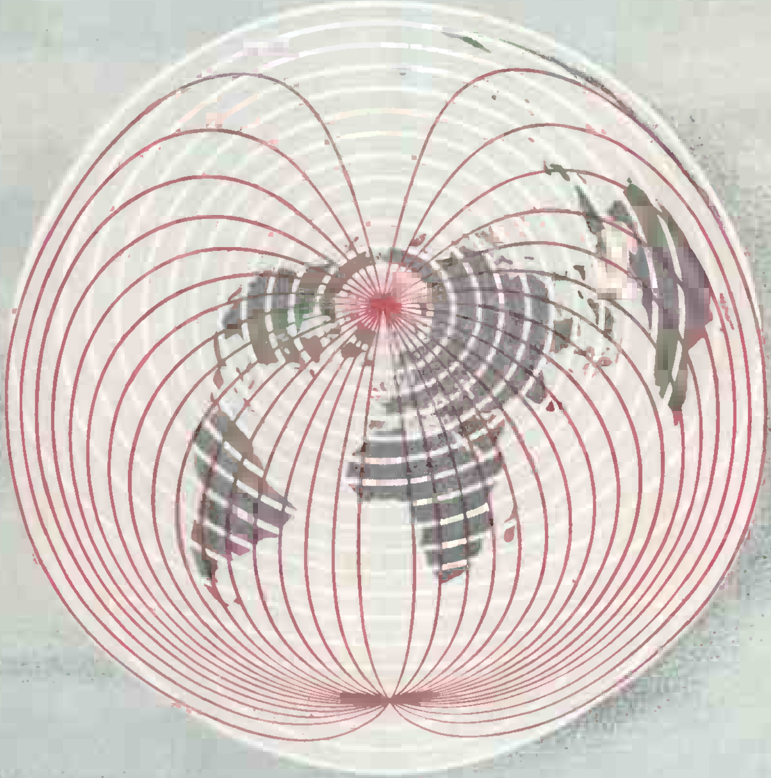
NOVEMBER 1955 TWO SHILLINGS

Wireless World

Radio · Electronics · Television



FORTY-FIFTH YEAR OF PUBLICATION

EDISWAN

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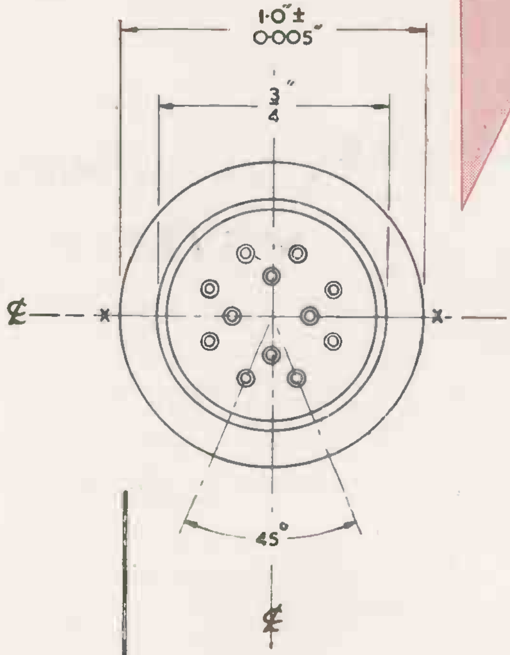

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Wireless World

RADIO, ELECTRONICS, TELEVISION

Managing Editor:
HUGH S. POCOCK, M.I.E.E.
Editor:
H. F. SMITH

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In This Issue

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FORTY-FIFTH YEAR
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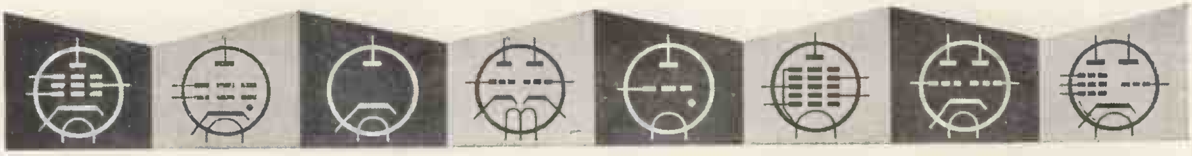


VALVES, TUBES & CIRCUITS

35. HIGH QUALITY SOUND REPRODUCTION

WIDE RANGE OF CIRCUITS

The high quality reproduction obtainable with modern audio valves at low cost has already been demonstrated by the circuit for a 5-valve 10-watt amplifier introduced last year. The '5-10' is now a firm favourite because of the easc with which it can be constructed and because it can be driven directly by many of the more popular and inexpensive types of crystal pickup.

Many constructors will, however, be interested in building a preamplifier for the '5-10' in order to use a pickup giving 40mV output, perhaps a magnetic type or a crystal pickup loaded for output proportional to stylus velocity. Suitable single-valve units of straightforward construction have been designed by Mullard engineers. There are two versions of the basic design. The first is referred to as preamplifier 'A', and is the one required by those who have already made a '5-10' in which the treble, bass, and volume controls are included in the main amplifier. The second version is known as preamplifier 'B', and is more suitable for those who are only just going to build the amplifier. Here the tone and volume controls are included in the preamplifier itself, giving more convenient access to the controls—particularly important if the equipment is to be assembled into a cabinet. The tone and volume controls in preamplifier 'B' are similar to those which can be incorporated in the main amplifier (as in the original design) but with the appropriate changes to component values. Both 'A' and 'B' are suitable for microphone input, or tape input with 30dB bass pre-emphasis at 120c/s.

Point-to-point wiring diagrams and chassis drawings are given in the booklet 'High Quality Sound Reproduction' for preamplifiers 'A' and 'B' and for the two corresponding versions of the '5-10' itself. The booklet also gives details of minor improvements and modifications made to the original amplifier circuit. Chiefly they are intended to take advantage of the high quality of the output transformers which have become available commercially and to give increased stability at the high and low frequency ends of the response. The rated output of the amplifier remains at 10 watts, but the overload point (onset of clipping with sine wave input) is now 14 watts: the hum and noise level is —75dB relative to 10 watts: and the basic sensitivity at the grid of the EF86 input stage is 40mV for 10 watts output with 26dB of feedback. The recommended rectifier is the Mullard EZ81, which has sufficient power reserve to supply the preamplifier and a radio feeder unit when either normal or low loading is employed in the output stage. The EZ81 has the same pinning as the EZ80 originally specified, but the *total* limiting resistance at each anode of the EZ81 must be at least 310Ω in this circuit.

Other Mullard circuits designed for high quality sound reproduction have been published recently in *Wireless World*. A 20-watt amplifier, sufficient for a small to medium-sized hall, was described in the May and June issues. The use of distributed load operating conditions in the EL34 push-pull output stage gives a total harmonic distortion of less than 0.05% at the 20 watts nominal output. A 3-valve preamplifier suitable for this and similar amplifiers was described in the July *Wireless World*, and the August issue contained an article on an f.m. tuner unit which can provide the input for the 10-watt or 20-watt amplifier. Point-to-point wiring diagrams and chassis drawings for these circuits, in addition to reprints of the *Wireless World* articles, are included in 'High Quality Sound Reproduction'.

A 3-valve 3-watt amplifier has been designed for those who require reasonably high quality at low cost and with the simplest possible construction. The total harmonic distortion is 1.5% at 3 watts; the sensitivity is 100mV, and the amplifier is suitable for all types of crystal pickup. This amplifier can be driven by the f.m. tuner unit via a 5:1 attenuator. An EZ81 must be included to provide power for the f.m. tuner, and the mains transformer must then be rated at 90mA or 100mA. Preamplifier 'A', primarily designed for the 10-watt amplifier, is suitable here also; a 5:1 attenuator is required to preserve the original basic sensitivity. Without the attenuator the sensitivities are increased by a factor of 5. Details of the 3-valve 3-watt amplifier are available only in the form of a leaflet (free, from the address below).

NEW PUBLICATIONS

'High Quality Sound Reproduction' is available from radio retailers price 3s. 6d. It contains 48 pages, of which 44 are devoted to the designs described elsewhere on this page. There are 24 pages of information not previously published, including 14 pages of constructional drawings. The pages are 10 ins. by 8 ins.

The 'Mullard Maintenance Manual' is now on sale at radio retailers price 10s. 6d. It provides the information of most use to the service engineer for repairing and maintaining radio and television sets and audio amplifiers, and includes data on valves and tubes for maintenance purposes as well as on the latest types. Constructors and designers will also find this manual extremely useful as a quick reference guide to data. For the complete information required in designing new equipment the Mullard Technical Handbook (available on a subscription basis) should be consulted.

To help home constructors starting to experiment with transistor circuits a new leaflet is available free of charge entitled 'Junction Transistors for the Home Constructor'. It contains eight circuits using Mullard OC70 and OC71 junction transistors, which are now readily available. Background information is included for those who would like to go more deeply into the subject.

Mullard

The free leaflets and further information can be obtained from

MULLARD LTD., Technical Service Dept., Century House, Shaftesbury Avenue, London, W.C.2.

MVM 338

Wireless World

NOVEMBER 1955 VOL. 61 No. 11

Television Complications

BRITISH television, in its original form, grew up pretty much according to plan and, in technical matters at least, the situation was always fairly well in hand. But subsequent developments, and particularly the incursion into another frequency band, have shown that it is almost beyond the powers of human foresight to envisage all the possibilities of trouble. That is why we are glad to see that the B.B.C. experimental transmissions in colour, which began on October 10th, were embarked upon with due caution and with no suggestion that the system used will be chosen for a regular service. According to the Corporation's statement, the so-called British N.T.S.C. system "*might* prove suitable" (our italics).

The British Radio Equipment Manufacturers' Association, in welcoming the start of the colour experiments, showed equal caution, and expressed the view that at least two years would elapse before any decision could be made.

Naturally enough, the industry is anxious that the general public should not be under the mistaken impression that colour television is likely to start in the immediate future. There is every reason, however, why the problems of colour should, in the meanwhile, be freely discussed in technical circles. Indeed, that applies to all aspects of television, and we sometimes think the official mind is unduly shy of the limelight.

An example of what seems to be unnecessary reticence has arisen over the transmission characteristics of the new London station at the Crystal Palace. A B.B.C. statement has just been issued saying that it is to work on the vestigial sideband method on vision, with the upper sideband partially suppressed; the present Alexandra Palace station works on double sideband. This change was generally expected and, indeed, was foreshadowed in *Wireless World* a couple of years ago; why the delay in making the announcement?

Another of the unexpected difficulties of television has come to light in connection with t.r.f. receivers, some of which will be rendered obsolete by the change mentioned in the last paragraph. As described in an article on p. 526, the use of these receivers, in conjunction with a Band III convertor, has been found to produce serious interference with nearby receivers tuned to Band I. Though we have published warnings against various difficulties in the use of convertors, we must admit to having overlooked this particular trouble.

Gallons Into Quart Pots

WE are constantly being reminded that the world's supplies of such vital commodities as coal and oil are running low. But complete exhaustion of our resources is never quite in sight, and, if and when the worst happens, nuclear energy is confidently expected partly at least to make good the deficiency.

Not so with the radio communication spectrum, in which there are no rich seams yet undiscovered and no new "gushers" waiting to be tapped. The full extent of our national resources is known precisely; these resources are inelastic and all that can be done is to use the communication channels we have to the best effect.

One method, which is of great practical significance at present, is to reduce the channel width. Many allocations were made on what now seems to be an unnecessarily lavish basis. A case in point is that of the mobile radio-telephone service, for which the channel width as at present allocated is 100 kc/s. The possibility of reducing this to 50 kc/s was considered in a report made to the Postmaster-General some months ago, but no decision was reached. Now, as reported on p. 527, a demonstration has been given of interference-free working in adjacent channels only 25 kc/s wide—an achievement twice as great as the proverbial one of getting a quart into a pint pot.

This excellent example of channel conservation has been brought about by the extension of straightforward and well-tried methods, and so there seems to be no technical reason why 25-kc/s channels should not be generally adopted in the mobile service, for which there is an acute shortage of space. The difficulties appear to be mainly economic, though it is understood the new 25-kc/s equipment is not significantly more costly.

Interference from Band-III Convertors

By F. HOWARD STEELE

Radiation on 45 Mc/s

THE advent of television broadcasting in Band III appears to add yet another source of interference to the B.B.C. transmissions in Band I. The trouble arises from Band-I t.r.f. set owners who have converted their sets to receive Band-III transmissions by adding one of the popular "universal" convertors to the front end of their receivers. These convertors usually consist of an r.f. stage followed by an oscillator/mixer, the oscillator being tuned so that the convertor output frequency is the same as the local B.B.C. transmission in Band I.

This I.T.A.-modulated Band-I signal is then amplified through the t.r.f. stages of the receiver until in the region of the detector a signal of several volts in amplitude is obtained. Unless the screening of the receiver is unusually efficient, a few millivolts of this I.T.A.-modulated Band-I signal is picked up by either the Band-I or Band-III aerial leads and is re-radiated. Because of local oscillator drift in the Band-III convertor this radiated signal is not of constant frequency, and variable frequency beats are produced with the B.B.C.'s Band-I transmissions.

The effect on the screen of television receivers operating on Band I anywhere within 100 yards or so of the offending "viewer" is extremely irritating. A vicious herring-bone pattern appears on the screen which is constantly on the move, starting first one way and then the other as the re-radiated signal drifts above and below the frequency of the local B.B.C. transmission in Band I.

Additional Complications

The cause of this interference would seem difficult enough to cure as it is, without two more contributory factors which make it well nigh impossible. The first of these additional complications is the number of t.r.f. receivers which are of the a.c./d.c. type and therefore cannot be properly earthed. The second is the current practice of using unbalanced coaxial cable as the downlead from an aerial which is inherently a balanced device. This prevents one from considering the downlead as a simple transmission line.

The last-mentioned complication can be remedied, of course, by fitting a balance-to-unbalance transformer at the aerial end of the downlead, but if this is done without careful thought impedance matching problems arise. Theoretically, if correct matching is to be obtained, one should use a quarter-wave line transformer between the end of the feeder and the upper element of the dipole and a three-quarter wavelength line between the end of the feeder and the lower element of the dipole. Apart from the complication of so doing, however, it would tend to make the collection of scrap iron we have on our chimneys these days look even more untidy than it does at present.

