Wireless World

OCTOBER 1954 VOL. 60 No. 10

Show Afterthoughts

AS our review of the National Radio Exhibition, published in this issue, will show, there has been a minor revolution in television receiver design. At least four basically different methods have been used to meet the forthcoming need for two-band tuning, and the tendency towards uniformity that was becoming evident last year has largely disappeared. The promise of a competitive television service has set a difficult task for designers, who were forced to evolve new sets without a full knowledge of the transmitting system with which they will have to work. But, in spite of all the uncertainty about the future and the sweeping changes that have been introduced, there is little if any sign that the new sets were produced under conditions of uncertainty and stress. In general, mechanical design has improved, although there is greater mechanical complexity, brought about by the addition of tuning for an extra band. Components are more accessible for maintenance and subsidiary controls are more sensibly placed for the convenience of the user.

On the electrical side there are certainly more refinements, most of which are brought about by the more stringent requirements of Band III, as compared with Band I. The r.f. circuitry of the typical receiver has been drastically changed, and the use of automatic gain control on the vision channel has become commonplace.

Reverting to the crucial question of channel selector design, it is as yet quite impossible even to guess as to which of the competing systems will ultimately find favour. The majority of makers clearly favour the 12-channel solution, with either a turret or fixed coils with switches. However, the proposed organization of British television is such that the viewer is not expected to need more than one channel in Band I and two in Band III; it is therefore possible that his wants may be adequately and more economically met by the simpler form of three-channel selector already provided by some designers.

Though the television set designers have embraced wholeheartedly the principle of two-band tuning, makers of aerials have, naturally enough, been rather more coy, as the solution of this particular problem is dependent to a greater extent on the siting and power of the projected new stations. Enough has been done, however, to show that, when the Band III service starts, viewers will have a wide choice of suitable aerials.

Enthusiasm for the projected v.h.f. sound broadcasting service did not appear to be so great as for two-band television. The comparatively few sets making provision for its reception mostly employed conventional circuitry. Bearing in mind the proposed three-programme method of distribution, there seems much in favour of pre-set tuning with switch selection of programmes. But this arrangement, seen only in one unit, calls for fairly extensive precautions against tuning drift, and might prove too costly for the general run of receivers.

The I.T.A.

HAD the designers of the new season's television receivers and aerials had the advantage of knowing as much as we now know of the Independent Television Authority's plans, their problems would have been rather more clearly defined—but not very much.

At the time of writing there is still a good deal of uncertainty. True, the principle of common sites for I.T.A. and B.B.C. stations has been fully accepted; going even farther, no basic objection has been raised against using the B.B.C. masts. The I.T.A. 7.5-10 kW transmitters, which have already been ordered, may even be housed in the B.B.C. station buildings. But, of course, the effective range of the I.T.A. stations will depend on how the aerials are mounted, and it has been stated that certain technical difficulties have yet to be solved. Readers may remember that *Wireless World*, discussing the advantages of co-siting the competing stations, suggested that Band III aerials might be "interlaced" with the slot aerials on the B.B.C. topmasts. This sharing of stations by competitors is mildly Gilbertian; it would be more rational to commission the B.B.C. to do all the transmission, leaving the I.T.A. to run its own programmes.

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Farnborough 1954: Radio at the S.B.A.C. Show

THE general impression gained from the radio exhibits at this year's flying display and exhibition held at Farnborough by the Society of British Aircraft Constructors was that, in the main, more attention has been given to consolidating existing techniques than seeking new ones. On all sides detailed improvements could be found; entirely new equipments were limited, but some had been introduced to replace gear which had begun to fall behind the requirements of the present time. Conservation of weight and space in airborne equipments is still one of the major causes for replacement of earlier designs.

One new high-power airborne h.f. equipment has been introduced by Marconi. It is designed primarily for pilot operation, with the emphasis on radio telephony. Both c.w. and m.c.w. telegraphy can, however, be employed. Its main feature of interest is that remote selection from either of two positions in the aircraft of any one of 200 crystal-controlled channels is provided. Crystals common to both receiver and transmitter are employed and in most cases the selected crystal frequency is that of the receiver's first local oscillator (the receiver is a double superheterodyne) and mixing its output with that of a fixed oscillator provides the transmitter drive frequency. The equipment is known as the AD307, covers 2 to 24 Mc/s and gives between 100 and 130 W output.

Another example of this type of h.f. airborne equipment is the Standard Telephones STR18C, of which some details were given in our report last year. It provides remote control of 100 channels in the band 2.8 to 18.1 Mc/s and gives 100 W output; again the emphasis is on radio telephony.

H.F. transmitters for ground-to-air communication are generally of from 30 to 100 W output, rising on special occasions to 1 kW. Some of the newest transmitters at the show were all of quite low power; for example, the Mullard SL18, a single-frequency transmitter working in the 1.5- to 10-Mc/s band, gives from 35 to 40 W output, while the Pye h.f. ground station, comprising a PTC931 transmitter and PTC941 receiver, gives 50 W output.

In the high-power class of ground transmitters comes one new model made by Redifon, known as the G143; it allows for remote selection of 10 spot frequencies in the band 2 to 26 Mc/s and gives over 1 kW r.f. output on telegraphy and 800 W on telephony.

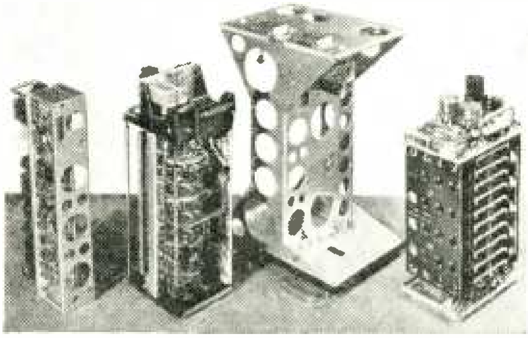
Redifon have also introduced a less ambitious communications set than their R50 series. It covers 250 kc/s to 24 Mc/s in six ranges. A gap is left in the tuning band around 570 kc/s for the i.f.

Another new and not too ambitious communications set is the Mullard GFR563, with a coverage of 210 to 540 kc/s and 1.45 to 32 Mc/s in six ranges. The sensitivity is said to be better than 3 μV for 10-db signal/noise ratio at 50 mW output with a 30 per cent modulated signal.

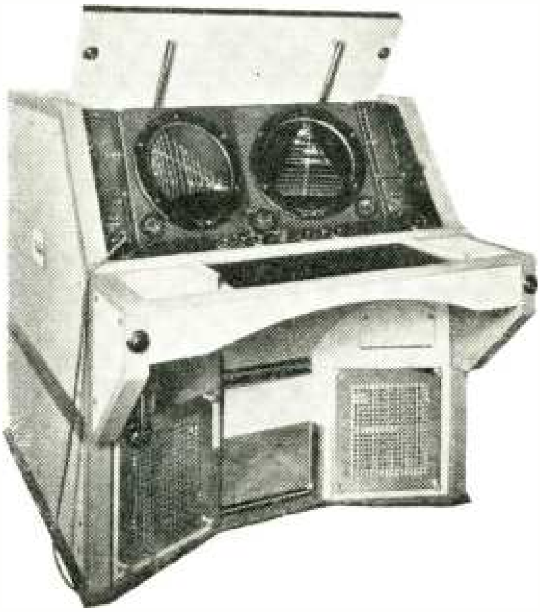
An unusual piece of h.f. equipment was shown this year by Plessey. It is for use in front of a single-channel receiver and converts it into a five-channel double-superheterodyne with either switch selection, or remote selection by motor, of five pre-tuned channels in the band 2.7 to 27 Mc/s. Plessey make a number of "front end" couplers of which this PV98 is but one, another is the PV14B permitting the use of 10 receivers on fixed frequencies from a common aerial without interaction, or of five dual-diversity sets. The same technique has now been extended to enable several v.h.f. receivers to be operated from a common aerial.

V.H.F. receivers in general have not undergone much change, a few new models have appeared, among which is the Burndept BE225 for ground stations. It has 18 valves, including the mains rectifier, with no fewer than 4 i.f. amplifiers (on 4.86 Mc/s). There are two tuned r.f. and three audio stages. It is a single-channel set with a crystal-controlled local oscillator.

Marconi's were showing a new v.h.f. ground station comprising transmitter, receiver, remote-control line equipment and aerial system designed to operate as one efficient electrical, though not physical, unit. This



Sub-assemblies forming one of the Marconi AD307 equipment's units.



Console display unit of S.T.C. three-dimensional "Precision Approach Radar".

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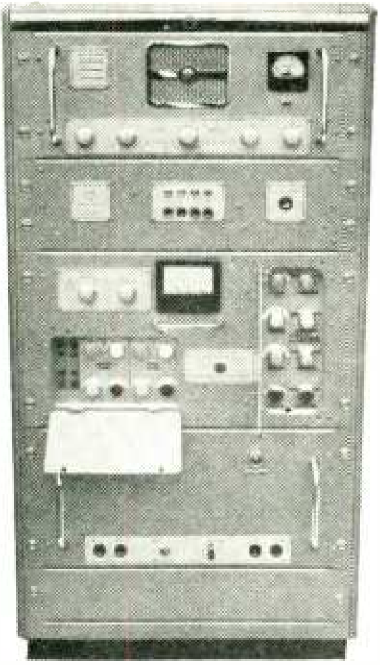
Meter-display unit in the Ferranti 1,000-Mc/s DME. Left: New version of Ultra "Sarah" air-sea rescue beacon with radio-telephone facilities.



Pye PTC931/941 4-channel h.f. ground transmitter-receiver.

is the AD801/818 equipment with a 50-W transmitter (AD801) working on any single spot frequency in the band 100 to 156 Mc/s. Amplitude modulation is used. The associated receiver is a double superheterodyne with a single crystal-controlled oscillator supplying, by means of its harmonics, both the mixer stages.

Very few changes were seen in airborne v.h.f. radio telephone equipment. One exception, however, is the Standard Telephones STR20, a new set intended for Service aircraft and replacing the STR9 series. It covers 100 to 156 Mc/s and provides 560 channels of 100-kc/s spacing, or 623 of 90-kc/s, and 20 of these are instantly available to the pilot.

The announcement that B.O.A.C. hopes to fit search radar in all forthcoming types of airliners naturally focused attention on the Ekco Airborne Search Radar. No basic changes have been made since it was described in *Wireless World* of December 1950; it will be recalled that it operates on about 3 cm and provides a p.p.i. display in the aircraft of dangerous cloud formations ahead, obstructions in the path of the aircraft, and it can be used as a navigational aid.

Other airborne navaids seen at the show included a 200-Mc/s DME (distance measuring equipment) shown by Amalgamated Wireless (Australasia). This is a double-pulse system enabling a wide range of codes to be employed for triggering and identifying ground beacons.

Murphy favour the 200-Mc/s band also for their DME which, when set to the required channel, searches in ranges up to the maximum of 200 nautical miles until the correct responses are received when it locks on the beacon.

Some few years ago Ferranti had a 1,000-Mc/s DME at the S.B.A.C. Show; this year a new, and smaller, version was available. Despite the high frequency a working range of 200 nautical miles also is obtained. A meter display is used.

The ground part of DME is generally a high-power beacon in the region of a kilowatt or so, mostly unattended and often having some kind of telemetering system to a nearby control station. Murphy were showing telemetering equipment of this kind.

Two types of airfield surveillance radar are available for keeping track of aircraft within the operating sphere of an airport. One is primary radar and the other secondary radar, and examples of both were shown and operated at Farnborough this year. The Decca Type 424, a primary radar, was described in *Wireless World* of November 1953, and no changes of any consequence have been made since then. Its range is about 25 miles. Decca were showing this year a new millimetric radar working on 8.7 mm and giving exceptionally good definition over ranges of 10 miles or so.

An example of long-range primary surveillance radar giving an all-round p.p.i. display up to about 60 miles is the Cossor Mark VI Airfield Control Radar. It works in the 10-cm band and uses a 14-ft diameter paraboloidal plastic reflector fed by a battery of small horns. A feature of this equipment is that the permanent echoes which often so clutter the face of the p.p.i. tube that aircraft tracks become difficult to follow can be removed by an attachment described as the MTI (moving target indication). This feature was found also in the Marconi approach control radar. It operates on 500-600 Mc/s, and is for long-range searching.

Secondary surveillance radar can generally cover a larger operational area owing to the fact that the ground transmitter has only to trip an airborne one. The Cossor system, for example, is said to have a range of 150 nautical miles. It does, however, need the aid of an airborne unit, whereas primary radar does not. On the other hand the secondary radar responses can be coded for self-identification.

Before leaving this subject mention must be made of the precision approach radar shown by Standard Telephones which displays three-dimensional information on two c.r.t. indicators. One is the azimuth deviation from a pre-determined approach path and the other glide angle. The ground controller talks the aircraft down by v.h.f. radio telephone. The Ekco "airfield approach aid," which is intended for the smaller aerodromes, is also a talk-down system.

A year or two ago Burndept and Ultra introduced lightweight radio beacons with radio-telephone facilities for air crews forced down in the sea. Both these equipments were shown this year in improved form, the improvements being mainly in such details as waterproofing, convenience of operation, and so on.

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WORLD OF WIRELESS

Tape Standards

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Amateur TV Interference

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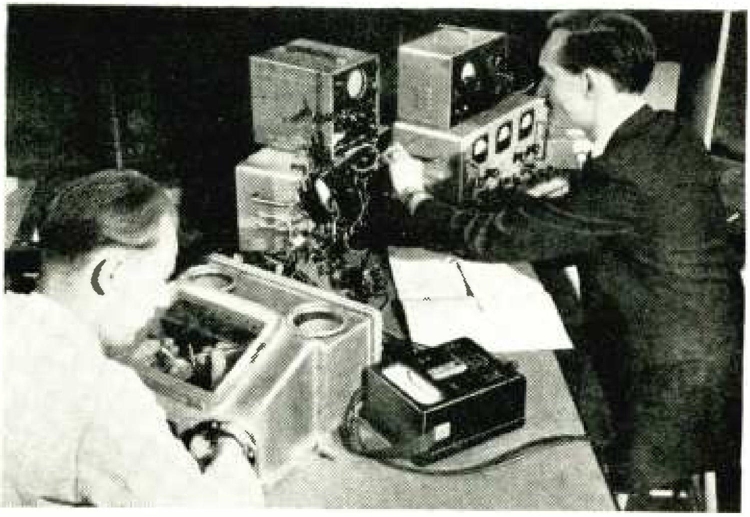
Fleming Valve Jubilee



SEMI-CONDUCTOR RESEARCH.—Measuring the characteristics of an experimental transistor under manipulation in a moisture-free box at the new G.E.C. semi-conductor research laboratories at Wembley. The company, in recognition of the revolutionary potentialities of solid-state physics for communications and electrical engineering, has deployed an unusually large scientific force on investigations into fundamental physics of semi-conductor materials.

Tape Sense

DUAL-TRACK recordings on standard ¼-inch magnetic tape can be made in four ways, depending on the direction of travel (as seen when the active side of the tape is away from the observer) and on whether the recording head is near the top or bottom edge of the tape. Basically, there are only two conventions, since a British Standard recording (left-to-right, top track) if turned upside down will play properly on a right-to-left, bottom track machine, and the so-called Continental standard will be met by either right-to-left, top track, or left-to-right bottom track.

The new H.M.V. tape records are made to the British Standard Specification (B.S.1568:1953) and machines which will play them without alteration include the British Ferrograph (Wearite), Grundig Models TK9 and TK819, M.S.S., Reflectograph, Simon and Truvox Mark III U.

Truvox Mark III mechanisms can be converted to the equivalent of the British Standard and should be sent to Truvox, Ltd., Service Dept., 328, Station Road, Harrow, Middlesex. The charge is £5 5s, which includes general reconditioning of the instrument.

The earlier Grundig Models 500L and 700L also require conversion before the H.M.V. tapes can be played on them, and Grundig (Gt. Britain), Ltd., Kidbrooke Park Road, London, S.E.3, will undertake the necessary work for £5 5s. Alternatively a conversion kit can be supplied to the user for £3 3s.

Television Interference

SO FAR amateurs have been held responsible for causing interference with television reception and have had to close down during television transmitting hours despite the fact that in many cases the trouble was due to inadequate selectivity and, to quote the R.S.G.B., "other undesirable features in the design" of some television receivers. As a result of representations by the R.S.G.B., from October 1st the Post Office will continue to expect the amateur to suppress all harmonics outside his authorized bands, but once this has been done, if the wanted signal "is a good one" and the interference is due to the choice of the i.f. for the complainant's receiver, or to the image response of his receiver, the G.P.O. will allow the amateur to continue operating after an interval of one month from the date on which the cause of the trouble is notified to the complainant by the Post Office.

The Post Office does not feel justified in automatically applying the same arrangement where the interference is proved to be due to the close proximity of the amateur station to the complainant's receiver.

Jubilee of the Valve

THE jubilee of the invention of the thermionic valve by Sir Ambrose Fleming on November 16th, 1904, is being marked by the holding of a conversazione in the Electrical Engineering Department of University College, London, where Sir Ambrose was professor of electrical engineering. Exhibits and documents relating to Fleming's work and examples of recent researches will be on view.

Admission to the conversazione, which will extend over three days (November 16th to 18th), will be by invitation ticket only. Senior engineers or members of the radio industry wishing to visit the College on one of those days should apply to the Assistant Secretary, University College, Gower Street, London, W.C.1.

As mentioned last month the I.E.E. has arranged a special meeting on November 16th to mark the jubilee. The proceedings will open at 2.30 and lectures on the genesis of the valve and the development of the triode up to 1939 will be given by Prof. G. W. O. Howe and Sir Edward Appleton, and at 5.30—following the tea interval—Dr. J. Thomson will lecture on "Developments in Thermionic Devices since 1939." Tickets for non-members are obtainable from the I.E.E., Savoy Place, London, W.C.2, where the meeting will be held.

37th Edition

AMONG the new features in the *Wireless World* Diary, 1955, is a section dealing with television attenuators and splitting circuits, a table for converting centi-

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metre-gramme-second (c.g.s.) units to the rationalized metre-kilogramme-second (m.k.s.) system of units, and measurements for aerials for v.h.f. broadcasting and Band III television. The revised list of valve base connections includes some 500 current types.

In addition to the 79-page reference section, which includes the usual quota of general radio information, the Diary—now in its 37th year of publication—has the normal week-at-an-opening diary pages. It costs 5s 10d (morocco leather), or 4s 1d (rexine).

PERSONALITIES

Sir Gordon Radley, C.B.E., Ph.D.(Eng) B.Sc., who has been engineer-in-chief of the G.P.O. since 1951, has been appointed deputy director general in consequence of the release of **Sir Ben Barnett,** K.B.E., C.B., from general administrative duties to enable him to devote all his attention to broadcasting work. Sir Ben retains the title of deputy director general. Sir Gordon, who joined the Post Office Engineering Dept. in 1920, has successively been controller of research (1944-49), deputy e.-in-c. (1949-51) and then engineer-in-chief.

Brigadier L. H. Harris, C.B.E., M.Sc., who succeeds Sir Gordon Radley as engineer-in-chief, has been controller of research for the past five years. He joined the engineering dept. in 1922. From 1943-45 he was Chief of Telecommunications, S.H.A.E.F.

G. J. S. Little, C.B.E., G.M., the new controller of research at the Post Office, has been assistant engineer-in-chief since 1947 prior to which he was for two years staff engineer in the Radio Maintenance Branch. He joined the Post Office research section in 1922.

Rear-Admiral Sir Philip Clarke, K.B.E., C.B., D.S.O., director of the Naval Electrical Department, Admiralty, since 1951, is to be the new president of the British Institution of Radio Engineers. He succeeds W. E. Miller, editor of *Wireless & Electrical Trader*, who has held the office since 1952. Admiral Clarke, who joined the Navy in 1914, was Director of Manning before assuming his present position

Dr. J. D. McGee, O.B.E., M.Sc., Ph.D., A.M.I.E.E., the Australian-born television research engineer and senior scientist of the E.M.I. Research Laboratories, which he joined in 1932, has been appointed by London University to the new Chair of Instrument Technology at the Imperial College of Science and Technology. After graduating B.Sc. (maths and physics) from Sydney University, from which he subsequently received his M.Sc. degree, he was awarded a research scholarship to Clare College, Cambridge, and worked in the Cavendish Laboratory under the late Lord Rutherford from 1928 to 1931. Whilst at E.M.I. he has been concerned mainly with the development of television camera tubes.

PUBLICATION DATE

We regret that owing to a temporary re-arrangement of our printing schedule it will be necessary to postpone publication of the November issue of *Wireless World* from October 25th until November 1st.

C. H. Foulkes, M.I.E.E., the new head of the valve division of Standard Telephones and Cables at Dowlish Ford Mills, Ilminster, Somerset, joined the company in 1936 as a laboratory assistant. The Ilminster division is responsible for the development and manufacture of "special valves" and is not concerned with broadcast receiving valves. Throughout the war Mr. Foulkes was at Ilminster engaged on the development of microwave tubes, but he has been concerned in recent years with work on repeater valves (including those for underwater cables) and high-power transmitting valves. He has recently returned from a tour of valve factories in the U.S.A.

C. E. Tate, who contributes an article on remote control in this issue, joined Standard Telephones and Cables in 1936 as a development engineer. After working on telephone circuitry for some time he was concerned with airborne receivers and direction finders. From 1946 to 1949 he was with Central Rediffusion Services, Ltd., in charge of the development of receivers and directional arrays for radio relay services. Since 1949 he has been with Marconi's W.T. Company, and is at present in charge of the Airborne Receiver Development Group.

B. C. Fleming-Williams, B.Sc., has left A. C. Cossor, Ltd., where he was director of research, and has joined Sylvania-Thorn Colour Laboratories, Ltd., as general manager. The company, owned jointly by Sylvania Electric Products, Inc., of the U.S.A., and Thorn Electrical Industries, Ltd., manufacturers of Ferguson domestic radio and television receivers, is engaged on research and development work on colour television—including the design of c.r. tubes. Mr. Fleming-Williams joined Cossors in 1935 and was responsible for the double-beam c.r.t. and, more recently, for the airfield control radar system now in use at London Airport.

H. J. Leak, M.Brit.I.R.E., managing director of the well-known company of manufacturers of sound reproducing equipment bearing his name, is visiting the United States in October and will be at the Audio Fair in New York (October 14th-17th). The Audio Engineering Society of America is conferring its Fellowship on Mr. Leak.

J. S. Clark, joint managing director of A. C. Cossor, Ltd., has been elected vice-chairman of the British Radio Equipment Manufacturers' Association, of which, as


Brigadier L. H. HARRIS


G. J. S. LITTLE


B. C. FLEMING-WILLIAMS


H. J. LEAK

already announced, M. M. Macqueen, manager of the G.E.C. Radio and Television Department, is chairman.

IN BRIEF

Television Licences in the U.K. increased by 45,682 during July bringing the total at the end of the month to 3,456,728. "Sound only" domestic licences totalled 9,779,056 and those for car radio 241,479; the total number of receiving licences being 13,477,263.

Television Trade Tests.—An additional hour of test transmission—from 12 noon to 1 p.m.—daily, except Sundays, is now being radiated from all B.B.C. television stations. The transmissions, which consist of Test Card "C" accompanied by recorded music, are at reduced power so far as the five main stations are concerned, the standby transmitters being used.

Attendances at the Earls Court Radio Show which closed on September 4th, totalled 315,970, some 20,000 more than last year's figure.

Northern Radio Show.—Plans are being made by the Radio Industry Council to hold an exhibition in Manchester next year—probably May 3rd to 14th.

"All seats sold" appeared on the notice boards of the Royal Festival Hall, London, within four days of the commencement of the sale of tickets for the lecture-demonstration on sound reproduction to be given by G. A. Briggs (of Wharfedale) on November 1st. In addition to the 3,400 seats sold the tickets for the 100 or so admitted to stand are also sold.

A number of radio and allied firms are among the 450 exhibiting at the **British Trade Fair**, Baghdad (October 25th-November 8th), and a composite exhibit of domestic radio and television equipment is being staged by the British Radio Equipment Manufacturers' Association. The 500-page bi-lingual (English and Arabic) catalogue has been produced by our publishers for the organizers—British Overseas Fairs Ltd.

The annual **Motor Show** at Olympia from October 20th to 30th, at which a number of car-radio manufacturers will be exhibiting, will be covered by three special issues of *The Autocar*—October 15th, show guide; 22nd, stand-to-stand report; and 29th, technical survey of design trends.

DETECTING PIRATES.—The new G.P.O. television detector vans, like the earlier type described in Wireless World, March, 1952, pick up the magnetic induction field set up by the receiver line-scan coils. Location is effected by successively switching the output of the three loops on the van roof to a sensitive receiver tuned to the 2nd harmonic (20.25 kc/s) of the line-scan frequency. The two loops on the left-hand side of the van give direction, while comparison of the output of the rear loops gives "sense".

New buildings for the **Medway College of Technology** at Fort Horsted on the Chatham/Rochester boundary have been brought into use this session. All the laboratories—including some specially equipped for radio and telecommunications courses—are now on one site. The college has a full-time course in electrical engineering (communications) for the London B.Sc., and among the part-time day and evening courses are those for the R.T.E.B. radio and television servicing certificates.

Tape Pals.—For some time there have been two organizations in America, each with an international membership, for the purpose of linking correspondents for the exchange of recorded tapes. One of these—World Tape Pals, P.O. Box 9211, Dallas, Texas—has a membership of some 400, about 50 per cent of them in the U.S.A. and 10 per cent in this country. The other organization is the Voicespondence Club of 1614 North Mango Avenue, Chicago 39, Ill. There are no membership fees, but correspondents wanting a "tape pal" are asked to send details such as tape speeds, single or double track and direction of travel, and an international reply coupon.

BUSINESS NOTES

The use of magnetic tape as a medium for data recording, and its application to the control of machines and industrial processes, is to be developed by a group of companies under the control of Gas Purification and Chemical Co., Ltd., Palmerston House, Bishopsgate, London, E.C.2. **Grundig (Great Britain), Ltd.**, will contribute their knowledge of recording techniques and other firms collaborating are Smart and Brown (Machine Tools), Ltd., Johnson British Electric, Ltd., and Beeson and Robinson, Ltd. (A general article on industrial uses of tape recording appears on p. 508 of this issue.)

Equipment for the extension of the Automobile Association's mobile radio scheme to four new areas was provided by **Pye, Ltd.** The A.A. now has radio-equipped patrol vehicles in the London, Birmingham, Leeds, Glasgow, Guildford, Newcastle, Manchester, Bristol and Nottingham areas. The last four centres are those recently equipped.

A second contract for the supply of television equipment for the Italian broadcasting organization, Radio Audizione Italiana, has been placed with **Marconi's**, who have already supplied sound and vision transmitters and ancillary gear. The new contract is for two O.B. units, studio equipment and monitoring apparatus.

Giannini, Ltd., has been formed in this country as a subsidiary of G. M. Giannini & Co., Inc., the American instrument and control manufacturers. The new company intends to negotiate licences for the manufacture of equipment—including telemetering systems and radar control gear—to Giannini designs for the British Commonwealth. Enquiries should be addressed to Christopher Dykes at 31, Pembroke Gardens, London, W.8 (Tel.: Western 9493).

Taylor Electrical Instruments, Ltd., the well-known manufacturers of test and measuring equipment, of Slough, Bucks, announce the introduction of three hire purchase schemes which provide for repayments spread over 3, 10 or 15 months.

The equipment for the fleet of new G.P.O. television detector vans, illustrated on this page, was developed from a Post Office experimental model by **G. A. Priechenfried and Associates**, 4, Lammas Park Gardens, London, W.5.

Gramercy Sound Associates, of 175, Fifth Avenue, New York 10, U.S.A., have notified us of their wish to receive details from British manufacturers of tape recorders and high-fidelity reproducing equipment.

W. Bryan Savage, Ltd., have opened their new London office and showroom at 17, Stratton Street, W.1 (Tel.: Grosvenor 1926), to which all sales correspondence should now be addressed.

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A Market Digest of opportunities for introducing British high-fidelity sound-reproducing equipment into the U.S.A. has been prepared by the Commercial Department of the British Embassy, Washington. It is available from the Export Services Branch of the Board of Trade, Lacon House, Theobalds Road, London, W.C.1. (Reference ESB/18548/54.)

Thirty-seven vessels—making forty-seven in all—operated by the British Tanker Company are to be fitted with Pye v.h.f. radio-telephone equipment by **Rees Mace Marine, Ltd.** Shore stations have been set up at the company's terminal ports—Sheerness, Kent, and Aden—and in addition communication can be established with the refinery at Fawley, Hants, and Falmouth, Cornwall.

Corran Works, Ltd., the Northern Ireland subsidiary of Pye, Ltd., is extending its factory space in Larne, Co. Antrim. The increased space will enable production to be doubled, necessitating an increase in staff of 500.

A.B. Metal Products, Ltd., have moved their London office from Berkeley Street, W.1, to larger premises at 17, Stratton Street, W.1. The telephone number is still Grosvenor 5206.

CLUB NEWS

Birmingham.—The meetings of the Slade Radio Society for the last quarter of the year open on October 1st with a talk by R. Lightwood (Philips Electrical) on the applications of electronics in industry. On the 15th J. Hughes, B.Sc., of the G.E.C., will deal with the production, testing and applications of transistors and on the 29th D. W. Morris's subject will be "Single Sideband Transmission and Reception for the Amateur." The society's annual dinner will be held on October 23rd at the Market Hotel. Meetings are held on alternate Fridays at 7.45 at the Church House, High Street, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Cambridge.—The Cambridge University Wireless Society's first meeting of the new academic year will be held on October 11th at 8.30 in the Cavendish Laboratory. A programme of talks is being arranged for the session. The society possesses a well-equipped workshop and operates a station with the call G6UW. Sec.: D. W. H. Ashton, Queen's College, Cambridge University.

Chester.—While the Army Emergency Reserve (Royal Signals) is in camp at Blacon, Cheshire, they are being invited to the Chester and District Amateur Radio Society (G3GIZ) which meets on Tuesdays at 7.30 at Tarran Hut, Y.M.C.A. Grounds, Chester. Sec.: N. Richardson, 23, St. Mary's Road, Dodleston, Nr. Chester.

Hounslow.—The autumn session of the Hounslow and District Radio Society opened on September 16th with a meeting at Grove Road Junior School, Hounslow. The club meets fortnightly on Thursdays, alternate meetings being devoted to club matters and R.S.G.B. group business. The October meetings are on the 14th and 28th. Sec.: R. J. Parsons, 16, Cypress Avenue, Whitton, Middx.

Kingston-on-Thames.—The Mullard 5/10 amplifier, described in our August issue, will be demonstrated by its designers to members of the Kingston and District Amateur Radio Society at their meeting on October 7th at 7.45 at Penryn House, Penryn Road, Kingston-on-Thames. The club normally meets on alternate Wednesdays. Sec.: R. S. Babbs, 28, Grove Lane, Kingston-on-Thames, Surrey.

Walton-on-Thames.—A. O. Milne (G2MI), president of the R.S.G.B., will open the Amateur Radio Exhibition, at Walton-on-Thames, being organized by the Q.R.P. Society. The exhibition, which will be held in St. Mary's Parish Church Hall, Church Street, on October 30th from 2.30, will include examples of low-power transmitting and receiving equipment, components and demonstrations of radio-controlled models. Admission to the exhibition, which is being supported by some local traders, is 1s. Sec.: J. Whitehead, 92, Rydens Avenue, Walton-on-Thames, Surrey.

BOOKS RECEIVED

Television and Special Tubes Vade-Mecum. Edited by Dr. J. A. Gijsen. International data book on cathode-ray tubes, gas discharge tubes, crystal devices and other valves not included in the complementary "Radio Tube Vade-Mecum." Pp. 244+VI; with diagrams of base connections. P. H. Brans, Antwerp (or from the Modern Book Company, 19-23 Praed Street, London, W.2, price 22s 6d.).

Telecommunications, by A. T. Starr, M.A., Ph.D., M.I.E.E. Text-book of principles and practice of line and radio communication systems written to cover the syllabus for this subject in the London University degree course. Pp. 454+IX; Figs. 381. Price 35s. Sir Isaac Pitman and Sons, Parker Street, Kingsway, London, W.C.2.

The Practical Electrician's Pocket Book, 1955. Edited by Roy C. Norris. Basic data on domestic and industrial appliances, installation and wiring. Pp. 550 with numerous illustrations. Price 5s. Published by *Electrical and Radio Trading*, 189 High Holborn, London, W.C.2.

Television Simply Explained, by R. W. Hallows, M.A., M.I.E.E. Revised second edition of a book describing the working of television for the ordinary viewer. Pp. 196; Figs. 96. Price 10s 6d. Chapman and Hall, 37 Essex Street, London, W.C.2.

Electrical Who's Who, 1954. Brief biographies of leading members of the professional and industrial branches of the electrical industry. Compiled by *Electrical Review*. Pp. 354. Price 21s. Electrical Review Publications, Dorset House, Stamford Street, London, S.E.1.

COMMERCIAL LITERATURE

Junction Transistor for hearing-aids, Type XFT1, in hermetically sealed flat glass bulb measuring only 15mm × 5.3mm × 3.8mm. Gives output of 1-2.5mW and power gain of 27-38db, depending on operating conditions. Preliminary data sheet from Hivac, Stonefield Way, Victoria Road, South Ruislip, Middlesex.

Aerial Multicoupler for 2-30 Mc/s, allowing up to ten receivers to be fed from one or two aerials. Input and output impedances are 75Ω unbalanced. Also a frequency convertor for f.s.k. telegraphy reception which takes stronger of two signals from a diversity pair and converts it to d.c. Leaflets from The Plessey Company, Ilford, Essex.

Wide-range Ohmmeter with 12 linear ranges from 3Ω full scale to 1MΩ full scale and 5 additional ranges for 1-1,000MΩ. Current and voltage ranges covering 0.3μA-300mA and 3-300V. Leaflet from the Clare Instrument Company, Rickmansworth, Herts.

D.C. Microvoltmeter with centre-zero scale of 10μV-0-10μV and ranges of ×1, ×10, ×100 and ×1,000. A novel type of d.c. galvanometer amplifier is used. This and many other instruments included in a new illustrated catalogue from W. G. Pye & Co., Granta Works, Cambridge.

Pallets and Stillages; an illustrated catalogue, giving standard sizes available, from H. & C. Davis & Co., 59 Old Town, Clapham, London, S.W.4.

Pre-set Potentiometers for live-chassis receivers; Type QM with insulated spindle and two-hole fixing and Type QS with live spindle and two lugs for fixing; both in values from 500Ω to 10MΩ linear law. Leaflet from Dubilier Condenser Co., Victoria Road, North Acton, London, W.3.

Marine Radiotelephone with output of 25 watts and range of 250 miles; transmitter frequency 1.6-3.7 Mc/s and receiver 185 kc/s-3.7 Mc/s. Operation is simple and the weight is 46 lb. This and other new marine equipments described briefly in News Letter No. 11 from Redifon, Broomhill Road, London, S.W.18.

Time and Motion Study correspondence course. Brief details on a leaflet from the School of Time and Motion Study, 243 Elgin Avenue, Maida Vale, London, W.9.

Insulating and Protective Tapes of cotton, varnished cambric, rubber, vulcanized bitumen and P.V.C. Catalogue giving sizes and recommended applications from British Insulated Callender's Cables, 21 Bloomsbury Street, London, W.C.1.

