th. Tickets for the course (fee £1) are obtainable from the Television Society, 164 Shaftesbury Avenue, London, W.C.2.

Advanced Courses.—Part-time courses in higher technology, provided at colleges in London and the Home Counties, are listed in a bulletin issued by the Regional Advisory Council for Higher Technological Education. In general, the bulletin includes advanced courses in the various branches of engineering, science and chemistry which do not regularly appear in college calendars or prospectuses as part of a grouped course. Over thirty colleges are listed and abridged details of about 250 courses are given in the bulletin, which costs 1s 6d and is obtainable from the Regional Advisory Council, Tavistock House South, Tavistock Square, London, W.C.1.

Radar Maintenance.—The next two-year evening course at the Norwood Technical College, Knight's Hill, West Norwood, London, S.E.27, in preparation for the Ministry of Transport radar maintenance certificate begins on September 24th. It will be held on Mondays and Tuesdays from 6.15 to 9.15. The college also runs a full-time course beginning on September 12th in preparation for the examination to be held early in December. The 1956/1957 prospectus from the college includes details of thirty-one part-time day and evening courses under the general heading "telecommunications."

Technical Writing.—A course of six lectures on the technique of technical writing is to be given by Geoffrey Parr (hon. sec. of the Television Society) at the Borough Polytechnic, Borough Road, London, S.E.1, on Fridays at 2.30 p.m. commencing on October 12th. (Fee 10s.)

Special evening courses arranged at the South East London Technical College include one of twenty lectures on "Operational Calculus with Applications to Electric Circuit Theory" (Tuesdays, beginning October 23rd) and another on "Vector Analysis and Fundamental Electromagnetic Theory" (Fridays, beginning October 26th). Fee for each is £2.

Sandwich Course.—Details of an engineering sandwich course (alternate weeks in college and industry) in communications, electrical or mechanical engineering, have been received from the South East London Technical College, Lewisham Way, S.E.4. The object of the four-year course is to provide a theoretical and technological training comparable with that of an engineering degree but so arranged that the student's theory will advance concurrently with his industrial training and provide a qualification acceptable for membership of the Institutions of Electrical and Mechanical Engineers.

Northern Polytechnic.—The telecommunications section of the prospectus from the Northern Polytechnic, Holloway, London, N.7, includes details of full- and part-time day and evening courses. At the end of the four-year full-time telecommunications course, students enter for the Grad. Brit.I.R.E. exam. and for the C. and G. full technological certificate in telecommunications engineering. The syllabus for the five-year telecommunications evening course also covers the requirements for these exams. The Polytechnic also provides evening courses in radio and television servicing, radar, electronics, electro-acoustics and computers.

Part-time day and evening classes to be held at the **Bognor Regis** Technical Institute include the City and Guilds radio service work course, and a telecommunications engineering course.

At the Brentford Evening Institute, Clifden Road, **Brentford,** Middlesex, classes will be held in radio and television servicing and for the radio amateurs' examination. There will also be a mathematics course. Fees range from 10s to 15s for the 37-week session.

Amateur Courses.—The East London group of the R.S.G.B. has again arranged, in conjunction with the Essex County Council, for amateur radio courses to be held at the Ilford Literary Institute (High School for Girls), Cranbrook Road, **Ilford.** An eight-month course for those intending to take the radio amateurs' examination will be held on Wednesdays at 7.30 and a six-month morse course on Mondays at 7.30. The classes start in the week beginning September 24th. Further information is obtainable from C. H. L. Edwards, 28 Morgan Crescent, Theydon Bois, Epping, Essex. Similar arrangements have been made by the Grafton Radio Society (Sec., A. W. H. Wennell, 145 Uxendon Hill, Wembley Park, Middlesex) with the London County Council for courses at Grafton School, Eburne Road, **Holloway,** London, N.7. Theory is taken at 7.0 and morse at 9.0 on Mondays, commencing September 24th.

Classes for the radio amateurs' examination will again be held at the Wembley Evening Institute, Copland School, High Road, **Wembley,** Middlesex, on Mondays and Thursdays, beginning September 17th.

RANDOM RADIATIONS

By "DIALLIST"

A New Resistance Alloy

DID you, I wonder, see the account of a new resistance wire, known commercially as Evanohm, which was published as an official N.P.L. communication in the July issue of Part B of *Proc. I.E.E.*? Evanohm is an alloy of 73 per cent nickel, 21 per cent chromium, 2 per cent copper, 2 per cent aluminium and 2 per cent other metals. Older alloys, such as manganin and constantan, have many good points; but it is exceedingly difficult to produce either commercially with the stability needed for standard resistors used at ordinary room temperatures. Evanohm, besides having three times the resistivity of manganin, can be given the required low temperature co-efficient by simple heat treatment. The values of resistors made with it have been found to remain stable within a few parts in 100,000 per year. Almost its only disadvantage seems to be that hard soldering is necessary. This new alloy should be most useful in precision electrical apparatus, particularly in circuits whose time constants must be stable.