Should any readers consider doing this, however, it should be remembered that the mechanical length of a piece of coaxial 75-ohm feeder is shorter than its electrical length, because of the slower propagation rate in this type of cable. The transmission factor of ¼in solid Polythene insulated coaxial is approximately 0.66 and the matching stubs should be shorter than the equivalent free-space wavelength by this factor.

The problem of providing a satisfactory r.f. earth at the receiver input terminals is more difficult. In theory the length of the earth wire should be a multiple of $\lambda/2$ where λ = wavelength of local B.B.C. transmission in Band I. In practice, it would appear impossible to calculate this length, due to the indeterminate stray capacitances to the surroundings of this earth wire and the difficulty of knowing exactly where "earth" is at the far end. A semi-practical solution is to insert a series LC circuit in the earth lead and by varying the L or the C attempt to tune the earth wire to an exact half wavelength. If this can be done (and so far the author has failed to do so) then the receiver input will be at r.f. earth potential so far as the Band-I transmission is concerned and, in conjunction with a balance-to-unbalance modification to the aerial system, one will be well on the way to solving the re-radiation problem.

Having stopped the t.r.f. receiver "bouncing up and down at the end of its earth wire" at I.T.A.-modulated Band-I frequency, the next problem is how to stop the spurious Band-I radiation from the t.r.f. receiver being passed back up the aerial feeders and being re-radiated by either the Band-I or Band-III aerials.

Considering the Band-III aerial first, the solution in theory is not too difficult. All that is required is a high-pass filter to be fitted in the aerial feeder as far away from the t.r.f. receiver as possible. This filter should look like 75 ohms when viewed from either the aerial or the receiver if a mis-match is not to occur and it should ideally have zero insertion loss at Band-III frequencies and an infinite insertion loss at Band-I frequencies. In practice a simple π-type filter with a capacitor as the series element appears to work reasonably well, but the calculated values of inductance in the shunt arms are so small as to make their construction largely a matter of trial and error. (To obtain the required 0.148μH one or two turns, ¼in diameter air-spaced, are necessary.) In addition, the two inductors need to be separated by an earthed screen (through which the series capacitor, about 12pF, passes) to avoid mutual coupling between them. The whole filter is then placed inside a fully screened box. Such a filter has a designed cut-off frequency of approximately 90 Mc/s and a characteristic impedance of 75 ohms—we hope!

In practice such a filter makes a substantial reduction in the level of radiated interference but is not in itself a complete cure by any means. One is still not on speaking terms with one's immediate neighbours

Stopping the Band-I aerial re-radiating is more difficult, and so far no satisfactory cure has been found. One cannot put a high-pass filter or even a band-stop filter in this downlead because, being a two-way device, it precludes the possibility of observing the Old Lady of Shepherd's Bush when one wants to.

Some Band-III convertors on the market short-circuit the Band-I aerial when it is not in use, but this discontinuity, of course, tends to set up standing waves in the Band-I aerial feeder with consequent radiation. A better solution would appear to be terminating the unused aerial feeder in 75 ohms and screening the termination.

It will be gathered from the above that the author owns a t.r.f. receiver and a Band-III convertor of the type referred to. Both the receiver and the convertor are fully screened and yet he must confess, however unknowingly at the time, to causing Band-I interference on the opening night of the I.T.A. transmissions—a fact which a kind but suspicious neighbour was not slow to suggest the following day. Since that time considerable thought has gone into ways and means of suppressing this interference, which in the author's location appears to be a very real problem. A considerable reduction in the level of interference has resulted, but the interference pattern is still visible on receivers up to 100 yards away.

The only foolproof solution would appear to be the conversion of the t.r.f. receiver to a superhet, using a commercial turret tuner as a front end and dropping the existing 45-Mc/s r.f. strip down to the new preferred British i.f. of 34.65 Mc/s. As the oscillator in such tuners is usually above the Band-I frequency (to avoid harmonic breakthrough) this inverts the relative position of the sound and vision channels and the sound i.f. comes out at 38.15 Mc/s. This, fortunately, is within the range of adjustment of the majority of existing sound receiver circuits and no modification is necessary.

Pending this rather drastic step, the author has not dared to tune in to the I.T.A., and is all the more infuriated to find that others are now causing exactly the same interference as he did on the opening night. It is small consolation to be able to show suspicious neighbours who "just drop in for a chat" that he, too, is suffering the same interference as they are.

Unless anyone can suggest a lasting, immediate and hundred-per-cent effective cure, it is up to all owners of t.r.f. receivers plus convertors to check without delay whether they are radiating this interference. Moreover, radio dealers should be discouraged from selling these Band-III convertors to any t.r.f. set owner unless he has checked that no interference will result. To have bought a convertor, to have sniffed the rabbit (however young and immature) and not to be able to watch his progress is almost intolerable, and yet it seems the only way if one is to remain at peace with those who live nearby.

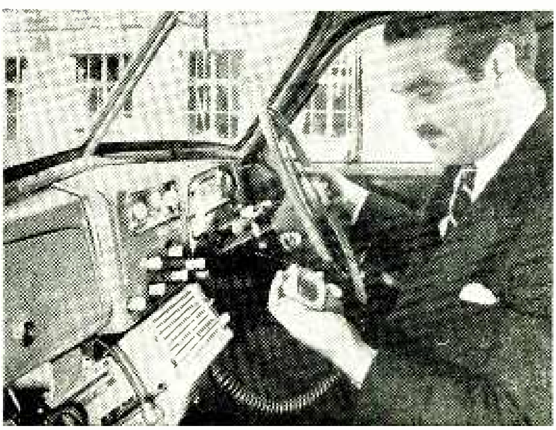
Narrower Mobile Radio Channels

BAND III is now in the process of being cleared for television purposes and when the job is completed the space left for private mobile radio users will be only about 7 Mc/s. This imposes a severe restriction on the development of mobile radio which can only be overcome by reducing channel widths. An official body has already recommended that the present 100-kc/s channel width should be reduced to 50 kc/s* but it now seems that the belt can be tightened even more. Pye Telecommunications have recently demonstrated a new two-way mobile radiotelephone, known as the "Ranger," designed for channels as narrow as 25 kc/s. This, of course, makes possible four channels in the space occupied by one at present.

With such close spacing the problem of cross-talk between channels becomes really acute, and it is essential that good frequency stability shall be maintained in the equipment. The Pye transmitters and receivers are crystal-controlled, of course, and the crystals themselves are cut in a manner which gives high stability operation (AT-cut crystals). The transmitter consists of an oscillator followed by three frequency multipliers and a power amplifier, with a modulator comprising a phase splitter and push-pull output stage. An r.f. output power of 4-6 watts is obtained and the frequency drift is claimed to be less than $\pm 0.002\%$. The receiver is a double superheterodyne with two crystals and eleven valves and is provided with noise-limiting and a.g.c. circuits. Sensitivity is $1\mu V$ for 100mW output, while the frequency drift here is claimed to be less than $\pm 0.0025\%$.

The equipment will work anywhere in the frequency range 25-174 Mc/s on either single- or double-frequency simplex, and is operated by a "press-to-talk" switch on the hand microphone. Transmitter, receiver and power supply are housed in a steel case intended for fitting under the dashboard of a motor vehicle, as shown in the photograph below.

In the demonstration of the equipment, four mobile units in motor vehicles were receiving from four 15-watt fixed transmitters in adjacent 25-kc/s channels (actually 161.725, 161.75, 161.775 and 161.8 Mc/s), the mobile transmitters and corresponding fixed receivers being spaced from these by 4.5 Mc/s (at 157.225, 157.25, 157.275 and 157.3 Mc/s respectively). In spite of this close spacing there appeared to be no cross-talk between channels except a slight trace when the mobile units had been driven very close to the fixed transmitter aerials.



* "Report of the Mobile Radio Committee," H.M.S.O., price 9d; summarized in "Mobile Radio," *Wireless World*, May, 1955.

WORLD OF WIRELESS

British N.T.S.C. Tests ✦ H.P. and Retail Sales ✦ Engineering Opportunities

Colour Television Tests

THE promised television test transmissions in colour began from Alexandra Palace on October 10th. The system being used in these initial tests, which are being radiated outside normal programme hours, is the British adaptation of the American N.T.S.C. system (see our August issue). Other systems may be tried later on.

These tests, which are being carried out in agreement with the Television Advisory Committee, are mainly to ascertain whether a truly compatible system should be the final objective. Viewers in the London area will have the opportunity of finding out if there is any appreciable degradation of the monochrome picture.

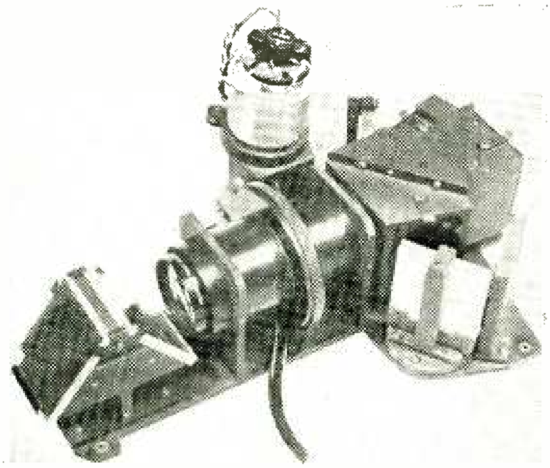
New Television Stations

TWO new television stations, both operating in Channel 4 (61.75 Mc/s vision and 58.25 Mc/s sound) have been brought into service by the B.B.C. during the past month.

The first, a 1-kW temporary Channel Islands transmitter at Les Platons, Jersey, at present has to rely on the reception of transmissions from the temporary station at North Hessary Tor. The permanent Devon station will be in use early next year. The signals are picked up at a receiving station at Torteval, Guernsey, and conveyed to Jersey by a radio link.

The other new station is the permanent transmitter at Meldrum, 20 miles north-west of Aberdeen. It has an e.r.p. of 12 kW and replaces the temporary transmitter at Redmoss, which has been in use for the past 12 months.

Both stations use horizontal polarization.



OPTICAL ASSEMBLY of the three-tube colour camera which, with its associated equipment, has been supplied by Marconi's for the B.B.C. colour television tests. The film and slide-scanning equipment being used in the tests was developed and built by the B.B.C. Research Department.

Rear-Admiral K. H. T. Peard speaking at the farewell dinner to Rear-Admiral Sir Philip Clarke whom he succeeds as director of the naval electrical department. Sir Philip has been nominated for a second year as president of the Brit. I.R.E.

Retail Sales

THE increase in the hire-purchase deposit on broadcast receivers introduced at the end of July is reflected in the survey of retail sales during August, prepared by the British Radio Equipment Manufacturers' Association. It will be seen from the table, in which the hire-purchase sales are given as a percentage of the total sales for each of the past six months (they are not available for January and February), that the proportion of credit transactions has dropped considerably.

	Sound	Radiograms	Television
January ...	98,000	35,000	103,000
February ...	99,000	33,000	98,000
March ...	95,000 (41%)	24,000 (62%)	85,000 (59%)
April ...	79,000 (42%)	16,000 (63%)	75,000 (59%)
May ...	75,000 (43%)	15,000 (68%)	62,000 (59%)
June ...	74,000 (40%)	13,000 (67%)	58,000 (57%)
July ...	84,000 (41%)	13,000 (67%)	61,000 (61%)
August ...	73,000 (33%)	11,000 (54%)	64,000 (53%)
	677,000	160,000	606,000

Engineers in the B.B.C.

OPPORTUNITIES for graduate engineers and physicists in the B.B.C. are outlined in a booklet "Engineers in the B.B.C." Of the 4,500 employed in the engineering division, 600 are fully qualified engineers and physicists and about 2,300 "engineers who may not necessarily be fully qualified academically" who are mainly employed on operations and maintenance.

Each year the B.B.C. offers a number of two-year apprenticeships to graduate engineers and physicists who obtain Honours degrees. The course includes a period of training at the B.B.C. Engineering Training Department at Evesham, six months' practical works training in industry and some months in two or more of the specialist departments of the B.B.C.

The booklet can be obtained from the Engineering Establishment Officer, B.B.C., London, W.1.

Welsh V.H.F. Service

PENDING the construction of permanent v.h.f. stations in North Wales, a temporary v.h.f. transmitter has been installed at the Penmon, Anglesey, medium-wave station and was brought into service on October 2nd. The transmitter, which is horizontally polarized, radiates the Welsh Home Service on 94 Mc/s with a power of about 1 kW. The station will eventually have three transmitters—one for each programme.

V.h.f. transmitters are already being installed at Wenvoe, Glam., which is is hoped to bring into service by the end of this year.

PERSONALITIES

F. S. Barton, M.A., B.Sc., F.Inst.P., M.I.E.E., has left the Ministry of Supply, where he has been since 1946 (latterly as principal director of electronics research and development), to become defence supply adviser to the High Commissioner in Ottawa. In 1922 he joined the radio department of the Royal Aircraft Establishment, Farnborough, of which he became deputy head in 1936, and from 1941 to 1946 he was director of radio engineering with the British Air Commission in Washington. His father, Professor E. H. Barton, F.R.S., D.Sc., was a pupil of Hertz in Bonn.

F. S. BARTON.

D. H. Black, M.Sc., Ph.D., F.Inst.P., who has been in the Civil Service since 1939, succeeds Mr. Barton as principal director of electronics research and development at the Ministry of Supply. For two years from 1943 he was on loan to the Admiralty after which he spent two years at R.R.D.E. (now R.R.E.), Malvern, before being appointed director of electronics research and development (defence) at the M.o.S., a post which he held until 1953 when he went to Australia as head of the United Kingdom Ministry of Supply staff in the Commonwealth. Before joining the Civil Service he was 14 years in industry, spending the last seven with Standard Telephones and Cables. Dr. Black, who is 56, is succeeded in Australia by Dr. W. H. Wheeler.

Dr. A. H. M. Arnold is leaving the National Physical Laboratory, where he has been head of the electronics section of the electricity division, to become reader in electrical engineering at King's College, London. Dr. Arnold, who in 1923 graduated from Liverpool University from which he received the degrees of Ph.D. and D.Eng., spent a year at Metropolitan-Vickers before going to the N.P.L. in 1926. He is 54.

F. H. Townsend, M.I.E.E., director and general manager of Cathodeon, Limited, Cambridge, was elected vice-president of the British Amateur Television Club at the second Amateur Television Convention recently held in London. Mr. Townsend joined the Pye Group seventeen years ago and has been with Cathodeon (a member of the Group) since its formation during the war.