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Radio Show

This Year's Trend in Vision and Sound Broadcast Receivers—and Some Highlights

In the following pages the technical staff of "Wireless World" reports on tendencies in design in those branches of radio most fully represented at the National Radio Exhibition. As at last year's Show, technical interest centred on television. A survey of aviation radio equipment shown at the Farnborough Exhibition appears on another page.

WHILE television receivers still vary a great deal in matters of detail, there is now a strong tendency towards uniformity in their general form. The vast majority of sets now have either a 14-in or a 17-in c.r. tube with magnetic deflection and permanent-magnet focusing; they have flyback e.h.t. and h.t. boost; they are either for a.c./d.c. operation or for a.c. only, but using a.c./d.c. technique; cathode-modulation of the c.r. tube is employed; and on the signal side the sets are superheterodynes.

The general basic trend of development is towards greater uniformity, as it has been for some years, but it is obscured this year by a new requirement, the necessity for providing for reception on Band III as well as on Band I. Designers have thus to cope with a new set of problems and they have by no means all found the same answers.

The Band III has dealt the final blow to the straight t.r.f. television set, for nothing but the use of the superheterodyne will suffice for frequencies around 200 Mc/s. It has also completely altered the conventional front-end of a television set. It has been usual for some years to employ a single pentode signal-frequency amplifier followed by a frequency changer which has been quite commonly also a pentode operating as a mixer-oscillator. This arrangement is now not at all favoured, except for purely Band I sets, where it is still used. The more stringent requirements of Band III have caused a general change to quite a different circuit. It is now the practice to use a double-triode connected as a cascode stage for the signal-frequency amplifier and to use a triode-pentode as a frequency changer. The triode section acts as the oscillator and the pentode as the mixer.

A major reason for the adoption of the cascode stage is the reduction of receiver noise which results. This occurs because a triode is inherently a quieter valve than a pentode since it has no partition noise. On Band I, receiver noise is not often a limiting factor, for external noise is usually more important than the noise even of a pentode. On Band III, however, external noise is likely to be less and signals may well be weaker.

Whatever the actual form of the circuit, some method of station selection by a panel control has for the first time become necessary in British television, and there are several schools of thought about the best way of providing it. There are five channels in Band I and eight in Band III and a set must be capable of receiving any one of them. It is not, however, necessary that the user should be able to select any one of the thirteen at a moment's notice. No one will be within range of stations on all channels.

There is no reason to suppose that anyone will require to select more than one channel on Band I and, perhaps, two on Band III, and it may be years before anyone needs more than one on Band III. This has been taken advantage of by many designers and quite a few sets have a panel selector arranged to give an instantaneous choice between two or three channels only, but those two or three can be pre-set to be any required ones. Others feel that it is simpler to provide a selector for the lot, or rather, for twelve out of the thirteen.

The main alternative arrangements are:—

1. 12-channel switch selection using either a turret or fixed coils with wafer switches. This gives five channels on Band I and seven on Band III; a pre-set control enables the seven to be either channels 6-12 or channels 7-13.

2. A basic selector as (1), but provided with coils for one channel in Band I and two in Band III only, the remaining switch positions being blanked off. The arrangement appears to the user to be that of a three-position switch. The argument in favour of the

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Review

arrangement is that as no one is expected to be able to receive more than three alternative channels it is wasteful to provide coils for 12 or 13. The coils can easily be changed by the dealer for other channels and with the full switch mechanism provided, additional channels can readily be catered for if the need should arise.

3. Continuous tuning for Bands I and III using separate control knobs for the two bands and a band-change switch. This enables the user to tune to any channel in either band and to have an instantaneous change-over by a switch from any channel in one band to any in the other. Since there are unlikely to be alternative programmes in Band III for some time to come, this would seem to meet all requirements in the reasonably near future. If alternatives in Band III do come, however, it would entail a retuning operation by the user to change the Band III programme.

4. The final arrangement is a set designed for Band I only with special provision for the addition of a converter for Band III. This is intended mainly for use in districts in which it is unlikely that Band III reception will be possible for a long time.

The sets of most makers fall into category 1 and of these probably most have a turret tuner. In the true turret there is framework which can be rotated in steps by a panel control and which carries a clicker mechanism for locating its position precisely at each step. The inductors for each channel, singly or in a group, are mounted on an insulating strip which carries connecting contacts and which is held in the framework by a clip. Usually each aerial circuit coil is held on one strip while the intervalve coil and the oscillator coil, being coupled together, are held on a second strip.

There are thus two detachable coil strips for each channel. This is done to enable a screeen to be interposed between them. A set of fixed contact springs presses against the contacts of the coils in use. Rotating the turret framework brings a new set of coils physically and electrically into the place occupied by the previous set.

The circuit diagram of a typical turret tuner is shown in Fig. 1; this is actually based on the Kolster-Brandes LVT50, but is a little simplified in that some of the decoupling has been omitted. A common aerial feeder and input filter are used for both bands and the signal passes to the coupling coil L_1 in the turret, whence it passes to the input tuned circuit L_2 and thence to the first valve V_1. Capacitance exists in the valve from the grid to the anode on the one hand and the cathode on the other. These two capacitances form two arms of a bridge connected from anode to cathode, the other two arms being provided by C_1 and C_2. The tuned circuit L_2 is across the diagonal of the bridge. When C_2 is properly adjusted L_2 is isolated by this bridge connection from the anode circuit. It is a form of neutralized circuit and while it may help in obtaining stability its main function is to minimize oscillator radiation.

The anode of V_1 is connected to the cathode of V_2 via the coil L_3, which is adjusted to resonate around the upper end of Band III in order to maintain the gain at the highest frequencies. V_1 and V_2 are the two halves of a double triode and L_1 and L_2 are the two coils of one section of the turret. They are screened from the three coils L_4, L_5 and L_6 which form the second section of the turret and which form the coupling to the mixer V_4 and the oscillator V_3. The mixer is a conventional pentode with grid-leak bias and grid injection, the intervalve coupling being of a quite normal type comprising L_5 and L_6.

The oscillator is the modified Colpitts type using the triode section of the triode-pentode V_3, V_4. The first part of the i.f. coupling, T_1, is included in the tuner unit. This tuner is built as a separate unit, including the turret, and is quite compact. It can be mounted in any convenient position to bring the turret control where it is wanted and it need not be particularly near the i.f. amplifier since it is practicable to employ a fairly long screened cable for the i.f. connection.

From the circuit point of view the second group of sets is no different; the omission of some of the coils for some of the channels not being a circuit matter. The third group also differs only a little. If the switch contacts in Fig. 1 are ignored the circuit is still that of the third group on either band, but the coils inductances are adjustable by ganged dust-iron cores or metal slugs for continuous tuning over the band. Two sets of coils with their ganged cores brought out to separate control knobs are provided

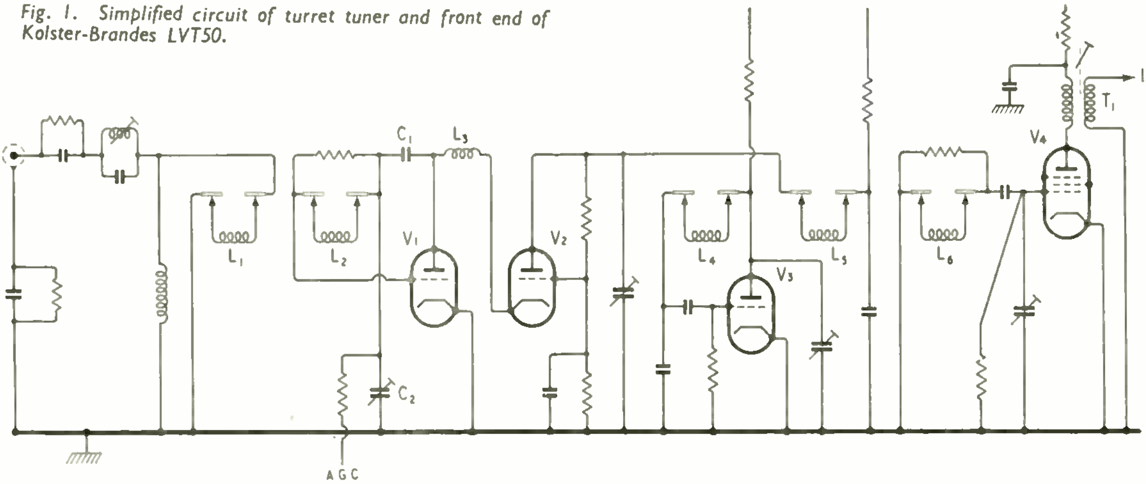
Fig. 1. Simplified circuit of turret tuner and front end of Kolster-Brandes LVT50.

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and a set of ganged change-over switches to change from one to the other.

One example of this method of tuning is in the Bush receivers. Here there are other minor circuit differences. Separate aerial feeders are used for the two bands—an 80-Ω coaxial cable for Band I and a 300-Ω twin-wire feeder for Band III, and the capacitance-bridge neutralizing circuit is not used.

In a few sets, notably the G.E.C. range, the tuning system is half-way between the second and third groups. A three-way selector switch is used and there are three sets of coils, one giving continuous tuning over Band I and two similarly covering Band III. The cores of the coils are not ganged and can be pre-set for any Band I and any two Band III stations.

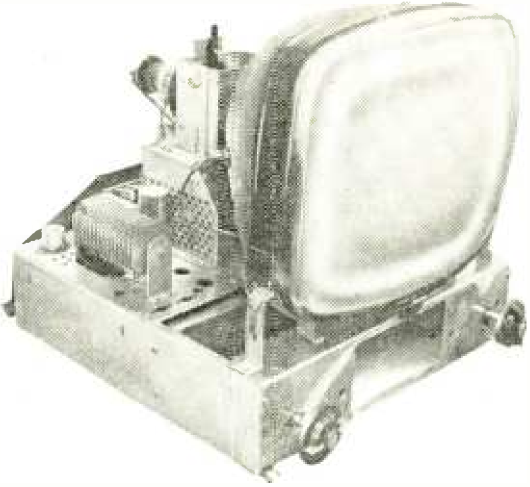
As an alternative to the turret, fixed coils and rotary wafer switches can be used. The basic circuit is unaffected by this and the general arrangement of Fig. 1 still holds. However, it is not then usual to change the coils completely from one channel to another. There is a basic coil for the highest frequency and the switch adds incremental inductance for each step; all the coils are in series and the unwanted ones shorted out by the switch. Pye adopt this method in a neat and compact tuner[1].

One at first sight odd result of the provision for alternative-programme reception is a great increase in the use of a.g.c. The need for this arises because it is unlikely that the two signals will be of the same strength, and it is undesirable for the user to have to make any large adjustment of gain when switching from one station to another. It has been a common practice for years to use a.g.c. in the sound channel, but up to now a.g.c. in the vision channel has been a rare thing.

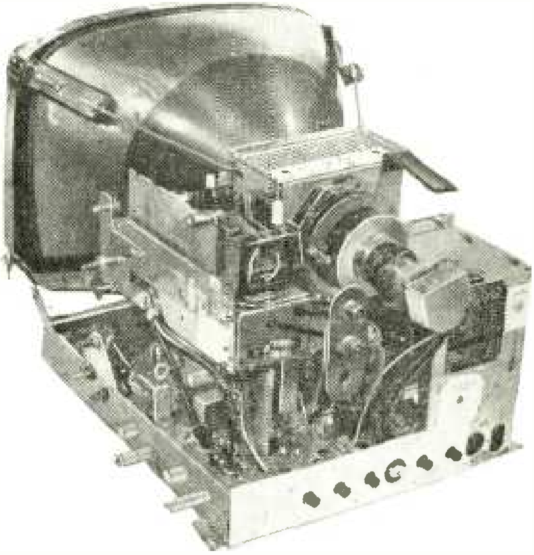
The attainment of a.g.c. in the vision channel is greatly complicated by the fact that the vision signal does not have a constant mean level. In a sound signal the mean transmitted carrier level is constant and the variations of modulation all take place about this mean level. In the vision signal as transmitted the only constant thing is the black level and the mean value varies with the modulation.

Because of this, if a true a.g.c. system is needed it is necessary to base it upon the black level of the signal, which is present for some 6 μsec after each line sync pulse and also during the frame flyback period. By a true a.g.c. system is meant one which has a performance strictly analogous to that of the ordinary kind used in sound receivers. It requires that the vision signal be gated at line or frame frequency so that the vision signal is passed to the a.g.c. detector only when the signal is at black level.

This results in a fairly complex circuit and this form is adopted by comparatively few set makers. Pye



Chassis of English Electric television receiver.



Ultra chassis. The tuner is mounted on the near side so that the controls project through the side of the cabinet.

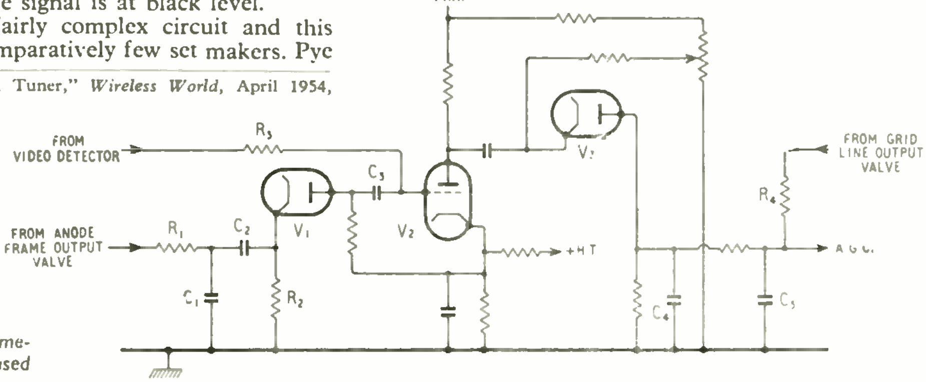


Fig. 2. Arrangement of frame-pulse gated-a.g.c. system used by Ultra.

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[1] "12-Channel Television Tuner," *Wireless World*, April 1954, p. 162.

were one of the first to employ such a gated a.g.c. system[2] and retain it in their VT4 model. Gating pulses are derived from the line time base and operate on the back porch—the black level after each line sync pulse.

Ultra use quite a different arrangement. It is a gated system, but one gated at frame frequency. The circuit is shown in Fig. 2. Positive-going pulses occur during the frame flyback on the anode of the frame output valve and are fed to the diode V_1 through the RC shaping network $R_1C_1R_2C_2$. This diode is normally conductive and is cut off by these pulses during a part of the frame-flyback period.

The signal from the video detector is applied to the grid of V_2 which is coupled by C_3 to the anode of V_1. This valve V_2 is biased beyond cut-off. The video signal is positive-going. Normally it is greatly attenuated at the grid of V_2 because the high resistance R_1 and the resistance of V_1 form a potential divider. It then does not operate V_2.

When a positive pulse cuts off V_1, however, nearly the full video signal appears on V_2 and since this is during the frame flyback period the video signal comprises only pulses changing from zero to black level. These pulses drive V_2 into conduction and produce negative-going pulses at the anode which make V_3 conduct to charge C_1 negatively to earth. Bias is applied to V_3 by a manual control to form the contrast control.

A minor peculiarity of the circuit is the connection of R_1 to the grid of the line-scan output valve! This, however, is only to obtain a source of negative bias. The output is driven into grid current and its grid consequently has a mean negative potential; R_1 and C_5 filter out the line-frequency components.

In contrast to this frame pulse gated a.g.c. system, Murphy use a line-pulse gated type in the V240A—a fringe-area model. The arrangement is sketched in Fig. 3. Gating pulses at line frequency are applied to the anode of V_1 through C_1; they are positive-going, are derived from the line time base and occur during the back porch of the signal. V_1 acts as a detector of these pulses, anode and cathode functioning as a diode. The current passed by the valve, however, depends on the grid potential and hence upon the magnitude of the video signal during the black signal of the back porch.

The resulting mean anode potential of V_1 is communicated to the grid of V_2 through R_1 and at the same time the gating pulses, reduced in amplitude by C_2, C_3 are passed to it. V_2 conducts to pass current on the gating pulses to an extent which is dependent on its mean grid potential and, therefore, on the video-signal amplitude. The output pulses of V_2 are thus related to signal strength and are rectified by D_1 to produce the a.g.c. voltage.

In view of the complexity of gated a.g.c. it is not surprising that many designers seek something simpler even if it is theoretically less perfect. English Electric adopt the simplest possible arrangement; the r.f. valve grid return is merely tied to the a.g.c. line of the sound channel. This is a reasonable arrangement when the main purpose of a.g.c. is to take up the variations of signal strength between two more-or-less local stations, because the ratios of the strength of the sound and vision channels will presumably be the same. It would be open to criticism, however, if it were intended to deal with a fading signal, for the sound and vision signals would not necessarily fade in the same way.

The usual course, however, is to adopt a system which, like the conventional sound-channel arrangement, operates on the mean signal level. In the H.M.V. Model 1828, the circuit of Fig. 4 is used.

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[2] "Vision A.G.C.," *Wireless World*, April 1953, p. 173.

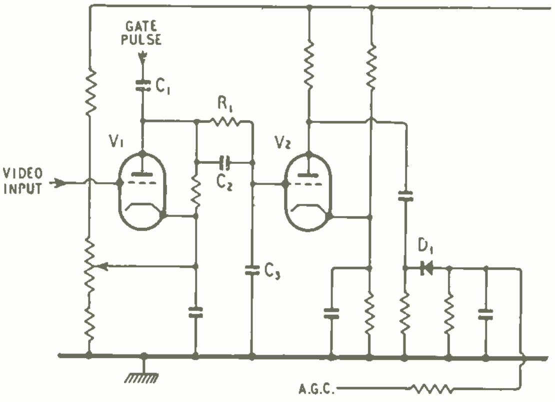


Fig. 3. Murphy line-pulse gated-a.g.c. circuit.

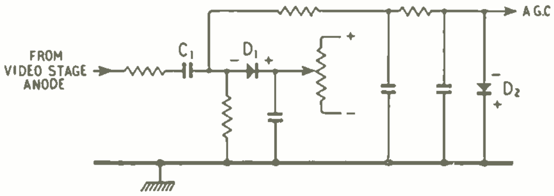
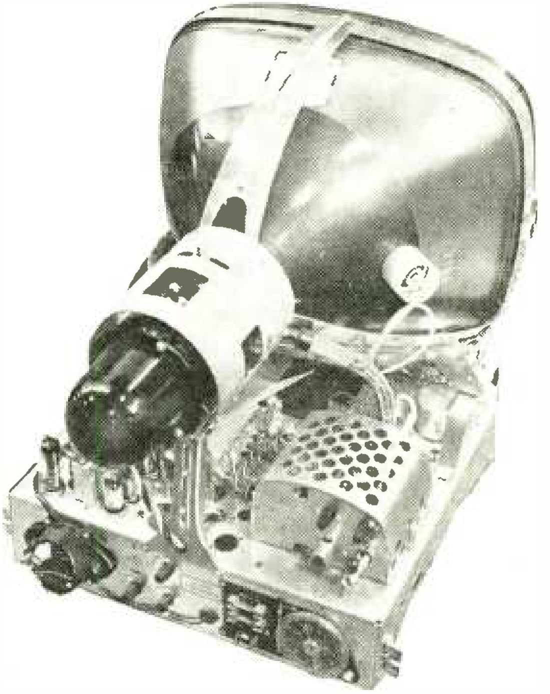


Fig. 4. A.g.c. circuit of H.M.V. fringe-area receiver.



Murphy chassis. Note the thorough screening of the line timebase, the deflector-coils and the inter-connecting leads.

The video signal is applied with positive-going sync pulses to D_1 which is biased by the manual contrast control. As a result a charge accumulates in C_1 representative of the mean signal level. This is applied with the video signal to the a.g.c. line via the RC filters which remove the video components.

The second diode D_2 is merely to prevent the a.g.c. line from becoming positive. As in another set referred to earlier, the negative voltage for the contrast control is obtained from the grid of the line output valve.

The a.g.c. bias obtained from a system of this type varies appropriately with any change of signal strength and it will readily deal with a fading signal. Its drawback is that it also varies with any changes of modulation which affect the mean brightness of the picture. It thus tends to keep the mean brightness constant whether this varies unintentionally with unwanted changes of signal strength or intentionally for artistic effect in the transmission.

This system is quite widely used in various forms and it is generally considered that its drawback is more than outweighed by its simplicity. Some may not, in fact, consider the maintenance of constant mean brightness a drawback for there seems to be some difference of opinion about the desirability of maintaining a fixed black level in the reproduced picture. The desirability of doing this is no longer taken as axiomatic.

Bush include this type of a.g.c. in the TV43 and do it without using any extra valves or metal rectifiers. A portion of the mean voltage on the sync separator grid is filtered in an RC circuit and fed back to an i.f. grid. The sync separator grid is acting in the usual way as a d.c restorer and so has a mean negative potential dependent on the signal strength and the modulation. The filters merely remove the video signal. Ekco adopted a similar arrangement last year.[3]

Flywheel sync is an arrangement which has been gradually creeping into fringe-area sets for several years but, contrary to some expectations, it has made little or no headway in other sets. Its use is still almost entirely confined to fringe-area sets. Murphy use a well-known form in the V240A; the sync pulses are applied to a phase-splitter and thence in push-pull form to a diode phase discriminator to which pulses are applied in parallel from the line timebase. A d.c. amplifier is used between the discriminator and the blocking oscillator and an unusual feature is the use of a non-linear resistance for the anode load of the amplifier. Its purpose is to stabilize the circuit against the effect of mains voltage changes.

A somewhat similar form of circuit is used in the Bush TV33, but a differentiating-cum-push-pull transformer is used in place of the valve phase-splitter.

Pye employ basically the same form of circuit, but it is the sync pulses which are applied in parallel to the diodes of the discriminator and the local pulses which form the push-pull input. A multivibrator type of saw-tooth generator is used and stabilized by a tuned circuit.

The flywheel circuit of the H.M.V. 1828 is quite different in the method of control, although it is of quite a well-known type. A sine-wave oscillator is used in the line timebase and controlled by a reactance valve. The sync pulses and the sine wave are compared in a balanced phase discriminator, the sine wave being the push-pull signal. The saw-tooth is subsequently derived from the sine wave by limiting and shaping circuits. This receiver is unusual in having a very long time constant in the flywheel circuit; it is, however, intended mainly for the reception of signals as weak as 25 μV and an unusually high degree of protection against noise and interference is considered necessary.

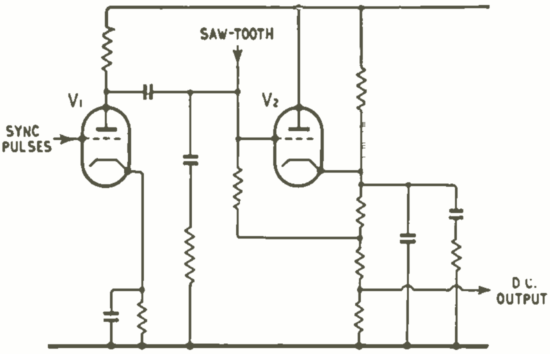


Fig. 5. Kolster-Brandes phase detector for flywheel sync.

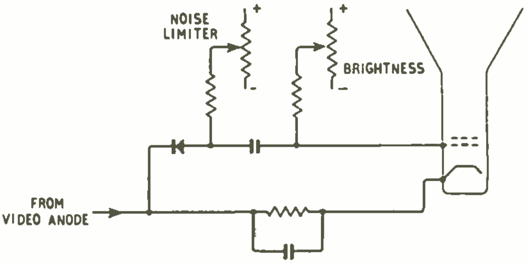


Fig. 6. Noise limiter of Alba TV14.

Kolster-Brandes use quite a different form of flywheel sync in the LVT50. It is an unbalanced circuit. A triode phase-reverser V_1, Fig. 5, delivers positive-going sync pulses to a cathode-follower detector V_2 to which is also applied a saw-tooth from the line timebase. The rectified output depends on the relative phase of the two signals and is applied to the blocking-oscillator to control its frequency.

Except in the fringe area sets, the normal method of direct locking is retained in most sets. Little change in methods of sync separation seems to have occurred, nor in timebase technique. Blocking oscillators and multivibrators are both popular for saw-tooth generators. Flyback e.h.t. and h.t. boost are universal in the line timebase, except in the case of projection types, and it is still usual to employ a line-scan auto-transformer with a core of Ferroxcube or other low-loss material. The use of a Ferroxcube-cored inductor partially saturated by a permanent magnet for securing linearity of scan is growing, but some firms still retain the older damped resonant circuit for this purpose.

Representatives of the single-valve line timebase (not counting the efficiency diode or e.h.t. rectifier) are still to be found and Stella have adopted it in the ST8317U. The circuit is a well-known one, the control and screen grids of the output pentode being coupled by a transformer. Cossor, however, use a multivibrative form of

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[3] "Radio Show Review," *Wireless World*, October 1953, p. 446.

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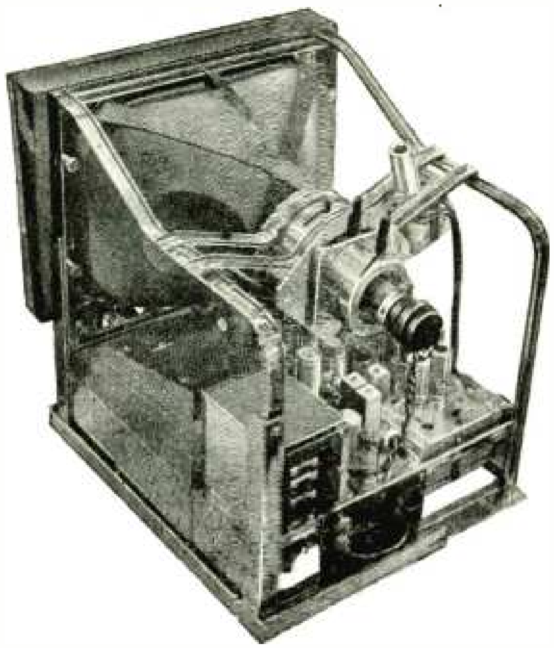


McMichael receiver chassis with shrouded deflector-coil assembly supported by guard rails.

timebase in which the output valve forms one of the multivibrator pair. This, again, is quite a well-known arrangement.

Although the use of an auto-transformer for coupling the output valve to the deflector coils, with an overwind for e.h.t., is still general, a few makers are adopting the so-called direct-drive circuit.[4] In this the deflector coil is placed directly in the anode circuit of the valve and the energy dissipated within it during flyback is replaced by the transference of energy from a loading coil capacitively coupled to it. The loading coil is made in the form of a transformer and produces the e.h.t. Murphy have adopted this arrangement in all models.

Normal practice, with all the usual variations in matters of detail, is followed in the frame scanning circuits. One new feature which is tied up with the frame timebase is flyback suppression, which is now applied in quite a large number of sets. In fact, if it has not already become, it is rapidly becoming, a normal part of a television set. It consists in the application of a blackout pulse to the c.r. tube during the frame flyback so that the flyback lines do not show.

Until recently this has not been considered necessary because the sync pulses themselves, which are always applied to the tube with the picture signal, are supposed to provide the necessary blackout. However, the desirability of maintaining the full black level at the tube is a controversial matter and quite a number of set makers deliberately reduce it and maintain that by doing so a better picture is secured.

In most sets the video signal is applied to the cathode of the tube and flyback suppression is effected by applying a negative-going pulse to the grid, although a few people feed a positive-going pulse to the cathode. Alba do this in their TV14 and the suppression circuit is nothing more than a resistance and capacitance in series connected between the anode of the frame-scan output valve and the cathode of the tube. Pye do much the same, but include an RC pulse-shaping circuit. Pilot, in the TV84 and TV87, apply the pulse to the tube grid and obtain it by inserting a resistor in series with the charging capacitor of the timebase. Kolster-Brandes do this also, but develop the pulse by differentiating the saw-tooth across the charging capacitor; Bush do very much the same.

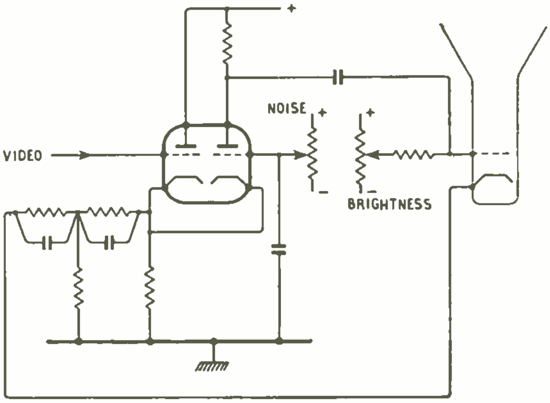
Noise suppressors are invariably fitted and take many varied forms. The commonest is probably the biased diode in shunt with the video output, but Stella use an even simpler scheme. The limiting action is obtained merely by applying a suitable negative bias to the suppressor grid of the video stage. This causes the anode current to saturate at a value dependent on the bias and so to limit the signal.

Alba use a method which is basically as simple as the shunt diode, but which applies the interference to the grid of the tube in the manner of a black spotter. This is shown in Fig. 6. The germanium crystal diode is non-conductive until the signal exceeds the bias voltage. It then conducts and the signal is applied to both grid and cathode and the potential difference between them is kept constant to give a limiting action.

Pye adopt a black-spotter. As shown in Fig. 7 a triode cathode follower is used for the video output and feeds the signal to the cathode of the c.r. tube. It feeds it also to the cathode of a second triode which is biased to be inoperative until the signal exceeds

Pam Band III convertor chassis.

Fig. 7. Black spotter used in Pye sets.



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[4] "Simple Line-scan Circuit," by W. T. Cocking, M.I.E.E., *Wireless World*, August 1952, p. 305.

peak white. When it conducts amplified interference voltages appear at the anode in the same phase and are applied to the grid of the tube. Because of the amplification the noise signal on the grid can exceed that on the cathode and so black out the spot.

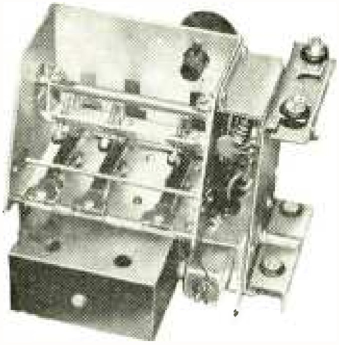
A trend which started some years ago towards the use of higher intermediate frequencies has been accelerated by the need for Band III reception. Frequencies between 30 and 40 Mc/s are now usual and are about as high as is possible. The precise figures vary from one maker to another. Thus Bush use 34.5 Mc/s for vision and 38 Mc/s for sound. Whereas H.M.V. employ 34 and 37.5 Mc/s. Three stages of amplification in the vision channel and two in the sound are quite common, although quite a number of sets have only two vision i.f. stages. Coupled pairs of circuits are quite widely used in conjunction with trap circuits for sound-channel rejection.

Trap circuits make their appearance in the aerial feeder circuit, too, here mainly to prevent the break-through of any signal on the intermediate frequency. The increase of intermediate frequency has made this risk greater since it is now nearer the signal frequency; hence the introduction of trap circuits to counter it.

Contrary to some expectations very few Band III convertors were on view. The technical problems of making a convertor for use with any receiver are considerable, and most of those exhibited were designed for use with specific sets. Ferguson, for example, had four different models for use with different Ferguson sets. One of the few for more or less general use is the Pam. It is self-contained with its own power supply and connects to the aerial feeder socket of the receiver. It is "straight-through" on Band I and a superheterodyne convertor on Band III. The circuit is a little different from the usual in that the input double-triode is not used as a cascode amplifier, but as a cathode-follower feeding an earthed-grid stage; also, the frequency-changer is a double-triode.

As already mentioned, 14-in and 17-in tubes, often rectangular, are now general. The 12-in seems to be on the way out and the 9-in has gone. Grey-tinted tube faces, or safety screens, are also general, so much so that the few white screens look a little odd. The extremely dark screens of a few years ago are less common, however, and a rather pale grey, which one does not always realize to be grey until one sees it alongside a white tube, is usual. A few people, notably Murphy, make the so-called light filter an optional extra.

One very welcome tendency is towards fitting the subsidiary controls at the front instead of at the back of the set, often covered by a hinged panel. This is probably a result of the bigger tubes which have made the adjustment of back controls not merely difficult, but quite impossible without a mirror. There is, too, a definite improvement in the standard of workmanship in receivers. Much better mechanical design is evident and, in the main, accessibility has been greatly improved.



Ferguson Band III convertor.

One result of the widespread use of larger c.r. tubes has been a decrease in the number of projection sets of the domestic kind. Ferranti retain the system in the 20T4D for a picture of 20-in diagonal and use a push-pull video stage, the signal being applied to both cathode and grid of the c.r. tube. This tube is, as usual, a 2½-in type operating at 25 kV and is used with a Schmidt optical system.

In the main, however, projection is now used for pictures of some 5-ft diagonal, and for this size of picture front projection is general. White-Ibbotson and Nera both demonstrated receivers in this category. Electrically these sets differ little from the more ordinary types. The use of projection does not affect the signal requirements prior to the video stage. Time-base circuits, too, are not much different; they are often basically simpler since less scan power is needed and flyback e.h.t. is not employed. They are, however, complicated in another way by the provision of safety circuits arranged to black out the tube in the event of a timebase failure. E.h.t. comes from an a.f. oscillator and voltage-tripler rectifier.

A newcomer in this field is H.M.V. with a 5-ft front projection picture provided by a 3¾-in tube operating at 28 kV. A feature is that focusing can be achieved without accurately placing the equipment relative to the screen. The screen is aluminium and curved on its longer dimension.

TELEVISION AERIALS AND ACCESSORIES

THE impression was given that most aerial makers have shrewd ideas as to what will be required for alternative programme reception, but are reluctant to come out into the open yet awhile. Apart from one or two firms who had dual-band aerials, most other makers were content to show various types of single-band arrays for Bands I, II and III. Band-II aerials are not included here, but not one single example was found of a combined television and f.m. aerial system.

Some useful purpose was served by showing separate aerials for both television bands, as some viewers will undoubtedly elect to use a separate aerial for Band III when the time arrives rather than disturb the existing one. It was reassuring to those who may have been in some doubt as to the wisdom of mounting the two aerials on one pole as the much shorter elements of the Band III types makes for a smaller and lighter aerial, even if one or more elements are wanted to give a comparable performance.

In general the 200-Mc/s models shown had more elements than the average Band I aerial and this is in keeping with most predictions, which assert that where a 2-element aerial now suffices for Band I a 3- or even 4-element system will most likely be wanted for the new service.