Terminology

UNLIKE A. Hardwicke (p. 282, June issue), I find the use of such expressions as "fire," "fire at" and "trigger-off" expressive and useful electrical terms. After all, guns aren't necessarily military weapons; they have their peace-time uses both for sporting purposes and for the mere filling of the pot. What the trigger does is to start a sudden violent action, and triggering-off seems to me just the right expression for what happens when, say, a pulse is applied to a flip-flop circuit. What, again, is an electron gun expected to do but fire electrons at a target? And doesn't the intransitive fire describe most graphically the coming into action of a thyratron? No, I'm all for sticking to those terms; but I'm not at all sure that we ought not to come into line with most other peoples of the world by making the word billion signify 10^9 instead of 10^{12}. As it is, when one comes across billion, trillion, and so on, in French, American and other foreign publications one has often to pause for a moment to find out how many noughts the writer intends to follow his first figure.

"You're on the Air . . ."

HAVE you seen the leaflet "You're on the Air, Mrs. Smith," published by the G.P.O. and obtainable at any post office for the asking? It's well and simply written and should bring home to many people the fact that a considerable variety of domestic and workshop appliances can, if they're not fitted with suppressors, ruin both sound and television reception in neighbouring homes. I feel that the G.P.O. would do well to make it more widely known that this leaflet is available free of charge. In the week before this was written I asked a dozen householder friends if they'd seen the leaflet and not one had so much as heard of it. The next test was still more illuminating. During a visit to a neighbouring town I went into the head post office and asked for a copy. The man behind the counter looked puzzled, but, having received my assurance that it must be in stock, he consulted a colleague, who was equally baffled. He then retired into the bowels of the building to make further inquiries, and after a short wait I got my copy.

A British Speciality

OURS was the first country to make use of underwater television. The original underwater camera was built, if you remember, by Marconi's in 1951 in response to a rush order from the Admiralty, who wanted the instrument as an aid to locating the wreck of the submarine *Affray*. Its success was beyond the wildest expectation. Several wrecks had been located on the sea bottom in the area where the disaster took place; but the TV camera identified one of them as that of the submarine without a shadow of doubt. As it was moved about the wreck the nameplate (I hope that's the correct nautical term!) was seen on the receiving screen. Since then wide use has been made of Marconi and Pye submarine cameras not only by salvage vessels but also by marine biologists and oceanographers. Two years ago Pye designed a special model for the search for the Comet 'plane, lost off the island of Elba. Many of these have since come into use in Canada, Australia, New Zealand, the U.S. and other countries. I also hear that a further large batch of "Elbas" is likely to be used in next year's investigation by American scientists of the polar ice-caps.

People Are Funny

WHAT queer ideas people do get about television! A friend told me the other day that he simply must get a receiver with a larger screen. He has a 10-inch screen, from which his eyes never move when cricket is being televised. When I asked why he needed something a size or two larger he said: "Because I want to be able to see the ball. With my set I can't always do so, but I find that I can if Jones invites me to watch a match on his 17-inch receiver." My endeavours to convince him that whatever was on Jones's screen must also be on his were not at first entirely successful. "You may be right," he said, "but all I can say is that if the ball's on my screen, it's so small that I can't see it." Then the solution occurred to me. I asked how far from his set he usually sat. "Oh," he said, "you won't catch me out there. I do always what the experts recommend and sit as far as possible from the screen." How he'd got hold of that idea I don't know; but I found that he normally sat a good ten feet from the screen—and had been doing so for years! I demonstrated by means of the back of the proverbial old envelope that his picture viewed at five feet would appear to be of exactly the same size as Jones's at about 8½ feet. Having now moved his chair to the right distance, he is able to enjoy his cricket without having to go round to his friend's house.

Triangular Cabinets

FREE GRID'S suggestion that some enterprising manufacturer should turn out television sets with triangular cabinets because they fit so comfortably into the corners of rooms comes a little late in the day. The suggestion was made some years ago in "Random Radiations" for console sound receivers and radiograms and was adopted by the Ambassador people, who found it very popular. Whether any television sets are made with such cabinets nowadays I can't say offhand, though my impression is that there are one or two. Cabinets of this shape, whether used to house sound or television receivers, could benefit not only the listener or viewer but also the serviceman. If the cabinet is rectangular, only the back can be detached and many parts of the "works" are inaccessible unless the chassis is taken out. With a triangular cabinet, on the other hand, both of the sides behind the front panel could be made removable; or the back might consist of a single V-shaped piece. In this way the serviceman could get at much more of the inside of the set without having to take out the chassis.

UNBIASED

By FREE GRID

Electronics on the Roads

I HAVE been studying an article in the American periodical *Tele-Tech and Electronic Industries* which deals with the question of reducing car accidents by electronic means. One suggestion which has real merit is the development of electronic "trainers." Presumably these would be on the lines of the system used in flying training and this has proved itself over and over again.