J. D. Parker, B.Sc.(Hons.), is the new secretary-general of the Comité International Radio-Maritime, of which H. C. Van de Velde is president. Colonel Parker, who is on the Regular Army Reserve of Officers, was in Royal Signals during the war and from 1941 to 1945 was in charge of the planning and technical section of the inter-services research bureau. After the war he joined the Control Commission in Germany as controller of radio. Before being called up in 1939 he was in the G.P.O.

W. A. Roberts, A.M.I.E.E., has been appointed regional engineer (Midland Region) by the B.B.C. in succession to **J. A. Cooper,** B.Sc.(Eng.), A.M.I.E.E., who is retiring after 32 years' service with the Corporation. Mr. Roberts, who joined the engineering division of the Corporation in 1937, became assistant to the chief engineer in 1949. Two years ago he was seconded to the Colonial Office as technical adviser on broadcasting development in the Colonies and was a member of the Commissions appointed to study broadcasting in the Gold Coast and Kenya. He returned to the B.B.C. a few months ago. Mr. Cooper, who has held his present position since 1950, was previously engineer-in-charge at Birmingham.

Michael Cooper, B.Sc., Grad.Inst.P., has been appointed planning engineer for teleciné and telerecording by Granada TV Network, Limited, the Monday-to-Friday programme contractors for the I.T.A. Lancashire station. He had been with the B.B.C. since 1951 where he was concerned with the planning and installation of studio and teleciné equipment. He was previously with Pye (1945 to 1946) and the G.E.C. Research Laboratories (1946 to 1951).

Granada TV Network, Limited, have also appointed **John C. McKenzie,** B.Sc., as television engineer for studio planning. In 1952, on leaving the University of Southampton where he obtained his degree, he was appointed research engineer at E.M.I. Research Laboratories where he was engaged on the initial experiments with the completely stabilized c.p.s. Emitron camera tube. For the past year he has been in the B.B.C. planning and installation department.

W. C. Pafford, who is both a television engineer and a lighting engineer, has left the B.B.C. after 23 years' service to join the Associated Broadcasting Company (now Associated Television, Ltd.), programme contractors for the London (week-ends) and Midland (week-days) I.T.A stations. He became a maintenance engineer at Alexandra Palace in 1936 and was later in charge of maintenance and war-time operations at the station.

L. E. C. Hughes, Ph.D., M.I.E.E., who was for some years with Londex, Limited, has recently been appointed head of the technical publications department of Ultra Electric, Limited. We understand that he is compiling a reference book on electronics applied to industry.

Walter Titmus, Assoc.Brit.I.R.E., has taken charge of the recently formed industrial controls division of the Solartron Electronic Group, Limited, which he joined in June after six years with Plessey's. From 1929 to 1938 he was with the Marconi International Marine Communications Company. In 1938 he joined the Army, becoming Captain (R.E.M.E.) in charge of the First Airborne Division's mobile and base radio workshops. From 1945 until he joined Plessey's in 1949 he was with E. K. Cole.

H. S. Payman, B.Sc., M.I.E.E., has been appointed general manager of Suflex, Limited, who are now manufacturing polystyrene capacitors in addition to their normal range of sleeving, wire and braided products. He was previously deputy director of component production and general manager of A.B. Metal Products.

F. Szekely, B.Sc.(Eng.), Grad.I.E.E., formerly on the staff of the B.T-H. Co., has joined the radio division of the Edison Swan Electric Co., Ltd., to promote the application of semi-conductors. After completing his graduate apprenticeship with B.T-H. he went into the research laboratory.

OUR AUTHORS

S. E. Gent, who, with **D. J. S. Westwood,** writes in this issue on vision a.g.c., has been with Ferguson Radio for seven years and for the past two years has been in charge of one of the Company's television laboratories. He was previously with Peto Scott where, during the war, he was working on military projects and subsequently on domestic radio equipment. He graduated from the Northampton Polytechnic in 1949. Mr. Westwood joined Ferguson in 1953, having previously been with Cossor. He obtained his engineering degree in 1949.

W. Woods-Hill, author of "Electronic Digital Computors," is manager of research and development in the Calculator Research Laboratory of the British Tabulating Machine Co., Ltd. During the war he spent several years in radio and radar development units of the R.A.F., and subsequently became liaison officer attached to the French Air Force during the installation of their radar school at Auxerre, Yonne. He operates an amateur transmitter with the call G4JV.

A. L. P. Milwright, who describes a new microwave course beacon in this issue, is a principal scientific officer in the Royal Naval Scientific Service. He is at the Admiralty Signal and Radar Establishment, Portsmouth, and is in charge of the group which carries out development on civil marine navigational aids for the Ministry of Transport and Civil Aviation.

IN BRIEF

Receiving Licences.—An increase of 60,832 television licences during August brought the total in force in the United Kingdom at the end of the month to 4,786,415. These, together with the 283,473 for sets fitted in cars and the 9,054,699 for sound only, made an overall total of 14,124,587.

Vice-Admiral Dorling, director of the Radio Industry Council, will open this year's **Amateur Radio Exhibition,** organized by the Radio Society of Great Britain, at 12 noon on November 23rd, at the Royal Hotel, Woburn Place, London, W.C.1. It will close on the 26th.

R.S.G.B. News Service.—British amateurs now have an official broadcast news bulletin which is radiated on a frequency around 3,600 kc/s on Sunday mornings from 11.0 to 11.20 G.M.T. The bulletin is broadcast first on R/T, then keyed in abridged form and repeated on R/T. The station, call GB2RS, is operated at Walton-on-Thames, Surrey, by F. Hicks-Arnold (G6MB).

Science and Management.—The programme of the National Conference of the British Institute of Management, which will be held at Harrogate on November 2nd to 4th, includes a number of papers of interest to electronics engineers. Dr. B. V. Bowden, principal of the College of Technology, Manchester, will speak on electronic processing of data for management and John Diebold (U.S.A.) will deal with automation. Details of the Conference, the theme of which is "The impact of science on management in the future," are obtainable from the Institute, Management House, 8, Hill Street, London, W.1.

The 100 papers (ranging from transistors to transducers and communication theory to circuit design) presented at the 11th **National Electronics Conference** held in Chicago at the beginning of October will be published in volume 11 of "Proceedings of the National Electronics Conference." It will be available early next year, price $5 from 84, East Randolph Street, Chicago 1, Illinois.

A steady growth in the membership of the **Tensor Club of Great Britain** during its first five years is recorded in the report sent to us by the joint organizers, Dr. W. J. Gibbs and S. A. Stigant. It now has a membership of 137 with over 50 per cent outside the U.K. Gabriel Kron, of America, an authority on tensor analysis, is patron of the club and during a recent visit to this country gave a series of lectures on the subject in London. Details of the club are obtainable from S. A. Stigant, 7, Courtlands Avenue, Hayes, Kent.

The annual dinner of the **Telecommunication Engineering and Manufacturing Association,** of which H. Faulkner is director, will be held at the May Fair Hotel, Berkeley Street, London, W.1, on November 10th. The Association is concerned mainly with general policy matters in the telecommunication manufacturing industry.

Television Test Signals.—At any time between 10 a.m. and 11 p.m. (Monday to Friday) or 9.30 a.m. to 11 p.m. (Saturday) when programmes are not being radiated from the I.T.A. Croydon transmitter, a test signal on full power is now transmitted. No test signals are radiated on Sunday. The B.B.C. test period is from 10 a.m. to 1 p.m. (Monday to Saturday) and for the usual few minutes before the opening of each programme. The times of the test transmissions from the Belling & Lee transmitter (G9AED) at the I.T.A. site at Lichfield have been modified slightly. They are now 10 a.m. to 1 p.m., 3.0 to 6.0, and 7.30 to 8.30 (Monday to Friday) and 10 a.m. to 1 p.m. Saturday.

R.I.C. Dinner.—Sir Walter Monckton, Q.C., Minister of Labour and National Service, is to be the guest of honour at the annual dinner of the Radio Industry Council at the Dorchester Hotel, Park Lane, London, W.1, on November 23rd.

The Second Congress of the **International Commission on Acoustics** will be held from June 17th to 24th, 1956, in Cambridge, Massachusetts, in conjunction with the fifty-first meeting of the Acoustical Society of America. The secretary of the Congress is John A. Kessler, Acoustics Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass., U.S.A.

Films on Loan.—Two more electronics films have been added to the list of those available on free loan from the Central Film Library of the Central Office of Information. They are "Ultrasonics" (20 minutes) and "Manufacture of radio valves" (26 minutes), both produced by Mullard. Particulars are obtainable from the Central Film Library, Government Building, Bromyard Avenue, Acton, London, W.3.

Demonstrations of **Closed-Circuit Television** are being given by a team of R.C.A. engineers at three international trade fairs being held in the Far East during the closing months of this year. The fairs are in India, Indonesia and Pakistan.

Electron Telescope.—With the object of showing the possible application of electronics to astronomical observations Pye fitted television equipment to the telescopes at Dublin Observatory and gave demonstrations to delegates attending the ninth general assembly of the International Astronomical Union held in the city in September. The meetings were attended by 500 delegates from 34 countries.

A course of six lectures on **Magnetic Amplifiers** is to be held on Wednesdays at 7.0 at the Technical College, Bradford, commencing on October 19th. (Fee 30s.)

Interference from Television Receivers.—A decree laying down the permitted limits of interference from television receivers in the broadcasting bands between 150 kc/s and 30 Mc/s was recently made in France.

A new 20-kW short-wave broadcasting station has been brought into service by the **Tanganyika Broadcasting Service.** It replaces an ex-Army 250-watt transmitter which has been in use since 1951. The transmitter, studio equipment and aerial system were supplied by Marconi's.

"Long-Range Television Reception."—In this article in the October issue, the heading for two of the screen pictures on p. 505 was unfortunately lost in the course of printing. It should have been **Switzerland.**

Since the Classified Advertisements pages were passed for press, it has been found that an incorrect advertisement for **Shirley Laboratories, Limited,** appears on page 159. The correct prices for the equipment are those given in Shirley's first advertisement under "New receivers and amplifiers."

The transmitting equipment for the **I.T.A. Midland Station** is being supplied *by* Pye and not *to*, as stated in the note on page 496 of our last issue.

Since the publication eighteen months ago of the U.N.E.S.C.O. book **"Television: A World Survey,"** there has been a large increase in the number of television stations in operation and many more countries have made known their plans for the future. A supplement to this international survey has therefore been published (H.M.S.O. 3s.) bringing up to date the information on the television service in 58 countries and non-self-governing territories.

The annual **Electrical Industries Ball** in aid of the funds of the Electrical Industries Benevolent Association will be held at Grosvenor House, Park Lane, London, W.1, on November 11th. Tickets, price 2½ guineas, are obtainable from the E.I.B.A., 32, Old Burlington Street, London, W.1.

The first three **Scholarship Awards,** under the scheme announced a few months ago, have been awarded by the General Electric Company. These scholarships are to be awarded annually to selected members of the G.E.C. staff and provide for degree courses, post-graduate research or specialized studies.

BUSINESS NOTES

A contributing factor in the recent successful trials of the **Pye** underwater television camera on Lake Zurich, Switzerland, was the combined lifting rope and cable produced by **B. I. Callender's Cables.** It is a double-plastic-sheathed version of a standard polythene-insulated television camera cable with a hemp covering; overall diameter is 1¼in. By using this combined cable the time for lowering the camera, which weighs 2½cwt, was reduced from 45 to two minutes.

Lecture demonstrations of high-quality sound reproduction have been given by **Goodmans Industries, Limited,** in some fifty towns throughout the country during this year. The next and probably the last town to be visited in the present series is Luton, where, on November 15th and 16th, a demonstration will be given at 8.0 p.m. in the Town Hall. Tickets are obtainable from S. Farmer and Company, of Luton.

In the report on the S.B.A.C. Exhibition in our last issue we referred, on page 492, to the **Burndept** u.h.f. aircraft receiver (Type BE.234) as employing a frequency multiplication of 12 to obtain the spot operating frequency. The multiplication figure should have been six.

"Carcinotron."—Our attention has been called to the fact that the word "Carcinotron," used in our June issue as a general term to describe backward-wave oscillator valves, is the registered trade mark of the Compagnie Générale de Télégraphie sans Fil.

The installation of Pye v.h.f. radio-telephone equipment in the vessels of two more Thames lighterage companies brings the total number of users of this equipment on the London river to 32 companies operating over 300 sets. **Pye Marine** have also recently installed a station at the Dock Master's office in the port of Aberdeen and equipment in a pilot cutter and a dredger operated from the port.

The air traffic control and communications equipment at the re-opened Lympne Airport, Kent, is being provided by **International Aeradio, Limited.**

A mobile radio-telephone-equipped office has been put into service by the Automobile Association. Constructed by **British Films, Ltd.,** of Balham, London, on an articulated semi-trailer, it is equipped with Pye R/T gear. A feature of the unit is the hydraulic 60-foot telescopic aerial mast built into the rear of the vehicle.

Radio communication equipment and radar navigational aids have been ordered from **Marconi's** by Shell Tankers, Limited, for eight tankers now being built. Marconi's have also recently provided radio and radar gear for new trawlers for Fleetwood and Grimsby.

The sales and order departments of **McMichael Radio, Limited,** are now at Wexham Road, Slough, Bucks. (Tel.: Slough 24541).

Taylor Electrical Instruments, Limited, of 419/424, Montrose Avenue, Slough, Bucks, are offering service technicians allowances varying from £2 5s to £10 5s on Taylor instruments (up to about 14 years old and in working order) taken in part exchange for one of their latest models. The reconditioned models will be offered at a very low price to amateurs and students.

Ex-Government anti-aircraft radar mounted on trailers (Type AA3, Mark II) have been reconditioned by **Winston Electronics, Limited,** of Shepperton, Middx, for Government meteorological work, especially in the tropics. The reconditioning includes the substitution of a spark-gap modulator for the thyratron system.

E.A.P. (Tape Recorders), Limited, have moved from 546, Kingsland Road, London, E.8, to larger factory premises at 9, Field Place, St. John Street, London, E.C.1 (Tel.: Terminus 9627).