Even when separate aerials are used there is no necessity to run separate feeders to the receiver and a common feeder for at least the greater part of the

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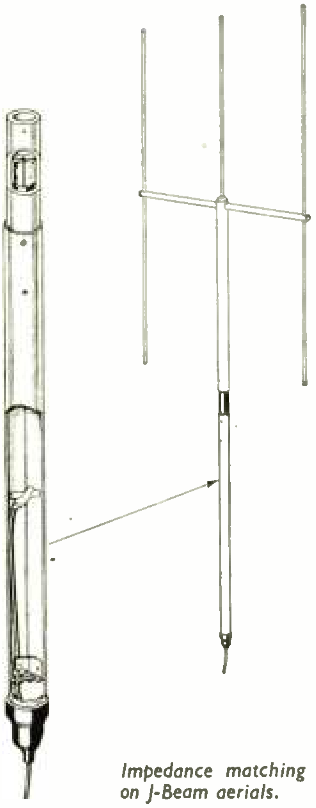
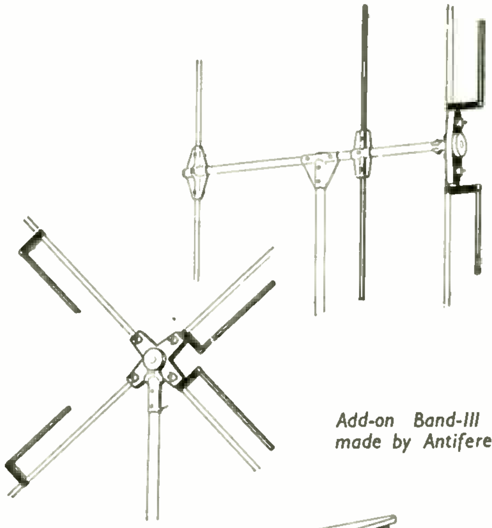
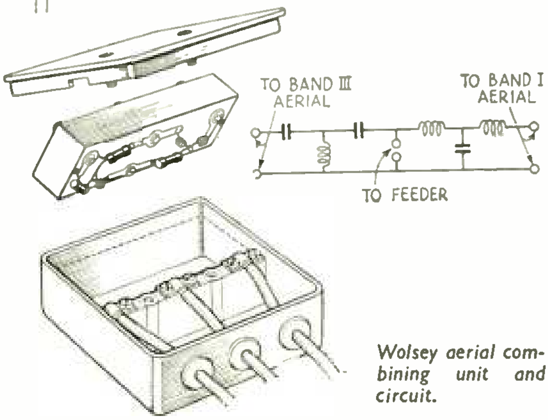


Impedance matching system used on J-Beam aerials.



Add-on Band-III aerial elements made by Antiference



Wolsey aerial combining unit and circuit.

distance can be made to answer the purpose without appreciable loss of signal strength from either aerial used alone. It is admitted that the Band-III feeder will generally have to be of a high grade—which is only another way of saying lower loss—than suffices for Band I, apart from the fringe areas. The Band III fringe area boundary is expected to be much closer to the station than the Band I, hence the general need for higher-gain aerials for this band.

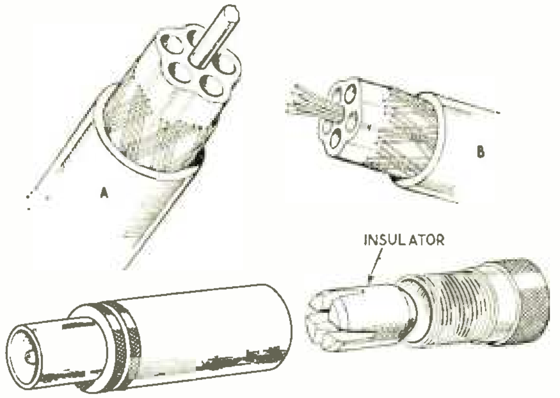
Combining two aerials to work into a single feeder is effected by a small unit introduced by Wolsey, and described as an aerial cross-over unit. It consists of two filters assembled back-to-back and terminating at the common junction in a single coaxial cable outlet to the receiver. The open ends of each filter join respectively to the two aerials by coaxial cable. The unit can be mounted outdoors on the mast supporting the two aerials, in the loft when relatively short runs of cable to each aerial are practicable, or anywhere else that is convenient. No switching is required at the aerial end of the common feeder, as the filters automatically separate the aerials electrically and quite negligible loss is introduced in the process. For example, the insertion loss is never greater than 1 db on Band I and 0.5 db on Band III; this is for a maximum signal rejection of 40 db in both cases.

Some dual aerial systems were, of course, shown. Telerection had two of the models exhibited last year, but which lose nothing in interest by their second appearance, especially as alternative television is now nearer realization. A rather novel approach to the problem is the add-on Band-III aerial elements devised by Antiference. These are short quarter-wave, or thereabouts, rods with right-angled brackets and clips for securing to the elements of existing Antiference "H" and "X" Band I aerials. It is proposed eventually to embody the novel capacitance method of coupling used on all Antiference aerials for these new attachments.

Antiference say that the add-on elements are not noticeably detrimental to the behaviour of the aerial on Band I and, curiously enough, actually show a gain of some 3 db over a normal 2-element aerial on Band III. Apparently the surplus structure of the larger aerial is reinforcing the signal pick-up on Band III and an increase in gain such as this is just what will be required in many cases to give a comparable performance on both bands.

A rather novel type of aerial was a skeleton slot shown by J-Beam Aerials for use on Band III. Little information is vouchsafed regarding its method of operation, but it is said that with a single reflector, at right angles to the orientation of the slot, a gain of 7 db over a conventional dipole is obtained. It behaves quite differently to a dipole, as was explained in a recent article in *Wireless World*, and shows horizontal polarization characteristics when erected with the slot vertical and *vice versa*.

Another unusual type of television aerial is formed by bending a conventional half-wave dipole into a square with insulators in the two opposite vertical sides (for vertical polarization). A low-impedance feeder is joined across one insulator and the aerial has a heart-shaped response (in the horizontal plane) rather like an "H," "K" or "X."

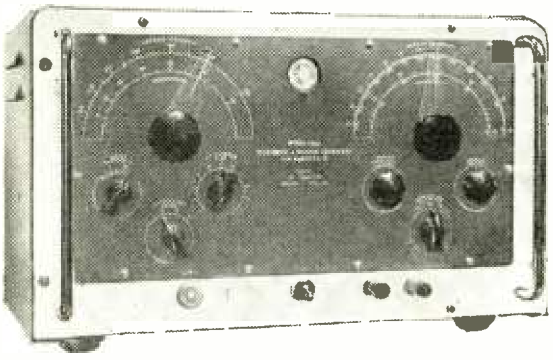


Aerialite semi-air-spaced coaxial cables (enlarged 4-5 times.) A is the "Super" and B the "Standard." Easy-fix plug also shown.

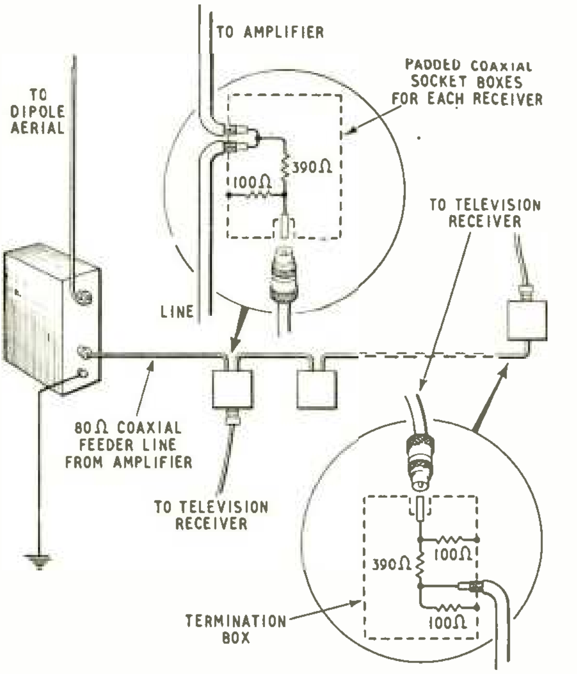
Whether or not the promise of Band III television and Band II f.m. broadcasting has influenced the design of coaxial cables is difficult to say, but the fact remains that Aerialite have evolved a new method of extruding the polyethylene insulation used in small-size v.h.f. aerial cables which provides five longitudinal air-channels and thus reduces the dielectric loss. The interesting feature of these new Aeraxial cables, as they are called, is that the improved characteristics are obtained at no increase in price. There are two types available, a Standard Aeraxial of 0.2 in (approx.) outside diameter and with a flexible centre conductor of 7/0.0076 in copper wires. Its loss per 100 ft is 2.1 db at 45 Mc/s rising to 4.5 db at 200 Mc/s. The Super Aeraxial measures 0.3 in (approx.) overall, has a 0.048-in solid copper centre conductor and the losses are 1.2 db at 45 Mc/s and 2.6 db only at 200 Mc/s. Both are nominally 70 ohms.

Another new aerial accessory is a coaxial plug with simplified cable fixing. It has three main parts only, a body, an insulator and a clamping nut. The centre conductor of the cable has to be soldered in, but heat-resisting insulation is used at this point; the main insulation is polyethylene.

The majority of television aerials—slots now excepted—have the feeder joined in the centre of the main dipole, where the impedance is nominally 70 ohms. However, the addition of parasitic elements and close spacing cause wide changes in the aerial impedance at this point and it can be as low as 10 or 12 ohms. Impedance matching between aerial and feeder is almost always used in television aerials although this may not be visible, as in the case of Belling-Lee and some other makes where the matching section is embodied in the cross-arm, or other convenient part. In other makes it is visible, the "delta" match of Telerection, for example, and now in the new Wolsey "Deltex" aerial. Here the "delta" matching unit is neatly tucked away in one of the angles of the "X."



Cossor Model 1322 dual-band Telecheck.



Belling-Lee distribution system for 10 television sets.

The only known exception to the more general centre-feed method of feeder connection is the end-feed adopted by J-Beam Aerials. It enables the aerial dipole to be made an extension of the mast by interposing an insulator at the base of the aerial, and the feeder (70-ohm coaxial) is run up inside the mast and joins to a quarter-wave matching transformer embodied in the top part. The whole is totally enclosed and weatherproof. It can be used with both vertical and horizontal types of aerial.

The distribution of television from a communal aerial has become quite an important factor to-day. This has for long formed one of the many activities of Belling-Lee, who this year have introduced a new distribution amplifier for feeding up to 10 television receivers. It has an overall gain of 20 db and, in conjunction with special feeder outlet boxes supplies each set with an adequate signal and without interaction between the various sets. It is entirely self-contained and operates from the normal a.c. mains. It is not a mast-head amplifier, although Belling-Lee make one of this kind. The drawing reproduced here shows a typical distribution system with the types of junction and termination boxes employed at each receiver point.

The initial adjustment, and subsequent maintenance of tunable all-band television sets, naturally requires the right kind of signal generator and so it was not unexpected to find new models covering the two television bands; also adaptors to extend the usefulness of existing test sets to Band III.

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The extension unit introduced by Cossor, for use with their Telecheck television alignment and pattern generator, takes the place of the internal variable oscillator, and the new unit's output, when mixed with the fixed oscillator in the Telecheck, gives an r.f. output in the range 155 to 225 Mc/s. It can be permanently attached to the Telecheck and provides on Band III all the facilities for alignment, bandwidth and linearity checking given by the main unit on Band I. Another new Cossor television test set is the Telecheck and Marker Generator. This is an elaboration of the ordinary Telecheck and provides carrier frequencies over the bands 10 to 70 and 160 to 220 Mc/s with a wobbulator for frequency-modulating the r.f. from 1 to 10 Mc/s and a marker oscillator covering 10 to 22 Mc/s with harmonics up to 220 Mc/s. This is for applying marker pips on the displayed response curve. A separate oscilloscope is used with this set. There is also a built-in crystal-controlled oscillator for accurate calibration of the marker oscillator.

Several firms were showing new dual-band television pattern generators; one, the Radar Model 405, made by Waveforms, provides a pattern of either vertical or horizontal bars, or a combination of both, and one pattern is stepped and graded. In all, five different patterns are provided as well as 30 per cent sine-wave amplitude modulation for adjusting the sound receiver and rejectors. The coverage is 40 to 70 and 180 to 210 Mc/s.

Dual-band television test sets providing checkered patterns are made also by Telequipment and Channel Electronic Industries. The former's set is an extension of the single-range model available hitherto. It covers 40 to 70 and 180 to 210 Mc/s in two ranges, and in addition to providing a variety of patterns for linearity adjustment, enables the receiver's response to be checked in steps of 1.5, 2, 2.5 and 3.0 Mc/s. Internal sine-wave modulation to a depth of 80 per cent is available for sound receiver and rejector adjustments.

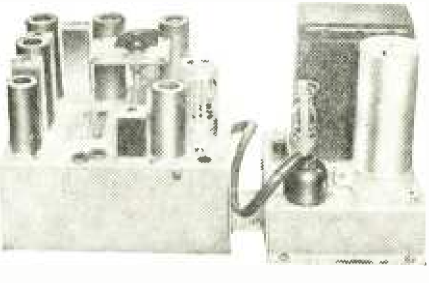
SOUND RECEIVERS AND REPRODUCERS

THE announcement of the building programme for the B.B.C.'s new v.h.f. (f.m.) transmitters came at a time when most manufacturers' plans for the new season's sets were well advanced. Consequently the impact of the "alternative service" on the pattern of sound broadcasting has not been as disturbing as some people predicted. True, there were not many set manufacturers who were not showing a cabinet with a dial or switch marked "F.M.", but fewer than a dozen were forthcoming with any information about the interior workings. In general, the structure of the sound receiver market remains much as it was last year, with table models at about £20-£25 as the backbone and self-contained transportables and the moderately priced radio-gramophones in a numerically strong position.

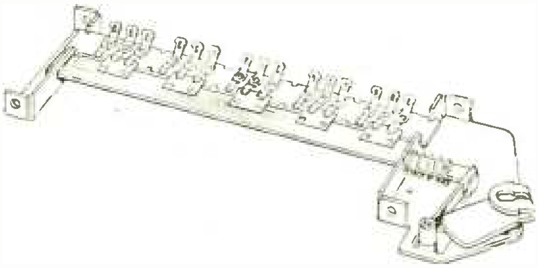
Problems arising from the addition of a v.h.f. range and a frequency discriminator to a receiver, designed to receive also the usual short, medium and long waves, have been reviewed in last month's issue.* Judging by the circuits which have so far passed the drawing-board stage, the ratio detector seems to be the most favoured type of discriminator. This circuit, when properly balanced, shows a high inherent rejection of amplitude modulation, and no separate limiter stage is required. At the intermediate frequency (of the order of 10 Mc/s) used after the v.h.f. mixer, two stages are necessary, and the heptode section of the medium- and long-wave mixer is pressed into service for the additional i.f. stage. The coupling transformers are connected in series and in most cases no switching is provided for the windings not in use. Most firms are using a double triode as a self-oscillating mixer and r.f. stage. The earthed-grid connection is favoured for the amplifier, and there is plenty of variety in "trick" methods of neutralizing, which are far more complex than the circuit diagram would imply. Stray capacitances are important, and to reduce those which are not wanted, new switch designs are being evolved. A typical example is the strip switch made by Plessey. This is cam operated and can be "cut to length" to bring the contacts close to the relevant parts of the circuit.

An exception to the general run of f.m. circuits is to be found in the Dynatron Type FM1 tuner unit. This has been designed to deliver about half a volt to the pickup terminals of the firm's radio-gramophones, or any high-quality amplifier, and a power pack is available in cases where the main amplifier cannot supply the required l.t. and h.t. There is much to be said for a separate f.m. unit, since the designer is free to choose the best valves and circuit for the purpose. Switched pre-tuned circuits for the Home, Light and Third programmes have been favoured in preference to continuously variable tuning, which can produce unpleasant sounds during the tuning process. Particular attention has been given to frequency stability. In addition to normal precautions against thermal drift, a separate reactance valve is provided to give automatic frequency control in conjunction with a Foster-Seeley detector.

Receivers for normal amplitude-modulated stations show few deviations from long-established practice, so



Dynatron FM1 tuner and power supply unit.



Slide switch designed by Plessey for use in a.m. f.m. receivers.

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* "Combination F.M./A.M. Receivers" by G. H. Russell. *Wireless World*, September, 1954, pp. 431-436.

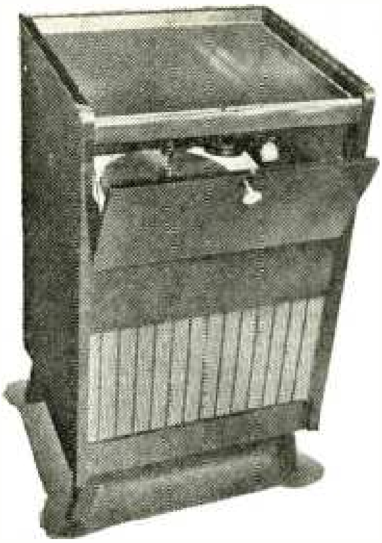
far as their circuits are concerned. There is a tendency to fit more internal aerials for high signal-strength areas, and ferrite rod aerials are more common than last year. At least one receiver, the Champion Model 822 battery portable, makes use of a "printed" circuit to give compactness and light weight. Most innovations are of an exterior rather than an interior nature, and the current vogue for clock tuning dials owes its origin to the combination of a real electric clock with alarm and switch accessories with a broadcast receiver as in the Ekco "Radiotime," the Philips Model 342A and the H.M.V. Model 1127.

Original ideas in cabinet design are still forthcoming, and we select for special commendation the glass-top solution to the problem of scratches and stains in the Trix "Recital" console record player, and the McMichael medium- and long-wave sound receiver (Model TT4) built into a trolley which can be used as a pedestal for a table-model television receiver.

In the field of sound recording and reproduction the event which has provoked the widest comment at the Show is the announcement that H.M.V. are issuing tape records as well as their long-playing and standard disc records. The low background noise, constant linear speed and long duration of these tapes will make a special appeal to high-quality enthusiasts. The tapes can be played on any high-grade dual track instrument, provided it conforms to the British Standard recommendation of tape motion left to right, using the top track with the coating away from the observer. The tape speed is $7\frac{1}{2}$ in/sec and the makers claim that frequencies up to 15 kc/s are recorded at this speed. A console reproducer (Model 3030) making use of a modified "Emicorda" deck has been designed by the Gramophone Company for their new tapes.

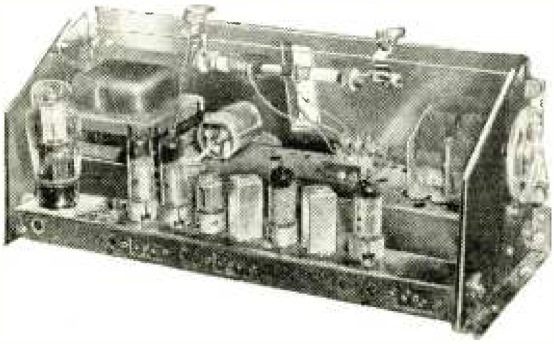
A high-quality tape reproducer (Model TR1) has been added to the "Reflectograph" range of instruments made by Rudman, Darlington. The interesting feature of this instrument is its variable speed control (3.75 to 8.5 in/sec) which enables exact musical pitch to be achieved. A response level within ±4 db from 50 c/s to 14 kc/s is claimed. The "Reflectograph" is used also for scientific and industrial data recording using pulse modulation methods.

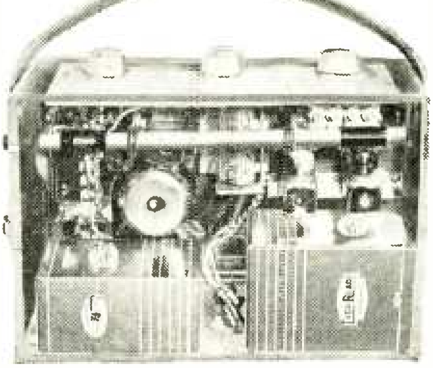
The "Ferrotutor" introduced at the Show by the British Ferrograph Recorder Company is designed primarily for language teaching. Suitably spaced phrases are recorded by the teacher on one track and are heard on headphones by the pupil, who replies or repeats the phrases and records them on the second track. The second track can be erased and the exercise repeated. Another application of this instrument is in the preparation of illustrated lectures. A com-



Trix "Recital" record player.

McMichael trolley receiver (Model TT4).



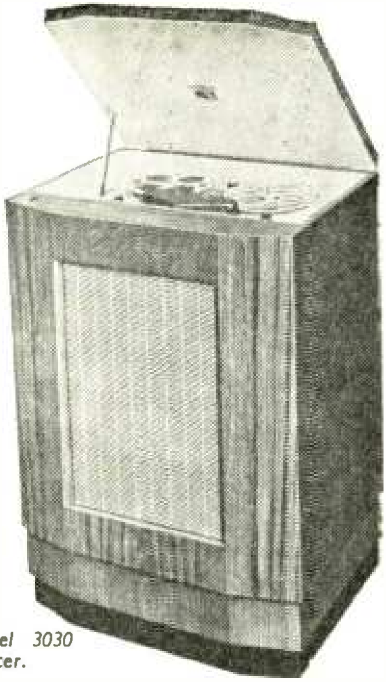


Ferrite rod aerials are used in the R.G.D. "One-Ten" receiver and the Roberts portable.

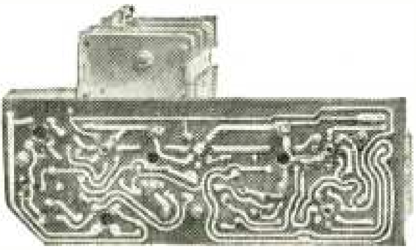
mentary is recorded on one track, while pulses on the other track are used to operate an automatic film-strip projector and display a sequence of pictures at appropriate intervals.

Tape threading is not a very difficult operation, but it can be time-wasting in an office, and in the "Tape Riter" dictating machine made by Hartley Electromotives it is interesting to find that cassette loading of both supply and take-up spools has been adopted. Other notable features of this machine are the fingertip controls centralized on the microphone barrel, and the fact that the microphone itself can be used as a miniature loudspeaker for low-level playback when normal reproduction from the built-in loudspeaker would be obtrusive.

The weight of magnetic recorders shows signs of a steady downward trend, and some are within reach of meriting the term portable. The "Playtime" recorder made by Tape Recorders (Electronics), Ltd., weighs only 16lb and measures 12½in × 10in × 4½in. It is driven by a single motor with belt drive for the capstan flywheel and take-up spool, the latter through a cork friction clutch. Fast re-wind is effected by engaging a friction wheel with the back of the driving belt. All electrical and mechanical functions are combined in a single "gear lever" control. There is no loudspeaker and power amplifier, and it is intended that the output should be fed to the pickup terminals of a receiving set or gramophone amplifier.



H.M.V. Model 3030 tape reproducer.



Printed circuit technique used in the Champion Model 822.

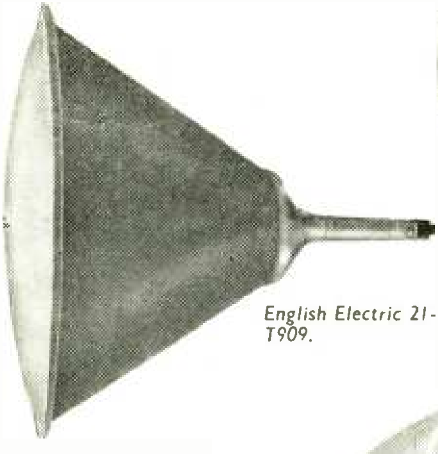
Hartley "Tape Riter" with cassette loading.

CATHODE-RAY TUBES AND VALVES

IN our Show report last year we predicted a trend towards even larger cathode-ray tubes than the popular 17-in rectangular type and hinted that there would soon be a number of 21-in tubes on the market. This has now been borne out by the evidence of this year's exhibition, where some half a dozen manufacturers were showing new tubes of this size. In alphabetical order they were the Brimar C21HM, the Ediswan CRM211 and CRM212, the English Electric T909, the Ferranti TR21/21, a G.E.C. development model and the Mullard MW33-21. All these are rectangular glass tubes except the English Electric T909, which is a circular metal-cone type like an earlier 21-in tube, the E.M.I. type 4/13.

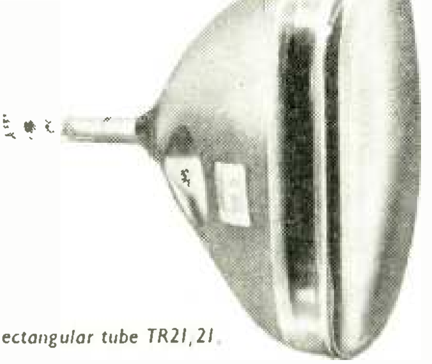
The metal-cone types are necessarily circular because of the method of manufacture, and consequently they take up more space in the cabinet than the rectangular types for a given size of picture. On the other hand they have the advantage of being only about 60% of the weight of equivalent glass tubes. Moreover, the construction of the English Electric metal tubes makes possible the reconditioning service which this firm has been running for some time.

As a rule the new 21-in tubes have deflection angles of about 70° and are therefore known as "wide-angle" tubes. It seems, however, that this will soon become an archaic expression, as "miniature" valves is already becoming, for there is a definite trend towards even wider deflection angles of about 90°. It was started last year by G.E.C. with a 12-in tube (again on show) and was continued this year by two of the new 21-in tubes, the Ediswan CRM212 and the Ferranti TR21/21. On these large tubes there is a very great

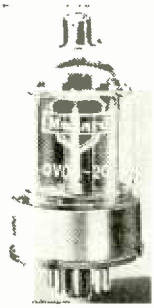


English Electric 21-in metal tube T909.

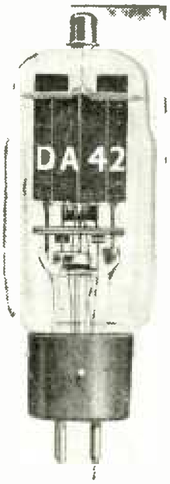
E.M.I. 3¾-in projection tube, type 3/17.



Ferranti 21-in rectangular tube TR21/21.



Mullard QV06-20 beam tetrode.



Osram DA42 triode power valve.

need for the new "wider angle" in order to reduce their considerable length (normally close on 2ft). The increase from 70° to 90° actually gives a saving in length of about 3-4 inches.

The operating characteristics of the 21-in tube are fairly well typified by the Brimar C21HM. With a final anode voltage of 16 kV and 300 V on the first anode, the modulating voltage required for beam current modulation of up to 150 μA is 30 volts peak-to-peak. The grid voltage limits for beam cut-off are −33 to −77 volts.

It is clear, however, that manufacturers are not going to stop at 21-in tubes. Last year Cathodeon were showing a 27-in tube and now Ediswan have produced one of this size, the CRM271. It is a rectangular type with a tinted glass face plate and gives a picture size of 24in × 18½in. Here again the firm have used the new 90° deflection angle and the length of the tube is just over 23 inches. The heater requires 12.6 V, 0.3 A and the final anode voltage is 16 kV.

With such large tubes as these the picture size becomes comparable with that of projection television. Moreover the directly-viewed pictures are generally a good deal brighter. Perhaps in recognition of this fact, a new projection tube has made its appearance giving a much brighter picture than is normally obtainable. This is the E.M.I. Type 3/17 and the greater light output is obtained by increasing the area of the screen and raising the e.h.t. voltage to about 28 kV. The screen diameter is actually 3¾in, compared with the 2½in of the existing projection tubes. A triode gun is used and the screen is aluminized. The maximum beam current is about 300 μA and the heater rating is 4-V, 1 A.

Another interesting development is the use of electrostatic focusing in cathode-ray tubes. It was first announced by Brimar last year and now they have another tube incorporating it, the C17JM. This is a 17-in rectangular tube with 70° (diagonal) deflection angle and a final anode voltage of 14 kV. The focusing action is achieved by an extra cylindrical electrode which is interposed at a gap in the long final anode cylinder. The control voltage applied to this is normally at about cathode potential but can be varied anywhere between −64 V and +350 V to obtain correct focusing. The first anode voltage is 300 V.

Whether electrostatic focusing will become popular or not is open to question. Although it avoids the need for external focusing arrangements it also makes the tube electrode structure more difficult to align in manufacture and consequently more expensive. There are signs, however, that other firms besides Brimar are actively interested and before long there may be more tubes of this type on the market.

Since the first spate of valves for Band III television tuners at the beginning of the year there have been no new types in this category. Brimar, Ediswan, Mullard and Osram all have their versions of the well-known cascode r.f. amplifier and triode-pentode frequency changer combination.

Most manufacturers, too, are building up ranges of valves for a.m./f.m. receivers, partly from existing types and partly by the introduction of new types. Among the latest of the new types are the Osram X719 triode-heptode frequency changer and the W719 variable-mu r.f. pentode, which has the high slope of 6 mA/V. Both valves are on the B9A base and have 6.3 V, 0.3 A heaters. In the Mullard range are the v.h.f. double triode ECC85, a triple-diode-triode EABC80 for use in ratio detectors, a versatile triode heptode ECH81 and a variable-mu r.f. pentode EF85.

Among new audio valves is the Osram N709 output pentode which is used in the output stage of the "912" high quality amplifier. It has an anode dissipation of 12 W and a maximum output of 17 W is possible from a push-pull pair. Another new power valve just introduced by this firm is the DA42 triode, which is intended for class B operation and will give an audio output of 175 W per pair.

A power valve with a very wide range of possible applications is the Mullard QV06-20 beam tetrode which has an anode dissipation of 20 watts. It will

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operate at full ratings at any frequency up to 60 Mc/s and at reduced ratings up to 175 Mc/s. A single QV06-20 in class C operation will deliver 69 watts at 60 Mc/s, while at audio frequencies a pair in push-pull, class AB_1, will give 120 watts. The slope is 7 mA/V.

Sub-miniature and special-quality valves are used more in military equipment than in domestic apparatus, but they are, none the less, now on the market for those who want them. The latest range of special-quality valves comes from Mullard, who have equivalent types to their well-known EB91, ECC91, EC91 and EF95. This firm have also produced a range of sub-miniatures which includes some rather interesting developments. The directly-heated triode DC70, for example, which is capable of operating efficiently at 500 Mc/s, giving an output of 450 mW as an oscillator. For the lower frequency of 200 Mc/s a sub-miniature battery pentode, DL73, is available, having an output of over 1 watt as a class C amplifier. Indirectly-heated sub-miniatures are also included with performances at least as good as comparable miniature types. Type EF72, for instance, has characteristics similar to the EF95 (6AK5) low-noise pentode, but has the lower heater consumption of 6.3 V, 0.15 A.

Many of these sub-miniatures are of the 10-mm diameter round type, the length ranging from about one to two inches. A group of smaller valves, the flat sub-miniatures, has also been developed. These are 1.25-V filament types on the B5A base, and are similar in size to hearing-aid valves. Some of these are provided with metallized bulbs for screening purposes, the metallizing being connected to the negative filament lead. The flat sub-miniatures have bulbs about 8.5mm wide and 6mm deep, the bulb length being of the order of 1½ in. A typical example is the DF62, an r.f. amplifying pentode for use in receiver input stages at frequencies up to 200 Mc/s. Flat versions of some of the 10-mm receiving valves have also been developed. They include a straight r.f. pentode, a variable-mu r.f. pentode, and a low power audio output valve, all with 25-mA filaments.

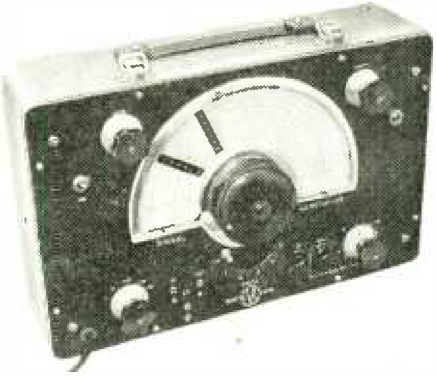
An even smaller valve, a 5-mm round sub-miniature on the B5B base, is the EA76 indirectly-heated diode. With a length of just over an inch, it is comparable in size with a germanium diode. Other valves in this sub-miniature range are a high-voltage rectifier, a tetrode thyratron, a voltage stabilizer, two low-consumption electrometer valves, and several low-power u.h.f. amplifier and oscillator valves.

OTHER EXHIBITS

DEVELOPMENTS in test gear are generally a reflection of what is going on in the rest of the radio world and this year, of course, the theme was Band II f.m. and Band III television. A new signal generator which covered both of these was shown by Avo. It has a frequency range of 5 Mc/s to 225 Mc/s which is divided into five bands. Four of these give an output which can be amplitude modulated by a sine wave or square wave of 1,000 c/s, while the fifth provides signals in the band 80-100 Mc/s which can be frequency-modulated by a 1,000-c/s sine wave. The carrier deviation on the f.m. band is ± 40 kc/s and the output of the instrument is 100 mV.

The new signal generator shown by Taylor, model 67A, also covers the Band III television frequencies. The frequency range is 100 kc/s to 120 Mc/s on fundamentals and this is divided into six bands, while on the top band the use of second harmonics brings the coverage up to 240 Mc/s. Modulation of approximately 30 per cent is provided by a 400-c/s audio oscillator, and a ladder type attenuator gives a total attenuation of 120 db. It is claimed that careful r.f. screening has kept the direct radiation down to the level of minimum output.

Interest in Band III techniques has rather tended to over-shadow developments in the less spectacular field of closed-circuit industrial television. Here the trend has been towards lighter and more compact equipment. Both Pye and Marconi were showing new models with miniature cameras measuring only about 5in × 5in × 11in and weighing only a few pounds. They both use small photo-conductive pick-up tubes of about 1-in diameter and the scanning standards can be either 525 lines or 625 lines. The video signal is used to modulate an r.f. carrier which can be tuned to any frequency between about 52 and 84 Mc/s and gives an output of 0.1 V. Pye also have a model designed for the British 405-line standards with an r.f. output tunable over the B.B.C. channels. In both makes of equipment there are three units altogether, camera, control unit and monitor, the transmitting circuitry being housed partly in the camera and partly in the control unit. In the Marconi equipment,


Avo signal generator for Band III and f.m.


Marconi miniature camera for industrial television.

for example, the camera contains the video amplifier, the sync and vision waveform mixer, a sync clipper and the r.f. oscillator, while the control unit houses the deflection circuits and sync and blanking pulse generators.

Another interesting example of miniaturization in television was an experimental line time-base oscillator using an OC51 point transistor. It was shown on the Television Society stand by C. H. Banthorpe and in size it only occupies a 2-inch cube. The time-base functions on the negative resistance characteristic of the point transistor and is intended to be used in a flywheel sync circuit. Control of frequency is effected by varying the h.t. supply.

Transistor circuits generally are characterized not only by their small physical size but by their low operating voltages. Component manufacturers are now realizing that the low voltage feature can be utilized to achieve an even greater degree of miniaturization in the parts surrounding the transistor. As an example, T.C.C. were showing some miniature capacitors for transistor circuits with exceptionally large capacitances for their size. Measuring only $\frac{1}{2}$in long by $\frac{1}{8}$in diameter they gave 2μF at 8-V working, 4μF at 4-V and 6μF at 1.5-V. This firm has recently branched out into the printed circuit business and they were showing an experimental three-valve sound receiver based on this technique. It was interesting to compare the printed circuit with the wired prototype which was also on show (see picture).

Printed circuits are, of course, only one of the modern methods of "prefabricated" construction now being developed. Another method represented at the Show was the so-called "unit construction" with standard plug-in sub-assemblies which can easily be replaced when they go wrong. This was to be seen in a new v.h.f. pack-set for radiotelephony shown on the Army stand (see picture). The set has six channels in which to work and each channel is controlled by an overtone crystal. The carrier wave is frequency modulated, and here a saving in valves is achieved by the use of a "ferric reactor," a small transformer-like device with one winding energized by the a.f. output and the other shunted across part of the r.f. tuned circuit. Altogether the set weighs only $9\frac{1}{2}$lb including batteries.