Other suggestions in the article are of less importance but nevertheless capable of considerable development. Many of them appeared in these columns a generation ago but I have never found time to put them into practical form. Thus *Tele-Tech* suggests the use of a capacitative pick-up on a car so that if it approached too close to an obstacle ahead, be it another car, a jaywalker or a brick wall, the brakes would be automatically applied. I put forward a somewhat similar suggestion using photocells 23 years ago. The snag was that by the time the car got within range it would have been too late for the brakes to be applied. In my opinion this snag of too limited a range would apply with equal force to any capacitative arrangement.

The boldest and most unusual suggestion put forward by the writer is that "leader" cables should be buried in the ground on certain highways. These cables would carry control frequencies which could take complete charge of the car. The driver could then drop off to sleep like the coachman of the old horse-drawn trams who used to leave everything to the guiding effect of the rails and the intelligence of his horses.

Datatron

MOST of you will have read about the latest type of electronic machine, hailing from America, which composes the music for over a thousand songs an hour. It has been called the Datatron and when I first heard this name I thought it a very poor effort as it did not distinguish this mechanical Mozart from any other type of electronic computing machine for all of them have to be fed with data before they will do their stuff.

But as I realized later, I had wrongly jumped to the conclusion that the coiner of the word datatron had taken an old and familiar friend, the latin word "data" and had married it to the Greek suffix "tron." In this I was no better than the Ministry of Information official who noticed an article on the homodyne in this journal during the war (April, 1942) and passed a marked copy to the Ministry of Labour and National Service in case it might help them to solve the very pressing manpower problem.

I apologize to the man responsible for this ingenious name for it is not a miserable Latin-Greek hybrid. Not only is it all-Greek and, therefore, etymologically unobjectionable but it is a very descriptive word. The "data" part of it is obviously derived from the Greek verb δατεομαι (dateomai) which means, among other things, "to tear to shreds."

Anybody who studied the doggerel and pedestrian piece of music published in the newspapers recently as one of the Datatron's efforts will at once realize that it is indeed music reduced to rags and tatters. These banal bars are well-deserving of the title of mangled music. In the past the B.B.C. has been accused of devoting too much of its programme time to canned concerts but at least the music was worth canning. None of our budding Beethovens need fear the competition of this robot Rachmaninoff. No doubt an ACE will soon be constructed to turn out synthetic Shakespeare by the yard.

Sinister Servicing

I FEEL very uneasy to learn that methods smacking of Himmler and the Gestapo have been introduced into the service department of a radio dealer. I am told the dealer has installed concealed microphones and other apparatus on his premises so that, when a customer brings in a set for repair, everything he says is recorded on tape so that it can be used in evidence against him if at some future date a dispute arises as to what the customer ordered to be done to the set. Even the poor wretch's telephone conversations are recorded.

Now at first sight this seems a harmless enough practice and one which serves as a safeguard to the customer as much as to the dealer; I have little doubt that in this particular case all is fair and above board. One can foresee, however, very unpleasant developments if the police start using concealed apparatus to take down the exact words used by some offending motorist whom they stop. Speaking as a motorist myself, I frequently say things in the heat of the moment which, acting on advice, I omit from my evidence when I go into the witness box, and there must be many motorists like me.

The unsavoury nature of this Star Chamber method of secret recording initiated by this radio dealer is bad enough but there is a far greater danger in that it is possible for the tapes to be faked by some unscrupulous future user of the system. Is it not possible to produce synthetic records of the human voice on magnetic tape as Rudolf Pfenniger did when he painted sound tracks on films? But there is nothing to stop an unscrupulous gestapo-minded radio dealer, or other person concerned, from painting what he likes on a film track and then running it through a reproducer and re-recording it on magnetic tape.

All he needs is a preliminary secret recording of the customer's voice to tell him whether his accent is Oxon or 'oxton.

"Everything you say . . ."

A.C.-Phobia in Scotland

MAY I thank the many readers who wrote to tell me why, in their opinion, the filaments of valves and lamps used for a long time on d.c. soon fail when put on to a.c. mains. Naturally the tendency of a.c.-carrying filaments to waggle in synchrony with the alternating magnetic field surrounding them is a contributory cause which everybody recognizes. In fact, an Aberdonian reader is convinced that the earth's magnetic field is a primary cause of early filament failure, and he tells me that he hopes to save many bawbees when he has found the correct angle to tilt his lamps so that reaction between the fields of earth and filaments is at a minimum.

He also points out that in Scottish latitudes the lines of force of the earth's magnetic field are packed closer together than south of the border. In other words, the magnetic field is denser and so filaments fail earlier. The result is that a.c. is none too popular among the thrifty Scots, and I hope the Electricity Board will take cognizance of it.

But magnetic reaction alone is no explanation why d.c.-nurtured filaments soon fail on an a.c. diet. The other ingredient which spells early failure is summed up in the word crystallization. The crystalline structure due to a d.c. diet differs from that due to a.c., and the effect of the change of diet is as disastrous as if a baby were suddenly switched from mother's milk to tripe and onions.