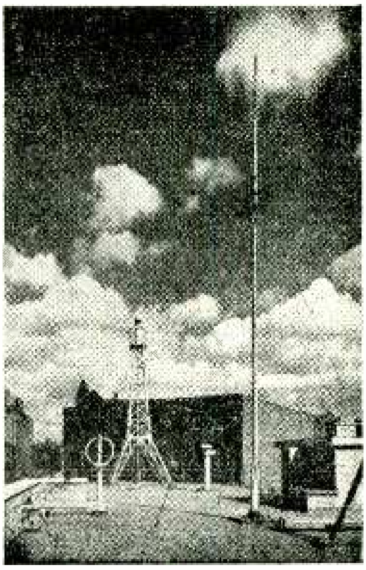
OVERSEAS TRADE

Canada.—A million-dollar contract for the construction of a mobile flight and tactical simulator to familiarize aircrews of the Royal Canadian Navy with the Grumman S2F anti-submarine aircraft, has been placed with Redifon, Limited. It combines facilities for flight familiarization with training in the use of radar and tactical anti-submarine equipment.

Component Exports.—According to figures issued by the Radio and Electronic Component Manufacturers' Federation, one-half of the present output of component manufacturers in this country, who now turn out about four million parts each working day, is exported either direct or assembled in equipment.

Thirty-one manufacturers of components and accessories participated in the joint exhibit organized by the R.E.C.M.F. at the **British Exhibition in Copenhagen,** which closed on October 16th after an 18-day run. In addition to the combined component display (the stands for which occupied a floor space of 1,300 square feet) Ekco and Mullard had individual stands. So far this year, exports of components to Denmark are well below the figure for last year, when the record total of £205,000 worth was imported from this country.

A mobile demonstration unit has been brought into service by the Automatic Coil Winder & Electrical Equipment Co., Ltd., for the display and demonstration of test and measuring equipment. It is now on a **Continental Tour** covering Belgium, Holland, Germany, Denmark and possibly Sweden.



RADAR SCANNERS, d.f. loop and a mast carrying a variety of transmitting and receiving aerials are mounted on the flat roof of the new Marconi House, Melbourne Street, Newcastle-on-Tyne. The depot has a test and repair shop, battery charging room, stores department and offices. In the building are also the Newcastle offices of Marconi Instruments and the English Electric Company.

The Ratio Detector

How It Works

By K. R. STURLEY,* Ph.D., B.Sc., M.I.E.E.

THE frequency modulation receiver must perform two functions additional to those required of its amplitude modulation counterpart. These two functions are:

1. The suppression of any amplitude modulation of the f.m. carrier due to noise, interference or variation of response over the receiver passband and

2. The conversion of the frequency deviation of the carrier to an amplitude variation directly proportional to the frequency deviation.

There are many methods of suppressing amplitude modulation: diodes so biased that their loading effect on the circuit varies with the applied signal: a saturated amplifier having an amplification factor inversely proportional to the amplitude of the input signal: waveform slicers that square the waveshape. The most satisfactory type of amplitude limiter is the saturated amplifier, whose output is constant and independent of the input after a certain value of input has been exceeded. Its main disadvantage is that it introduces attenuation because its output is generally less than its input and it adds to the cost of the receiver.

The great value of the ratio detector is that it combines the role of amplitude limiter with that of frequency-to-amplitude converter, and at the same time gives appreciable gain. At its best it is not as good as the saturated amplifier followed by a frequency-to-amplitude converter, but a previous article[1] has given the difference in signal-to-noise ratio as only 2dB. Seeley and Avins, who were the inventors of the ratio detector, describe how it works and indicate the salient design points, but their article[2] is not easy to follow. There have been some attempts since to suggest a simple explanation of its operation but none that the author has seen have been at all convincing and some have left "confusion worse confounded." This article hopes to remedy the position, so let us start with a statement of what the ratio detector is.

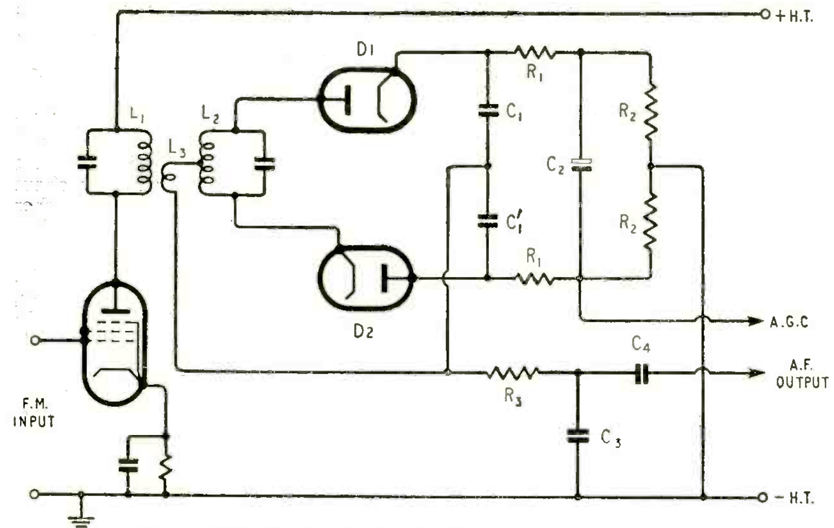
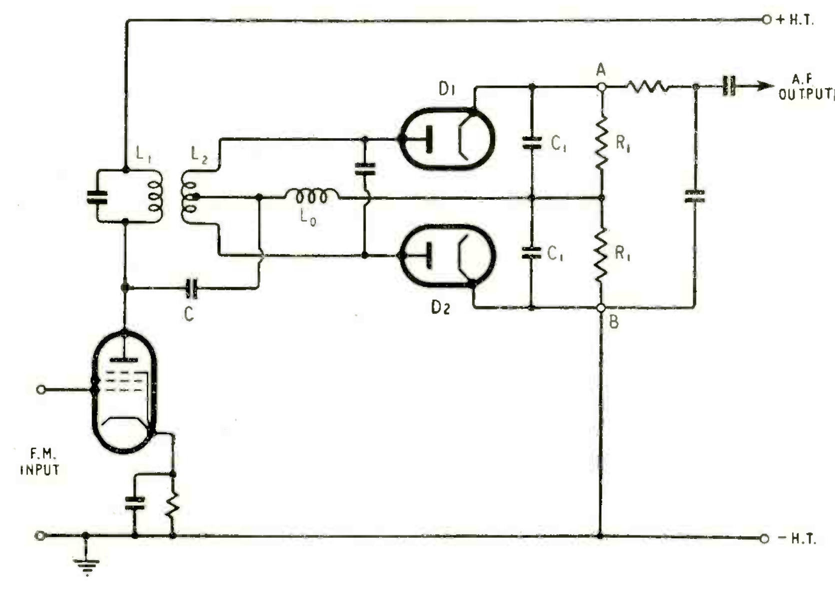


Fig. 1. Typical ratio detector circuit.

Below : Fig. 2. The phase discriminator.



The ratio detector is a modified form of the phase discriminator with the diodes performing the dual role of detection and variable damping. It functions in the same way as the phase discriminator to convert the frequency-modulated input to a combined frequency- and amplitude-modulated signal. Its diodes are so arranged that they provide variable damping to any undesired amplitude modulation already present at the input, reducing overall gain when the signal amplitude tends to increase and increasing it when signal amplitude falls.

There are many possible variants of the ratio detector, but a common form is shown in Fig. 1. As with the phase

* Engineering Training Department, B.B.C.

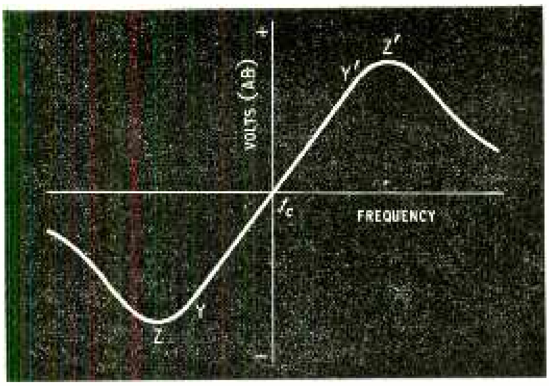


Fig. 3. Output voltage/frequency curve for phase discriminator.

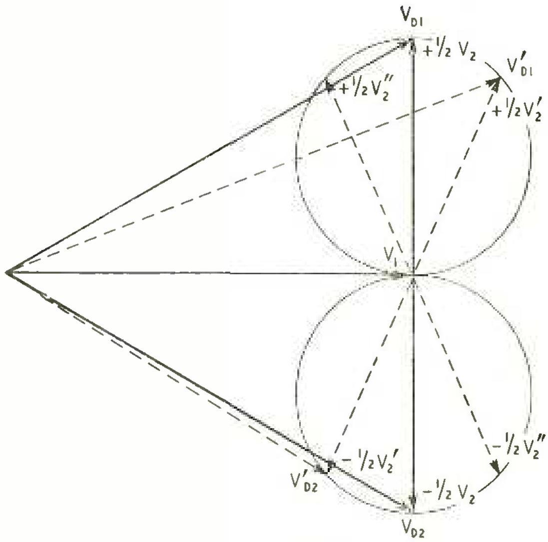


Fig. 4. Vector diagram of phase discriminator.

discriminator each diode obtains its driving voltage from the primary (common to both diodes) and from a half secondary. In this case the primary voltage is derived via a tightly coupled tertiary winding L_3 giving a voltage step-down of about 0.6. The reason for this is that otherwise diode damping is too great on the primary. The diodes are not connected back-to-back as in the phase discriminator but are in series, with the cathode of one joined through a resistance-capacitance load to the anode of the other.

First let us discuss the action of the diodes in detecting the amplitude change of the f.m. signal. We can best approach an explanation via the normal phase discriminator shown in Fig. 2. The secondary of the coupled circuits is centre-tapped, and half its voltage in series with the primary is applied to a diode D1 and the other half also in series with the primary is applied to a second diode D2. The primary voltage is developed via capacitor C across the r.f. choke L_0 between the centre tap of the secondary and the centre point of the diode load resistors. The outputs of the two diodes are connected in phase opposition, and an overall output voltage/frequency curve similar to that of Fig. 3, is obtained when the primary and secondary are tuned to the carrier unmodulated frequency. By correct choice of coupling and damping of the circuits, a linear conversion from frequency to amplitude change is obtained between the two limits YY′. The reason for the S shaped curve of Fig. 3 is best explained by reference to the vector diagram of Fig. 4. The primary voltage vector is V_1 and the two half-secondary voltage vectors $\pm\frac{1}{2}V_2$ are shown in phase opposition because of the centre tap. At resonance the primary and secondary vectors are at right angles, but for other frequencies greater or less than resonance the two secondary vectors are tilted to positions such as, for example, $\pm\frac{1}{2}V_2'$ and $\pm\frac{1}{2}V_2''$ respectively. The amplitudes of the secondary vectors decrease as the off-tune frequency increases, and their loci are the circles shown. The primary voltage vector does not appreciably change its length until the off-tune frequency is large. Assuming V_1 remains constant, we see that the voltage V_{D1} and V_{D2} applied to the diodes have maximum values when the secondary vectors are at approximately 45°. This explains the turn-over points Z and Z′.

Let us now take the simplified phase discriminator circuit of Fig. 5(a), and see what happens to the detected voltages across the diode load resistors R_1. When the carrier frequency is unmodulated and the phase discriminator is correctly aligned, the magnitude of the r.f. voltage applied to D1 is the same as that applied to D2, so that the d.c. voltage across AB is equal and opposite to that across BC, giving zero voltage across AC. For example, V_{AB} might be + 3 volts and V_{BC} −3 volts. If the carrier frequency is increased to $(f_c + f_d)$, V_{AB} might rise to +4 volts and V_{BC} fall to −2 volts, giving a total change of 2 volts across AC. A sinusoidally frequency deviated carrier would produce the waveforms shown in Fig. 5(b). Though the d.c. voltages across AB and BC are of opposite polarity, the audio-frequency changes across these points are of the same sign and add to each other to give

$$\Delta V_{AB} = \Delta V_{BC}$$

and $\Delta V_{AC} = \Delta V_{AB} + \Delta V_{BC} = 2\Delta V_{AB}$

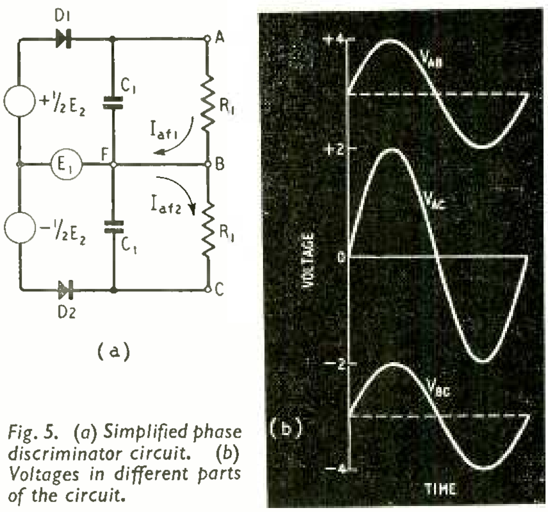


Fig. 5. (a) Simplified phase discriminator circuit. (b) Voltages in different parts of the circuit.

The audio-frequency voltages across AB and BC will cause a.f. currents I_{af1} and I_{af2} to circulate in ABF and CBF as shown in Fig. 5(a). These two currents are equal and opposite in the centre limb and cancel each other. As far as the audio frequencies are concerned there is no voltage across FB and we could remove the link FB were it not that it provides the d.c. return path for each diode through the primary generator E_1. The d.c. current from D1 cannot pass through D2 because D2 cannot conduct in the opposite direction. A point worth noting is that when the carrier is at f_c, and the phase discriminator is correctly aligned, there is no output if the carrier is amplitude modulated. We can easily see that this must be so because increase of V_{AB} to +4 and V_{BC} to −4 still gives $V_{AB} = 0$. If the carrier is not at f_c or the phase discriminator is not correctly aligned to f_c, amplitude modulation is not suppressed. Thus if the carrier is at $(f_c + f_d)$, $V_{AB} = +4$ and $V_{BC} = -2$ giving $V_{AC} = 2$: amplitude modulation increasing the carrier amplitude by 50% takes V_{AB} to +6 and V_{BC} to −3 giving $V_{AC} = 3$. That is why we find that when an f.m. receiver is tuned in, background noise, which is mainly amplitude modulation, is a minimum when the receiver is correctly tuned to the incoming carrier. It is one way in which one can ensure that tuning of an f.m. receiver is correct.