Miniaturization, it seems, is a process that is not going to stop at any particular point. It is no exaggeration to say that microscopes will soon be needed in large quantities in the radio industry for looking at components. Magnifying glasses are already being used. A case in point at the Show was an array of tiny magnetic cores, each having a diameter of less than one tenth of an inch. Composed of a new material called Ferroxcube D1, they formed the basic elements of a magnetic matrix storage system for electronic digital computors. It was built by Mullard's and is similar in principle to the R.C.A. "Myriabit" storage matrix which has already been described in *Wireless World*.* The device consists of a network of 32 horizontal wires and 32 vertical wires, and at each intersection the wires pass through one of the miniature cores. There are 1,024 intersections and cores altogether, so the device is capable of storing that number of binary digits.

To feed information into any one core, a current pulse of half the amplitude needed to saturate the ring is passed into each of the two wires which intersect at that point. At this one core the total current is sufficient to saturate the Ferroxcube, but any other core on each wire receives only half the saturation current and because of the rectangular hysteresis loop of the material its magnetic state is sensibly unchanged. In the magnetized core the state of positive remanence represents the binary digit "1" while the state of negative remanence signifies the presence of the digit "0."

To "read out" the information stored in any one core a negative current pulse is applied to each of the wires intersecting at that point. If the core is in a state of negative remanence, negligible change of state can occur. If, however, the ring is in a state of positive remanence (i.e., it carries the digit "1"), the arrival of two simultaneous negative pulses is sufficient to switch it suddenly from positive remanence to negative remanence. When this happens a large and sudden change of flux occurs in the core. This change of flux is sufficient to induce a voltage pulse in a third wire which is threaded through all the cores in the matrix. This is the "read out" wire, and it plays no other part in the operation of the matrix.

In the Mullard matrix, as distinct from the R.C.A., a fourth wire is incorporated. This makes possible a common addressing system when a number of the matrices are used as a parallel operated store.

Another interesting computing device using a network of cores and threaded wires—but for a different purpose—was the noughts-and-crosses machine shown by the National Physical Laboratory. This

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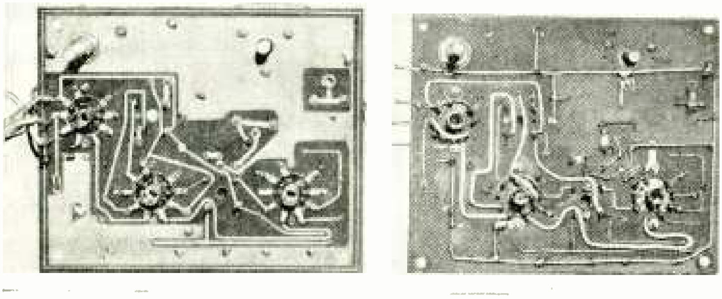
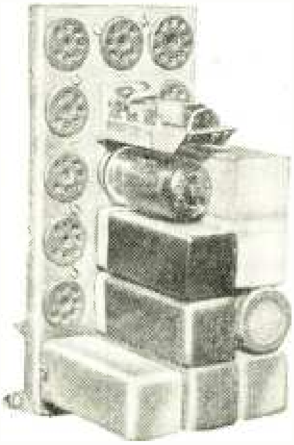
* "Storage Systems" Wireless World, August, 1954



Printed circuit by T.C.C. (left) with wired prototype (right).



Unit construction in Army pack-set.

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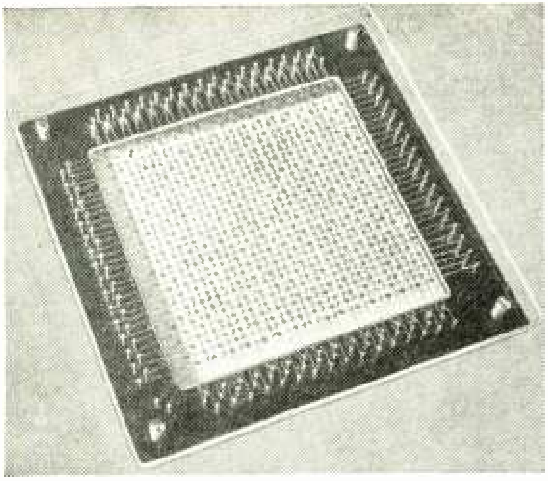

Mullard magnetic matrix "memory."

computor, designed by D. W. Davies, plays a game of noughts-and-crosses with a human opponent and never loses. The human player makes a move by pressing a button corresponding to the chosen square on a display board and a lighted X appears in this square. The machine then automatically makes a reply move and causes a 0 to appear in another square.

In order to do this, the machine has to "try" the situation on the display board against a great number of possible situations (for which the appropriate reply moves have already been worked out) and this is done by the so-called "coil maze." For each of the nine squares on the board there are three Ferroxcube cores, one for X, another for 0 and the third for Blank. All the 27 cores have energizing windings which are fed from a 20-kc/s oscillator, but in each square one of the three is shorted out, either X or 0 or Blank, according to the situation there. Thus there is a pattern of non-energized cores corresponding to the pattern of Xs, 0s and Blanks on the board.

To detect this pattern, wires are threaded through the cores in various different configurations (157 of them altogether) and their ends are taken to an electronic null-detector. Thus, when a particular wire has no voltage induced in it, clearly it must be threaded through a pattern of cores which are all shorted out and non-energized—and this pattern represents the situation on the display board. All the other wires, of course, have voltages induced in them. The null-detector is arranged to work sequentially through the whole set of wires by means of a uniselector, and when it comes to a non-energized wire it gives an output signal.

The noughts-and-crosses machine was one of the special Electronic Exhibits arranged at the Show. Another interesting exhibit in this section, shown by the International Radio-Controlled Models Society, was a display of equipment representing the various methods of radio control. One of the more elaborate systems worked on the well-known principle of transmitting various audio tones for the different control functions, but the receiving equipment was somewhat unusual. Instead of using ordinary filters or tuned circuits to sort out the received audio frequencies it had regenerative filters using valve circuits with positive feedback. Each filter is, in fact, an oscillator tuned to the required frequency but not quite in a state of oscillation. A very sharp response is obtained when the appropriate frequency is received, and the system has the advantage that it does not attenuate the a.f. signal in the same way as a conventional filter.

The complete receiving equipment comprises a super-regenerative tuned-line receiver working on 465 Mc/s, two stages of audio amplification (one with negative feedback), a six-channel filter of the type described and six trigger circuits which are controlled by the outputs of the filter. The a.f. range covered by the six filters is roughly 3.8-4.2 kc/s.

Radio Laboratory Handbook

"EXPERIMENTING is a good deal less light-hearted than it used to be," says M. G. Scroggie, somewhat wistfully, in his preface to the sixth edition of this well-known book. He points out how things have changed since 1938, when the first edition came out, but hopes that the new edition which has been almost completely re-written to keep in step with modern developments, has not become so grave as to disappoint those readers who liked the original style.

A glance through the pages shows that it has not. The book has been greatly enlarged and presented in a new format but still retains its eminent readability. In fact, it is likely to be useful to workers in other fields besides radio where electronic techniques are used, for it does not assume a great knowledge of radio and particular attention is given to the general principles of experimentation and interpretation of results.

After describing the layout and furnishing of an up-to-date laboratory, the book goes on to fundamental principles of measurement; sources of power and signals; indicating instruments; standards; bridges; choice and care of equipment; measuring circuit parameters, signals and equipment characteristics; a chapter on v.h.f.; then "dealing with results." Finally a large section of 65 pages is devoted to useful reference material. Altogether there are 436 pages and 299 illustrations.

"Radio Laboratory Handbook," sixth edition, by M. G. Scroggie, B.Sc., M.I.E.E., is available from booksellers, price 25s, or direct from our Publishers at 26s 3d, including postage.

Standardizing L.S. Measurements

IT is now generally acknowledged that, in the present state of the art, objective measurements cannot completely describe the performance of a loudspeaker, but that they are useful in identifying the grosser faults and in determining sensitivity and efficiency.

To ensure that results obtained in different laboratories can be compared, it is essential that they should be made under the same conditions, and in British Standard 2498: 1954 recommendations are made for methods of measuring performance and expressing the results. For instance, a standard baffle 6ft square is recommended, with the aperture 8-in off centre in one direction and 4-in off centre in another at right angles. The microphone distance should be not less than 3ft.

When listening in a small room, the mean spherical response is more relevant than the response at one point on the axis, and a formula is given from which the mean spherical response can be calculated from measurements taken at specified angles from the axis. In plotting curves it is recommended that the length of one decade on a horizontal logarithmic scale of frequency shall equal the height of 40db on a linear vertical scale.

Other measurements discussed in this Standard, which

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is obtainable, price 3s from the British Standards Institution, 2 Park Street, London, W.1, are non-linearity distortion, efficiency, power-handling capacity and transient response.

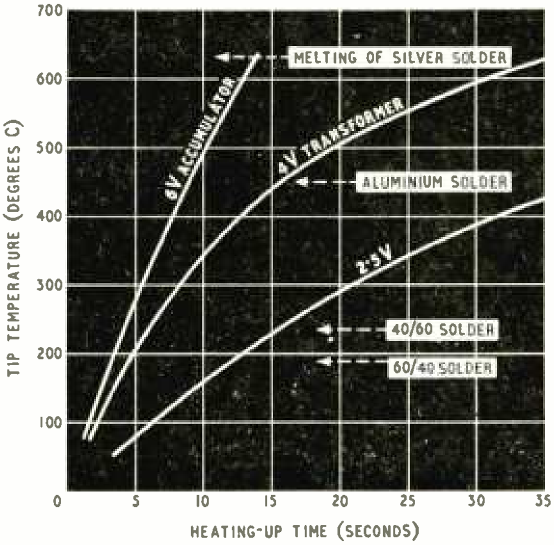
Carbon-element Soldering Iron

A NEW type of soldering iron now coming on to the British market has the unusual feature of a carbon element instead of the more conventional wire element. It is particularly suitable for intermittent soldering operations at the test bench and for use on miniaturized equipment, where a very localized heat is required to avoid burning adjacent components. At rest the iron is switched off. When it is picked up to make a joint, a switch ring is pushed forward by the thumb and this causes a high current to pass through the element which brings the bit to soldering temperature in about 6 seconds. When the iron is put down again the switch, of course, is automatically released and the current is turned off.

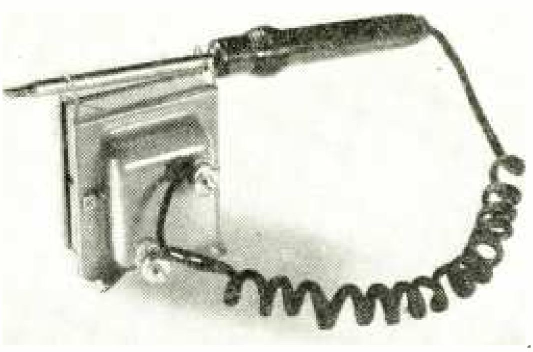
Because of the rapid heating of the iron from cold and the smallness of the bit the heat is very localized at the tip. The shaft does not have time to become heated. In fact, there is very little storage of heat in the bit, as in conventional soldering irons, and it merely serves to conduct the heat from the element straight into the work. Moreover, because the element can be brought to a very high temperature (white hot if necessary), the iron, small as it is, can be used for soldering on chassis or other large pieces of metal. Even though the work conducts the heat away very rapidly the transference of heat from the element to the work is even more rapid and the required soldering temperature is soon reached. For the same reason the iron can also be used for silver soldering, where a temperature of about 600-700°C is needed.

The iron is normally fed by a 4-volt step-down transformer from the mains, but it can also be worked directly from a car battery. It will operate at any voltage between 2.5 V and 6.3 V and the effect of different voltages on the heating-up time can be seen in the graph. The current drain at 4 V is approximately 30 A.

Made by Scope Laboratories of Melbourne, Australia, the iron is now available from the Industrial Equipment Division of Enthoven Solders, Ltd., of 89, Upper Thames Street, London, E.C.4, who are the sole distributors in Britain. The iron itself costs 39s 6d, while the transformer is 31s 6d. Spare carbon elements can be obtained for 1s and new bits for 10½d.



The effect of different voltages on the heating-up time.



The iron on a rest fixed to the transformer

FURTHER EDUCATION

IN our last issue (p. 438) we tabulated details of the courses in radio and allied subjects provided at further education establishments in England. We have now obtained similar details for Scottish and Welsh establishments and these are tabulated below. The letters F, P and E indicate full-time, part-time day, and evening courses, respectively, in telecommunications (col. A), radio theory, electronics, transmission, radar, and marine wireless (B), radio servicing (C) and television servicing (D).

	A	B	C	D
SCOTLAND				
Aberdeenshire				
Aberdeen Central F.E.C.	E			
Aberdeen Trades College (Evening) F.E.C.		E		
Angus				
Dundee T.C.	E	E	P	P
Dumfriesshire				
Dumfries High School F.E.C.		E		
Fifeshire				
Cupar, Bell-Baxter F.E C.	E			
Lanarkshire				
Burnbank School of Engineering	P E	E	P E	P E
Coatbridge T.C.		E	E	
Glasgow, Allan Glen's School		E	E	E
Glasgow, Royal T.C.		F E		
Midlothian				
Edinburgh Heriot-Watt College ..	F E	E		
Leith Technical and Commercial Institute			E	E
Leith Nautical College		F		
Renfrewshire				
Greenock Technical School			E	
Greenock, Watt Memorial School ...		F		
Paisley T.C.		P		
Stirlingshire				
Falkirk High School F.E.C.		E		
Stirling High School F.E.C.	E	E		
WALES				
Caernarvonshire				
Caernarvon & Anglesey Senior T.I. ...	P E			
Cardiganshire				
Aberystwyth C.F.E.	P			
Denbighshire				
Colwyn Bay Tech. E.I.	E			
Wrexham Denbighshire T.C.			E	
Glamorganshire				
Cardiff, C.T. & Commerce	P E	E		
Rhondda T.I.	E	E		
Swansea T.C.	E	E		
Treforest, Glamorgan T C.	E	E		
Monmouthshire				
Newport T.C.	E		E	

F.E.C. Further Education Centre ; C.T. College of Technology ; T.C. Technical College ; T.I. Technical Institute ; E.I. Evening Institute ; C.F.E. College of Further Education.

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New Pickup Arm

NOVEL DESIGN GIVING GREATLY REDUCED TRACKING ERRORS

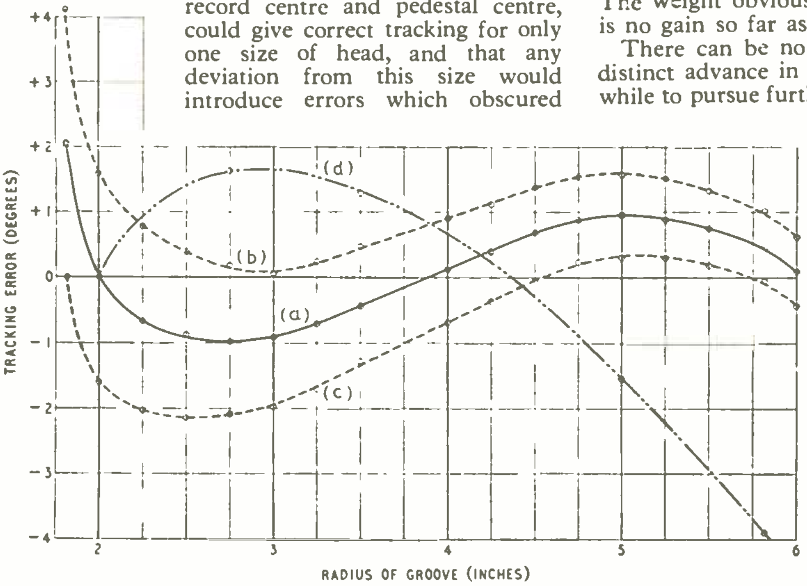
Composite photograph of the BJ arm in three positions.

THE lateral-cut gramophone record is produced by a cutter head moving on guides along a radius of the disc, and ideally a similar mechanism should be used for the reproducing pickup to avoid distortions arising from tracking errors. In practice a true radial mechanism is expensive to produce if it is to have friction losses sufficiently low to enable microgroove records to be traced without groove jumping.

A cranked arm, properly designed, is the conventional method of reducing tracking error, but as the accompanying curve (d) shows, errors of 3 deg to 4 deg are unavoidable with arms of reasonable length (8 inches is the average).

Such errors are very considerably reduced by a new design of arm, produced by Burne-Jones & Company, Ltd., 309-317, Borough High Street, London, S.E.1, in which two arms of different length form a link motion which keeps the head aligned very closely to the ideal tangential setting, irrespective of the radius of the groove. The geometry is difficult to visualize, but the accompanying "ghost" photograph gives some idea what happens as the pickup traverses the disc.

To check the alignment, we have drawn the mechanism on a large scale and measured the errors, which amount to less than ± one degree on a 12-inch record. In the course of plotting, two interesting facts emerged: (1) the distribution of error is extremely sensitive to the positioning of the tone arm pedestal; (2) provided that the pedestal is repositioned to compensate for change of overall length of the arm, the tracking error is unaffected by changes of length overhang of the stylus in front of the pickup socket. One of the first things we discovered was that the template originally supplied with the arm, and giving a fixed distance between record centre and pedestal centre, could give correct tracking for only one size of head, and that any deviation from this size would introduce errors which obscured the inherent excellence of the arm itself. By using a modified centring method the curve (a) was produced and could be repeated for any size of pickup. As an experiment an error of ±3½ millimetres was introduced in the positioning of the pedestal and the effect on the tracking error is shown by curves (b) and (c). We understand that a new template is being issued which will avoid any possibility of error from this cause.



Curves showing angular deviation of virtual radii, produced by the pickup head, from true radii to the point of contact with the record groove, at different distances from the centre of the record. (a) Optimum setting of BJ arm for any pickup; (b) and (c) effect of moving arm bodily 3.5 mm on either side of the best position; (d) error curve of optimum conventional bent arm of same length (8 inches); arm angle 23°, stylus overhang 0.54 inch.

The mechanical construction and workmanship of the arm is in keeping with the tracking accuracy achieved. It has good torsional rigidity and the hardened steel pivots should stand up to continued use without need for adjustment. The counterweight does not move horizontally with the arm and forces due to "swinger" records are consequently reduced. The weight obviously must move vertically, so there is no gain so far as warped discs are concerned.

There can be no doubt that the BJ arm marks a distinct advance in design, which will make it worth while to pursue further the reduction of *tracing* distortion (as distinct from *tracking* distortion) by the use of styli of other than spherical shape.

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Remote Control of Radio Receivers

BY C. E. TATE,*
A.M.I.E.E.

Servo Tuning Control Operating Over a Single P.O. Line

A RADIO receiver is often required to be operated from a remote point, either from the point of view of situating the receiver where the aerial is in an interference-free area, which may be remote from civilization, or it may be that aerials cannot be erected at the spot where it is desired to operate. In such cases a remote control is needed and economy in the number of wires used between the receiver and controller is essential in order that the cost may be kept down.

The system to be described is capable of operation over a single pair of wires independent of earth. The wires may be several miles in length.

The system has been designed for use with standard Post Office telephone circuits and consequently the fairly stringent requirements imposed by the G.P.O. for equipment attached to their circuits had to be met. The maximum d.c. voltage that can be connected to a P.O. line is 50 volts, and the direct current passed down the line must not exceed 15 mA. The maximum audio-frequency signal transmitted must not exceed 5 mW, and tones of frequency below 250 c/s or above 3,000 c/s cannot be used. The balance of the line to earth must be maintained. For the purpose of this control system a "physical pair" is necessary, therefore any repeaters have to be bypassed to maintain the d.c. path.

Other considerations in the design of this equipment were that the tuning of a receiver had to be controlled from a remote point with such facility that a c.w. signal could be tuned and held when using a narrow-band note filter. Obviously no interruption of the receiver signal could be tolerated whilst performing any function of the remote control equipment. As other receiving equipment might be used in the same station as the receiver being remotely controlled, the remote control system must not cause any radio interference.

It was also required that the signal from the tuned receiver should pass along the pair of lines used for control.

In a system of this kind indication must be provided at the remote end of the position of the receiver tuning scale, and it was arranged that temporary disconnection or reversal of the line should not upset the correctness of this indication or derange the apparatus in any of its functions. Reversal of the line has no effect, and the equipment returns to its previous setting immediately after any disconnection. The equipment at the remote end was designed to be as simple as practicable, so that if necessary an operator could have several controllers available on his desk.

The upper limit of resistance of the lines over which the equipment would function was set at 1,000 Ω; this corresponds for underground routes in a city such as London to a distance of about seven loop-miles assuming some 50 per cent of 10-lb cable and 50 per cent of 20-lb cable. For overhead routes, junction circuits are usually run in 70-lb cable, which in cadmium copper would give 30 loop-miles for 1,000 Ω; ordinary subscribers' circuits run in 40-lb cable would give about 20 loop miles.

Ability to switch the receiver on and off was not required for the particular application described, but this facility could easily be incorporated as will be shown later.

In the course of the development several methods of tuning the receiver were investigated, such as systems employing relay switching or two-way d.c. keying, operated in conjunction with step-by-step mechanisms or synchronous motors with magnetic clutches. All of these systems suffer from undesirable "bang-bang" characteristics which can be mitigated somewhat by providing two speeds on the motors and changing to the slower speed for final tuning, but are not entirely eliminated. Another trouble was the difficulty of overcoming the effects of line disconnection or reversal, and of making sure that the remote and main tuning scales remained in step. The method finally selected was a zero-seeking servo arrangement.

The basic circuit of the system adopted is a Wheatstone bridge, with two arms variable, one of the variable arms being carried to the remote point along the line. This system is shown schematically in Fig.

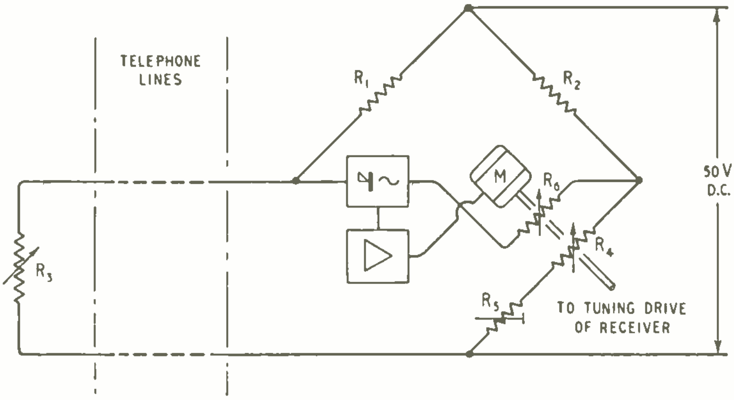

Fig. 1. Basic bridge circuit with remote resistance control.

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* Marconi's Wireless Telegraph Company.

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1. The resetting by the operator of the distant resistance R_3 causes an error current in the detector arm of the bridge and the servo motor M readjusts R_1 to restore a balance. The limits imposed by the P.O. regulations determine the resistance chosen for the arms of the bridge. On the one hand the d.c. voltage applied to the line must not exceed 50 volts, therefore the maximum voltage is chosen as this gives the best sensitivity, also the current taken along the line must not exceed 15 mA and this, of course, fixes the minimum values of the bridge arms R_1 and R_2. The minimum value is employed in order to obtain maximum power in the detector arm. A preset fixed resistance R_5 is incorporated to compensate for the resistance of the line.

As the bridge proportions are varied by the adjustment of the resistances R_3 and R_1, the error current for a given difference in resistance, which corresponds to a given angular displacement of the two sliders, is changed. This condition, if allowed to persist, would render the design of the servo loop difficult as it would tend to produce either a sluggish response at the least sensitive end, or, if the gain were adjusted to give sufficient setting accuracy at this end, instability and hunting would occur at the most sensitive end. A compensating resistance R_6 was therefore incorporated, which is controlled by the motor to render the error current for a given displacement substantially constant for small angles for any value of R_3 and R_1. This correction could have been made more simply if the resistance law of R_3 and R_1 could have been made logarithmic, but since the high resolution required entailed the use of ten-turn helical potentiometers, which are available only with a linear resistance law, this was not possible. Associated with these resistors were similar gear trains at the main and remote stations, but that at the main station had an extra train of gears reducing from a light, low-inertia, high-speed motor, down to the control resistance R_1 and then down to a shaft having a 270° sweep coupled to the receiver tuning dial. The sensitivity compensating resistor R_6 was also coupled to this shaft. At the remote end the control resistance R_3 was rotated by hand, but a similar gear train drove a replica of the receiver scale. In order to pass the signal along the line this d.c. circuit was introduced and extracted at the centre point of balanced line transformers, bypassing the signal with condensers (Fig. 2).

The problem remaining to be solved to complete the tuning arrangements was that of interpreting the error signal and causing it to operate the servo motor.

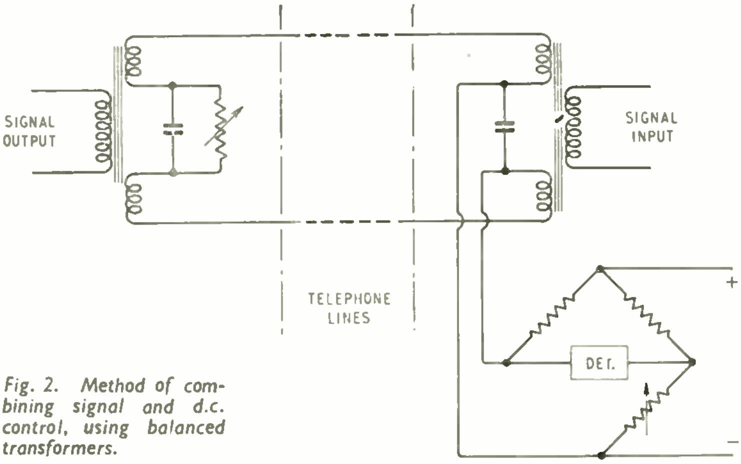

Fig. 2. Method of combining signal and d.c. control, using balanced transformers.

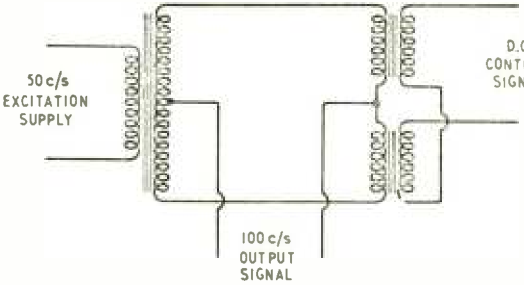

Fig. 3. Basic circuit of second-harmonic magnetic modulator.

The type of motor chosen was a very small two-phase induction motor developed for the Admiralty as a compass repeater. This motor had desirable characteristics in that it was designed for a low armature moment of inertia, and had a high-resistance rotor to give high starting torque. Being an induction motor it has no brushes and would consequently be eminently reliable. It would drive the gear train at full speed with a driving power on the control phase of about 3 watts, and would creep in on as little as 0.2 watts. Reversal of the phase of the supply to the control winding relative to the reference phase causes reversal of the motor armature.

The tuning requirements, which were stringent as a c.w. signal had to be tuned on a 300-c/s wide note filter, made it essential that there should be no overswing, little backlash and negligible time delay in following any tuning adjustment made at the remote end. There should be no zero drift, as this would cause the signal to be detuned by the servo on its own accord. The detector had to be capable of driving the motor from an error signal of about 10 μA in an impedance of about 200 Ω.

A symmetrical valve d.c. amplifier with high zero stability, followed by a push-pull stage gating an a.c. voltage did not look inviting. The obvious choice would be a push-pull magnetic amplifier with a.c. output, except for the drawback of time delay. A magnetic amplifier of the necessary gain working at 50 c/s would have a time constant of some seconds—far too long for the job. The answer was a blend of both techniques—a second-harmonic magnetic modulator and a valve amplifier.

Second-harmonic magnetic modulators have a centre stability of a very high order and are very symmetrical. Providing the d.c. path is blocked in the output circuits so that no self-excitation occurs, the time delay is negligible.

The second-harmonic type magnetic modulator is a device which produces a sinusoidal output at twice the excitation frequency fed to it, the phase of the output voltage being dependent on the sign of the direct current fed to the control winding. The output voltage is also proportional to the current flowing in the control winding. The mechanism of operation has been described by F. C. Williams.[1]

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[1] F. C. Williams and S. W. Noble. "The Fundamental Limitations of the Second-harmonic Type of Magnetic Modulator as Applied to the Amplification of Small D.C. Signals" *Proc.I.E.E.* Part II August, 1950.

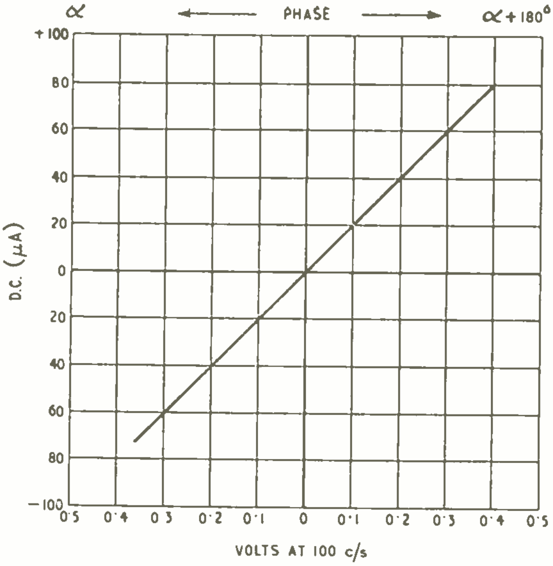

Fig. 4. Output characteristic of magnetic modulator.

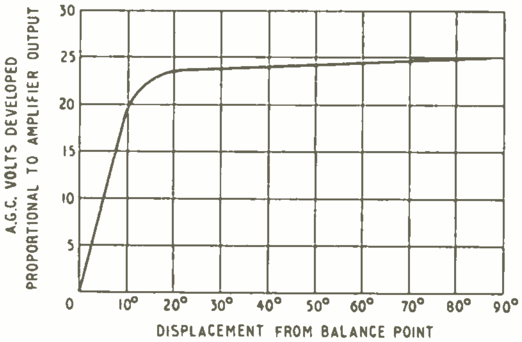

Fig. 5. Automatic gain control characteristic.

One advantage of the device is that it does not require saturation of the iron in order to function, a slight non-linearity being sufficient to produce an output. As a consequence a good output waveform can be obtained.

The modulator used in this equipment consisted of a stack of standard Type 496 Mumetal laminations which carried three windings, a d.c. control winding on the centre leg, and balanced a.c. windings on the outer legs. The a.c. windings are phased so that their fluxes oppose each other in the centre leg, and no volts are induced into the control winding. The circuit is shown schematically in Fig. 3, and the characteristic in Fig. 4

The valve amplifier used was a resistance-coupled amplifier having three stages, and its output was fed to the control phase of the servo motor. It was arranged to have a phase delay such that its output was in quadrature with the reference phase of the motor. The reference phase of the motor was excited by the 100-c/s ripple voltage from a full-wave rectifier supplying the d.c. power to the Wheatstone bridge.

A servo system of this kind, where the error from the desired position of the controlled element is used to correct the position of that element, is known as a closed-loop, position-control servo, and various specialized techniques are necessary to prevent overshoot or hunting. This hunting is caused by the inertia of the controlled element and the consequent storage of energy in it when it is in motion. The orthodox ways[2] to stabilize such a system are either to feed back, negatively, signals derived from the speed of motion of the controlled element—either plain "velocity feedback" or its differential "acceleration feedback"—or to insert in the feedback loop "phase advance" or "integrating" networks which operate only over a limited range of speeds.

The complication involved in producing such a refined servo was not really warranted in this case, and hunting was prevented by the use of a special a.g.c. system. In order to allow a.g.c. to be used the signal arriving at the driving motor must be at a maximum steady value for large errors, but proportional to displacement for small errors. (See Fig. 5.) This is achieved in this design by arranging that the first stage in the amplifier chain acts as a limiter. The a.g.c. then functions in the following manner.

Assume that one control resistance is displaced 90° from the other. The motor will be receiving full driving power and the amplifier gain will be clamped down by some 20 volts of a.g.c. As the motor runs in, the rate of change of signal fed to it is small, and the a.g.c. line is able to discharge slowly and maintain the motor running at substantially full speed. However, when the motor arrives at a point about 10° from home, the signal becomes proportional to displacement, and no longer is the a.g.c. system able to discharge at a sufficient rate to keep the output up and the motor running at full speed, so the motor slows to a speed which enables the a.g.c. line to open up the gain sufficiently fast to feed it. The motor finally comes to rest with the a.g.c. fully discharged and the amplifier at full gain giving the motor the benefit of all the amplification available to obtain the final accuracy of "run-in." The time constant of the a.g.c. system can be matched to the motor inertia by correct proportioning so that the motor runs in towards zero with a steady deceleration and no overshoot.

The volume control of the receiver was achieved at the far end of the line by a potentiometer. This was simple and had the advantage that as the line always carried full signal, the signal-to-noise value of the line was maintained at its best value. Signals below 1 milliwatt along P.O. lines are not recommended, owing to their susceptibility to interference.

The scale repeat-back was automatically achieved by the zero-seeking characteristic of the tuning control system, the only requirement being to compensate for the line resistance at mid-scale by adjustment of R_6 until the reading coincided.

On-off switching of the receiver was not provided on this equipment, but this could be achieved relatively simply by providing a limit switch at one end of the tuning scale. If this end were that corresponding to the highest control resistance, this could be interlocked with a warning system in the following way. Suppose a receiver was intended to be on service, and the line became disconnected through some fault, the control unit would immediately run to the end of the scale corresponding to the highest resistance, seeking to balance the bridge, and switch off the receiver. This would give a warning at the main station that something was amiss, and appropriate action could be taken.

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[2] Chestnut and Mayer. "Servo Mechanisms and Regulating System Design" (Chapman and Hall).

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LETTERS TO THE EDITOR

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

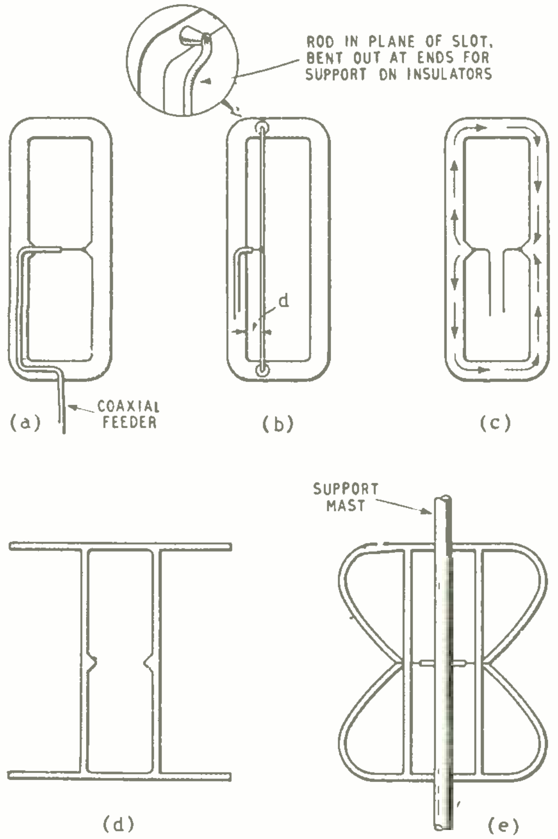
"*Skeleton Slot Aerial*"

I FOUND H. B. Dent's article (your August issue) very interesting and would like to add the following comments:

One way of overcoming the asymmetry in the polar diagram measurement is to bring the feeder in at a null point and carry it up the side of the slot as I have shown at (*a*) in my diagram, the braid being in contact with the aerial surface all the way. This automatically takes care of the balance-to-unbalance condition and prevents radiation from the outer of the feeder. There would be a serious impedance mismatch, of course, but this would not matter if one is only interested in checking the shape of the polar diagram. Possibly a neater way of doing it would be to make the slot out of tubing and thread the feeder round inside it.