Let us now turn, to the ratio detector, whose simplified circuit is as shown in Fig. 6(a). Diode D2 has been reversed and the link FB removed. Removal of this link does not open-circuit the d.c. return path because D2 can now take the current from D1. Reversal of D2 has had another effect, for the d.c. voltage across AB must have the same polarity as that across BC, so that if $R_1 = R'_1$ and the r.f. voltages applied to the diodes are the same as for the phase discriminator.

$V_{AB} = V_{BC} = 3$ volts.

and $V_{AC} = V_{AB} + V_{BC} = 2V_{AB} = 6$ volts

Since the two capacitances C_1 and C'_1 are equal they will also be charged to 3 volts each, and the voltage across FB will be zero.

Let us imagine that the carrier frequency increases to $(f_c + f_d)$. The r.f. voltage applied to C_1 increases to produce a d.c. voltage after detection of 4 volts whilst that across C'_1 decreases to 2 volts. The total voltage across A and C is unchanged at 6 volts, i.e., no a.f. voltage is developed across AC when the carrier is frequency-modulated. It is this fact which makes possible the use of the diodes for variable damping as well as detection. We could connect a large capacitor across the points AC without disturbing the detection of f.m. waves though we will appreciably affect the detection of amplitude modulation initially present on the f.m. wave. We shall see later that this is just what is required to give variable damping.

Since the voltage across AC remains at +6 volts, it follows that the voltage across BC is also constant at +3 volts. Now the voltage across FB is

$V_{FB} = V_{FC} - V_{BC} = 2 - 3 = -1$ volt.

Conversely when the carrier frequency falls to $(f_c - f_d)$ the voltage of F rises to +1 volt above B. Thus when f_d is varying sinusoidally we have an a.f. voltage across FB and if we earth B we can take off an a.f. voltage from F through a suitable CR network to the a.f. amplifier valve. The a.f. coupling capacitance is necessary, for we must not disrupt the d.c. path by offering an alternative through E_3.

Provided the ratio detector is correctly aligned and balanced about B we find that like the phase discriminator it suppresses all amplitude modulation when the carrier is at f_c. For example increase of carrier amplitude merely increases the voltages FC and BC together and their sum is always zero: the $C_1R_1C'_1R'_1$ is a balanced bridge circuit at f_c. At any other frequency the amplitude modulation is not suppressed. Failure to suppress amplitude modulation at f_c

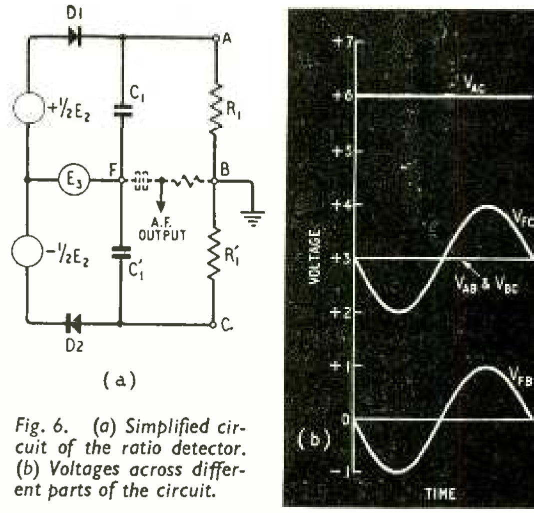


Fig. 6. (a) Simplified circuit of the ratio detector. (b) Voltages across different parts of the circuit.

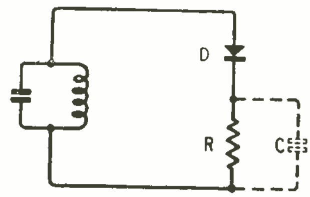


Fig. 7. Tuned circuit shunted by a resistance load.

can occur due to out-of-balance. Thus if $R'_1 = 0.9R_1$ amplitude modulation suppression occurs at some carrier frequency $f_c + \Delta f$ giving a division of voltage across C_1 and C'_1 of 1 to 0.9.

The waveforms of the various voltages in the circuit when the carrier is frequency-modulated are shown in Fig. 6(b). A significant difference between the ratio detector and phase discriminator is that the a.f. output voltage, V_{FB}, is only half that, V_{AC}, available from the phase discriminator, i.e., there is a 6dB loss from the ratio detector connection. If this were all that resulted, the ratio detector would certainly not be popular. This disadvantage can, however, be offset because the series connection of the diodes and the fact that there is no a.c. voltage across the points AC allow the diodes to be used as a variable damping resistance without impairing their detection characteristics.

Before dealing with the changes necessary to allow the diodes to function in this manner, let us see what happens when a diode is shunted across an r.f. tuned circuit. In Fig. 7 a diode is shown in series with a resistance R across a tuned circuit. If the diode is a perfect unidirectional device of resistance R_d and there is no capacitance across R, not even strays, the diode conducts on each positive half wave and during this time reflects a resistance $R_d + R$ across the tuned circuit. Since this operates half the time it will be equivalent to $2(R_d + R)$ for the whole cycle. When R is shunted by a capacitance C and the time constant CR is much greater than $1/f_c$ but much less than $1/f_a$(max), where f_a(max) is the maximum audio frequency, two things happen to the r.f. current taken by the diode:—

(1) it will increase many times in value, and

(2) the time during which it lasts will be appreciably reduced.

The r.f. current increases because the capacitance short-circuits R and its value is only limited by the voltage applied, the diode resistance R_d and the internal resistance of the r.f. voltage source. The time during which current occurs is reduced because the CR combination acts as a self-bias circuit preventing diode conduction until this self-bias voltage is exceeded. Current amplitude is increased to a greater extent than duration is shortened, so that the energy taken from the tuned circuit is greater. The result is that the diode presents a resistance R_E of about ½R to the tuned circuit.

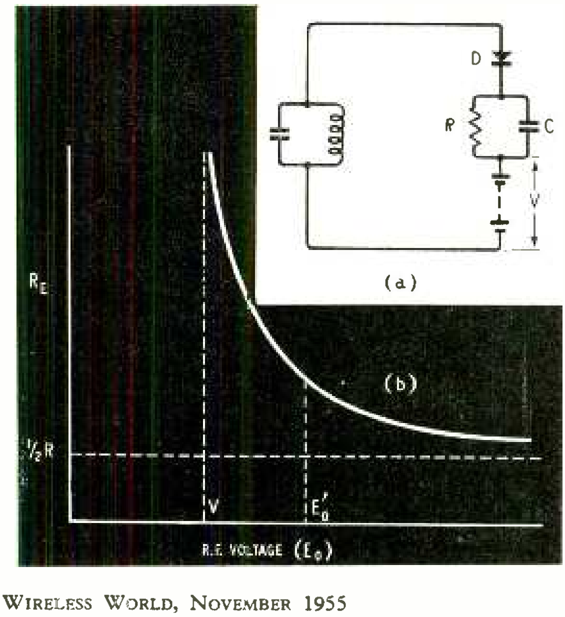
With both types of circuit there is practically no change of resistance reflected from the diode with change of r.f. voltage amplitude, and this method of damping is of no use to us. Let us now take a diode with a CR circuit and apply a fixed bias voltage V of polarity to stop conduction (Fig. 8(a)). Until the r.f. voltage initially exceeds V no current flows and there is no resistance across the tuned circuit from the diode. When the r.f. voltage greatly exceeds V the action of the diode is almost independent of V and determined only by its CR circuit: it then reflects a resistance of ½R across the tuned circuit. At intermediate voltages the resistance is greater, so that if we plot a curve of equivalent resistance R_E from the diode against r.f. voltage we should get a relationship like that of Fig. 8(b). This does show the kind of variable damping characteristic we require, for resistance decreases as amplitude increases. If we operate with the tuned circuit in the anode of a pentode at an r.f. voltage of E_0' (Fig. 8(b)), any change of E_0 would produce a change of R_E and vary the gain of the pentode in a direction opposite to the input amplitude change causing it. As an example let us assume the following conditions

Tuned circuit dynamic impedance, $\frac{L}{CR} = 0.5M\Omega$

g_m of valve = 5mA/V

Equivalent resistance of diode at E_0 = 9.8V, R_E = 40,000Ω; E_0 = 10V, R_E = 20,000Ω; E_0 = 10.2V, R_E = 13,000Ω.

Fig. 8. (a) Tuned circuit shunted by a biased diode with RC load. (b) Resistance (R_E) reflected from diode, plotted against r.f. voltage.



The anode load of the pentode consists of R_E in parallel with 0.5MΩ, and the latter is large enough to be neglected. The gain of the valve at the different values of E_0 will be g_mR_E, viz.,

E_0	*Gain*	*Input Voltage*
9.8	200	0.046
10.0	100	0.1
10.2	65	0.154

We see that, with the value we have chosen, an input voltage change equivalent to 50% amplitude modulation has been reduced to a 2% amplitude modulation of the output voltage. A still greater reduction of amplitude modulation could be obtained by a greater change of R_E.

If a diode is to be used in a receiver as variable damping the fixed bias voltage can easily be obtained from the h.t. supply, but the effectiveness of the damping will be confined to a comparatively small range of output voltages about E_0'. Such a scheme would not be satisfactory in a receiver which was designed to accept either weak or strong signals and which had no additional limiting action before the diode damper. The ideal arrangement would be to have the bias voltage variable to suit the output voltage, decreasing bias when the output voltage is less than E_0' (Fig. 8(b)) and increasing bias when the output voltage is greater. This would allow us always to operate on the part of the $R_E - E_0$ curve giving the best amplitude suppression. This can be achieved by letting the diode provide its own self-bias, using an RC combination whose time constant is much longer than the reciprocal of the lowest amplitude modulation frequency likely to be encountered, i.e., about 0.1 sec corresponding to a frequency of 10 c/s. The circuit would be as shown in Fig. 9. C_1 and R_1 would be

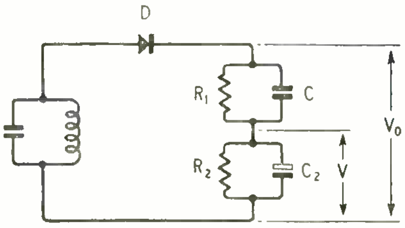


Fig. 9. Variable damping diode.

about 300pF and 1000Ω and C_2 and R_2 25μF (electrolytic) and 10,000Ω. Minimum damping resistance would be ½R_1 to any amplitude modulation change and we should have variable damping similar to that shown by the curve in Fig. 8(b). The operating output voltage E_0' will have a definite relationship to the bias voltage V and will be approximately $\frac{V_0}{0.9} = \frac{R_1 + R_2}{0.9R_2}V$;

the 0.9 is included to allow for a diode detection efficiency (ratio of d.c. voltage to peak applied voltage) of 90%. If R_1 is made zero the output voltage operating point is almost coincident with V, the $R_E - E_0$ curve is very steep falling to almost zero damping resistance, and the diode suppresses (or considerably reduces) any positive amplitude change. For any negative amplitude change there is no damping from the diode because the bias V holds it non-conducting. Seeley and Avins refer to this condition as fully stabilized because all the detected d.c. voltage is used as the bias voltage V. It is obviously an undesirable condition in which to work and the more normal method is to operate with about 80% of the detected d.c. voltage stabilized, i.e., used as the bias. With this degree of stabilisation, the variable damping detector should appreciably reduce input voltage amplitude modulation of as much as 90% in either positive or negative direction. Naturally the amount of suppression in the negative direction will be determined by the undamped Q of the secondary and also the primary coil, since maximum gain cannot exceed the undamped gain. Q_2 and Q_1 should therefore be as high as possible.

So far we have discussed the effect of diode damping to any change of carrier amplitude, but it is also essential to know what the damping will be to a constant carrier amplitude because this will determine the gain of the stage to a frequency-modulated signal. The equivalent resistance reflected into the tuned circuit from the diode in Fig. 9 at a constant carrier amplitude is determined not by R_1 alone but by the sum of $R_1 + R_2$, and it will in fact be nearly $\frac{1}{2}(R_1 + R_2)$. This is very important because it means that the gain of the stage to a frequency-modulated constant-amplitude signal can be reasonably large and the heavy damping is only effective on carrier amplitude changes. We are in fact making use of a low ratio of a.c./d.c. load in the diode circuit: only the d.c. load affects the carrier amplification whereas the a.c. load damps any changes in carrier amplitude.

Having explained the principle of variable damping by diodes let us now see how it is applied in the ratio detector to provide amplitude limiting. Let us imagine that we have a centre-tapped tuned circuit across which we wish to have variable damping. Clearly

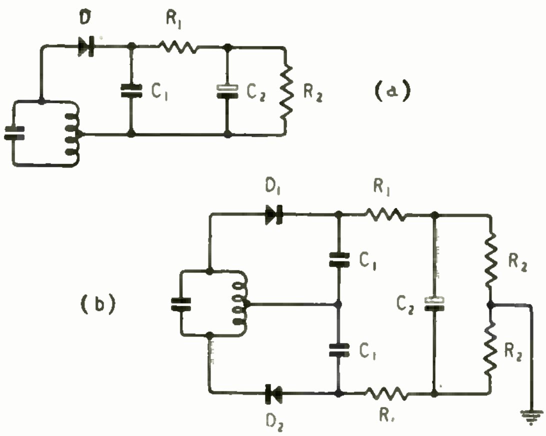


Fig. 10. (a) Variable damping diode across a centre-tapped circuit and (b) in a balanced circuit.

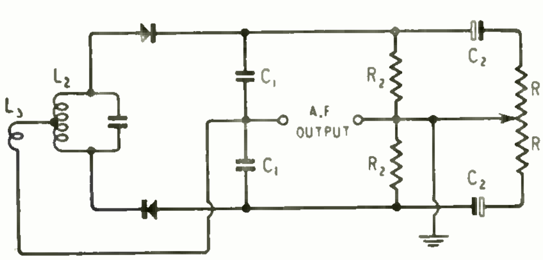


Fig. 11. Alternative ratio detector connection.

we could place across one half of the circuit the variable biased diode as shown in Fig. 10(a). The r.f. bypass capacitance C_1 is shown connected direct to earth instead of to the junction of R_1 and R_2 as in Fig. 9. This has no effect on the operation of the circuit, but it does ensure that the r.f. performance is not influenced by possible inductance in the C_2 leads. Since the centre-tapped circuit is balanced it is preferable to have a balanced damping circuit and this can be realized by using two diodes connected in series across the whole tuned circuit with their common load resistance centre-tapped to earth, as in Fig. 10(b). It is only one step from Fig. 10(b) to the ratio detector of Fig. 1. The link from the centre of the coil to the junction of capacitors C_1 is replaced by the tertiary coil. We have already shown that frequency modulation of the carrier produces an a.f. signal across the two capacitances C_1 in Fig. 10(b) and that the resistance arm $(2(R_1 + R_2)$ carries only a d.c. current and no audio frequency. It is therefore possible to connect a large capacitor across a whole or part of the resistance without affecting the performance of the circuit as a detector of frequency modulation.

We have seen above that the large capacitance must not be used across the whole of the resistance load, otherwise no suppression of negative amplitude modulation occurs. Even if the negative modulation problem did not exist we could not use a large capacitance across all the resistance because if there were a quick reduction in amplitude of the f.m. carrier the bias could not fall fast enough and the diodes would be cut off. We should then have either no audio-frequency output from the f.m. carrier or else a very distorted output.

Suitable values for the components in Fig. 1 are $C_1 = 330$pF: $C_2 = 16$ to 25μF (electrolytic), $R_1 = 1000\,\Omega$, $R_2 = 6800\,\Omega$. R_3 and C_3 are selected to give the required de-emphasis of the audio frequencies, possible values are $50{,}000\,\Omega$ and 1000pF and C_4 (0.01μF) is the audio-frequency coupling capacitance. With the component values quoted above the damping resistance effective at constant carrier amplitude will be approximately $(R_1 + R_2) = 7800\,\Omega$ across the complete secondary and $\frac{1}{4}(R_1 + R_2) = 1950\,\Omega$ across the tertiary winding. The reason for the lower damping resistance across the tertiary is that the r.f. currents from each diode traverse the tertiary coil. Since the tertiary winding has a step-down of about 0.6, the resistance reflected across the primary will be $1/(0.6)^2$ of that across the tertiary, i.e., it will be about the same as that across the secondary. This explains why a tertiary is essential in order to reduce the damping on the primary and so increase overall gain to the f.m. signal. Any amplitude modulation of the f.m. carrier will see an effective variable resistance whose minimum value is $R_1 = 1000\,\Omega$ across the secondary and $250\,\Omega$ across the tertiary.

Many factors contribute to optimum amplitude limiting and not least the design of the coupled circuits, the undamped Q of which (particularly the secondary) should be as high as possible if effective suppression of negative amplitude modulation is to be achieved. A suitable design has already been given in this journal[3]. It is important, too, to operate the circuit in the balanced condition at the unmodulated carrier frequency, f_c. This is achieved by adjustment of one of the R_1 resistances until a.f. output is a minimum when an amplitude-modulated input carrier of frequency f_c is applied. The resistances R_2 should have tolerances of $\pm 1\%$. Amplitude suppression is, of course, obtained from diode damping when the circuit is not balanced, but the suppression will be less effective when the carrier deviation, f_d, is positive than when it is negative, or *vice versa*.

Since the ratio detector offers a fixed damping resistance to any steady value of carrier amplitude it will be clear that a "semi-permanent" change in carrier amplitude must produce a corresponding change of audio-frequency output from the frequency-modulated carrier. Hence tuning from a strong to a weak incoming signal will cause the a.f. output to fall. With the saturated amplifier limiter there is no change in a.f. volume and we have perfect automatic gain control (a.g.c.) characteristics.

This disadvantage of the ratio detector can be partially overcome by using the d.c. voltage developed by the ratio detector diodes to provide an a.g.c. voltage to bias preceding i.f. amplifier stages. The point from which a.g.c. could be obtained is indicated in Fig. 1. An alternative ratio detector circuit is shown in Fig. 11: the main difference between it and Fig. 1 is that the resistances R_1 are placed in series with C_2 which is split into two capacitors to maintain circuit balance. Adjustment of the earth tapping point on R_1 gives fine control of balance.

To sum up, we see that the success of the ratio detector is due to the fact that the resistance load of the diodes carries no audio frequency when the carrier is frequency-modulated. This allows us to use a low ratio of a.c. to d.c. load and by this means suppress amplitude change on the carrier.

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[2] Seeley, S. W. and Avins, J. "The Ratio Detector," *R.C.A. Review*, Vol. 8, June, 1947, p. 201.

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LETTERS TO THE EDITOR

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

Fourier—Fact or Fiction?

IN his article on Fourier analysis in the September *Wireless World*, "Cathode Ray" becomes confused because of careless use of the term "frequency."

He gives a simple and valid definition of frequency; viz., the rate at which identical events occur. It follows that any waveform can have one and only one frequency and it is meaningless to ask whether a waveform having only one frequency is necessarily sine. It is not necessarily anything.

Fourier's theorem states that any periodic function can be made up from a number of sine functions of different frequencies. It is common usage to say that a waveform contains frequencies other than its own, when what is meant is that the waveform can be made up from sine waves of these other frequencies, together with a sine wave of the fundamental frequency. The difficulty arises when "Cathode Ray" uses the word frequency without referring it to any particular waveform.

For instance, in asking what frequencies a sine waveform may contain, we are really asking what sine waves, with their harmonics, are needed to make it up. The answer is obviously the pure fundamental, which is where we came in.

Southampton. G. F. FOOKS.

"CATHODE RAY" wishes, on p. 456 of the September issue, that some mathematician would chip in with a neat proof to support his arguments; but unfortunately the theorem he was hoping for is false. I have sent for his criticism what I think is a fairly neat proof that any waveform (within reason) together with the same one moved $\frac{1}{4}$ the way along the wavelength (the same relationship as the sine to the cosine) can be used at frequencies 1, 2, 3 . . . . times that of another given wave function, to analyse the latter in "components" of the former.

So "Cathode Ray" is right to proceed to look for other features of the sine in order to justify its preference, and I admire the reasons he gives. But he overlooks one important one; namely, that with sines and cosines, the coefficients in the Fourier series (i.e., the amplitudes of the harmonics) are relatively easy to compute; if we had used any other basic waveform they would have been very much more difficult.

Braunstone, Leicester. J. P. DOUGHERTY.

"Cathode Ray" replies:—

It is hardly surprising that my metaphysical musings on Fourier in the September issue aroused some comment, not to say protests.

Some correspondents have shown themselves still unable to look at the sine waveform with an open mind. G. F. Fooks scores a definite point, I think, in his criticisms. But even he lapses into sine worship in his last paragraph. My whole point was that, however advantageous it is in practice to regard sine waves as basic, in principle one could choose otherwise.

J. P. Dougherty has supported me in this with a mathematical proof, which looks all right, though I am not mathematician enough to pronounce with authority on its validity. Incidentally, what he seems to have taken for an appeal to establish the sine wave as the only possible basis of a "Fourier" series was intended to be a challenge. His proof that other waveforms could be used relieves me of the fear that someone would successfully accept the challenge, and I am much obliged to him for his mathematical blessing on what might seem my rather presumptuous questioning of the divine right of sines.

With regard to his second point, I thought I had at least implied it in the words (p. 457) "So if electrical engineering (for example) were based on any other waveform, the whole thing would be unbearably complicated and difficult." But it is just as well to have it stated plainly.

I am indebted to J. F. Stray for referring me to Eddington's "Philosophy of Physical Science," Chap. VII, in which Sir Arthur contends that some so-called laws of nature are in fact man-made. He likens these to a "law" a sculptor might propound—that shapeless blocks of marble naturally contain the form of a human head, his evidence being that such a form can be isolated by means of an experimental analysis using a hammer and chisel. What I would like to ask the distinguished author is what view he would take of the matter if the chips were all found to be of identically the same human form, and of sizes that were exact integral sub-multiples of the main head. "CATHODE RAY."

Neon Tuning Indicator

IN the article by John D. Collinson on page 429 of the September issue it is stated that "With finite values of μ and R_k the anode current changes will not be equal and opposite, but unbalance is immaterial as it reduces to zero at the working point." The second part of the statement is surely incorrect.

The changes in anode current do not matter provided the anode currents passed by each half of the valve at the working points are equal and that the mean characteristics are equal. In short, the two halves of the circuit must be balanced statically at the working point.

In practice this seems very unlikely, especially as no selection between valves is possible since these will usually be in the same envelope. This is easily confirmed by shorting the input to the indicator and it will be seen that the neons do not glow equally except in exceptional choice of components. This means that the indicator will not indicate zero voltage for equal neon brightness but will indicate a constant error voltage, the error depending on the static unbalance of the circuit.

This difficulty may, of course, be overcome by inserting a small resistance in the cathode lead of one-half of the valve, thus altering the standing current balance and making the neons glow equally for zero input voltage.

The statement that the indicator indicates balance to within ± 3 kc/s thus seems unjustified.

I should add that I am using the modified form of this indicator with a ratio detector and find it gives excellent results,

North Harrow, Middx. A. LIONEL WILLIAMS.

The author of the article writes: I agree that the unbalance only reduces to zero at the working point with perfectly balanced valves. The suggested modification is therefore valuable if it is thought that errors due to normal valve unbalance are serious.

In practice, however, it seems that commercial double triodes balance rather better than Mr. Williams implies. In the circuit given, a 20 per cent unbalance between anode currents requires 75 mV to bring them into balance. With a discriminator output of 100 mV per kc/s deviation this corresponds to a tuning error of ±750 c/s.

The figure of ±3 kc/s quoted actually includes the expected valve error together with the human error in estimating the relative brilliance of the neons, the latter error being the greater. JOHN D. COLLINSON.

"Etched Foil Printed Circuits"

H. G. MANFIELD is to be congratulated on the very interesting and informative article in your September issue.

However, neither with nor without the benefit of Crown Copyright does copper liberate hydrogen from nitric acid and it is suggested that the word "gas" be substituted for "hydrogen" in an otherwise outstanding article.

Hornchurch, Essex. L. D. STUART.

Television Aerial Feeders

"DIALLIST'S" comments on balanced *versus* unbalanced television aerial feeder cables in your August issue conflict with my own experience so I cannot let them pass without some comment.

I have conducted reasonably careful tests using coaxial cable and both screened and unscreened twin cable and I concluded that:

(a) Feeder pick-up was only important when the feeder cable was in a strong interference field remote from the aerial (e.g., a long feeder cable in a building running very close to power supply cabling carrying a considerable level of interference signals, the aerial itself being mounted outside and well above the building).

(b) When there was appreciable feeder pick-up, the type of cable was unimportant but the preciseness of the match to the receiver was all important. A twin feeder connected to an unbalanced input was as bad as a coaxial feeder connected to a balanced input.

As "Diallist" will be aware, to achieve a good balanced input to a receiver is not all that easy. Even careful attention to the design of the input circuit and care in positioning components will rarely produce a balance-to-unbalance ratio at v.h.f. much better than 20 dB. Certainly a turn or so of wire over the grid coil of the first stage with both ends brought out to a second- or third-rate socket cannot possibly give a balanced connection.

I have yet to meet a commercial TV set with a balanced input worthy of that description or with a twin aerial feeder socket really suitable for use at v.h.f. and I suspect that the cost of providing a really good balanced input is likely to make the most enthusiastic manufacturer jib. In these circumstances, since we are both agreed that good matching at the receiver input is essential, it would be better to recommend the set maker to stick to his unbalanced input and the set owner to install coaxial feeder cable.

Cheltenham, Glos. T. A. LEWIS.

"Back to Methuselah"

I AM not sure what to make of "Free Grid's" reference to W. T. Cocking and myself as "irregular" contributors, coming as it does from such a source. However that may be, his crediting me with a mere 28 years' irregularity jerked me up out of my bathchair to seize reed pen and papyrus. If "Free Grid" will turn up the issue dated August 15th, 1923 (i.e., over 32 years ago), he will see on page 660 my contribution on a voltage raiser for valve transmitters. (Note particularly, *valve* transmitters.)

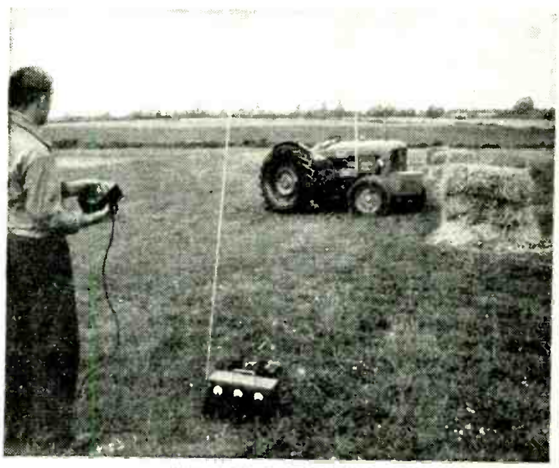
On the other side of the page he may be interested in the photograph of an up-and-coming youngster, called Captain Eckersley, inspecting the new B.B.C. apparatus (installed in the studio!) for relaying the London programme to transmitters in other parts of the country. I am sure "Free Grid" would find the wiring of this equipment a fit subject for one of his entertaining comments.

Bromley, Kent. M. G. SCROGGIE.

Magnetic Tape

ALTHOUGH a number of theoretical claims have been made that tape recordings can be stored for extended periods, it would be interesting to know if any reader has stored a tape for five years and finds that its original quality has deteriorated by "print through" or other causes.

Pinner, Middx. A. H. BEAN.



Driving a diesel farm tractor by radio control is hardly likely to become general practice, but it has been introduced by Ford's as a novel method of demonstrating their Fordson Major. There are six controls covering steering (L & R), clutch, implement lowering and raising, and engine switch. The radio equipment, which was designed by G. Honnest-Redlich, of Radio & Electronic Products, is operated on the tone-modulated carrier system, the carrier being 27.12 Mc/s and the modulating frequencies between 250 and 400 c/s.

Dual-band Television Aerials

1—*Alternative Designs for Combined Band I and Band III Reception*

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

BY now everybody concerned with television understands that Band I is the frequency spectrum embracing the five existing B.B.C. television channels and Band III is the v.h.f. spectrum which will ultimately be devoted, exclusively, to television and will be divided into eight channels. In round figures Band I covers from 41-68 Mc/s and Band III from 175-215 Mc/s. This brings one to the first important point, namely, the frequency ratio of Band III to Band I. The lowest value is about 2.6/1 and the highest is about 5.3/1.

Consider a simple vertical half-wave dipole resonant at 45 Mc/s (Fig. 1). For a vertically polarized wave arriving normal to the axis of the dipole (see the arrow) this aerial will develop an open-circuit e.m.f. across its terminals x, y, given by:

$$e_0 = \frac{E\lambda}{\pi} \quad \ldots \quad (1)$$

where E is the incident field strength in volts/metre and λ is the wavelength of the radiation.