To obtain a good match, an arrangement similar to that shown at (*b*) can now be used. The slot is divided vertically by a rod which is supported at the ends of the slot on stand-off insulators. The spacing, *d*, must be found by trial and error but for a 75-ohm feeder it would be somewhere between $\frac{1}{8}$ and $\frac{1}{4}$ of the slot width. The spacing and length of the rod should be adjusted alternately for best results. Once the correct measurements have been found a similar aerial can be built for any frequency by simply scaling all the dimensions up or down in the ratio of the wavelengths[1], though it is always advisable to leave a small margin for final adjustment. The theory of this method of feeding slot aerials is described in detail in a paper by Monteath.[2]

The use of rod reflectors to modify the radiation pattern of a slot aerial is not a new idea and is, incidentally, the subject of a B.B.C. patent application (No. 19736/51). I should imagine that the single reflector illustrated by Mr. Dent achieves gain in the horizontal plane at the expense of the vertical polar diagram and that it would be better to use two rods, stacked half a wavelength apart and approximately level with the ends of the slot.



Mr. Dent mentions the similarity in polar diagrams between the slot and two dipoles. This can be explained by considering the disposition of the various currents: Diagram (*c*) shows the current paths on a skeleton slot aerial. Along the edges of the slot the currents are in opposite phase and the effect is the same as that on a twin-wire transmission line which does not radiate. It is the currents passing round the ends of the slot that do the radiating and these are distributed in space much the same as they would be on two dipoles spaced half a wavelength apart and fed in the same phase. In fact, we have only to grow a pair of arms at each end of the slot (see (*d*)) and we have got that very thing—two dipoles fed in phase by a slight variation of the well-known Y-match! Since these arms evidently do not contribute much to the radiation (though they will affect the impedance) it does not matter very much what we do with them. Let us, then, stretch them a little and bend to the shape I have shown at (*e*). Now, add a support mast in the neutral plane down the centre of the slot and the result bears a tolerable resemblance to a pair of RCA "Batwing" elements.

It would seem, therefore, that Mr. Dent's skeleton slot, a pair of dipoles and the batwing aerial all work on very much the same principle.

Banstead, Surrey. T. R. BOYS.

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[1] "The Use of Scale Models in the Development of Broadcasting Aerials," by T. R. Boys, *I.E.E. Students' Quarterly Journal*, Vol. 23, No. 90, December 1952.

[2] "Wide-Band Folded-Slot Aerials," by G. D. Monteath. *Proc. I.E.E.*, Pt. III. Vol. 97, No. 50, December 1950.

"*Why Lines?*"

WITH my new Lissajous-figure television receiver I get rather a queer effect. Whereas in the old days I used to get a ghost image from a local gasometer ½-inch to the right of the main image, the new atomic power station which has supplanted it gives quite a different effect on my Lissajous-scanned set.

Now, I get *two* ghost images, one just under ½-inch to the left and another the same distance to the right. They are greatly expanded in size as compared with the original (real) image and towards the edges of the picture the ghost images are very distorted and I find myself more intent on watching them than the real picture.

The picture also appears very "fuzzy," possibly due to other minor spurious images which used not to show up under the old Marconi-E.M.I. system in use back in '54.

My dealer tells me it's because of the supersonic vibrations set up by our space travel vehicles. Do you agree? B. H.

IT would appear that the great difficulty of the sinusoidal scanning methods described by F. P. Hughes (your August issue) would in fact be synchronization, though he says it would be so easy. Obviously, even slight relative phase shifts would give a good deal of distortion. Absolute synchronization would be essential and no relative phase shifts in the sync or amplifier channels would be permissible. This is far from being as easy as it looks; even injection does not often give zero phase angle. Furthermore, lack of sync would give a ghastly

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mosaic instead of mere picture shift as at present. And what about adjustment?

Maidenhead, Berks. F. V. BALE.

Ignition and Television Interference

MAY I add a few lines to the remarks of Arthur Lindon (your August, 1954, issue) concerning interference both with and caused by television receivers? I, too, have noticed "Diallist's" suggestions for dealing with owners of unsuppressed car engines, but cannot call to mind that he has any views on dealing with what from the Post Office analysis of faults due to interference (published by *Wireless World* some months ago) seems to be a much more widespread nuisance; i.e., radiation from television timebases.

Unlike ignition interference, the latter is continuous. So far, it would seem that the owner of offending apparatus is under no obligation to remedy the trouble. An acquaintance of mine suffered (as did his neighbours) from a whistle of such strength that reception on 1500 metres was impossible. The offending set was located by the G.P.O., who said they could do nothing since the owner was unwilling to go to any expense. My friend and his neighbours, on G.P.O. advice, therefore put in screened aerial leads and moved their sets about in their rooms with the result that, though they can now receive intelligible signals, reception is still most unsatisfactory.

There is one thing that puzzles me. The G.P.O. say they have no powers of compulsion over owners of offending television receivers since the laws governing interference suppression do not apply. Surely, where a television set owner refuses to take the necessary steps, the licence should be withdrawn, for clearly stated on the back of it, among the "conditions," is the clear proviso that the licensed apparatus shall not be used in such a manner as to cause interference.

Sheffield, 8. J. PLATTS.

ARTHUR Lindon's letter in your August issue suggests the Post Office lacks the authority to stop radiation of interference from television receivers. But, on reading my recently renewed broadcast receiving licence, I see that Condition No. 3 lays down that "The apparatus shall be so maintained and used that it does not cause interference . . . ." Radiating television receivers presumably infringe this condition.

Far be it from me to suggest that the G.P.O. should exercise a little dictatorship, but could not the radiation nuisance be stopped by the enforcement of the above clause by the exercise of clause 6, which states that "The apparatus shall cease to be used at any time on the demand of a duly authorized officer of the G.P.O.?" Seriously, though, if Mr. Lindon is troubled by a whistle on 200 kc/s, I suggest that he invokes the aid of the G.P.O. whom I have found most helpful in interference suppression.

Leigh-on-Sea, Essex. G. O. THACKER.

"*Inexpensive* 10-*Watt Amplifier*"

IN the brief description of this amplifier appearing on p. 398 of your August issue there is a statement which might be misleading if taken at its face value: "The first stage is the low-noise EF86, which is *direct-coupled* to a Schmitt-type cathode-coupled phase splitter (ECC83), thus reducing phase shift at low frequencies."

The coupling between these two stages is not direct in the proper meaning of the term, since the 0.1-μF coupling condenser is just as much in series with the 1-MΩ grid leak when placed below the grid leak as it would be in the normal position, and the input to the phase splitter, which is taken across the grid leak, falls off to nothing at zero frequency as usual. If there is reduced phase shift at low frequencies, therefore, it is because of the circuit values chosen and not because of any direct coupling.

While on the subject of push-pull "quality" amplifiers, I should like to express my surprise and regret at the obstinate refusal (almost the world over) to adopt the tertiary-feedback-winding system (P. J. Baxandall, *Wireless World*, Jan., 1948). Instead of using this elegant and excellent arrangement, which requires an output transformer of quite moderate complexity, designers strain themselves to get an output transformer of fantastically low leakage inductance, and even then they have an amplifier which goes unstable if connected to a capacitive load (e.g., a long speaker lead).

Malvern, Worcs. E. F. GOOD.

[*We have referred the question of coupling to the designers of the Mullard amplifier, who reply as follows:—*

"At very low frequencies there is some inherent phase unbalance between the two halves of the Schmitt phase splitter; this is dependent upon the time constant of the coupling to the grid of the second triode (R_8, C_7).

"A further phase shift occurs in the coupling network from the anode of the previous stage to the input grid of the phase splitter valve. It is this phase shift which is reduced by means of the d.c. connection, the input to the phase splitter being taken across R_8 and C_7 in series and not across R_8 on its own." ED.]

Vector Diagram Conventions

IN response to my request for criticisms of my system of vector diagrams, David Morris cites (in the September issue) the rigidity of the tie-up between circuit diagram and vector diagram. While I agree that this feature of the system does mean that the shape of the diagram for (say) a series circuit depends on the order in which the components are connected, which in theory may not always be important, I cannot believe that this alone could be an adequate ground for rejecting the system altogether. For one thing, the relative potentials of the components *do* depend on their positions in the circuit, and a great advantage of my system is that all these potentials are always clearly shown in the one diagram.

But let us disregard this, and the other advantages of the system, and consider the example cited by Mr. Morris against it. In order to illustrate the results of varying each of three circuit impedances in turn, he prefers to draw three separate vector diagrams. Yet two of the loci he desires can at least equally well be developed from my single diagram, and the third can in practice also be visualized quite clearly. Not only is there a saving of the effort of drawing the diagrams, but the whole study is much clearer if undertaken with a single diagram, representing the single circuit. If the attention is distributed over three different diagrams, in which the vectors occupy different positions, this clarity is lost, and it is easy to become confused. I would certainly not attempt to justify these diagrams, and therefore the need to redraw my circuit diagram to match each does not arise.

"CATHODE RAY."

AMPLIFIER CIRCUITS

Two Corrections

In the circuit of the Mullard 10-watt amplifier (p. 398, August issue) a 33-kΩ resistor should be inserted in the h.t. line immediately to the left of the 1.2-kΩ smoothing resistor and its junction with the 30-μF capacitor.

Similarly, in the G.E.C. "912" amplifier (p.430, September issue) a 10-kΩ resistor should be inserted in the h.t. line immediately to the left of the connection to the centre tap of the output transformer primary.

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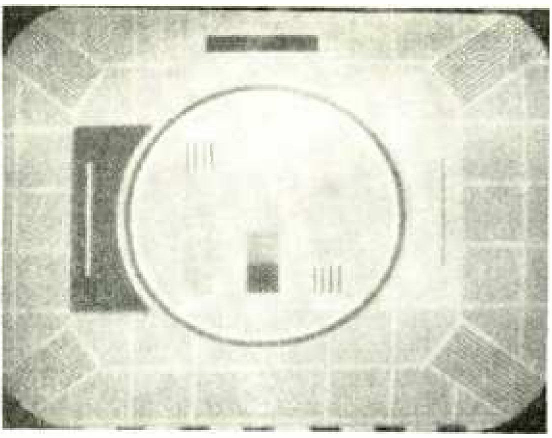
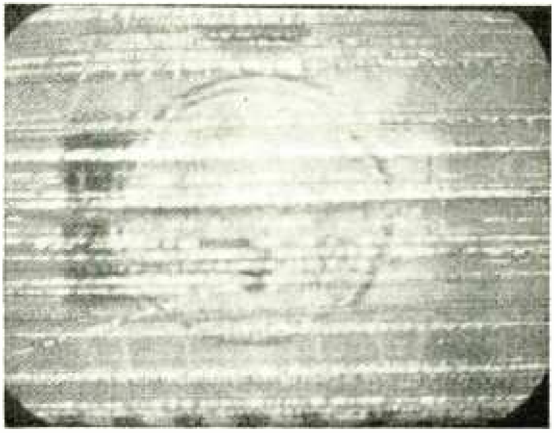


Band III Television Interference



Interference from " suppressed " electric shaver on television Bands I and III is compared in these photographs. Top left shows test card C on Band I and above on Band III.

Some Tentative Observations and Suggestions for its Suppression

By F. R. W. STRAFFORD, M.I.E.E.*

THE present trend of sound and vision broadcasting towards the higher frequencies raises interesting problems concerning man-made interference, its effects upon reception, and the means for abating it.

This transition from medium and long waves to v.h.f. is accompanied by great changes in the mechanism of interference propagation, and the techniques of suppression, now well established, seem to be no longer generally applicable.

It is not very difficult to understand why this should be so. Interference of the type discussed in this article is mainly the result of an abrupt fluctuation, or a continuous series of such fluctuations, of an electric current.

The simple process of switching an electric lamp on or off is an example of the former, while the superimposed rhythmic ripple from a commutator motor is an example of the latter. A succession of discrete fluctuations, such as is radiated from a car ignition system, is generally referred to as impulsive interference, while the continuous fluctuations from commutator motors is described as smooth interference.

All abrupt fluctuations of electric current may be analysed into a spectrum of individual sine-waves whose amplitude and frequency distribution are determined by the amplitude/time characteristic of the originating fluctuation. This is all very well known and need not be treated in detail, except to remind the reader that the more abrupt the fluctuation, the wider its inherent frequency spectrum will be.

There are other sources of interference which generate a single frequency (monochromatic interference). Typically these include harmonic radiation from c.w. transmitters, oscillator radiation from television receivers, and electron oscillations from certain types of lamps.

Because the frequency distribution of interference is determined by the nature of the initiating disturbance, it is reasonable to expect that certain types of offending appliances at medium and low broadcasting frequencies will be relatively innocuous in the TV frequency spectrum. Likewise, the reverse may occur.

This speculation is fully justified when one examines the interference records compiled by the Radio Branch of the G.P.O., to whom the author is indebted for permission to quote.

Table I is a part-extract from the latest monthly Post Office statistics purposely high-lighting the effect discussed.

From the TV viewpoint the interference from cer-

TABLE I

Type of appliance	Number of complaints about each source.	
	M.W. and L.W. Sound Broadcasting	TV Broadcasting
Fluorescent tubes ..	135	25
Filament-type lamps	10	211
Neon signs	37	124
Radiation from TV time-base circuits ..	595	2
Hair dryers	52	532
Sewing machines ..	159	841
Vacuum cleaners ..	93	237
Ignition systems of petrol engines ..	4	114

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* Belling and Lee, Ltd.

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tain types of lighting, vehicle ignition, and domestic appliances using small commutator motors, is seriously predominant.

The interference from lamps is a form of Barkhausen-Kurtz oscillation which was recently described by "Cathode Ray."[1] Suppression of this form of disturbance does not appear to be an economical possibility; the fault should be removed by the lamp designers.

The problem of interference from neon signs, which would also appear to be on the increase, has yet to be investigated. If the radiation turns out (as the author would expect) to emanate from the envelope of the sign, in which the gas discharge takes place, then it may be necessary to introduce some shielding by means of a metallic gauze or something which will not greatly impair the illumination efficiency of the sign.

It is possible that lamp interference may be less on Band III, but more work is required to be certain of this.

On the other hand, ignition interference looks as if it possesses the qualities of the many-headed Hydra. Although the radiated intensity falls off somewhat through Band II (f.m. broadcasting) and Band III, the decrease is insufficient to warrant the omission of suppressors and, what is worse, the simple resistor suppressor recommended for use in the distributor lead (and of great assistance in protecting Band I TV from interference) appears to have only a small effect on Band III. Indeed, it appears that additional resistors mounted at the sparking-plug terminals will be essential to bring the average interference level on Band III down to what was considered acceptable on Band I. In fact, it is likely that further resistors at *each* outlet connection from the distributor may be essential for stubborn cases, which, in the case of a four-cylinder engine, involves nine individual suppressors!

Presumably, this loss of suppression is due to the by-passing action of the self-capacitance of the resistor, and some new design approach to the problem is an urgent requirement.

Domestic appliances using fractional-horsepower commutator motors are the most serious household offenders, and yet most amenable to control if owners would not use them during TV broadcasting hours. Perhaps this is too much to expect from a race which dislikes regimentation, so that the fundamental problem of supression must be solved.

In treating this problem it is desirable to examine, in closer detail, the mechanism of the propagation of interference from a small commutator motor. The irregularities of current, due to the commutating action of the motor, give rise to a wide r.f. spectrum and the currents may be circulated in the symmetric or asymmetric mode, usually both. The division of current into these modes (Fig. 1) is simply a matter of electrical balance and unbalance.

If perfect balance could be achieved *by design* the circulation mode would be confined to the symmetrical *and little or no suppression would be required at TV frequencies.* This point will be discussed in greater detail later.

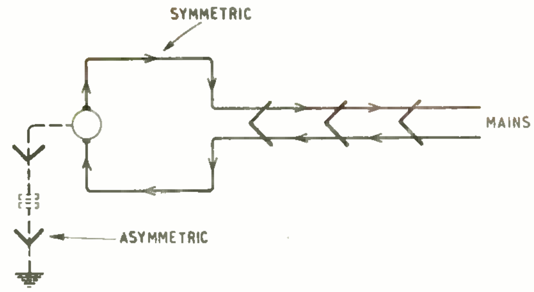

Fig. 1. Symmetric and asymmetric interfering currents.

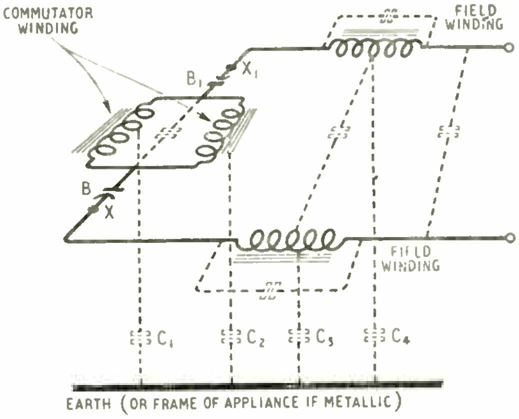

Fig. 2. Greatly simplified r.f. circuit of series-wound motor showing distributed capacities.

Fig. 2 shows, in full line, the circuit of a split-field series-wound motor, and one commutator winding. The interfering potentials are generated in series with the brushes B, B_1 at the point in the circuit marked X, X_1. The dotted capacitors attempt to give a general, but very over-simplified, picture of their distribution. If C_1, C_2, C_3 and C_4, that is, all the distributed capacities to earth, or to the motor frame, were zero the interfering current would be confined to the machine circuit and would result in the symmetric mode of propagation. This mode is easily removed from the mains at broadcast frequencies for it is only necessary to place a capacitor across the motor terminals to confine the interfering currents to the motor circuit, Fig. 3(a).

Of course, this is wishful thinking, but it might be possible, by design, to construct a machine such that the distribution of capacitance resulted in zero current flowing to frame, or earth, just as one can introduce circuits into r.f. bridges to achieve similar effects.

At the present time the suppression engineer must attempt to limit this flow of current by other means and this involves *raising* the circuit impedance over the r.f. spectrum involved. This can only be achieved by series-connected inductors Fig. 3(b). In order to secure maximum attenuation of the asymmetric current over a restricted band of frequencies (say TV) it is desirable to design each inductor so that its self-capacitance resonates with its inductance, thereby providing the high parallel impedance resulting from such a technique. It has been found that production of dust-cored r.f. self-resonant chokes requires that a large proportion need adjustment on test to bring the resonance at mid (TV band) frequency. If this is not done considerable suppression efficiency is lost.

Recapitulating, it can be seen that the symmetrical

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[1] *Wireless World*, May 1954.

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mode may be confined to the machine by a shunt capacitance, and the asymmetrical mode *limited* by the use of series inductors, preferably self-resonated.

At this stage the mode of propagation of the interference into the receiver must be discussed because certain factors, insignificant at the medium- and long-wave broadcast frequencies, become *predominant* in the TV spectrum.

At broadcast frequencies the symmetric interference is propagated along the mains wiring and is not very seriously attenuated thereby. The layout of mains wiring is such that, at r.f., some unbalance will occur primarily at junction, switching, and fusing points, and the asymmetric component thus created will radiate an electric field which will induce interfering e.m.f.'s into the receiving aerial. All this may be removed by the simple expedient of shunting a capacitor across the motor terminals (Fig. 3a).

An entirely different state of affairs exists at TV frequencies. The motor is, physically, not negligibly smaller than the wavelength, and possesses a degree of radiation resistance previously quite negligible at the lower broadcast frequencies. Hence, confining the current to the motor circuit by means of a shunt capacitance can *intensify* it and, if one considers the equivalent circuit of the motor to be in the form of a loop aerial, considerable radiation will take place unless the motor is efficiently screened and earthed, and this latter is most difficult to achieve at TV frequencies, even in the laboratory.

Also, at TV frequencies a capacitor shunted across the motor terminals may not completely confine the symmetrical current to the motor circuit. The mutual inductance, M, of the connecting leads positioned immediately on either side of the capacitor junction (Fig. 3c) permits current to be generated in the mains leads. But because of the greater attenuation losses of the mains wiring at these frequencies the interfering radiations due to unbalance may be quite small compared with the direct radiation from the motor.

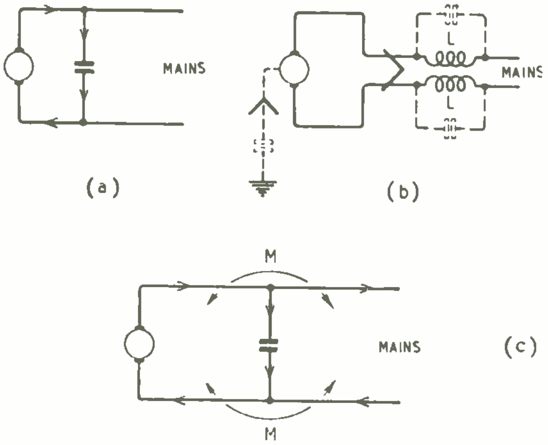

Fig. 3. (a) A capacitor shunted across the motor terminals confines most of the interference to the motor circuit. (b) A pair of inductors limits the magnitude of asymmetric interfering currents. (c) Interfering currents may by-pass the capacitor due to mutual inductance between connecting wires.

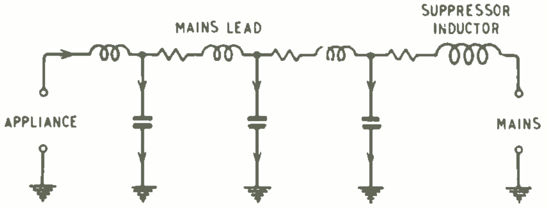

Fig. 4. Equivalent circuit of mains lead from the asymmetric viewpoint.

On the other hand, unless steps are taken to remove the asymmetric component from the mains wiring by means of series inductors (Fig. 3b) considerable radiation will result.

On Band I, TV interference may be reduced considerably by connecting a pair of self-resonant inductors in the mains connections to the motor. It has been found that these may be connected several inches from the brush terminals without impairing seriously the degree of suppression. This enables the user to purchase a suppressor and connect it in series with the mains lead to the appliance without disembowelling it.

Experiments indicate that this procedure cannot be used on Band III. The radiation resistance of the vital few inches of flex between motor and suppressor becomes sufficiently high to permit of a high level of radiation to occur before the inductors can limit the asymmetric component.

At first sight this seems difficult to understand, since the high impedance of the inductor should be the determining factor wherever it may be connected along the mains lead. But the distributed properties of the lead must not be forgotten. Fig. 4 depicts this, from which it is clear that asymmetric current can circulate, thereby radiating an interfering field, before being attenuated by the inductors.

It will be noted that the equivalent circuit depicts only one lead of the mains pair. This is because the pair can be regarded as connected in parallel at all points from the asymmetric viewpoint; that is, the current is divided equally between each wire and travels in the same direction with the same phase.

It is concluded therefore that useful suppression of interference on Band III requires that high-impedance (self-resonant) inductors be fitted as close to the motor brushes as possible within the appliance.

The unsuppressed asymmetric level of interference at the terminals of four typical portable domestic machines has been measured at a frequency in Bands I and III and is given in Table 2.

Generally, the terminal e.m.f. is lower on Band III than on Band I—very considerably so in one case (34 db), but this, unfortunately, does not necessarily mean a reduction of radiated electric field, for this

TABLE 2

Machine	55 Mc/s db above 1μV	180 Mc/s db above 1μV	Difference db
Sewing; 3-core ..	66	60	6
Hair dryer; 3-core	92	77	15
Hair dryer; 2-core	90	56	34
Small a.c./d.c. motor; 3-core ..	82	66	16

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is what ultimately generates the interference at the receiver input. These radiation fields are proportional to current *intensity* and *radiation resistance*, so that while the generated e.m.f.'s may be smaller in magnitude the resultant fields may be greater on Band III than on Band I if circuit impedance is lower and/or radiation resistance is higher.

In addition, it has been pointed out that suppression becomes physically more difficult as the frequency is raised, and no doubt limits will be reached, perhaps on Bands IV and V, where the known suppression techniques can no longer be applied.

Everything seems to point to the desirability of reducing interference at the design stage of the motor, and to do this a greater knowledge of its equivalent circuit and impedance values is necessary.

During the course of experiment it was found that a motor with square-section brushes carefully "bedded in" to the commutator curvature generated much lower interference than a similar motor with circular-section brushes. Changing them over immediately proved the importance of using "bedded in" brushes. Another significant point is that the number of commutator segments is important, the fewer the segments the greater the interference. This is presumably due to the increase in the amplitude of the superimposed voltage irregularities as the number of segments is decreased.

Finally, as an example of the failure of Band I suppression measures on Band III the photographs in the heading of this article are presented. The appliance concerned is an electric shaver in which very compactly designed and carefully disposed suppressor elements were built into it. It was obvious that careful consideration had been given to suppression at the design stage. Nevertheless, while almost perfect suppression had been achieved on Band I, as the photograph shows, it was unhappily, only too obvious how ineffective this has become on Band III due, presumably, to the increased radiation resistance of the appliance which, incidentally, was not totally enclosed in a metallic shield. The receiver had its gain adjusted on each band so that the test card was reproduced at the same white level. Band III transmission was obtained by single frequency-conversion of the existing Band I service.

In conclusion it is regretted that this article has a strong negative outlook. A great deal of work, a lot of it by motor designers, will be necessary before a further contribution on a happier note can be made.

OCTOBER MEETINGS

Institution of Electrical Engineers

Radio Section.—Address by C. W. Oatley, M.A., M.Sc. (chairman), on October 13th.

Discussion on "Whether Compatibility is Necessary for a Colour Television System in Great Britain" opened by E. P. Wethey on October 25th.

Both the above meetings will be held at 5.30 at Savoy Place, London, W.C.2.

Cambridge Radio Group.—Address by G. E. Middleton, M.A., (group chairman) at 6.0 on October 12th at the Cambridgeshire Technical College, Collier Road, Cambridge.

Mersey and North Wales Centre.—"The Experimental Synthesis of Speech" by W. Lawrence, B.A., at 6.30 on October 18th at the Liverpool Royal Institution, Colquitt Street, Liverpool.

North-Eastern Radio & Measurements Group.—Address by D. H. Thomas, M.Sc.Tech. (group chairman), at 6.15 on October 4th at King's College, Newcastle-upon-Tyne, 1.

North-Western Radio Group.—"The Measurement of the Small Signal Characteristics of Transistors" by E. H. Cooke-Yarborough, M.A., C. D. Florida and J. H. Stephen, Ph.D., "A Versatile Transistor Circuit" by E. H. Cooke-Yarborough, M.A., and "The Transistor Regenerative Amplifier as a Computor Element" by G. B. B. Chaplin, M.Sc., at 6.45 on October 20th at the Engineers' Club, Albert Square, Manchester.

Northern Ireland Centre.—"Recent Telecommunications Developments in Northern Ireland" by Major P. L. Barker, B.Sc., (chairman) at 6.30 on October 12th at the Engineering Department, Queen's University, Belfast.

South Midland Radio Group.—"The Birmingham-Manchester-Holme Moss Television Cable System" by R. J. Halsey, B.Sc., and H. Williams at 6.0 on October 25th at the James Watt Memorial Institute, Birmingham.

Southern Centre.—"Recent Trends in Loudspeaker Design" by Major A. E. Falkus at 6.30 on October 29th at the South Dorset Technical College, Weymouth.

Reading District.—"The Future of Electronics in Industry" by E. R. Davies at 7.15 on October 18th at the George Hotel, King Street, Reading.

British Institution of Radio Engineers

London Section.—Annual general meeting at 6.0 followed by address of the president, Rear Admiral Sir Philip Clarke, K.B.E., at 7.0 on October 27th at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.

South Wales Section.—Annual general meeting at 6.30 followed by "The Design of Switching Circuits" by Professor Emerys Williams, Ph.D., (University College, Cardiff), on October 6th at the Cardiff College of Technology, Cathays Park, Cardiff.

Merseyside Section.—"The Cyclotron" by M. J. Moore at 7.0 on October 7th at the University, Liverpool.

North Eastern Section.—"Radio Production" by H. G. Wood, M.A., B.Sc., (British Productivity Council) at 6.0 on October 13th at Neville Hall, Westgate Road, Newcastle-upon-Tyne.

British Sound Recording Association

Manchester Centre.—"Design of a Recording System" by H. G. Bennetts at 7.30 on October 11th at the Engineers' Club, Albert Square, Manchester.

South-Western Centre.—"Towards Perfection in Electro-Acoustic Reproduction" by D. M. Chave (Lowther Manufacturing) at 7.30 on October 20th at Callard's Café, Torquay. (Joint meeting with Institute of Practical Radio Engineers.)

Television Society

London.—"The 'Roving Eye' O.B. Unit" by T. Worswick, M.Sc., and G. Larkby (B.B.C.) at 7.0 on October 8th at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

"An Unconventional Television Wire Distribution System" by E. J. Gargini (E.M.I.) at 7.0 on October 28th at the C.E.A., 164, Shaftesbury Avenue, London, W.C.2.

Radio Society of Great Britain

London.—"Transistors and Crystal Valves in Radio" by B. R. Bettridge (G.E.C.) at 6.30 on October 22nd at the I.E.E., Savoy Place, London, W.C.2.

British Kinematograph Society

Film Production Division.—"New Studio Techniques at Highbury" by T. C. Macnamara, W. D. Kemp, B.Sc., A. M. Spooner, Ph.D., B.Sc., B. R. Greenhead and N. Q. Lawrence, at 7.30 on October 20th at the Gaumont-British Theatre, Film House, Wardour Street, London,. W.1.

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Stylus in Wonderland

An Excursion into the Realms of "High-Fidelity" Disc Recording

By O. J. RUSSELL, B.Sc.(Hons.), A.Inst.P

THE Irishism has it that "all improvements are for the worse," a sentiment not without philosophical undertones. Progress in the art of sound recording has certainly made improvements to recordings, but these "improvements" may often make matters worse in other directions. The price of progress often seems to consist in the creation of fresh problems.

Part of these new problems have been created by the striving for the utmost in so-called "high-fidelity" recordings. While it is easy to equate wide frequency range with "high-fidelity," this is only part of the story. Transient response appears to be the most important factor in the recognition of instruments. The characteristic sound of an instrument, it would appear,[1] is determined by its "keying characteristic," that is the attack or build-up of a note under the impact of a step impulse from the executant. The exact relative amplitudes of the various harmonics is obviously less important in the recognition of instruments. This would seem to follow from the fact that various instruments can be identified even when reproduced on indifferent equipment. Certainly the majority of popular priced receivers and radio-gramophones make very limited approaches to the professed ideals of the high-fidelity purists. In this connection it must also be acknowledged that there is considerable evidence for the contention that a genuine binaural or a stereophonic sound system of limited frequency response is more pleasing and satisfactory than a single wide-range monaural system.[2]

The goal of a wide frequency response has very definitely been tackled by the record manufacturers. The pre-war recording limit of some 8,000 c/s has been extended to 15,000 or even 20,000 c/s. The provision of recording extending into the supersonic region may assist in the correct rendition of transients. However, as the atmospheric absorption at these frequencies may vary by several db depending on climatic conditions, either an air-conditioned listening room or a top corrector geared to a barometer seems a necessary part of the reproducing system.

The seeker after "high" fidelity, or even "medium" fidelity reproduction is now faced with a bewildering variety of recording curves. It was always necessary to monkey with the recording characteristic even in the earliest days of electrical recording. A constant-velocity characteristic in the bass region is impracticable, as the large excursions in the groove modulation would necessitate wide groove spacings in order to prevent grooves cutting into one another. Wide groove spacing would result in a very short playing time; a 12-inch, 78-r.p.m. record would have a possible playing time of less than a minute with an unattenuated bass characteristic. Accordingly, the recording characteristic of Fig. 1 was all the pre-war "hi-fi" addict had to worry over. The bass attenuation could be corrected by a single RC coupling network based upon the turnover frequency f_0.

Such a recording characteristic presented no difficulties at all, especially as high-pressure espionage methods were not needed to discover the characteristic actually employed. In fact the E.M.I. group of companies still employs such a recording curve for 78 r.p.m. discs. Despite this, no serious difficulty in the reproduction of frequencies up to 20,000 c/s from E.M.I. recordings is evident.[3]

The "improvers" have been engaged in a jolly game of recording characteristics. Originally a mild degree of top boost had obvious advantages. Thus by boosting the recorded top level, and reproducing with an equal amount of top cut, the reproduced level would be flat. In the process, needle scratch would be reduced by the reproducing top-cut circuit. Result an improvement in signal-to-noise ratio by an amount roughly equal to half the total top boost. An idea probably inspired by the use of top boost in f.m. broadcasting techniques. The use of a mild degree of top boost gives an overall recording curve somewhat

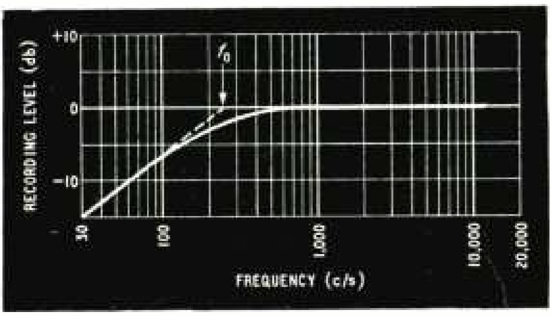

Fig. 1. Recording characteristic representative of pre-war practice. Bass amplitude is restricted to permit of reasonable groove spacing.

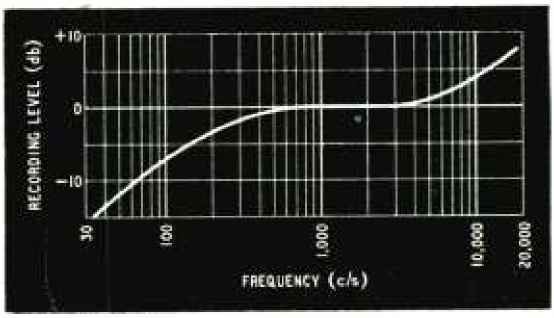

Fig. 2. A moderate degree of top lift in the recording characteristic gives an improvement in the reproduced signal-to-noise ratio.

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like Fig. 2, which might be termed the Decca "ffrr" type of recording characteristic.

The extremist technical elements in some quarters were not satisfied with mildness however. First, top boost was accentuated even more, to "improve" signal-to-noise ratio still further. Secondly, bass cut was applied with a much higher cutoff frequency, say 800 c/s instead of 250 c/s, so that bass cutting started much earlier than in the older recordings. The end product is the recording curve of Fig. 3, which has virtually no straightline portion at all. This may be termed typical U.S.A. and l.p. type of characteristic. Such a characteristic is essential for long-playing recordings, as the extreme bass cutting reduces groove modulation to an extent permitting much closer than normal spacing of grooves. Also the use of top boost assists in the reduction of surface noise, despite the 10 db lower overall recording level necessary on l.p. recordings as compared with 78 r.p.m. recordings. Moreover, the standard one-mil (0.001 inch) stylus radius used for l.p. reproduction enables the top frequencies to be successfully traced despite the top boosting.