Notice that the vertical directional characteristic as given by the dotted line shows a maximum in the direction of arrival normal to the dipole axis.

In these conditions the dipole is equivalent to a generator possessing an internal resistance of approximately 80 ohms and if terminated by an 80-ohm load, conveniently through a transmission line of characteristic impedance $Z_0=80$ ohms, the voltage across the load will be given by:

$$e_1 = \frac{E\lambda}{2\pi} \quad \ldots \quad (2)$$

assuming that the line losses can be neglected.

This is all well known but has to be reintroduced as the basis for considering what happens when one attempts to use the same aerial at frequencies other than the fundamental resonance, and particularly over the Band III spectrum.

Three effects must be taken into consideration because they all act in a way which reduces the e.m.f. at the terminals x, y, and which can never attain the value at half-wave resonance if loaded with 80 ohms. First, the induced e.m.f. becomes a most complicated function of frequency. Second, the impedance as seen at the terminals varies with frequency. It is high (several hundred ohms) when the frequency ratio is about an even integer and falls to about 80 ohms when the ratio is about an odd integer. Third, the vertical directional characteristics split up into a number of lobes and never show a principal maximum in the direction of arrival normal to the axis of the dipole, which is the direction which is used for all practical purposes. A particularly bad case is when the ratio is 4 to 1 in which case the induced e.m.f. is zero at normal incidence (Fig. 2). This would result in minimum signal reception and maximum interference from aircraft (flutter) and ignition interference.

*Belling and Lee Ltd.

It is beyond the scope of the article to analyse these three effects because it involves laborious mathematics and seems to defy simple explanation. It is one of those problems which is best solved by experiment and measurement. Perhaps one of the reasons why no one has bothered much about it is because it would be bad engineering to attempt to use a resonant dipole at far-removed frequencies, but the television aerial installer should be in a position to know just how Band I aerials behave on Band III, particularly on certain channels. It so happens that the range of Band III/Band I ratios (2.6 to 5.3) provides all the conditions for adverse performance, from gross mismatch to the load impedance, to splitting up of the vertical directional characteristics.

Very careful measurements have been made of the relative gains of Band I aerials over the Band III spectrum and the results are shown in the family of curves of Fig. 3. A resonant dipole on each Band I channel was fed through a balanced 80-ohm transmission line to an 80-ohm load, and thence to an accurately calibrated measuring receiver. Spot measurements were taken at each of the eight channels on Band III, (a) with the Band I aerial under consideration, and (b) with an optimized resonant half-wave dipole on the Band III channel under consideration. The ratio of these two amplitudes expressed in dB

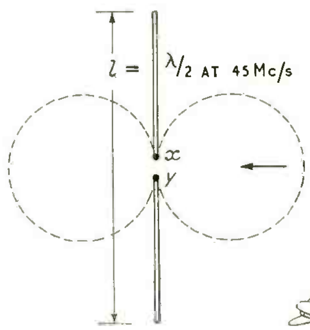


Fig. 1. Simple half-wave dipole showing the vertical directivity at 45 Mc/s.

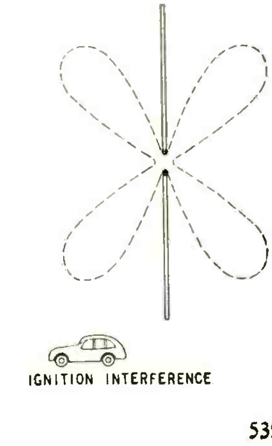


Fig. 2. Vertical directivity of 45-Mc/s dipole at 180 Mc/s.

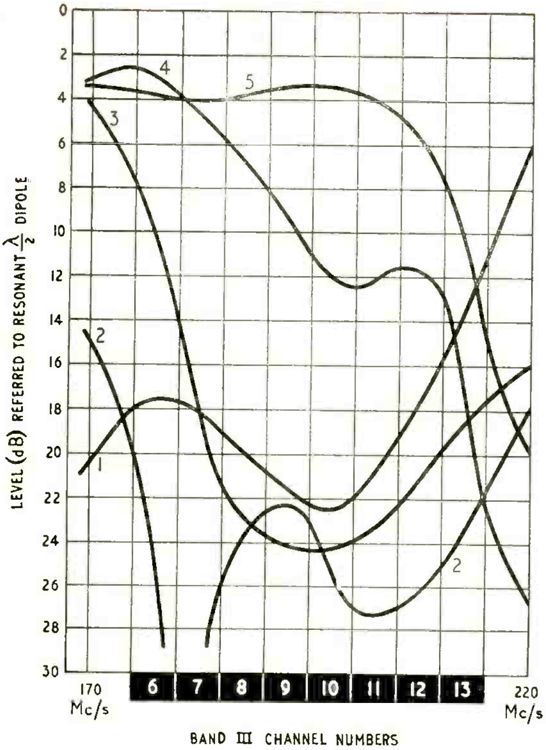


Fig. 3. Response of Band I dipoles (Channels 1-5) over Band III.

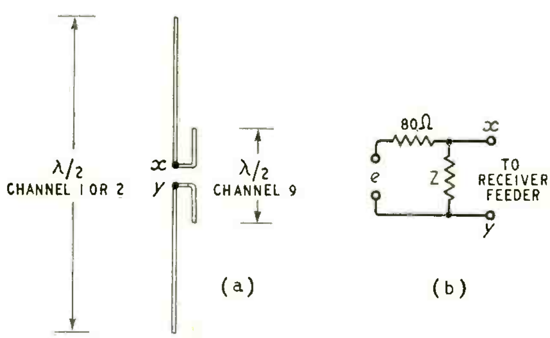


Fig. 4. Channel I or 2 dipole adapted to provide Channel 9 reception at moderate efficiency.

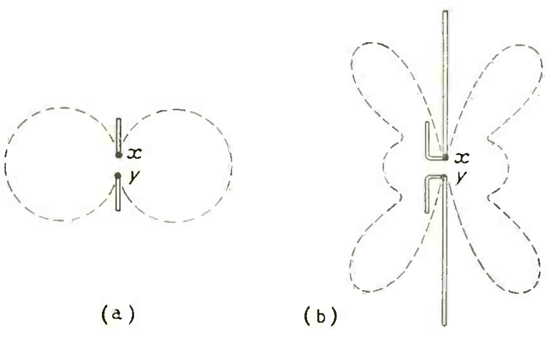


Fig. 5. Showing how the Band III vertical directivity is affected by the Band I elements.

gives the loss one incurs by attempting to use the Band I aerial on Band III.

Apart from this loss, which is particularly high for dipoles designed for Channels 1 and 2, the vertical directional characteristics take the form of lobes directed upwards and downwards thereby increasing the susceptibility of the installation to aircraft flutter in respect of the upward lobes, and ignition interference for the downward lobes (Fig. 2).

The performance of Band I multi-element aerials follows the same pattern over Band III as the simple dipole, because the various parasitic elements are so hopelessly out of resonance that their contributions can be ignored. It would take a great deal of work to check all the possible arrangements, but a few odd measurements support this view.

At the present time we are concerned with the dual reception of Channels 1 and 9 in London, 2 and 9 in Lancashire and 4 and 8 in the Midlands.

It will be seen from Fig. 3 that dipoles for Channels 1, 2 and 3 are extremely inefficient in the middle of Band III where the only television allocations to date exist. Not one of the five dipoles can be said to be moderately efficient over the whole of Band III, but a Channel 4 dipole is reasonably responsive on Channel 8. This observation will be dealt with later.

Notwithstanding the poor performance of Band I aerials on Band III, particularly Channels 1 and 2, there are so many of them that serious consideration has to be given to ways of improving their performance on Band III without introducing any serious loss on Band 1. The attachment of additional elements of appropriate dimensions can effect considerable improvement, but, according to the author's tests, cannot bring the aerial up to the performance of a simple half-wave dipole designed for the particular Band III channel which it is desired to receive. At best the Band III performance is about 3 dB below that of an optimized dipole, that is, with the longer elements wholly removed (Fig. 4(a)).

This method of adaptation is thus quite useful in areas of high Band-III field strengths, but is only usefully confined to Channel 1 (London) and Channel 2 (Holme Moss) dipoles. Both of these exhibit a high impedance at the terminals x, y, on the I.T.A. Channel 9, since the frequency ratio is about an even integer (4/1). Thus we may consider the equivalent circuit on Band III to be a generator with an internal resistance of 80 ohms whose output terminals x, y, (Fig. 4(b)) are shunted by an impedance (Z) of several hundred ohms. In view of the high shunt value of Z why should the performance be measurably inferior to a simple Band III dipole? The answer is, simply, that the vertical directional characteristics are modified because the Band I elements are contributing adversely with their upward and downward lobes. This is best seen by using the dipole as a radiator and transmitting energy from it. For a given energy applied to the terminals x, y, most of it is radiated in all directions at right angles to the axis of the dipole on Band III *if the Band I elements are removed.* On replacing these elements some of this energy is used for radiating upward and downward lobes which serve no useful purpose and must reduce the energy radiated in the desired direction. By the principles of reciprocity the directional characteristics of a given aerial are identical for transmission or reception which proves the point. Fig. 5 may assist the reader in following this explanation.

A better method of converting Channel 1 and 2

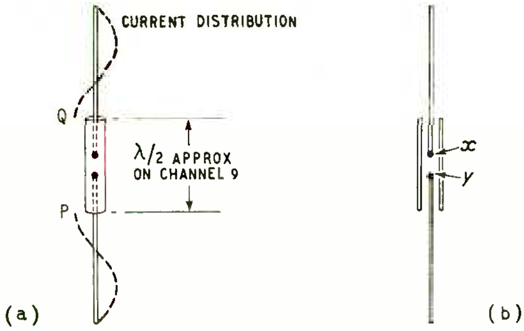


Fig. 6. Co-phased Channel 1-2, 9 conversion.

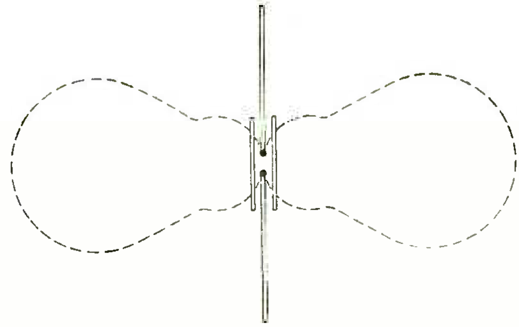


Fig. 7. Vertical directivity of co-phased conversion.

aerials to Channel 9 will now be described.† The Band I dipole is surrounded by a metal sleeve of approximately two inches diameter, symmetrically disposed about the junction (Fig. 6(a)) and is approximately half a wavelength from tip to tip on Channel 9. In practice the cylinder may be dispensed with and replaced by at least two metal rods suitably spaced off with insulators, although one rod does work fairly well. In this arrangement the sleeve (or rods) act as a continuation of the low-impedance coaxial transmission line normally connected to x, y so that at points Q and P, where the current is maximum and the impedance therefore low, there is a reasonably good impedance match. Of course, the current is maximum at Q and P because they are approximately $\frac{3\lambda}{4}$ from the outermost tips on Channel 9, always remembering that we are discussing Channels 1 and 2 dipoles, where the frequency ratio is of the order of four to one. Moreover, the upper and lower elements are fed in phase so that this co-phased conversion should be almost as efficient as *two* resonant Channel 9 dipoles placed one above the other and co-phased. Then the increased gain would be 3 dB. The measured gain of this co-phased conversion is about 2 dB above a simple resonant dipole. A further very good property is seen in Fig. 7 which shows that the vertical directivity is concentrated along the normal direction of arrival of the signal, thereby reducing aircraft flutter and ignition interference to a greater degree than that possible by the former adaptation of Fig. 5.

So far the adaptations described do not confer any horizontal directivity on either aerial. Of course, the Band I aerial can have its usual parasitic reflector and/or directors added to give it horizontal directivity but the Band III performance will still be that of an omni-directional dipole.

Observations on the transmission of the experimental station G9AED (Channel 9) were conducted in a mobile research unit in which the vision signal (test card) could be compared on (a) a simple omni-directional dipole and (b) a three-element directional array. In many instances serious "ghosts," due to delayed reflections, were noticeable when the dipole was in use, but in most cases they were eliminated by changing over to the three-element array. "Ghosts" were certainly far more prevalent on Band III than on Band I as was predicted in an earlier article by the author[1]. Objects such as churches, large blocks of flats, and electricity cable pylons were often responsible, while cooling towers and gasholders were outstandingly bad, and so were sharply rising hills, if they were sited behind the receiving installation. Thus while an adapted Band I dipole may not give rise to "ghosts" on that band there may be serious "ghosts" on Band III.

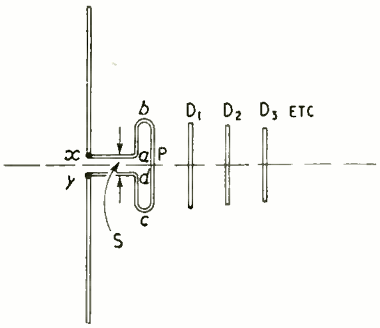


Fig. 8. An adapted Channel 1-2, 9 aerial providing gain and horizontal directivity on Channel 9.

The next step is to design an adaptor which can provide horizontal directivity on Band III, and a neat way of achieving this for Channel 1 and 2 adaptations will now be described with reference to Fig. 8†.

As usual the feeder to the receiver is connected to the Band I dipole terminals x, y, and the folded dipole is correctly dimensional for the Band III channel required, i.e. the distance bc approximates to one half wavelength. Consider the conducting loop $x\ a\ b\ c\ d\ y$; this may be regarded as a section of transmission line short-circuited at the point P. From normal transmission line theory a short-circuited line of length $\frac{n\lambda}{4}$ where n is odd, behaves as a high impedance at its input terminals (in this case x, y). Therefore, by making the length $x\ a\ b\ P$ such that this condition obtains *on Band I* a high impedance is shunted across x, y which will absorb negligible energy, since it is in parallel with about 80 ohms, i.e. the radiation resistance of the Band I dipole, and will therefore not adversely affect its performance.

On Band III the Band I element presents a high impedance at the terminals x, y but the folded dipole which has a terminal impedance at a, d of about 300 ohms on Band III, is transformed down to 80 ohms at the junction x, y by the parallel conductors x, a and y, d by the familiar stub technique. The spacing, S, is chosen to satisfy the characteristic

†Patents pending.
[1] F. R. W. Strafford, "Band III Television Aerials." *Wireless World*, April 1954.

impedance required for the parallel section to achieve the desired transformation from 300 to 80 ohms.