High-frequency Distortion

Many American firms use virtually the same characteristic for standard 78 r.p.m. records. This with the object of reducing surface noise, and also for the purpose of recording at a higher overall level. The extreme degree of bass cutting does permit of either closer groove spacing, or of a higher overall recording level. Unfortunately this means that the recorded top amplitudes may reach excessive values. Tracing with conventional pickups and styli becomes difficult. Although "harmonic distortion" may be slight, and in fact harmonic distortion of a 10,000-c/s fundamental would be unnoticed, *difference tones* of an unfortunate audibility may easily be produced by a non-linear pickup reproducing two supersonic frequencies. To quote an example ". . . no large increase in distortion occurs in reproducing the 16-db pre-emphasised continuous spectrum . . . yet the addition of a few prominent tones to this spectrum in the region above 2,000 c/s will result in intolerable distortion."[4]

Accordingly a "double think" has occurred on the advisability of a full 16 db of boost at 10 kc/s (N.A.B. recording standard) or even extending to 20 db boost at 15 kc/s ("Orthacoustic" recording standard). Some American firms have reduced the degree of top boost to a modest 12 db at 10 kc/s (Victor). No one at the moment in the U.S.A. appears to use less than this degree of top boost. Accordingly Fig. 4 represents two possible limits for American recordings, both l.p. and 78 r.p.m. A compromise playback curve is capable of effectively reproducing most American recordings to within a couple of db or so. The dotted line in Fig. 4 shows the inverse of this curve, which, together with the circuit of Fig. 5, was proposed by the Audio Engineering Society of America.[5] It will be seen that this gives a very small error in reproducing either type of curve.

In the purist world several more switched playback curves are needed, but in practice the use of a flexible tone control circuit in the main amplifier enables any slight differences to be corrected. In fact there is a tendency to provide three types of 78 r.p.m. characteristic to cover the E.M.I. curve (Fig. 1), and the "ffrr" type of curve (Fig. 2), with an American 78 and and an l.p. position. However, the fashionable equalizing pre-amplifiers are even subdividing l.p. characteristics into various categories. There is clearly a limit to this process, as otherwise the equalizing pre-amplifier will require a minor reference work to accompany it.

The situation also is not helped by the appearance of a number of new companies which often specialize in American and foreign recordings generally. In my innocence I had assumed that these records were processed here from tapes. Apparently this is seldom the case, and the pressings are generally made from masters sent from the country concerned. Although in some cases records of English artists are also made here and processed from the tapes. Thus one company, it would seem, may issue recordings with a range of characteristics depending on circumstances. One company frankly admitted that it did not know what characteristic was in use for its U.S.A. pressings, although British recordings were of the Fig. 2 type of curve.

In other cases dark rumours circulate the "hi-fi" bazaars that the actual recording curve is vastly different from the published curve. Indeed, one obtains the impression that sometimes the characteristic is regarded as a top-secret commercial possession, and that publication would be detrimental to the company.

The existence of heavily "top-boosted" recordings which have also an extreme degree of bass cutting is hardly an academic issue. Reproduced on average equipment without equalization the result is most shrill and unnatural. A considerable number of "playing desks" for 3-speed reproduction are available. These desks are in many cases fitted with pickups capable of a quite high standard of reproduction, which only accentuates the lack of bass and the preponderance of top. One looks in vain for any equalizing control. By adding approximately 2s 6d worth of R and C to the output of a popular playing desk, I was able to prove to the amazed owner that something approaching "high fidelity" was possible, and that the irritating "thinness" of the l.p. discs and U.S.A. type 78 r.p.m. discs could be transformed into a well-balanced reproduction with adequate bass and unobstrusive treble. Considering that these playing desks are not cheap, and that l.p. discs cost some 30s or so, the additional cost of some form of simple equalizing circuit is small. Certainly the public at large can notice the difference, even when playing into a cheap broadcast receiver, for

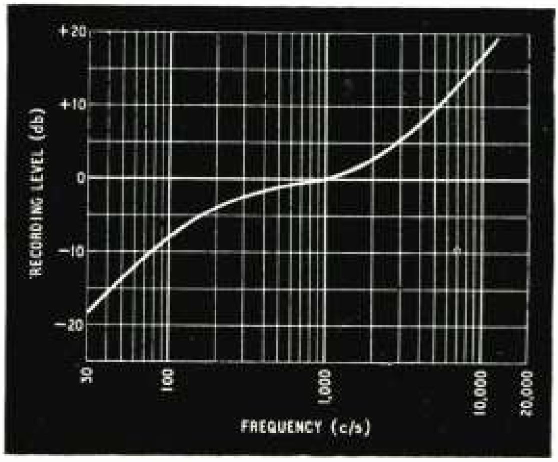

Fig. 3. Frequency distortion when carried to extreme limits introduces some unexpected problems.

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an additional 20 db of unbalance between top and treble cannot be eradicated even with a very indifferent reproducer.

It is quite possible that designers feel quite unable to cater for all the recording characteristics now unleashed on the public. However, for the general market some attempt at equalizing seems desirable, if only to produce a noise that can be listened to in reasonable comfort. The "hi-fi" addict is in a less happy position. It seems that in many cases he can not be certain *which* characteristic is employed even by a single company. Moreover, even where a single characteristic is nominally in use, it now appears that this is not an infallible guide. Electronic designers in their innocence may label the equalizer switch position for a specific recording. This may in fact be an undue confidence in the stability of a recording curve. It would appear in many cases that the recording engineer has a considerable latitude in this respect. Thus the exact bass turnover frequency may be adjusted "to suit the music," which I gather means that when playing time and groove modulation conflict, the bass turnover is adjusted to suit. Moreover the question of amplitude limiting and volume compression is a singularly difficult one to track down. We are assured that this is standard practice in recording, but the only definite evidence I have is a statement from one company that in their case limiting or compression is never used.

Tape "Masters"

The universal use of tape recording methods has raised many new objections. This mainly from high-brow reviewers who object to classical recordings being bisected at precisely the worst possible point . . . artistically speaking. It would also appear that recording level, noise level and even recording characteristics may abruptly change due to a "tape join." The spotting of "tape joins" is an essential accomplishment of the first-class record reviewer. In this connection also, a peculiar situation has arisen in connection with l.p. records which contain dubbings from early 78 r.p.m. records. Almost always the reviewer is at pains to emphasize the superior quality of the l.p. dubbing as compared with the 78-r.p.m. originals. While this is certainly a possibility in cases where both records were made from an original tape master, it is difficult to see how this can happen in the cases where a 78 r.p.m. pressing was used to make the l.p. version.

All this progress, therefore, has brought us to the stage where top boost is employed to improve record signal-to-noise ratio. This, however, at the risk of tracing difficulties, and unpleasant distortion effects, which may be avoided by refraining from excessive boost. Despite this English recordings (including the E.M.I. group with no top boost) are quoted as having some 5 db lower noise level than U.S.A. recordings, when reproduced with a flat frequency response.[5] The purchaser of a record, even if aware that equalizing is necessary, cannot be certain in many cases what equalizing is needed. To complicate the issue, more than one time constant may be needed in both bass and treble to correct for the actual characteristic used. Also, a record player made by one firm may give balanced reproduction of its rivals records, while giving a screechy, unbalanced reproduction of its manufacturer's own records.

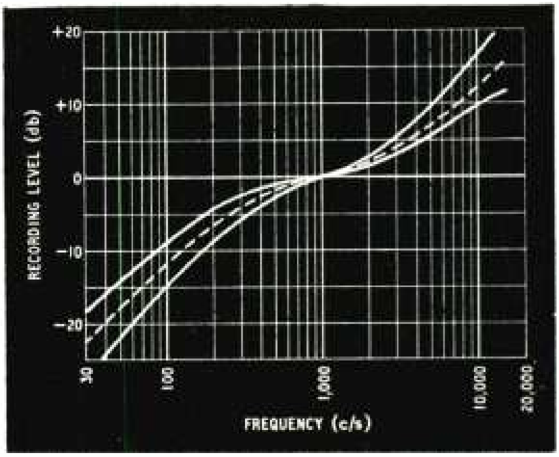
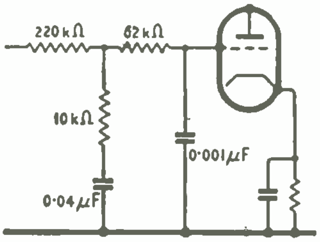


Fig. 4. The two full-line curves represent the variation found in current American practice. Good compensation within these limits is given by the circuit of Fig. 5. The compensation would be exact for the dotted characteristic.

Fig. 5. Correction circuit (see reference 5) that will cope with most American recordings both 78 r.p.m. and l.p.



While the need for some regularization of this situation has been long apparent, agreement over recording standards seems as elusive as international political agreement. Recent American attempts to define a single standard American recording specification have only been able to reduce recording characteristics to a total of four. Including, say, E.M.I. and Decca "ffrr" characteristics, it seems that a minimum of six equalizing curves, and possible eight to cater for l.p. idiosyncrasies, should be available at the control board of a modern "hi-fi" radiogram. Armed also with flexible bass and treble tone controls together with rumble attenuators, dynamic scratch filters, steep-cutting surface noise eliminators, and fast-gating "pop" noise slicers, the musically inclined listener has every chance of extracting entertainment from a record. That is if he can stop worrying about stylus wear and whether the makers have automatically corrected for the inner groove tracing loss, or whether the servo-tracking top booster should be cut in. Recent press comments to the effect that "the record is nearly over before concert room balance is achieved" have more than a trace of truth.[6] Moreover, critics' comments on orchestral balance, "thinness" of string reproduction and such-like matters, have been in some cases merely due to the use of incorrect equalizing. While the august pages of *The Gramophone* seem free from this error, it is difficult to see how it can be avoided when several characteristics may be employed on differing records from the same maker.

It seems evident that prejudice in British circles against U.S.A. recordings is largely due to the need for more extreme equalizing on U.S.A. recordings. Conversely, much favourable American comment on British recordings in the immediate post-war period is explained. The ordinary listener was unable to

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keep abreast of the complexity of recording characteristics. Thus, reproduced with little or no equalizing, British recordings would sound full and balanced, compared with the U.S.A. records on which top boosting had been applied with enthusiasm. This compares with the situation here, where some record players make little or no provision for equalizing, so that those records employing a Fig. 3 characteristic sound thin and devoid of real bass.

Despite the fact that the public are unlikely to demand equalizing networks on their record players, there can be little doubt that they will strongly prefer correct equalizing. They can hardly be expected to demand something they do not know exists. The first disc player manufacturer who backs up the provision of equalizing with adequate press publicity will no doubt reap some adequate return for his enterprise.

Some of these facts are somewhat surprising, and, indeed, alarming, to those simple souls who require to reproduce a gramophone record with reasonable fidelity. Some half-dozen equalizer networks is the minimum requirement, assuming that minor discrepancies may be accommodated by use of a wide-range tone control unit. However, some measure of standardization to reduce the many varied recording characteristics now in use seems long overdue. Perhaps when this is finally achieved, the gramophone industry could consider a few more "improvements." One suggested improvement is the issue of standard 78-r.p.m. pressings optionally in noiseless plastic. A further suggestion is the issue of "extended play" 45-r.p.m. records, pressed on 10-inch discs. This would obviate the very real risk of high intermodulation components on the inner grooves of the present 7-inch 45-r.p.m. "extended play" records. It would seem too much to ask, of course, that the recording characteristic be indicated on the record label itself.

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[3] Mitchell, B. E. G., "Commercial Disc Recording and Processing." (I.E.E. Lecture Reprint available from E.M.I., Ltd., Hayes, Middx.)

[4] Lewis, W. D., & Hunt, F. V., "Theory of Tracing Distortion in Record Reproduction." *J. Acoust. Soc. Amer.* 12, 3 (Jan., 1941), p. 348.

[5] *Audio Engineering*, Jan., 1951, p. 22.

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[7] Bird, K., "Hi-Fi in the Home." *The Observer.* Jan. 31st, 1954.

Magnetic Recording

For Purposes Other Than Entertainment

By H. G. M. SPRATT, B.Sc., M.I.E.E.

THE main advantages of magnetic recording are sufficiently well known to require no more than enumeration: (1) wide frequency band, (2) high dynamic range, (3) low noise level and (4) capability of re-use after erasure. These good qualities were early appreciated and exploited for the purposes of entertainment. There are, however, a number of other less obvious advantages which can be classed together under the heading "mechanical adaptability," and these have extended the use of magnetic recording into fields which other recording processes cannot readily enter. Because the significance of these secondary features is not immediately obvious, a brief survey of them would seem a logical introduction to a study of the various applications they have made possible.

In the first place, it is quite easy to effect multiple-track recording on standard ¼in-wide tape and the width can, if desired, be extended up to several inches. It is easy to provide reels of tape in lengths up to 5,000ft—longer if the machine is designed to take them—and it is easy to run lengths of 1,200ft or more continuously as closed loops. As an alternative, the recording material can be supplied and used in the form of rectangular sheets instead of tape. Furthermore, if the standard base is insufficiently robust, a thicker material such as 0.005in cellulose tri-actetate can be substituted. This is standard cine-film base which can be slit to 16mm or 35mm, with or without the normal perforations added, and either fully or stripe coated. Finally, if all these varieties of base fail to satisfy, the magnetic coating can be applied to solid metal in the form of a drum or disc, by dipping or spraying. This last technique ensures full dimensional stability at the highest practicable running speeds, and this in turn permits the use of non-contact heads since a constant separation between head and coating surface is guaranteed while the high speed ensures a reasonable playback voltage. The use of rotating drums or discs also facilitates synchronizing.

Turning to consider some of the applications, we will start with the more obvious, and those least removed from conventional operation. Under this heading comes the "talking book for the blind,"[1] an equipment using a few hundred feet of ½in-wide tape on which 24 tracks are recorded. A cassette houses the loaded and unloaded spools and when this is placed in position in the machine, the tape is wound from one spool to the other. At the end of each run the cassette is turned over and the head shifted to register with the next track. Thus one reel of tape, running at a speed

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which starts at 3¾in/sec and finishes at 7½in/sec along any one track, can provide some twelve hours of playing time with clear-quality speech.

Another long-playing application of considerable importance is airport monitoring. For some time now it has been considered essential to preserve a continuous record of the conversation and instructions passing between control tower and aircraft in anticipation of possible mishaps and subsequent courts of enquiry, and this requirement is easily met by long-playing magnetic recorders. The tape speed is about 3¾in/sec and multi-track operation is employed, one track logging the time. By using reels of about 4,000ft, four hours of unbroken recording is obtained. The recorders operate in pairs and the stand-by unit is automatically switched into operation just before the tape on the working unit has run out.

The office dictating machine, when constructed along conventional lines, is likewise not far removed from the domestic recorder. It usually employs 600ft or smaller reels of tape and runs at a slow speed. Easy control of run-back is important and a common feature is a foot-switch for "inching." Dictating machines are, however, not all of a pattern and one equipment ("Dictorel") employs a rectangular sheet of magnetically coated material provided with registering eyelets, and this sheet is wound round a rotating drum so that a helical track is recorded as the head traverses from one edge to the other.

One valuable time-saving device, known to be practicable, does not appear to have been incorporated in dictating machines so far, probably owing to cost. This is the use of a rotating multiple playback head combined with fast recording and slow reproducing speeds. With normal equipment a message recorded at a fast dictation speed may naturally enough prove impossible on playback to take down without frequent stops. If, in an attempt to ease matters, the playback speed is halved, the reproduction may be well nigh unintelligible owing to the drop in pitch. A method of overcoming this difficulty is to provide three or four playback heads mounted symmetrically round a rotating turret and connected to a commutator so that each is switched in and out of circuit in turn. The playback speed is halved but the turret rotates in opposition to the tape movement so that the relative speed of tape and heads is the same as the original recording speed and the pitch remains unchanged. With careful design no particularly disturbing effects appear to arise through the commutation.

Sound Reinforcement

A further step away from the conventional is the employment of magnetic recording for special acoustical purposes[2]. For a start it goes without saying that, with its facilities for multi-track operation, magnetic recording is ideally suitable for stereophony[3] and binaural working. Successful trials have been carried out of both these techniques and no more remains to be said. Another variant of multi-track operation, however, is aimed at improving sound distribution in large buildings, and has been successfully applied in the case of St. Paul's cathedral[4]. With a normal type of public-address system in buildings of this size, the time delay between the sound arriving direct from the source and that from the local reinforcing loudspeakers is sufficiently long to mar intelligibility seriously and to obscure the true direction of the source. This trouble has been overcome by introducing specific amounts of delay into the individual loudspeaker lines, the maximum being applied to those farthest from the pulpit. The equipment used (Pamphonic) employs a rotating disc around the edge of which an annulus of magnetic material is laid down. Around the periphery, also are located a recording head, a number of pickup heads appropriately spaced, and finally an erase head. The recording head is fed from the microphone at the source, the playback heads are located so as to introduce in each case the requisite amount of delay for the particular bank of loudspeakers served, and the erase head clears the tape just before it reaches the recording head again.

A rather similar principle is involved in the generation of artificial reverberation[5] to meet the needs of broadcast and recording studios. The building of special reverberation rooms is obviously expensive while the provision of movable damping panels and the like is cumbersome and not particularly cheap. If, however, a magnetic recording is made in a reasonably damped room and then played back through two or more reproducing heads mounted one behind the other and feeding into a common amplifier, any reverberation effect can be simulated. The "reverberation time" is controlled by the distances between the heads and the reverberation frequency characteristic by attenuators and filters in the pick-up output circuits.

Data Recording

In laboratory experiments, data recording, telemetering and the like, magnetic recording can assist in a variety of ways. One simple but powerful aid in the laboratory is the facility for making a verbal recording on tape during the course of an experiment, calling out meter readings and the time at which they are taken, adding a running commentary and, incidentally, leaving the hands free all the time. On the other hand, when recording of data is required, a departure from conventional technique is often found necessary.[6] The normal amplitude modulation of the tape is seldom satisfactory owing to the small but ever-present variation of sensitivity, and the complete loss of any d.c. component. These difficulties can be overcome by employing a frequency-modulated carrier, provided the transport system has been designed to give outstandingly good speed constancy. As alternatives, most of the pulse-modulation systems are equally applicable.

There are at least three systems which rely upon special designs of head to meet the requirements of data recording. In the first method[7] a mixture of transverse and perpendicular recording is employed to ensure accurate reproduction of square waves and d.c. components. The pick-up head is provided with two additional windings, one of which is fed with h.f. current saturating part of the iron circuit every half-cycle and causing the reluctance to vary cyclically while the other is fed with a constant d.c. polarizing current.

The second method is called "boundary-displacement recording."[8] Here, in the absence of signals, the whole width of the tape is magnetized to saturation except for a straight narrow strip running down the centre, on opposite sides of which the magnetization is of opposite polarity. When signals are applied, the strip moves towards one side or the other in accordance with the signal waveform. The effect is produced by means of a special composite recording head which incorporates a permanent magnet and a soft-

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iron circuit on which the signal coil is wound. The pick-up head is conventional. Good amplitude linearity and high sensitivity are claimed for this system, but not d.c. working.

In the third method, the recording head is conventional while the playback head has a miniature cathode-ray tube inserted in its iron circuit.[9] This tube has a split target, and deflection of the beam due to flux variation alters the potentials of the two halves differentially. This potential difference constitutes the input voltage to the playback amplifier. It is generally higher than the average head output, but a more important feature is the fact that it is proportional to flux and not rate of change of flux. Hence the d.c. component is preserved and the low-frequency response is flat; the h.f. response is, however, less than with a conventional magnetic head.

Whatever the system employed, it should always be borne in mind that, when analysing very low-frequency waveforms, it is usually advantageous to record them at a low speed and play them back into the analysing instrument at a much higher tone. Provided the increase in speed is sufficiently great, this procedure will shift the frequencies into a range where they can be handled by normal analysers. Mention of analysers calls to mind noise measurement, for which magnetic recording is naturally suitable. This is particularly the case where subjective effects are of importance, as in road vehicles,[10] and binaural recording can be introduced with advantage.

Medical Applications

In medicine use has been found for magnetic recording by psychiatrists in both diagnosis and treatment. In diagnosis, the advantages of possessing complete records of consultations for subsequent study at leisure are fairly obvious. As regards treatment, the same equipment can be used to repeat conditioning messages to a patient during sleep by means of a receiver placed under the pillow.

The uses and potential uses of magnetic recording in education are far reaching. They can, however, be covered in a few sentences since standard equipment is generally employed. Voice training, speech improvement and speech therapy can all derive appreciable benefits. Educational films can be dubbed with running commentaries in any language if magnetic stripes have been provided, while if the film has a composite half-photo, half-magnetic stripe two languages can be recorded. Finally, a technique has been developed for language teaching (Magnegraph). A twin-track equipment is employed and on one track a "master" record in the particular language is laid down while the other is used by the student for practising. The equipment is so designed that he can erase his own track but not the master.

In the field of advertising the long endless loop comes into its own since it can be employed to provide a sound commentary for unattended displays. In much the same way tape recording can be used with film-strip projection (Magnegraph). When the sound commentary on a particular frame being displayed is completed, a warning signal from the tape instructs the operator to change to the next frame. It is, of course, possible to arrange for the warning signals to operate relays which shift the film strip automatically and this has been successfully tried out.

While the endless loop has a number of uses in communications, one only need be mentioned here, namely its application to speech secrecy. A simple method of achieving some degree of secrecy is to record the message on tape, transmit it at a greatly increased speed and finally reconvert it to normal speed after reception, again by means of magnetic recording. A more elaborate and effective procedure is to record the message on a loop, pick it up on several playback heads spaced at intervals behind the recording head and pass the outputs through different band-pass filters to a common amplifier. A reverse process at the receiving end enables the message to be reconstituted. Such a message is virtually impossible to decode without knowledge of the number of pick-up heads, their order and relative "delays," the pass bands of the filters and the particular head with which each is associated.

Whilst on the subject of communications, an equipment designed to answer the telephone in the subscriber's absence should be mentioned. On the arrival of a call, the equipment switches itself on, indicates that the called subscriber is away and invites the caller to leave a message. Any such message is recorded on tape and at the end of a predetermined period of silence the machine switches itself off.

An entirely different technique which can reasonably be associated with communications is "Ferrography" or magnetic printing.[11] A photographic negative of the information to be copied is scanned by a photocell in a normal facsimile equipment which is provided with a second drum to accommodate a sheet of magnetic material. Signals from the photocell are passed to a recording head which is simultaneously scanning the magnetic sheet. If this sheet is subsequently dipped in a suspension of ferromagnetic particles, the attractive forces will cause a visible image to be built up which can then be transferred by contact pressure to a blank sheet of paper.

In the field of electronic computing the magnetically-coated drum seems to be firmly established as an information store of intermediate access time.[12, 13] So far, electrolytic nickel appears to be favoured for the drum coating, but the normal iron oxide used for tape should be equally satisfactory if properly applied. Such a drum, 11½in in diameter, will accommodate 64 tracks in an axial length of 2in and 2,880 pulse intervals per track, although it is believed that this latter number could be doubled. Furthermore, one track can be utilized for maintaining synchronous running of the drum. This track has a number of equidistant pulses recorded around it which on playback are compared in a discriminator with the output from a crystal oscillator of appropriate frequency. Uncontrolled, the drum would run too fast, but the discriminator supplies a varying d.c. to braking coils mounted round one end face and so maintains synchronous running. In the particular equipment described non-contact heads, separated 0.001in from the coating surface, are employed.

Machine Control

The last application to be described which comes strictly within the scope of this article is the recording and copying of irregular shapes, an industrial process of importance in the manufacture of certain cams and the mass production of shoe soles, etc.[14] Because of the inconstancy of tape sensitivity, amplitude modulation is rejected in favour of a form of pulse modulation. The master shape is rotated and a feeler following the profile drives a differential capacitor

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which controls the pulse-width/space ratio of a multivibrator. The pulses are recorded on tape at saturation level and on replay they appear as spikes which are used to drive another multivibrator. This second multivibrator controls a servomotor which drives the reproducing mechanism.

Up to this point it is felt that the exclusion of the entertainment field, as expressed in the title, has been strictly observed. However, because of the wider prospects envisaged for the future, it would be remiss to conclude without brief reference to a new development which so far comes under the heading of entertainment, namely, recording of colour-television signals. The system in question uses ½in-wide tape running at 30ft/sec and five channels are recorded, three for video, one for the sound sub-carrier, and the fifth for synchronizing. As the response extends up to 30 Mc/s it would now appear possible to record and reproduce wavelengths as short as 1/10,000in on magnetic tape. This is an outstanding advance in the "state of the art" and is likely to extend the already wide fields of magnetic recording.

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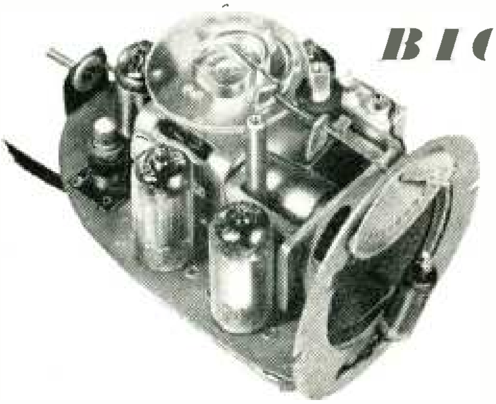
BICYCLE RADIO



The Faras bicycle receiver and batteries. No space is wasted, as the enlarged interior view on the left shows. The tuning indicator is in front of the loudspeaker.

A BICYCLE radio set in the shape of a headlamp measuring 6 x 3 in and known as the "Faras" receiver is now available in this country. It is of German origin.

The receiver is a 5-stage, 4-valve superheterodyne, and compressing it, complete with a moving-coil loudspeaker, into such a small volume is no mean achievement, especially as everything is very accessible when the chassis is removed from its case. Miniature, not sub-miniature, valves and parts are used and the circuit consists of a frequency changer, i.f. amplifier, germanium crystal detector, a.f. amplifier and output valve. A neon tuning indicator, a.g.c. and negative feedback are included.

Separate h.t. (67.5 V) and l.t. (1½ V) batteries are carried in a small plastic satchel, which can be strapped either to the bicycle crossbar or saddle, whichever is the more convenient. Current consumption is reasonable and if the set is used with discretion the h.t. battery should give several months' service, but the l.t. (two U2 size in parallel) will need replacing more frequently.

A removable telescopic aerial, measuring 7½ in closed and 30 in fully extended, suffices to give satisfactory reception almost anywhere; some eight to ten stations were received at adequate loudspeaker strength in the heart of London, so in the quieter lanes of the countryside, and especially on high ground, even more may be expected in daylight and considerably more after dark.

The set is single waveband only, with the choice of short or medium waves. It is easily detached from the bicycle and can be used as a portable either in the house or on picnics. It is obtainable from G. I. Developments, 48, Moorgate, London, E.C.1, and costs £11 plus £4 2s 6d U.K. purchase tax. The weight is 3½ lb complete.

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H.M.V. TAPE RECORDS

Some Details of Recording Materials and Methods

THE decision to issue tape recordings of famous artists and orchestras under contract to the Gramophone Company has finally disposed of dark prophecies that the vested interest in discs would prove an insurmountable obstacle to the exploitation of what is inherently a superior technical method of sound reproduction. Readers of this journal do not need to be reminded of the fact that reduced linear groove speed near the centre of a record, often combined with an orchestral climax, causes an increase in tracing distortion; that stylus wear must be watched—unless one can afford a diamond—and that recent improvements in surface noise have served to emphasize the irregular and to some people more irritating "plops" arising from dust attracted by the electrostatic charges to which the new record materials are prone.

Tape, on the other hand, is not without its drawbacks, and the delay in issuing tape recordings has been caused primarily by the search for a really stable, non-curling base material which is not affected by moisture and can be relied upon to have a shelf life comparable with that of the disc record. It is considered that the unplasticized p.v.c. base now used by E.M.I. will meet this requirement. In addition, it is treated to minimize the electrostatic charges which attract dust, and great care is taken to ensure completely uniform dispersion of the oxide particles in the coating. The tapes which will be sold to the public are in fact of exactly the same grade as those used for the master recordings in the studio.

The equipment used for duplicating the tapes is also of the same quality as that used for making masters—the Type BTR2 professional recorder. Batteries of these machines, running at the adopted speed of 7½ in/sec, are fed from the master tape which is run at either 30 or 15 in/sec. There is no appreciable loss of quality in transcription and the frequencies recorded on the 7½ in/sec tape go up to 15 kc/s.

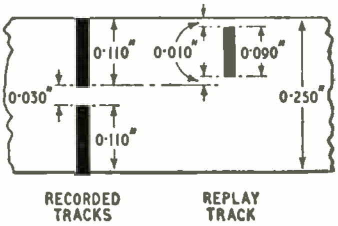

Fig. 1. Dimensions of dual track and recommended width and siting of playback head.

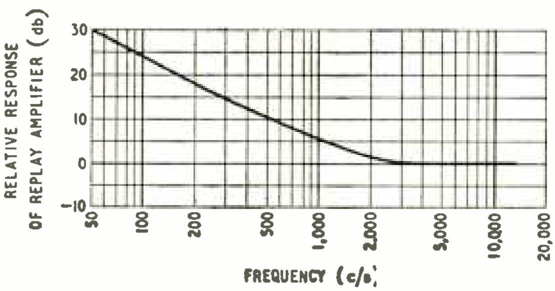

Fig. 2. Recommended playback characteristic for use with H.M.V. tape recordings.

Recordings are of the twin-track type and are made to be played from left to right on the upper track when the active side of the tape is away from the observer. Tape leaders are printed so that when the reel is turned so that the title can be read, it is ready for placing on the machine. A white leader tape indicates the beginning of the first half-track and a red of the second. Dimensions of the recorded tracks are given in Fig. 1. It is recommended that the width of the playback head should be less than that of the track, to avoid noise arising from possible blemishes on the edge of the tape. The reels are supplied on spools conforming to B.S. 2478 : 1954 and are self-supporting with 45 mils clearance from the inside faces of the flanges on each side. To ensure tight spooling a tension of 80 to 90 grams is recommended.

Playback Characteristic

Tapes are recorded on the assumption that they will be played back on equipment conforming to the C.C.I.R. reproducing characteristic specified for programme interchange in broadcasting organizations. This states that with an "ideal" head (one having a short gap, long arc of tape contact and negligible losses) the associated amplifier should have a response curve equivalent to that of a series combination of resistance and capacitance with a time constant of 100 μsec. The response is shown in Fig. 2, and any deficiencies in the playback head or amplifier should be compensated to fit this curve.

The tape coating is of the high-coercivity type and should not show any sign of print-through between turns when stored at normal room temperatures. It is not likely to be accidentally erased by stray fields of lesser magnitude than those experienced, say, within a few inches of a loudspeaker magnet.

We have had an opportunity of hearing some of the first recordings and can endorse the claims for high quality and unobtrusive background noise. Good equipment is necessary to realize the full potentialities of these tapes and this is more costly than that required for reproduction from discs. Both systems are likely to enjoy peaceful co-existence for many years to come, and the choice for the individual is a matter for his own sense of values.

"Combination F.M./A.M. Receivers"

A CORRECTION

In the circuit of Fig. 5 on page 435 in our September (1954) issue the markings of the switch joined to the grid of the triode section in the ECH81 were unfortunately transposed. The upper fixed contact should be marked B and the lower one V.

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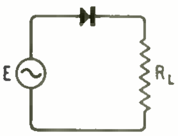
RECTIFICATION

By "CATHODE RAY"

Interpreting Meter Readings in a Simple Circuit

AS I have remarked before, it is astonishing how much a rectifier complicates the simplest circuit. It does this even if the rectifier is theoretically ideal—without any " bottom bend " or curved characteristic. One would hardly think that such a perfect rectifier, consisting of zero resistance to current in one direction and infinite resistance to current in the other direction (a simple on-off switch, in fact) would inevitably make the action of everything connected with it much more involved. Without the rectifier, Fig. 1 is as simple as the village idiot; but plus rectifier it possesses unsuspected complexities of character. However, I don't propose to go into any subtleties or finer points just now; this is going to be for anyone just starting on rectifiers, and especially the measuring and reckoning of currents and voltages in connection therewith.



The subject of this article—the simplest possible rectifier circuit.

When measuring d.c. one uses a d.c. meter, or a universal meter switched to " D.C." And correspondingly for a.c. A rectifier is usually introduced to the novice as a thing for converting a.c. to d.c. So he might very well suppose that all he had to do was to use a.c. meters at the input side and d.c. meters at the output. But there is a good deal more to it than that!

Fig. 1, of course, is absolutely the simplest possible rectifier circuit, classified officially as a single-phase half-wave rectifier with resistance load and no smoothing. Just to reduce even this to its simplest terms, let us assume that the rectifier is of the perfect on-off theoretical type just mentioned, and the a.c. generator has a pure sine waveform. Fig. 2(a) is a picture of one of its cycles. One is enough, because the others are all the same. " E_{max} " is the usual symbol for the peak e.m.f.

The ordinary moving-coil meter, as used for d.c., moves one way for positive and the opposite way for negative. If the current through it is changing very rapidly, the inertia of the coil and pointer prevents it from following those changes. If you connect it to a 50-c/s a.c. supply, the most you are likely to see is a slight vibration of the pointer. At higher frequencies even this wouldn't be noticeable; the pointer would stay practically motionless at zero. This kind of meter, thanks to the inertia of its moving parts, settles down at average or mean value of the current. And the mean value of any whole cycle of a.c. is always zero; the negative half-cycle just counterbalances the positive half.

The action of the rectifier in Fig. 1 is very simple indeed (we think!) because it just lets all the positive half-cycles through unaffected and stops the negative halves completely. The waveform across R_L, corresponding to the cycle we have been looking at in Fig. 2(a), is therefore as at (b). Supposing we connect a moving-coil voltmeter across R_L, what do we expect it to read? When it was connected direct across the generator it read nothing, because for every push it got one way it almost immediately got an exactly equal push the other way. Now it gets a push one way during half the cycle, which tends to make it read that way, and during the next half-cycle it gets no push at all, which tends to make it read nothing. Evidently it will read the average between the push and the no-push, which (since they occupy equal periods of time) will be half the reading that would be given by a continuous succession of pushes, such as would be obtained from a full-wave rectifier (of which more anon). Moreover, each push itself is not all the same amount of push, but begins gradually, works up to a maximum, and then tails off gradually. So we do not expect the voltmeter to read even half E_{max}, but only half the average or mean voltage during the positive half cycle.

Now if Fig. 2(b) were a section across a wall of sand, and we wanted to find the average height of the wall, we would probably re-shape the sand until it was level from back to front, as in Fig. 3, and reckon its new constant height as the average of the old varying height. If we did the thing carefully we would find it to be just under 64% of the previous peak. The same thing can be done less messily by drawing a

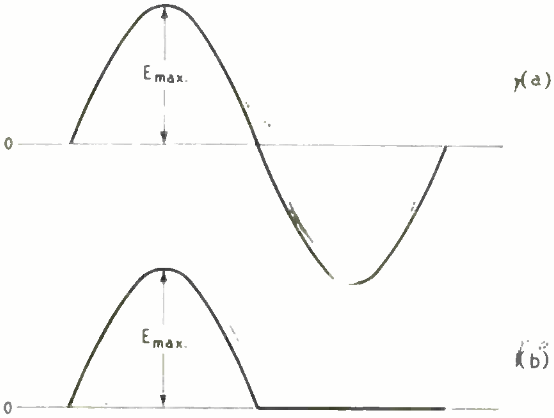


Fig. 2. The voltage waveform (a) delivered by the generator, and (b) appearing across the load resistance, R_L. (b) is just the first half-cycle of (a), followed by no voltage for the next half-cycle.

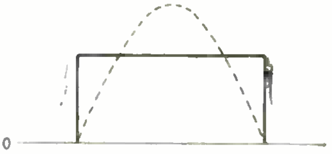


Fig. 3. The mean or average of the half-wave (dotted) is the same as that of the flat-topped half-wave having the same area under it.

sine wave on paper and then measuring the area enclosed by the half cycle. The height of a rectangle of equal area and width is the average height of the half-cycle. But in much less time than it takes to draw the curve accurately and measure the area under it, anyone with a little knowledge of the integral calculus can show that the mean value of half a sine wave is $2/\pi$ or 0.6366 times its peak value (in this case E_{max}). The average of half a cycle over the time of a whole cycle is of course half this, $1/\pi$, or 0.3183 E_{max}.

Next, what does an a.c. voltmeter read across the generator? If we actually try it, using a number of voltmeters of different types but all of guaranteed accuracy, they will all read the same. But that simple and satisfactory result conceals a complication that may mislead us badly in certain circumstances. However, before getting on to that, we will be quite right in expecting that they will not read E_{max}, seeing that except instantaneously twice per cycle the actual voltage is less. We might, if we were new to this, expect the voltmeters to read the mean voltage (reckoning negative the same as positive), that is to say 0.637 E_{max}. There we would be wrong. Why?

The most likely sort of a.c. voltmeter would be the type incorporated in universal multi-range meters. These are really moving-coil meters adapted for a.c. with the aid of rectifiers. Above about 20 or 30 volts these rectifiers are very nearly as good as perfect. They are full-wave rectifiers, so the second half-cycle is not blank as in Fig. 2(b) but is the same as the first. So the pointer is deflected to the same place on the scale as it would be if the same instrument without the rectifier were connected to a direct voltage equal to 0.637 E_{max}. Why, then, does it not read 0.637 E_{max}?

The reason is that when, say, a d.c. voltmeter on its 250-volt range is switched over to the 250 volts a.c. range, the switch does more than just bring in a full-wave rectifier. It actually alters the meter so as to make it read about 11% higher when a given voltage is applied. In other words, the instrument no longer reads the correct mean value of the half-cycles. Again, why?

Harmless Deception ?

Well, obviously, if the real value of an alternating current was its mean value, then it would have no value at all. As we have seen, the mean of a whole cycle is nil. Negative cancels positive. We know that it is not necessary to use a rectifier in order to make our a.c. supply yield light, heat or power. So clearly the effective value of a.c. is something different from its mean value. Even before we come on to a.c. at all we learn that the heat or power given by electricity is proportional to the *square* of the current. Watts are equal to amps times volts, and more amps need more volts, so watts are proportional to amps-squared or volts-squared. Now the square of a negative number is the same as the square of the same number positive, so the effective value of the negative half-cycle is the same as the positive half. To find the power of a whole cycle we must first square all the instantaneous voltages in Fig. 2(a). That gives the curve shown in Fig. 4. We know the peak value straight off; it is E^2_{max} of course. It turns out that the shape of the wave is exactly the same as that of a sine wave of twice the frequency, but raised so as to be all above the zero line.* And because a sine wave is symmetrical above and below its horizontal base (shown dotted), the mean

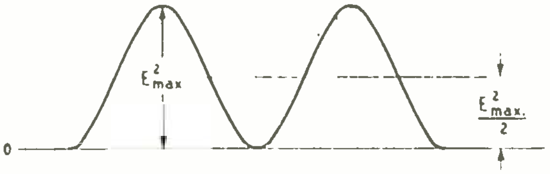


Fig. 4. When instantaneous voltages in Fig. 2(a) are squared, this is the result.

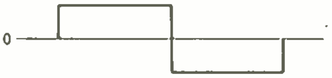


Fig. 5. In a square wave, all three values —"peak," mean and r.m.s.—are the same.

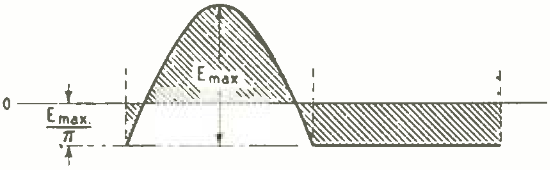


Fig. 6. When the d.c. component has been taken from Fig. 2(b), this is what is left.

height of this curve is half the peaks, namely half E^2_{max}. And because power is proportional to voltage-squared, voltage is proportional to the square root of power. So our effective voltage is $\sqrt{(E^2_{max}/2)}$, or $E_{max}/\sqrt{2}$, or 0.707 E_{max}. For reasons that the above process makes obvious, another (and commoner) name for effective value is root-mean-square (r.m.s.) value. For sine waveforms, at least, it is 0.707/0.637, or 1.11 times, or 11% more than the half-cycle mean value. That is why the rectifier type of a.c. meter, which if exactly the same as a d.c. meter with the addition of a rectifier would read low, has to be internally altered to compensate for this.

Since the r.m.s. value is the one that indicates how much heat or power we are getting, it is the one normally used. So it is denoted by a plain capital letter, E, V, or I, as distinct from E_{max} and E_{av}, the peak and mean values. When our 230-volt d.c. supply is changed over to a.c., its voltage is made so that its r.m.s. value is 230, because that raises our heaters, etc., to the same temperature as the d.c., notwithstanding that the peak value delivered is $\sqrt{2} \times 230 = 325$V.

Our rectifier meter, then, by means of internal jiggery-pokery, is made to read something that is contrary to its true nature, namely r.m.s. values. This deception is quite harmless so long as the instrument is being used to measure voltages or currents of sine waveform, for which the r.m.s./mean ratio is 1.11. But if the waveform is different, this ratio is in general different, and then there is a discrepancy between what the meter has been made to look as if it were doing and what it really is doing. What it is doing is reading 1.11 E_{av} of the full-wave-rectified voltage. To take an obvious example, suppose the meter were used on a square-wave supply, Fig. 5. Here E_{max}, E, and E_{av} are all equal. So the meter would read 11% high, and that is quite a serious error. But nothing like as bad as it would be on some waveforms, as we shall see.

How about other types of a.c. voltmeter? Valve

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*Trigonometricians will know this, because $\sin^2 x = \frac{1}{2}(1 - \cos 2x$

voltmeters are rectifier voltmeters, but their rectification is not so simple, so we shall leave them till later. Electrostatic voltmeters are true voltmeters (for they are deflected by voltage, not by current passed through a high resistance by a voltage) and they are square-law instruments—the deflection is proportional to the square of the voltage, so they need no rectification and they naturally read r.m.s. values on any waveform. So would voltmeters depending on heating action, but although thermojunction meters are sometimes used for measuring current they are rarely used for voltage, because they are relatively insensitive, and easily burn out.

Just to complete this first stage of the inquiry, what would these various a.c. voltmeters make of the rectified output, Fig. 2(b)? Any true r.m.s. voltmeter would of course read the r.m.s. value of that waveform. Now it was obvious (wasn't it?) that the *mean* value of that waveform is half the mean value of two working half-cycles. So perhaps you have already jumped to the conclusion that its r.m.s. value is half the r.m.s. value of two half-cycles, so that the voltmeter will read $E/2$, or $0.353\ E_{max}$. If so, better go through the whole process. As Fig. 4 shows, the mean voltage-squared for the first half-cycle is $E^2_{max}/2$; for the second, nil; and for the whole cycle it must be the average of these two, namely, $E_{max}^2/4$. Now take the square root of this to find the voltage—$E_{max}/\sqrt{4} = E_{max}/2$, or $0.5\ E_{max}$, or $E/\sqrt{2}, = 0.707E$. Not 0.500E. Is that a surprise?

More Surprises

Well, here perhaps is another. Fig 2(b) is not a proper alternating voltage; it doesn't alternate. It is really a mixture of a.v. of awkward waveform and a direct voltage. An a.c. voltmeter would be quite within its rights if it had a transformer or capacitor coupling, which (whether incorporated in the instrument or inserted between it and R_L in Fig. 1) would block the d.c., and what the meter would get would be as in Fig. 6. This is purely alternating, which means that the shaded area below the zero line is equal to that above the line. It looks rather a tricky job on paper to set the line so as to make this so. The d.c.-blocking device does it automatically, of course. But it is quite easy to calculate. We know that the mean value of the rectified voltage (Fig. 2(b)) is $E_{max}/\pi = 0.318E_{max}$. That is to say, as a direct voltage it is equivalent to a steady voltage equal to $0.318E_{max}$ throughout the cycle. So if we subtract this d.v. from Fig. 2(b) we get Fig. 6 in which the whole waveform has been " pushed down " so that it begins $0.318\ E_{max}$ below the horizontal base line. The fact that this downward shift represents the mean value of Fig. 2(b) means that the area under the half-wave in Fig. 2(b) is equal to the area of the rectangle in Fig. 6, $0.318E_{max}$ high and one whole cycle wide. If we subtract the white part of this rectangle from both, we are left with the fact that the shaded area above the line is equal to the shaded areas below the line, which agrees with our requirement that Fig. 6 must represent a purely alternating voltage. Its r.m.s. value can be calculated, for we have just found the r.m.s. value of Fig. 2(b)—the a.v. plus the d.v. It is $E_{max}/2$. And the r.m.s. value of pure d.v. is of course the same thing as the only value it can have, in this case E_{max}/π. To get the r.m.s. value of the a.v. alone we cannot just subtract; we must first square them, then subtract, then take the square root of the result. Filling in the values, we have as the required r.m.s. value of the a.v. alone (Fig. 6) $\sqrt{(E_{max}/2)^2-(E_{max}/\pi)^2} = 0.385\ E_{max}$, or 0.545E. So that is another voltage reading we can get from our simple Fig. 1!

But it isn't all. Our rectifier voltmeter, being scaled to read 1.11 times mean values, would, if connected in place of the true r.m.s. voltmeter straight across or instead of R_L, read $1.11 \times 0.318E_{max} = 0.354E_{max} = E/2$. If connected via the blocking capacitor it would read 1.11 times twice the mean value either half-cycle in Fig. 6. This is a little more difficult to calculate; I make it $1.11 \times 0.496E = 0.551E$. So inserting the capacitor in series actually increases the reading on this type of instrument, though it considerably reduces it on the square-law type!

We shall be losing count of all this if we don't collect the results together. The table shows the readings in terms of E (the r.m.s. value of the generator e.m.f.), assuming the rectifier is perfect, the generator has a sine waveform and no resistance, the blocking capacitor has negligible impedance, and the rectifier meter reads 1.11 times mean values.

Type of voltmeter	Across E	Directly across R_L	Across R_L via blocking capacitor
D.C.	0	0.450E	0
Rectifier a.v.	E	0.500E	0.551E
Square-law a.v.	E	0.707E	0.545E

Even though this list lacks the still different readings given by most valve voltmeters, it has quite a variety! It should make one a little careful about voltmeter readings in even the simplest rectifier circuit. And if the waveform of E were *not* sine, most of them would be different; the only reading that could be relied upon to remain correct (apart from the two zeros) would be the square-law voltmeter across E. That is one of the only two readings that are important for most purposes. The other is the one taken with the d.c. voltmeter across R_L, and, since we normally want the mean value, the fact that with impure waveforms it is unlikely to be exactly 0.450E is of little account. If the same instrument is used with rectifier for a.c., then the ratio 0.450 should hold good for all waveforms, though the indicated E would not always be the true E.

Rectifier Ratings

So far we have considered the voltage across the generator and across the load, but not the voltage across the rectifier. During the first half-cycle the resistance of the perfect rectifier is nil, so there can be no voltage across it; during the second it is infinity so the full generator voltage comes across it. The waveform is therefore the same as Fig. 2(b)—though of course shifted along half-a-cycle—and there is no new information to add to the table. The one important thing about the voltage across the rectifier is its peak value, which is referred to in rectifier data sheets as the *peak inverse voltage*, and which must not be allowed to exceed the maximum specified. If a sine waveform can be safely assumed, it is 1.414E, but if the waveform is liable to be peaky it is advisable to measure it, using a peak voltmeter or cathode-ray tube.

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In doing so, make sure that what is measured is the full peak voltage from zero, not the peak from the a.v.-only base-line in Fig. 6.

So much for voltages. How about current readings? Well, at least there can be only one current at a time in a series circuit like Fig. 1, so it makes no difference where it is measured, and the only complication that can arise is the kind of meter used and which values count. The current has the same waveform as the voltage across R_L, namely Fig. 2(b). As regards the load side, we are chiefly interested in how much d.c. this current makes. In other words, its mean value. That is what is read, simply and conveniently, by a d.c. moving-coil ammeter or milliammeter. Whether it is the raw Fig. 2(b) or has been more or less smoothed out makes no difference. (But we shall see later that this last statement must in practice be qualified.)

An Old Trap

On the generator side, if we stick rigidly to our Fig. 1, with its theoretical resistanceless generator, the current question will be of no interest at all. But if we become a little more practical we must admit that between a nearly resistanceless generator (the mains) and our rectifier and load there is likely to be a transformer, and that even if its resistance is not large enough to have a significant effect on all the preceding calculations we must take account of the current in designing or choosing the transformer. The mean value has only an incidental interest, as a possible complicating factor in the design of the transformer owing to its polarizing effect on the core. The chief questions are the amount of power to design the transformer to give, and the gauge of wire needed to avoid overheating of its windings.

The heating is proportional to current-squared, so unless we have a true r.m.s. current meter (which is unlikely) we ought to know how to calculate it from the mean value we have read on the d.c. meter. In this simple case it is very easy. Since the current is proportional to the voltage across R_L, the middle column of the voltage table supplies the needed ratio. It shows that the ratio of r.m.s. to mean value is 0.707/0.450, = 1.57. The heating effect is therefore 1.57^2, or nearly $2\frac{1}{2}$, times as great as it would have appeared if we had fallen into an old trap and used the d.c. reading. For example, if the resistance of the transformer secondary were 50 Ω and the d.c. reading were 0.2A, the heating power in that winding would not be $0.2^2 \times 50 = 2$ watts, but $(1.57 \times 0.2)^2 \times 50 =$ nearly 5 watts.

The disadvantage of getting at it indirectly like this from the d.c. reading is that it can only be relied upon if the supply has a sine waveform. We shall see (if we get that far) that with some common types of rectifier circuit a pure supply waveform does not prevent the r.m.s./mean ratio rising far above 1.57. But sufficient unto the day is the evil thereof.

If we assume that the same basis of calculation will do for the primary winding too, we shall err on the safe side, but we shall err. For, as we observed before, the Fig. 2(b) waveform is not alternating, and a transformer cannot transform d.c. So the current waveform in the primary necessarily lacks the d.c. component, and its waveform is therefore as in Fig. 6. The r.m.s. value of this, as shown by the table, is 0.545/0.707 = 0.77 times that of the same current in the secondary, so the heating effect is only $0.77^2 =$ about 0.6 times as much. It looks as if it would be a waste of copper to use the gauge that would be needed for the same current plus d.c.

I don't know what you are thinking, but might you be getting a little worried by this? I confess I was for a while, at the thought that there is more power in the secondary than the primary. Where does the d.c power come from, if the primary winding supplies only the a.c. power? Try answering that one before reading on! Well, of course it would be impossible to get more power out of the secondary than is being put into the primary. Yet the r.m.s. current-squared in the secondary, assuming an ideal 1 : 1 transformer, is nearly 70% greater than in the primary!

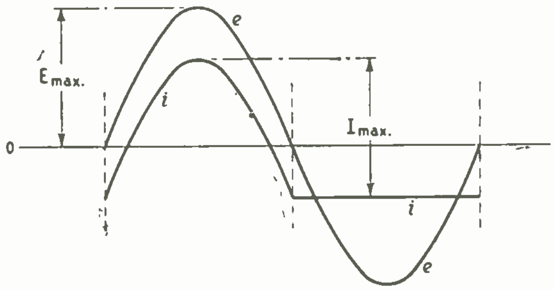

Fig. 7. Instantaneous voltage and current waveforms in the primary winding of a transformer feeding the Fig. 1 circuit.

The Balance of Power

But spare yourself dreams of perpetual motion and the downfall of the Law of Conservation of Energy. The root of the fallacy is that one is so used to power being reckoned as proportional to current-squared. The power dissipated in a resistance R undoubtedly is I^2R, but we have perhaps been forgetting about R. The power is proportional to I^2 only when R is constant and in this circuit it conspicuously isn't. It varies between R_L and infinity in every cycle. So the only sound basis is to reckon power as the mean value of current × voltage over a whole cycle. In the secondary circuit this is quite easy, because during the current-passing half-cycle the conditions are the same as if the rectifier were not there, and during the remaining half-cycle there is no current so no power. So the mean power is half of what it would be if the rectifier were shorted; namely, half of I^2R_L. Or, using the table, the r.m.s. voltage over the whole cycle is 0.707E and the r.m.s. current is $0.707E/R_L$, so the power (since both have the same waveform and are in phase) is $0.707^2E^2/R_L = \frac{1}{2}E^2/R_L$, which is the same result. In the primary it is not nearly so easy, because the voltage and current waveforms are as shown in Fig. 7, and it looks a tricky job multiplying these together at every point and taking the average of the result. I have not even attempted it, but if you do and find that the answer does *not* equal half EI be sure to let me know!

By assuming an ideal transformer, we have left out of account the magnetizing current, which, although nearly 90° out of phase, does in practice somewhat increase the primary current.

It is possible that you spotted an apparent anomaly in the balance of power even before we got on to transformers. It was when I had mentioned that the mean values of the output (current and voltage) are the same whether they come as delivered, in the rough, or after having been smoothed out by a filter. But the

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power depends on r.m.s. values, and is less after it has been smoothed. To be precise, it is $(0.45/0.707)^2 =$ about 0.4 times as much—less than half. Assuming for the sake of argument that the low-pass filter is free from resistance, so cannot itself get rid of any power, where does the missing 60% go? It cannot be used up in the rectifier, because that too is perfect. The answer is rather complicated, because it depends on the type of filter, and especially on whether capacitance or inductance comes first, starting at the rectifier end. Suffice to say that whatever type is used it knocks our simple assumptions for six; the waveforms are completely different and all our calculations fall down. If you like, you can think of the alternating power as being returned to depôt by the filter. Although the load impedance to the d.c. is still R_L as before, the impedance to the a.c. is either very much lower or higher. In practice, then, a filter radically alters the type of rectifier circuit, and the foregoing results don't apply.

The Current Passing

There remains to be considered the current passing through the rectifier. Here we must not neglect the peak value, because that is one of the limiting factors in any rectifier. We have already discovered that the mean value of the Fig. 2(b) waveform is $1/\pi$ times the peak value, so, as the current waveform is the same, its peak value is π times the reading of the d.c. meter. And that is quite a lot bigger. Again, a sine input is assumed; with other waveforms the ratio might be higher still. The other current figure usually quoted for rectifiers is the mean value. That, I think, is chiefly a matter of convenience—the fact that it is what commonly-available meters read, and is the significant figure for the output. But it is the r.m.s. value that the rectifier itself is more likely to be conscious of. Presumably the fact that it is greater than the mean value is allowed for by the rectifier manufacturers in their catalogues. The fact that the amount greater depends on the supply waveform is difficult to allow for. Presumably they either allow for the worst probable waveform, or hope that sine waves will prevail.

For the sake of completeness I suppose we ought to go into what happens when we try to measure the r.m.s. current with a rectifier type of a.c. meter. Our voltage table shows that, given a sine-wave supply, its reading on the primary side of the transformer (third-column figures) is, neglecting magnetizing current, reasonably correct; theoretically, 1% high. On the secondary side it is badly out—nearly 30% low. It would be silly to try to do it this way; much better to measure the mean value with the d.c. meter and multiply by 1.57—or a bit more to allow for odd supply wave-forms.

We have come to the end, and have had time for only the really trivial Fig. 1—and not even all about that! When I look at the serried ranks of other and much more difficult rectifier circuits waiting in the queue, an endless vista of continuations of this article opens up before me. Appalled by this sight, I conclude that on the somewhat extensive foundations that have just been laid it will be possible (by another sudden change of metaphor) to quicken our pace. If the principles of this simple circuit can be assumed to be understood, then the difficulties of the others may be more apparent than real. I hope so, anyway.

Better Technical Writing

WHEN the Radio Industry Council's plan for making monetary awards to technical authors was formally inaugurated two years ago, Sir Ernest Gowers, author of "Plain Words," expressed the hope that, out of "this stimulating and interesting enterprise" would come, not only an increased spread of knowledge, but development of the capacity among scientific and technical workers to express themselves in terms which the reader can readily understand.

Writing recently about the awards to heads of firms and research establishments, Vice-Admiral Dorling, Director of the R.I.C., said "The last two years indicate that the scheme is, to a heartening extent, attaining its objective" [of encouraging the writing of articles reporting technical radio-electronic progress in Great Britain].

A leaflet setting out the details of the awards scheme is now available from the R.I.C. (59, Russell Square, London, W.C.1). It is in the form of a small poster suitable for display on staff notice boards; the aim is that the scheme may be publicized as widely as possible among those doing work providing material and inspiration for writing technical articles.

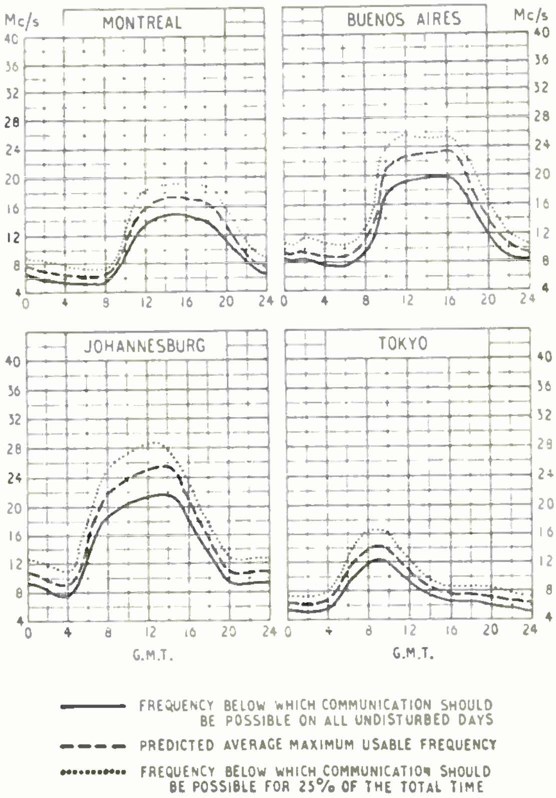
Up to six premiums of 25 guineas each are awarded each year to the authors of articles printed in the public Press. Awards for 1954 will be made at the end of the year, and the R.I.C. invite entries from editors and authors before December 31.

Short-wave Conditions

Predictions for October

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 October.

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



TRANSISTOR H.T. GENERATOR

Replacement Unit for Hearing Aid H.T. Batteries

By D. L. JOHNSTON*

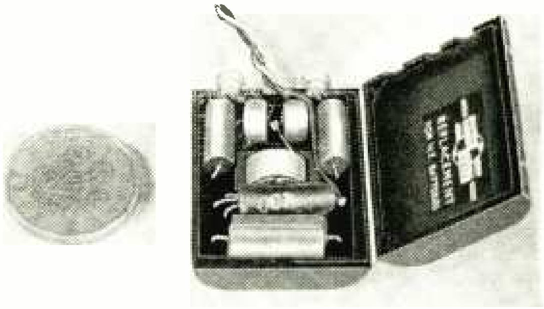
JUNCTION transistors are very suitable for h.t. generators of the oscillator-rectifier type. Because of their low impedance they can be employed to generate low and medium h.t. voltages from a single dry cell supply, and the conversion efficiency can be as high as 60 per cent, which is unattainable at low powers with small valves or vibrators. For miniature portable equipment this is important, as single cells are a more compact and cheaper source of power than h.t. batteries, and have a longer shelf life.

At present the only transistors available in this country have a low rating of power dissipation (about 5 milliwatts), but this has proved adequate for circuits to replace the high-tension supply in hearing aids[1] and other "pocketable" instruments such as radiation monitors and test instruments. Work on these lines has proceeded independently in the U.S.A. and details of this have just been published.[2] Readers will also remember the design for a transistorized megohmmeter in the March, 1954, issue of *Wireless World*.

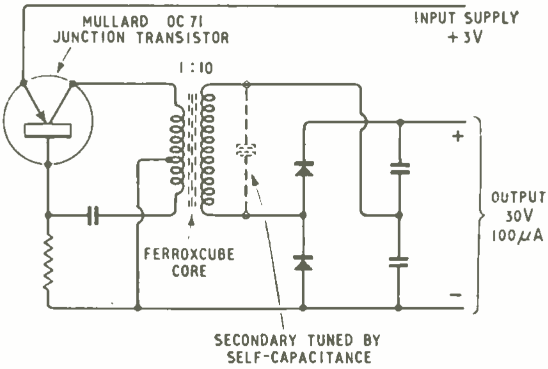
Transistors rated at over one watt are now available, at a rather high price, in the U.S.A., and with these larger and higher-voltage h.t. supplies will be possible. A television set or a transmitter with h.t. derived from one or two flash-lamp batteries will be quite practicable.

It may puzzle readers why transistors should be used to generate h.t. voltages for valve circuits instead of using transistors throughout. The explanation is that transistors are low-impedance devices and somewhat noisier than valves, and are not necessarily better than valves in all applications. For example, a pocket valve-voltmeter using miniature valves will have a much higher impedance than one with transistors, although a transistor h.t. generator can readily be employed to enable the instrument to work from a dry cell.

An interesting form of the transistor h.t. generator has been designed for the conversion of existing hearing aids to eliminate the h.t. battery. The whole generator circuit is contained in a case measuring 1⅜in × 1 1/16in × ½in and interchangeable with the h.t. battery it replaces.



Open view of transistor h.t. generator — the interior is normally filled with potting resin.



Circuit of h.t. generator to replace battery in a hearing aid.

The transistor oscillator functions in the earthed emitter mode and feedback is obtained by tapping the inductance which also constitutes the primary of the step-up transformer. Two germanium diode rectifiers are arranged in a voltage-doubler circuit, giving an output of 0.1 mA at 30 V.

This particular unit provides over 30 volts at 100 microamps from either a 1.5- or 3-volt supply, at an efficiency of up to 60 per cent. The circuit described by Pearlman employs a voltage quadrupler and a 50 : 1 transformer, and provides 700 volts at 6 µA, with an efficiency of 42 per cent.

SUB-MINIATURIZATION TECHNIQUES

A RECEIVER unit for the 190 to 550-kc/s band, using 12 valves, with a front panel 1⅞in × 5¼in and a total volume of only 55 cubic inches, is described in an American National Bureau of Standards publication, recently issued. The set is designed to plug into a recess in an aircraft instrument panel, and to operate with 26V h.t. from the main aircraft d.c. supply.

Special components, such as silvered glass capacitors, a gain control with step contacts etched on a ½in diameter glass cylinder ¼in long, have been developed and are illustrated and described. One of the most interesting features is the method of tuning the r.f. coils to follow a linear frequency law by means of ferrite cores actuated by screw threads with non-uniform pitch. Methods of cutting these threads on a production basis are described in detail. Exact tracking of the oscillator is effected by adjustable cam plates, and a method of temperature compensation by mounting the cam adjusting screws in bimetallic strips is proposed.

Copies of the report, NBS Circular 545, are obtainable from the Government Printing Office, Washington, D.C., the price being 50 cents (plus one-third to cover postage).

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* Fortiphone, Ltd.

[1] Patents applied for. Fortiphone, Ltd.

[2] Pearlman, A. R., "Transistor Power Supply for Geiger Counters." *Electronics*, August, 1954, p. 144.

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Flywheel Synchronizing

1.—*Basic Principles*

By W. T. COCKING, M.I.E.E.

NOISE and interference can affect a television picture not only by producing a visible pattern upon it but also by upsetting the synchronizing. The usual British practice is to synchronize the line time-base directly from the line sync pulses in the received signal. With this direct-locking system, each scanning line is supposed to be controlled directly by a sync pulse, but there is the possibility that noise or interference may produce spurious pulses which may trip the time-base incorrectly.

It is found in practice that noise has the effect of producing slightly irregular synchronizing. The effect is as if the timing of the sync pulses varied in a random manner and the scanning lines move sideways relative to one another in a random fashion. The amount of the displacement is usually quite small, but it makes the vertical edges in the picture ragged and the sides of the raster itself also become ragged.

The effect of interference is usually somewhat different. The commonest kind is ignition interference, and it is often of much greater intensity than noise and it occurs less frequently. The usual visible effect is, therefore, of perhaps one line only, or perhaps a few adjacent lines of one frame, being displaced sideways relatively to the others. The displacement may be much more than is usual with noise. The effect is commonly known as line tearing.

Line jitter, due to noise, and line tearing, due to ignition interference, can be almost completely overcome by the use of flywheel synchronizing. This derives its name from the fact that it imparts a kind of flywheel effect to the time-base which enables it to run correctly for a short time even in the absence of sync pulses. Synchronizing is effected, not line by line directly from the sync pulses, but on an average basis by the cumulative effect of many sync pulses.

This sounds an ideal system which it would be advantageous to adopt forthwith in all television receivers, and it is a fact that its use is now universal in the U.S.A. The American television system has different characteristics from ours, however, and what is suitable, desirable, or even necessary for it may not be for ours. Flywheel sync is, in fact, a good deal more complex than the ordinary method of direct locking. It may involve the use of several more valves, it complicates the circuitry considerably and it usually entails the use of a more stable saw-tooth generator. This not only results in a more expensive receiver but it also increases the possibility of defects arising and may make maintenance more difficult.

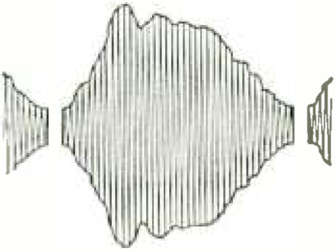

Fig. 1. Envelope of typical television in its r.f. or i.f. condition. The signal ceases during the sync pulses.

It is, therefore, undesirable to adopt flywheel synchronizing unless it affords a worth-while improvement. It has obviously been found worth while in the U.S.A., but that does not mean that it is necessarily so here under our different conditions. It is advisable, therefore, to examine the whole question of line synchronizing in some detail.

It is first of all necessary to be clear about the way in which noise and interference can affect matters. Noise and interference produce voltages in the r.f. and i.f. circuits of the receiver which can exist only with frequencies within the pass-band of the receiver. The rate of change of amplitude of any such voltage is limited by the bandwidth of the receiver and at the output it cannot possibly be any greater than is permitted by that bandwidth.

Effect of Noise and Interference

The receiver bandwidth is never greater than is necessary to handle the television signal and so it follows that the rate of change of amplitude of the receiver output on noise or interference cannot exceed the maximum rate of change of the television signal itself. This is quite different from the conditions in the sound channel, where the bandwidth is often ten times that needed by the signal. One is there accustomed to regarding interference as producing large spikes on a relatively slowly changing signal. This condition only exists in the vision channel when the interference happens to occur while the vision signal is changing only slowly. As far as synchronizing is concerned, it is the leading edges of the pulses which are important and on these the signal is changing at its maximum rate and interference or noise cannot produce an output changing any faster.

In the British television system, positive modulation is used, which means that the r.f. envelope has the form shown in Fig. 1 and the sync pulses correspond to a cessation of the signal. Any noise or interference which occurs during a sync pulse comes through the receiver unaltered to produce an output where there should be no output. It is possible, therefore, for a sync pulse to be obliterated by noise or interference.

Anything which occurs elsewhere has an effect which depends on its phase relative to that of the signal. It is possible for noise and interference to produce spurious pulses in the sync range of amplitudes at any time but it is not very probable that they will do so. They can be produced only by the noise or interference cancelling the signal which exists at that time; to do this, it must have the same amplitude and be in antiphase. The chances of this are rather remote.

However, if the two are of nearly the same amplitude and nearly of opposite phase, the cancellation, although not complete, may bring the output into the

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sync range of amplitudes and so may provide a spurious sync pulse.

In general, however, interference and noise will much more often add to the vision signal to increase the total amplitude than it will cancel it. This reasoning is borne out by visual examination of a picture which is suffering from interference. It is visible far more often as white spots than as black, and the cancellation effect would produce black spots.

One may expect, therefore, that the major effect of noise and interference on synchronizing will occur through that part of it which coincides with the sync pulses, and that any occurring away from these pulses will be relatively trivial.

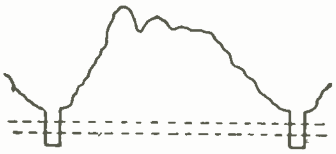

Fig. 2. A typical video waveform is shown here. The sync separator acts as a slicer to pass only amplitudes which pass between the slicing limits indicated by dotted lines.

Conditions are just the opposite with the negative modulation of the U.S.A. and some continental countries. The sync pulses then correspond to 100 per cent modulation and will be comparatively rarely cancelled by noise or interference, but noise or interference occurring at any other time can readily produce spurious pulses in the sync region. The probability of noise and interference affecting the synchronizing is thus much greater with negative modulation than with positive.

After detection and subsequent amplification, the video signal is applied to the sync separator. This is normally adjusted to act as a double limiter or slicer. The waveform is as shown in Fig. 2 in which the bounds of the slicer are indicated by dotted lines. Only signal levels between these lines are passed.

Effect of Noise on Direct Locking

Where noise or other interference is of small amplitude it cannot affect the output of the slicer during the sync pulse, for it is not great enough to bring it above the lower limit. Neither can it affect the output between the pulses for, even if it is by chance in anti-phase with the signal, it is not strong enough to bring the combined signal level below the upper slicing limit.

The only times when such noise or interference can affect the output of the slicer are at the beginning and end of the sync pulse. If it is in the right phase, anything occurring immediately before the sync pulse reaches the upper limit of the slicer at the start of the pulse, or immediately after it has passed the upper limit at the end of the pulse, can cause a premature crossing of the slicing region on the one hand or a delayed crossing on the other.

Noise or interference occurring during the crossing of the slicing region, or immediately after it at the start of the pulse, or immediately before it at the end, can delay the crossing on the one hand or make it premature on the other.

With the normal direct system of locking, the sync pulses are differentiated before being applied to the time-base and it is only the leading edges that are used. When interference or noise is small, therefore, it is only that occurring in the immediate vicinity of the leading edge that can have any effect at all upon the synchronizing. The total time of transition of the leading edge of the pulse applied to the separator is of the order of 0.25 μsec. It is only noise or interference which exists over a particular period of about 0.25-μsec duration in each 100 μsec that can affect the synchronizing. The result is that when noise and interference are small the effect on synchronizing is very small indeed.

This is the normal condition of reception within the service area. Noise is usually quite unimportant. Ignition interference depends very much upon the precise location of the receiver and is sometimes serious and sometimes negligible. Probably, on the average, it causes a small amount of line tearing, but not to a degree which viewers find troublesome.

As the signal weakens, the effects of noise and interference increase. Eventually, they may at any time break into the slicing region to cause spurious pulses which may affect the synchronizing. As already explained, anything which occurs between sync pulses demands a rather special phase and amplitude relation to the signal to be able to produce such a spurious pulse. Such a pulse can, therefore, only occur rather rarely and, even if it does, it will not necessarily affect the time-base. The amplitude cannot exceed that of a normal sync pulse and the normal time-base is inherently insensitive to such pulses unless they occur within, roughly, the last third of the scan.

The sensitivity of a time-base to a triggering pulse normally depends on the instantaneous amplitude of the saw-tooth at the moment when it is applied. There is a certain threshold level below which it has no effect at all. In normal operation, this threshold level is adjusted to occur at about two-thirds of the scan so that the time-base is not triggered by the half-line pulses which occur during the frame flyback. If this is not done, the line time-base is tripped by these pulses at half-line intervals and the extreme top of the picture is displaced sideways by a small amount.

With normal direct locking, therefore, there is a great deal of inherent protection against noise and interference. Anything occurring during the remaining third can affect the synchronizing only under certain special phase and amplitude relationships with the signal, so that its effect is unlikely to be very serious. The only time when the apparatus is wide open to interference and noise is during and immediately after the leading edge of the sync pulse.

The time for which this possibility exists is a small fraction of the line time and it is because of this that ignition interference does not usually have a great effect upon the synchronizing. Noise has a much greater effect, because it is more continuously distributed in time.

In spite of the inherent protection against a great deal of noise and interference, as the signal gets weaker the protection gets insufficient and there is no doubt that in fringe areas something more is wanted. The inherent protection which exists is due, in essence, to a form of time selection which amounts to a crude system of gating. It would be possible to improve this quite a bit, but hardly to an extent which would justify the complication.

An alternative to time selection is frequency selection and this is at the basis of all forms of flywheel sync. The line sync pulses have a duration of 10 μsec and are repetitive at a frequency of 10.125 kc/s.

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The waveform can, therefore, be built up from a series of harmonic sine waves of 10.125 kc/s fundamental frequency having particular amplitude and phase relations. The phase of the fundamental bears a specific relation to the timing of the sync pulses and therefore contains all the information necessary to effect synchronizing.

If the sync pulses are passed through a very sharply tuned circuit resonant at their recurrence frequency, this circuit will select the fundamental sine-wave component to the exclusion of the harmonics. It will produce a sine-wave output which, for a given circuit, will bear a fixed phase relation to the input pulses. Only the components of noise and interference lying within the bandwidth of this filter circuit will be passed and, as the sync signal has become a pure sine-wave of no bandwidth, there is no limit to the selectivity that can be used. Hence, noise and interference can be reduced as much as we want by making the selectivity high enough.

In order to control the time-base, some particular feature of the sine wave is selected as a reference point and new sync pulses are generated to coincide with it. The instants at which the sine wave passes through zero are convenient ones, for instance, for the wave can be squared and differentiated to produce new pulses.

This arrangement takes the form shown in Fig. 3. The pulses from the sync separator are applied to the frequency-selective filter to produce a substantially pure sine-wave output. This is passed through a phase-shifter to produce about 90° change of phase, then to the squarer and thence to the differentiator. The waveforms are sketched in Fig. 4.

The phase shifter is necessary because the output pulses must coincide with the sync pulses if the picture is to be properly placed on the raster, but the peak of the sine wave corresponds to the sync pulse and the output pulses are derived from the zero points on the sine wave.

The arrangement of Fig. 3 does not demand a great deal of apparatus. A single high-Q tuned circuit driven by a pentode valve can be used for the filter and another pentode can act as a squarer. The rest of the apparatus is built up mainly of simple RC networks.

Looked at from another point of view, the tuned circuit is shock excited by a sync pulse and rings at its natural frequency. This, perhaps, makes the flywheel action more evident.

Practical Difficulties

Certain difficulties arise in practice, some of which demand a high-Q circuit to overcome them and others a low-Q circuit! The half-line pulses which occur during the frame-pulse period form a disturbance which seriously affects the operation unless the Q is fairly high. It has been shown that the Q should be greater than 30 for this disturbance to be small.* The effect is to produce a line displacement at the top of the picture and is not unlike that obtained with direct locking when the sync-pulse amplitude is too great. The effect is not of major importance for, at the expense of some complication, it is possible to remove the half-line pulses from the wave applied to the tuned circuit.

A more serious difficulty arises from the fact that the 10.125-kc/s frequency of the sync pulses is only a nominal figure and the actual frequency may vary over a range of about 4%. This is because the frequency is tied to that of the supply mains. If the frequency changes, the tuned circuit is no longer in resonance and there is a phase shift between the output sine wave and the input sync pulses. The local pulses produced from the sine wave, which control the time-base, then do not occur at the same times as the sync pulses. The picture remains in synchronism but becomes displaced on the raster. Flyback may start before the sync pulse so that the right-hand side is cut off, or it may start after the sync pulse so that a black edge appears on the right and the left-hand side may be cut off.

This effect requires the use of a low-Q circuit to minimize it, but it seems hardly practicable to avoid fitting a panel tuning control for the tuned circuit so that it can always be brought to resonance by bringing the picture to its proper position.

This effect of the picture moving on the raster with variations in frequency or circuit "constants" is characteristic of all kinds of flywheel sync systems, although to quite a small degree in some.

There is another effect which is common to all and this is a distortion of the shape of the picture if the selectivity is made too great. Normally, in

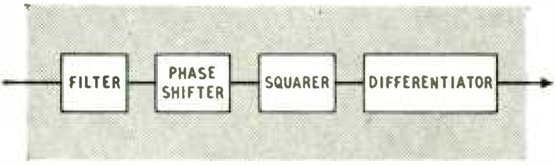

Fig. 3. Block diagram of one form of flywheel sync system. The waveforms are shown in Fig. 4.

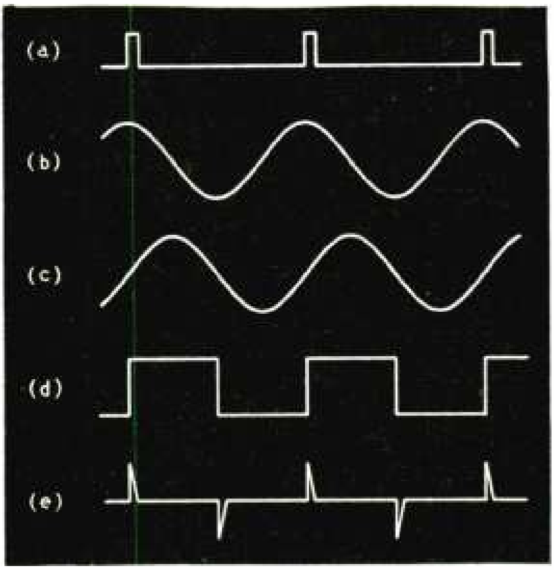

Fig. 4. Waveforms in the circuit of Fig. 3. The input sync pulses are shown at (a) and the output of the filter at (b). The phase-shifter and the squarer produce the changes indicated at (c) and (d) and the final differentiation produces the new sync pulses (e).

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* "Flywheel Synchronization of Saw-Tooth Generators," by P. A. Neeteson (Cleaver Hume).

television, the direct-locking system is used both for the time-bases in the transmitting cameras and for the time-bases of the receivers. If the sync pulses do not recur quite regularly, therefore, there is no very dreadful effect; both are controlled line by line by the same pulses.

When flywheel sync is used at the receiver, however, conditions are very different, for the receiver circuit will be constrained by the flywheel system to run more regularly than the transmitting circuit. The result is that although the edges of the *raster* will be quite uniform the picture will be irregularly displaced upon it.

Flywheel sync, therefore, demands a much higher standard of perfection in the transmitted sync pulses than will suffice for direct locking. To avoid this form of distortion, it is necessary to make the selective circuit of low-enough Q for it to follow any variations of the pulses. In other words, if the sync pulses do not occur quite regularly, they have a phase modulation on them and the selective circuit must have a bandwidth large enough to pass this modulation.

Exactly the same kind of effect occurs with all kinds of flywheel-sync circuit even if, because of differences of circuit, the language used to describe it is different. A distorted picture results if the bandwidth is too small to pass any variations in the transmitted pulses (flywheel effect too great) and this limits the amount of noise and interference reduction that is obtainable. There must be a compromise between picture distortion on the one hand and line jitter and tearing on the other.

The use of too narrow a band-width results in the sides of the picture being somewhat bowed which suggests that the sync pulses have a slight phase modulation at frame frequency. This is especially the case when the transmission is an outside broadcast. The bowing is not too large and, for fringe-area reception, is probably greatly preferable to line jitter and tearing, especially as it will disappear with improvements at the transmitting end. For local reception, however, where jitter is absent and tearing rare, it makes the use of flywheel sync disadvantageous.

Because of this effect, many practical flywheel circuits embody a compromise bandwidth which does not give the full noise reduction possible but which gives a picture free from bowing.

It should be made clear at this stage that the form of flywheel circuit referred to here and illustrated in Fig. 3 is hardly ever used in practice. Practical circuits are invariably of the negative-feedback type and are virtually servo systems. They do, however, still depend upon frequency selectivity, although this is obtained in a different way.

(To be continued)

AMATEUR TELEVISION TRANSMISSIONS

Picture received from amateur station at a distance of 31 miles. Some frame height distortion is present.

EAVESDROPPING on the amateurs has always been a pleasant diversion for those who tire of the more official broadcast programmes. The scope of this pastime has now been greatly increased by the possibility of "looking-in," as well as "listening-in," as more and more amateur television stations come on the air—though, of course, it requires a convertor in addition to the ordinary television set. Some of the pictures being transmitted are exceptionally good, and on the left is an example of what might be picked up. This image (from a "live" programme) was transmitted on 436 Mc/s by G2WJ/T of Dunmow, Essex, using an image iconoscope camera. The standards were 200 lines, 50 pictures per second, with sequential scanning. It was received at Abbots Langley, Herts, at a distance of 31 miles, by G3GDR, using a 70-cm convertor and an ordinary 10-in commercial television receiver, and this photograph was taken from the screen of the set. Similar pictures can be received anywhere within 35 miles of Dunmow.

For those who have the necessary equipment for viewing but are not sure whether there is a transmitter in their district, we give below a list of amateur stations in current operation.

Location	Call Sign	Vision frequency (Mc/s)	Vision power (W)	Sound frequency (Mc/s)	Standards (lines)
Dunmow . .	G2WJ/T	436	20	145.2	200 sequential
S. London	G3CTS/T	427	—	423.5	405 interlaced
Upminster	G3FNL/T	445	25	—	405 interlaced
Plymouth	G5ZT/T	427	3	—	200 sequential
Sunderland	G3BLV/T	—	20	—	405 interlaced
Baldock	G2DUS/T	427	3	—	200 sequential
Belfast . .	G13FWF/T	437.75	40	1.8 band	405 interlaced
St. Albans	G3JVO/T	445.5	10	—	200 sequential
Leicester . .	G3BAY/T	—	—	—	—
Under construction :					
Blyth . .	G3ACK	426	50	422.5	405 interlaced
Chelmsford	G3CVO	438.2	6	145.1	405 interlaced

Operating times are not known except that G2WJ/T is normally on the air at 6.30 p.m. on Saturdays. The figures given are likely to change without notice.

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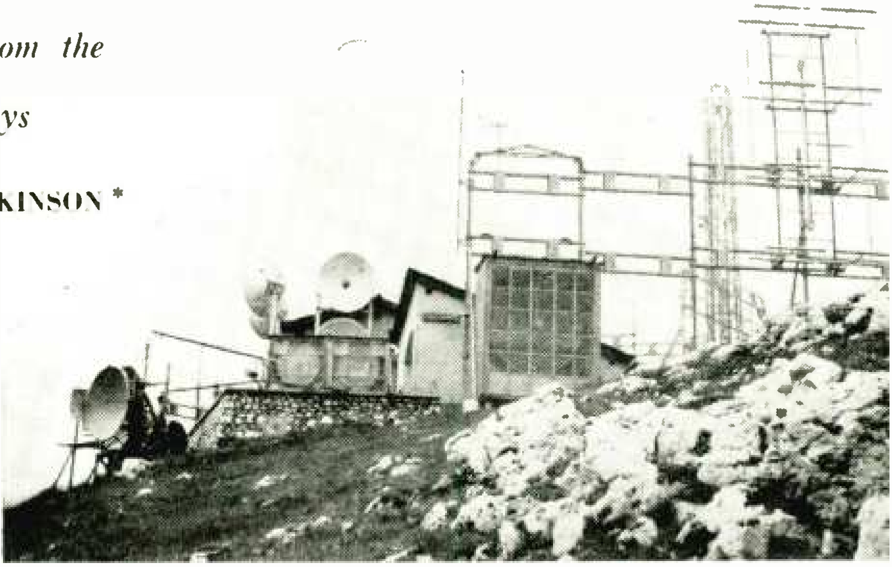
European Television

Lessons Learnt from the International Relays

By J. TREEBY DICKINSON *



Aerial installations on the summit of the Chasseral, in Switzerland, which provided the international links to Hornisgrinde (Germany) and to Milan, via Jungfraujoch and Monte-Generoso, the vision and supervisory speech links from the various programme sources in Switzerland and the main link with the two Swiss transmitters.

IT is now possible to look back on the series of international television relays which took place during June and July with sufficient detachment to justify an appraisal of their value. Moreover, as it has now been possible to make a preliminary, but necessarily rather superficial examination of the large quantity of technical data gathered during the six weeks that the tests and programme exchanges lasted, we can enumerate some of the lessons we have learnt as a result of the operation.

Perhaps, however, we should first recall that eight countries—Belgium, Denmark, France, the German Federal Republic, Italy, the Netherlands, Switzerland and the United Kingdom—participated in this experiment and that programmes originated by one country were simultaneously broadcast in all the countries. In order to make this possible, the individual national television networks were temporarily linked together by various means—usually by transportable microwave-relay equipment of the kind used for relaying television outside-broadcast signals from the point of origin to some convenient point on the permanent network. In many cases the equipment actually used for the international links was in fact material temporarily diverted from outside broadcasting for this purpose.

It will be recalled also that three standards are used by the participating countries—405, 625 and 819 lines. The consequent necessity of converting the signals from one system to another at two points in every relay, with an inevitable loss of quality, was commonly supposed to be one of the most important potential causes of failure. Indeed, the network was originally planned so that two standards-convertors would never have to be connected in tandem, that is to say, the original signal would be delivered to the input of each of the two convertors—it was never to be converted first to one standard and the converted signal passed on for further conversion to the third standard. It was the engineers' anxiety on this account and equally because of the lack of reserve equipment over most of the temporary links that caused them to insist on the experimental nature of the operation. Incidentally, the results of the preliminary tests did little to dispel that anxiety.

Apart from the test period, however, when continuous difficulty was experienced due to the last-minute installation of essential equipment, the standards-convertors behaved very well indeed. Except for momentary periods of maladjustment, no serious deterioration of the quality of the pictures can be attributed to the convertors. In this respect, at any rate, the plurality of television standards in Europe is little more than an inconvenience, and is not the menace it was once considered. In point of fact, the reliability of the links proved to be the greatest source of worry. Whenever the links worked the technical quality was usually acceptable, but, before the coming series of programmes of a similar nature can be undertaken, considerable attention is having to be given to the reliability of the interconnections.

What, then, we may ask, was the reason for the unreliability of the temporary links? To some extent it was certainly due to the temporary nature of some installations. Far more often than one would have expected, failures were provoked by excessive fluctuations of the mains supply voltage or even by complete supply failure. Often this was due to the inaccessible sites of the relay stations, involving either long temporary supply cables or continual operation from petrol-electric generating sets which were not intended for use over long periods. The weather was also very unfavourable and there were several failures attributed to rain, wind and lightning. On the other hand, at least one breakdown was caused by the overheating of a relay installation through the sun

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* European Broadcasting Union.

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shining on the metal enclosure in which it was housed. Not only were the mains responsible for complete failures, there was a lack of consistency of performance due largely to the mains fluctuations.

In a preliminary note concerning these programme exchanges* we described the test signals which had been standardized for use immediately before each transmission. They were a long square pulse of one line length, varying in amplitude from picture black to white level (Test Signal A), one or more narrow pulses (Test Signal B) and a "saw-tooth" rising from picture black to white level during the period of a line (Test Signal C). The third was, however, found to be the most informative but the original testing schedule was not ideal, because when a long network was set up, adjustments made to improve the performance of an early link had repercussions all the way along the line. For this reason the schedule of tests just prior to transmission was lengthened and the period allotted to each test-signal was divided into two, adjustments being made during the first half and measurements during the second. It may be mentioned here that at a meeting in Paris immediately after the exchanges it was agreed to modify the test-schedule for future relays and increase the time of the pre-transmission test-period to 2¼ hours. A standardized resolution and gradation pattern is to be devised by the European Broadcasting Union and a special test film incorporating patterns and scenes designed to indicate the commoner shortcomings of transmission, will be prepared.

The agreed tolerances on the transmission characteristics were found in practice to be very suitable. In particular, it was noted that good resolution was obtained when the rise-time for a square wavefront was 0.3μsec or less. When this figure was exceeded, impaired definition was observed and the Paris meeting agreed that, in future large-scale relays, a rise-time of 0.1μsec over each individual section of the network—a section being from one national control centre to the next—should be aimed at, so that the overall figure for the whole network might be expected to be less than 0.3μsec.

Permanent European TV Centre ?

This brings us to the question of the general supervision of the whole network which was the responsibility of the International Co-ordination Centre at Lille set up by the Radiodiffusion-Télévision Française, who accepted responsibility for a very large percentage of its staffing and running costs. At Lille there were two independent units, one concerned with the presentation of the programmes and the other—the Technical Co-ordination Centre—with the technical supervision of the network. It quickly became apparent to the author and Stéphane Mallein of R.T.F., who shared the responsibility for the operation of the Technical Co-ordination Centre, that its functions would be rather different and more comprehensive than had been originally supposed. In fact, its tasks fell into two separate categories. First, the operational control of the network as a whole, involving decisions relating to routing, test schedules, switching procedure and the like, and secondly, the actual checking of the technical quality of transmission over the network at any given instant. The first-mentioned responsibility was, of course, the intended task of the Technical Centre and it was carried out effectively. For the second, however, the technical equipment at the centre was inadequate and the geographical position of Lille made it impossible to monitor effectively many of the programmes. Where the programme originated at a distant point in the network the magnitude of the accumulated distortion was apparent at Lille. The centre was able to measure the transmission characteristics and, if any parameter was out of tolerance, ask for measurements to be made at each national centre in turn back towards the origin until the defective section was identified. This could not, of course, be done when the programme originated in France or a country near Lille.

When this problem was discussed at the Paris "post mortem" meeting, it was decided that, for future relays involving a large number of countries, it may be desirable to dissociate the two functions. The actual co-ordination of programmes would be done from any reasonably central place having good telephone and teleprinter communications with all the national centres, whereas the responsibility of monitoring the technical quality of transmission will have to be delegated to one or more of the national centres for each particular relay. The Paris meeting decided to invite the Administrative Council of the E.B.U. to consider the establishment of a permanent European Television Co-ordination Centre.

Future Plans

Although in the foregoing we have inevitably stressed the difficulties encountered and the shortcomings of the network, it must nevertheless be said that from the point of view of the ordinary viewer the continental exchanges were very successful. However, viewers were doubtless prepared to accept, or even expected, a certain amount of distortion during the June-July period, as it was widely known that the operation was a "first attempt" and indeed some surprise was expressed that there was only one major breakdown in vision. Something better technically—and perhaps it is not out of place to add: something better from the programme point of view—will have to be offered next time. The Programme Committee of the E.B.U. has already planned a season of shared programmes continuing from now until New Year's Day, but there is little time to set up new relay routes with more permanent installations. Moreover several of the relay stations used during the June-July exchanges were sited in high and exposed positions which would be quite impracticable under winter conditions.

Another difficulty encountered by the engineers operating the network was in describing to one another over the supervisory telephone circuits the technical quality of the pictures and the characteristics of oscilloscope displays. It is clear that even in countries nominally speaking the same language there are important differences in the technical terminology, especially regarding television waveforms and picture faults. In an attempt to make it easier for the supervisory engineers to describe quickly their observations, the E.B.U. is at present considering how best to standardize the terminology, in French and English, the two official languages of the Union, and the feasibility of introducing a numerical code to indicate the severity of certain effects. Final decisions on all these matters will have to be taken at the E.B.U. meetings which are now being held in London.

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* *Wireless World*, July, 1954, p. 319 et seq.

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Midget Television Set

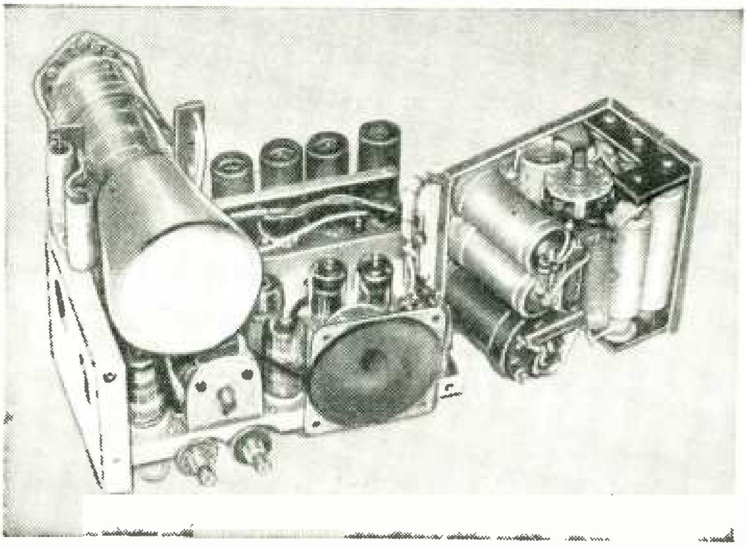
"IS it a model of a television set or just a very small television set?" This was the subtle problem which seemed to worry the authorities at the *Model Engineer* exhibition this year when they considered L. G. White's latest essay in miniaturization. One felt they would have been more sure of themselves had it not been actually a *working* receiver. Be that as it may, the significant thing to a radio technician was that, although the set as a whole was scaled down, its components were the same size as those in ordinary television receivers. The avoidance of spurious feed-back and instability in such a closely packed chassis must have been a real headache to the designer.

The actual dimensions of the set are 7in × 6in × 4in, excluding the rear projecting portion of the cathode-ray tube. A picture of approximately $1\frac{3}{4}$in × $1\frac{1}{2}$in is displayed on an ECR30 instrument c.r. tube, and in addition to the television sound the Home, Light and Third programmes on medium waves can be received. The receiver is a "straight" t.r.f. type and it uses 13 miniature valves and two germanium diodes. There are four stages of r.f. amplification for the vision signal (the first two being common to sound) and the germanium crystal detector is followed by one stage of video amplification and then the c.r. tube. The overall bandwidth to the tube is 1.5 Mc/s. In the sound channel the crystal detector is followed by two a.f. amplifying valves, and the first of these can be switched into a regenerative detector circuit to give reception on medium waves.

Sync separation is provided by a thermionic diode. The time-base generators, line and frame, each consist of a double-triode multivibrator and a double-triode paraphase output stage. Multivibrators are used in preference to blocking oscillators because they only require one double valve whereas the blocking oscillator needs a valve plus a transformer and therefore takes up more space.

For the power supply, a.c./d.c. technique is used. The valve heaters are all in series and are fed from the mains through a resistance line cord. High tension is obtained from a valve rectifier and several RC smoothing stages, while e.h.t. for the c.r. tube (1.5 kV) is produced in the same unit by a series of voltage doublers. A small shielded transformer supplies the heater voltage for the tube.

A special demonstration of the set was arranged for *Wireless World* and, in spite of severe interference in the building, very good pictures were obtained. The aerial used was nothing more than two pieces of flex arranged as a half-wave dipole and suspended from a window curtain-rail.



Chassis of the receiver (approx. quarter size), showing how the power unit (right) can be detached to give access to the rest of the circuit.

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RANDOM RADIATIONS

By "DIALLIST"

Not So Hot

PREVIEW day at the Radio Show is intended primarily for V.I.P.s and overseas visitors, a large proportion of whom are potential buyers of our products. Some manufacturers must have forgotten this, or they'd have taken more trouble about the adjustment of their receivers displayed on August 24th in "Television Avenue"; or was it the fault of the signal being piped round the show? Considering how good our 405-line pictures can be, it was not a little galling to hear foreign visitors telling one another how much better things are with 625 or 819 lines. Among the more glaring of the faults that I noticed were these: bad ringing; sound-on-vision; poor linearity; r.f. interference (due, presumably, to the "alternative" signal); too much contrast—there was more than one negative picture; brightness so far advanced that the frame flyback lines were showing; frame jitter; line tearing; incorrect focusing . . . and quite a few others. Set after set was giving a travesty of the performance of which it was capable. I hope things were better from the opening day onwards.* I don't know, for I hadn't the heart to visit "Television Avenue" again. The fashionable TV receiver this year is unquestionably that with a 17-inch c.r.t. I shall probably call down a storm of criticism on my devoted head when I say that in my considered opinion a tube of that size is too big for 405 lines, unless you have spot-wobble, or spot-astigmatism. Well, I'll risk it, for that's what I hold quite firmly.

What's the Hurry?

THOSE whose job it was to answer enquiries and give explanations at the stands of receiver and aerial manufacturers at the Radio Show must have grown a little tired of the endless stream of questions about reception of the alternative television programme. The man in the street (even if the said street is that of a back-of-beyond village) is possessed of the idea that wonderful alternative programmes, receivable everywhere, are just around the corner: if he doesn't take immediate steps to acquire a 13-channel receiver and the appropriate aerial outfit, he'll find himself badly left. It is difficult to persuade him that it's likely to be a long time before the first of these transmissions becomes available, and even then only in three areas. To meet this insistent demand manufacturers have been more or less forced to produce 13-channel receivers. But I was glad to see that many of them have also 5-channel receivers at lower prices. These take the line—and I'm sure it's the right one—that there's no sense in paying for facilities to receive the other eight unless and until you know that you can get one of them. When the alternative programme comes your way a neat and inexpensive adaptor is at once available.

A.G.C. and the Local Station

THE local-station medium-wave receiver that I've installed in the lower compartment of my console television set has evoked quite a few criticisms. J. L. Osbourne, the designer, in his letter published in the September issue stoutly maintains that I erred in eliminating a.g.c., on the grounds that even if the local stations don't fade (they don't) it is unlikely that all will put a signal of the same amplitude into my aerial. Actually, there is a considerable difference in the three signal-strengths: the Home is the biggest, the Third rather smaller and the Light the smallest. But as the signal level doesn't vary, except when one or other of them is transmitting with reduced power, I can't see that the inclusion of a.g.c. is warranted. What I have done is to gang up the 3-position potential divided (used as volume control) with the 3-position station-selector switch. This may be all wrong in the eyes of the purists; but, believe me, it works.

Ah Me!

My great regret is that I made up the local-station receiver for use with the a.f. output stages of the television set before the announcement was made that all three programmes would shortly be available on v.h.f. with frequency modulation. Though not a few people spend time and money on trying to obtain high-fidelity reproduction from medium-wave transmissions, there isn't much point in so doing, for no set can (or at any rate should) reproduce what isn't there. I'll admit, though, that you can make the m.w. broadcasts sound a whole lot better than they do when reproduced by the ordinary domestic receiver. I suppose that I'll now have to start thinking out

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* Better, but still room for improvement.—Ed.

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(unless one of *W.W.*s brainy contributors saves me the trouble) a 3-station frequency-modulation receiver to replace the present medium-wave outfit in the lower compartment of the TV set.

Pigeon Flutter

A FRIEND of mine has a peculiar television problem. A near neighbour of his has a large flock of pigeons, which decide every now and then to rise in a body and to conduct a series of aerobatics. He finds that they cause very much the same kind of picture flutter as that normally associated with the passing of an aeroplane. I don't see any reason to doubt him: birds, particularly when flying in tight formation (as pigeons do), can be almost as effective reflectors of metre-wave radio transmissions as aeroplanes. This was brought out in the early days of the war when the first tentative proximity fuzes for A.A. shells were under trial on the south-east coast. Many premature bursts occurred and it was some time before it was realized that these were due to wave-reflections from seagulls! Is one justified in reporting to the overworked anti-interference department of the G.P.O. the spoiling of TV pictures by pigeon flutter?

CITY & GUILDS EXAMINATIONS

THE examiners of the City & Guilds of London Institute have, from time to time, drawn attention to the weakness in mathematics displayed by many of the candidates sitting for the telecommunication engineering examinations, especially those unable to attend courses of instruction at a technical college. The institute has, therefore, adopted a recommendation that there should be a pass in both Mathematics I (introduced this year) and II for the award of the intermediate certificate in telecommunication engineering.

In the City & Guilds regulations and syllabuses covering telecommunications and electrical subjects for 1954-55 it is pointed out that the M.K.S. system of units will eventually be used exclusively in the question papers but during the transition questions will be framed in both M.K.S. and c.g.s. units and answers using either system will be admissible.

Next year's examinations in telecommunications principles will be held from May 4th to 10th, in mathematics for telecommunications from May 17th to 19th, and in radio from May 9th to 16th. The written examinations for the R.T.E.B. certificate for radio servicing will be held on May 3rd and 5th and the practical test on May 14th. Those for the television servicing certificate will be on May 9th and 11th (written) and 18th (practical). The Radio Amateurs' Examination is fixed for May 6th.

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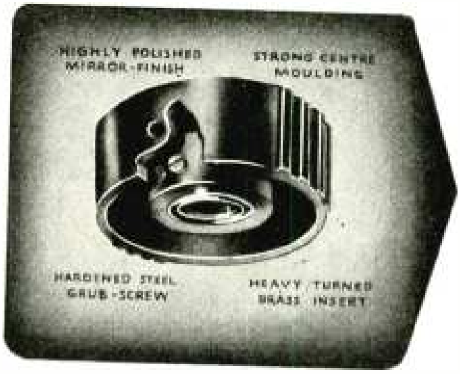

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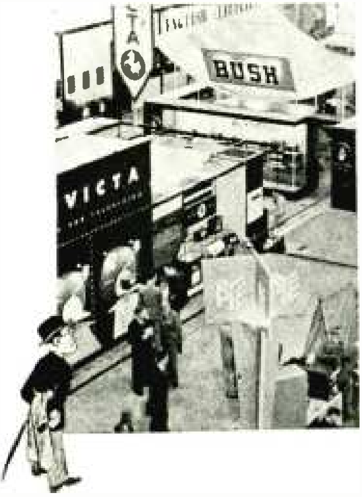

On-the-Record Interviews

IT IS reported by a correspondent in *World's Press News* that during an off-the-record interview with a V.I.P. an enterprising journalist had a tiny tape recorder concealed in his pocket, so that the interview became very much an on-the-record one. I should very much like to have details of this vest-pocket tape recorder as the smallest one I could find at this year's Radio Show weighed 14½ lb and was of considerable bulk as one would expect. There is, I am told, one weighing only 12 lb, but it is far from pocketable.

I use a very different method when I wish to put an off-the-record interview on the record, and my apparatus really is of pocket size. What I do is to leave the recording apparatus, which is coupled to a microwave receiver in my car, parked outside or very near to the building where I am to interview my victim. Since the required radio range between the car and myself will be but a few yards I have only to use a fly-weight and fly-power transmitter.

I do not descend to the subterfuge of concealing my transmitter in my pocket. It is disguised as a hearing aid and the wire running up to my ear is the aerial. I start the tape motor before leaving the car but I am hoping in future to start and stop it as necessary by a simple radio-telearchic method which has been suggested to me by the Sarah sea-rescue apparatus which was demonstrated at this year's show. Sarah seemed to combine speech and pulse technique very successfully and with its 16 watt power has a range of very many miles.

Doll's House T.V.

VERY FEW of the reports on the Radio Show made more than a passing reference to what I regarded as one of the most interesting items in the exhibition—a working model of a doll's house television receiver.

Now I am not suggesting that there is likely to be any great demand for doll's house television sets *per se*, but immediately I saw the set I realized that it was the exact thing I wanted to fasten on the arm of my easy chair to give me personal viewing. In a couple of years' time these small personal television receivers will be a necessity in every home in order to avoid family dissension as to whether the B.B.C. or I.T.A. programme should be viewed.

It would, however, be necessary, to provide a connection for headphones if two members of a family wished to stay in the same room while receiving different programmes. Incidentally, I deplore the lack of a headphone connection in today's sound-only personal portables.

The Electronic Typist

IN A RECENT science review published by *The Times* there was an announcement by a well-known firm of electronic engineers of an impending development which, in my opinion, is fraught with very grave social consequences. From this firm's very guarded statement, I gather that its electronologists—*le mot juste*, I think—have in the laboratory stage an automatic typewriter which will one day sweep out of our offices what I once heard a misogynist call "female typing facilities."

Now I don't know exactly what sort of a machine this firm's engineers are striving to create but it is probably similar to one which I have often thought of introducing myself; namely, a machine to convert the spoken word into typescript without the necessity of any time-wasting and tea-consuming females. The reason why I have held my hand is solely that I realize the serious social consequences which such a machine would introduce into office life.

Maybe the directors of the firm responsible for this device are all rather young and have no recollection of the crude barbarities and coarse profanities which were commonplace in offices before the coming of the typewriter and the civilizing influence of its female operators.

I can only say that I, for one, shall not be prepared to install an "electronic typist" until it can fulfil all the functions, humanizing as well as utilitarian, which our existing flesh and blood ones and their predecessors have fulfilled since their introduction in the latter days of Queen Victoria when, as my grandfather has told me, they had a sobering effect on all male members of his staff.

Panhellenic Plurals

I WAS interested in the letter of D. J. Bataimis of Athens in the September issue. His plea that we should use the correct stem "*iont-*" when forming ionogenic (or more correctly iontogenic) words means uprooting many precedents. Faraday who very aptly coined the word *ion* in 1839, gave us *ions* for the plural, while in the issue of *Nature* for October 9th, 1890, a writer used the adjective *ionic;* maybe some of you know of a still earlier reference.

But we must not forget that when we threw overboard the expressions "condensers," "resistances," etc., we created a good precedent for jettisoning precedents. Let us, therefore, go further than the suggestion of Mr. Bataimis and speak of *ionta* instead of *ions* and let us use "*-tra*" for the plural of the great and growing "*-tron*" family. A hybrid Latin-Greek word like positron requires more radical treatment but can easily be turned into "theton" or "thetatron." But surely this job of standardizing words is one for some body like the International Organization for Standardization?

Talking of hybrid words reminds me of television. I wonder if Mr. Bataimis can suggest a satisfactory substitute for this euphonious and universally accepted bit of jungle jargon? What, I wonder, is the word used in Athens today? Could it be τηλεβισιν? Perish the thought!

Mitres and Scalpels

IT IS very gratifying when suggestions appearing in these columns are promptly taken up by those in high places. I am glad to see that the Archbishop of Canterbury agrees with some of my views in the July issue when I pleaded for a similar degree of aid to be given to the deaf as is given to the blind to help them enjoy the B.B.C. programmes.

The Archbishop wants special TV programmes for the deaf, but I cannot help feeling that a better idea for those too afflicted to use headphones would be for explanatory captions to be shown on a small c.r.t. at the side of the main one. This would need extra ether space but not a very wide band, and, of course, the captions to Band I programmes need not be radiated in that band.

Those charged with the cure of our bodies, as well as those ordained and consecrated to the cure of souls, are also thinking along the same lines as myself. I see that a hospital in Bristol has adopted the closed-circuit home-grown programme system which I advocated last February.

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