This system may now be made directional by the addition of one or more directors D_1, D_2, etc. The same result could be achieved by connecting the folded dipole terminals *a*, *d* to the plain dipole terminals *x*, *y* by means of a diplexer, which is a combined high-pass low-pass filter with inter-band cut-off frequencies, but the use of a diplexer is confined mainly to other aspects of installations and will be discussed later. In this particular application, however, it is a more expensive way of achieving the same result.

As in the case of the simple adaptations of Figs. 5 and 6 the method can be extended to Band I dipoles possessing a reflector and/or directors.

(*To be concluded*)

New Vision A.G.C. System

Advantages Obtained from an Improved Method of Gating

By S. E. GENT,* B.Sc. (Eng.), Grad.I.E.E., and D. J. S. WESTWOOD,* B.Sc. (Eng.)

WHATEVER the argument for using vision a.g.c. in the past, there is little doubt that, with the advent of Band-III television and the introduction of more than one programme, an efficient system of this kind is now a highly desirable, if not essential, part of all except the very cheapest of receivers.

The main reason for this requirement is the certainty that in most districts the Band-I and Band-III signals supplied to the receiver will be of different strengths, and it will not be desirable for the viewer to have to readjust the gain control of the receiver when switching from one programme to the other. One might argue that this could be overcome by pre-set gain controls in the receiver, one for each channel, which could be adjusted by the service technician and then left. But even if this is accepted for two or even three channels it must be remembered that there will one day be more channels in use, and the prospect of thirteen pre-set gain controls is a little staggering, to say the least! It is to be expected that variations in signal strength on Band III may be more serious than on Band I, and this may be used as a further argument in favour of a.g.c.

The majority of current a.g.c. systems will not deal efficiently with aircraft flutter unless the flutter frequency is very low, but it is claimed that the new system described in this article can be better in this respect than previous systems.

Obviously, in order to deal adequately with comparatively fast changes of signal strength, such as are caused by aircraft flutter, the time constant in the a.g.c. smoothing circuit must be short, and the a.g.c. voltage must be derived entirely from the vision signal and must be independent of the picture information and the sound signal.

Also, in order to cater for all likely ratios of Band-I to Band-III signals, the a.g.c. should have a large range of control over the gain of the receiver, say 60dB, and there should be no necessity for a pre-set sensitivity control. With a large control ratio such as this, care must be taken to delay the control on the r.f. stages relative to that on the i.f. stages, and then to proportion it correctly, if a good signal-to-noise ratio is to be maintained over the whole control range of the system. This necessitates a larger a.g.c. voltage than if no delay were used.

Moreover, in order to simplify the viewer's task in adjusting his receiver, the a.g.c. operation should be independent of other adjustments, for example, time-base locking.

It was with these points in mind that this new system was devised, but before describing it we will give a brief survey of the other methods at present in use and their shortcomings.

Commonly Used Systems.—The simplest form of a.g.c. uses the mean d.c. voltage developed as a result of diode action at the sync separator grid. The general arrangement is shown in Fig. 1. The contrast control usually operates by applying a positive bias to the a.g.c. control line, thereby cancelling part of the developed negative bias. A diode is included, termed a delay diode, and this clamps the control line to earth for signals below a certain level which is determined by the setting of the contrast control.

There are three objections to this system. The smoothing circuit must deal with the 50-c/s video and sync components, resulting in rather a long time constant. On pictures of small d.c. level, such as dark scenes, the a.g.c. voltage diminishes and there is a tendency for the background to show up because of the increased gain. This is particularly annoying in weak-signal areas where the background may already be rendered brighter than intended by the presence of noise on the signal. The third objection is that the available voltage from this system is inadequate to allow a delayed system of control on the r.f. stage.

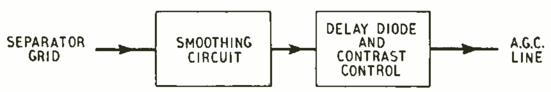


Fig. 1. Simple a.g.c. system using mean d.c. voltage at sync separator grid.

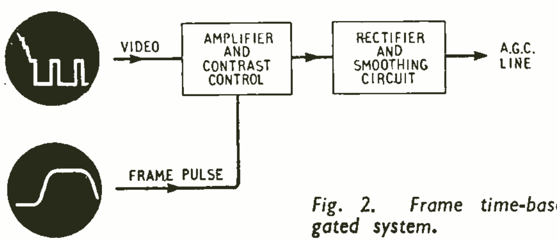


Fig. 2. Frame time-base gated system.

* Ferguson Radio Corporation.

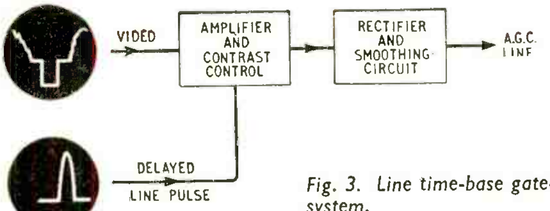


Fig. 3. Line time-base gated system.

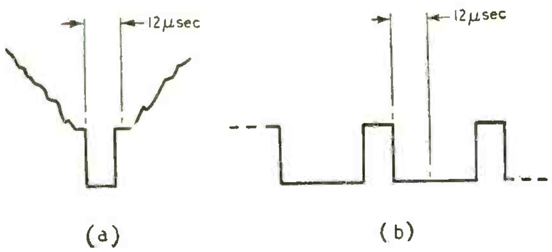


Fig. 4. Standard sync waveform showing (a) a line sync pulse and (b) part of frame sync pulses.

Fig 2. shows the basis of frame-pulse gated a.g.c. This method gates the valve producing the control voltage so that the output depends on the amplitude of the sync pulses during the frame fly-back, and since picture components do not occur during this period, the output is a true measure of the signal level. The contrast control may operate to determine the amount of pulse amplified by the a.g.c. valve. Because the gating frequency is so low, a long time-constant is required in the smoothing circuit. The frame hold control must be correctly set before the contrast to ensure that the gating waveform occurs at the right instants

For the line gated system shown in Fig. 3 the gating pulse is derived from the line time-base, and is delayed so that it operates the a.g.c. system during the " back porch " period of the line sync pulse. Since the back porch does not exist at the gating times during the frame pulses, i.e., approximately 12μsec after the negative-going edges in Fig. 4(b), there is a loss of a.g.c. during these periods, making it necessary to use a fairly long time-constant in the smoothing circuit. There is interaction between the line hold and contrast controls, because the system relies on the line time-base timing to obtain gating pulses at the correct instants. Usually these pulses are taken from the output circuit of the time-base, which does not operate for some time after the rest of the set has been switched on because of heating delay in the efficiency diode. Thus a protection circuit is required for this period to prevent overloading of the video circuits.

The "Sync-Gated" System.—The new form of a.g.c. system is basically a gated system, controlling the amplitude of the signal during the " back porch " of the line sync pulse, but the gating pulse is derived from the sync pulse itself rather than from the time-base, thus overcoming the difficulties experienced with some of the other systems as a result of the interdependence of " hold " and contrast controls. Reference to Fig. 4, showing the standard 405-line television synchronizing waveform, will explain the principle of the system. If this waveform is examined it can be seen that there is always a period of black level immediately following the positive-going edge of a sync pulse, whether it be a line or a frame pulse. Hence, a short-duration pulse derived from this edge and delayed slightly so that it occurs a microsecond or two after the edge, would form a suitable gating pulse for an a.g.c. system.

This is the basis of the new arrangement, the required gating pulse being obtained simply by differentiating the sync pulse and making use of the positive half of the waveform so obtained. This pulse is then added to the video waveform, the total amplitude being equal to the sum of the original pulse and the " back porch " level of the video signal (see Fig. 5). This total amplitude is made always to exceed the peak video amplitude and is passed through an amplifier, the pulses appearing at the anode of the amplifier being peak-rectified and used as a.g.c. voltage.

A very important feature is that the pulses are still present during the frame sync intervals—in fact they occur at twice the line frequency during this period—and so the considerable fall in a.g.c. voltage which occurs with line time-base gated systems during the frame sync interval is replaced by a small increase in voltage which can, however, be kept to a minimum by operating the rectifier under, as nearly as possible, peak rectifying conditions. In actual practice it has been found that, for a given percentage of 50-c/s ripple on the a.g.c. line, a considerably shorter a.g.c. time-constant can be used with this system than with the line time-base gated system, thus improv-

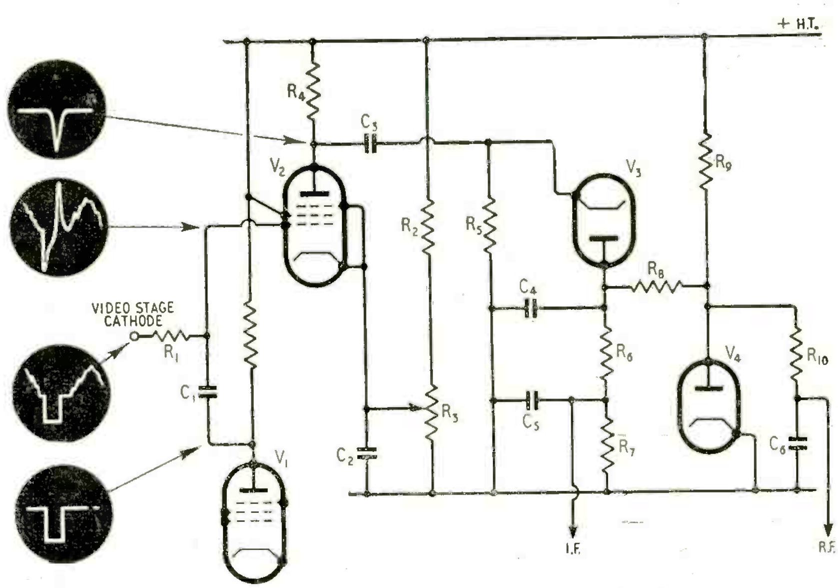


Fig. 5. Circuit of the new sync-pulse gated system.

ing control of rapid fading such as aircraft flutter.

It is, of course, essential that the sync separator in the receiver is capable of maintaining its output sync pulse constant in amplitude and speed over an adequate range of contrast settings, otherwise a positive feedback loop will exist via the a.g.c. line, and low-frequency fluctuations will occur in the gain of the controlled stages of the receiver. In commercial receivers the sync separator usually limits inadequately below about 10 volts peak-to-peak video signal, with the result that these fluctuations may occur if the contrast control of the receiver is adjusted to give a video voltage of this order at the cathode (or grid) of the cathode-ray tube. This is not considered to be a very serious objection, since such an amplitude of video signal represents a picture of extremely low contrast on the average cathode-ray tube.

A practical circuit is shown in Fig. 5. The video waveform including sync pulses is taken from the video stage cathode and a differentiated pulse from the sync separator (V1) anode, formed by the short time-constant C_1R_1, is added to it at the grid of the a.g.c. amplifier V2. Since the cathode of the video stage is a low-impedance point, the amount of pulse fed back into the video amplifier is very small. The delay in the sync separator is sufficient to ensure that the positive part of the pulse lies over the back porch.

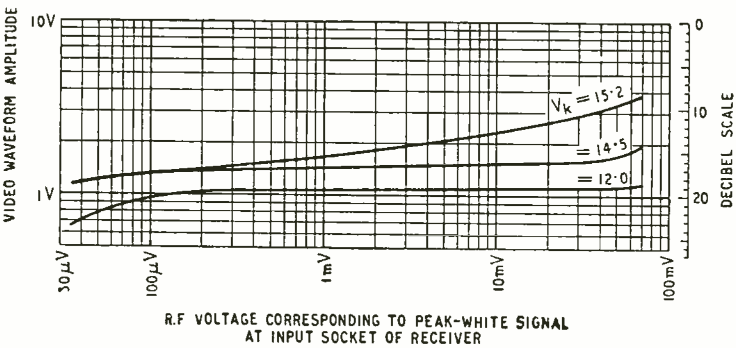
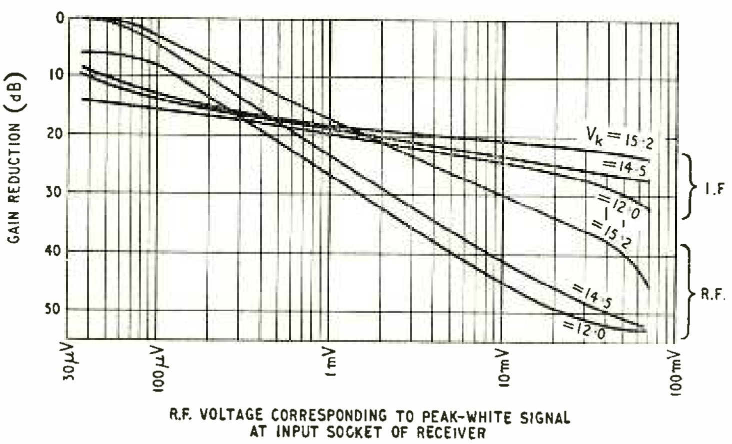


Fig. 6. A.G.C. curves for Ferguson Model 203T receiver with various settings of the contrast control. The video waveform amplitude is peak-to-peak (including sync) measured at the cathode of the video amplifier stage. It should be multiplied by 23 for the amplitude at the cathode-ray tube.

Fig. 7. A.G.C. curves for the 203T receiver showing the distribution of control between r.f. and i.f. stages.



The valve V1 is operated under very short grid-base conditions so that the pulse produced is constant in amplitude over a wide range of contrast, and this amplitude is sufficient to extend well beyond the peak-white level at the grid of V2. This valve is biased by the contrast control R_3 and resistor R_2 so that it conducts only on the tips of the pulses. Hence the output at the anode of V2 consists of pulses whose amplitude for any given contrast setting depends only on the back porch level and therefore the signal level.

These output pulses are coupled to the diode V3 circuit by C_3 and R_5. The diode load is split into R_6 and R_7, the tapping supplying bias to the vision i.f. stage. A delay network comprising R_8, R_9 and the diode V4 supplies bias to the r.f. stage. The capacitors C_4 and C_5 are small, so that a short time-constant exists on the control line of the vision i.f. stage. Since there is a small change in the a.g.c. voltage during the frame pulses, a longer time-constant is used for any stages common to vision and sound. Thus extra smoothing, R_{10} and C_6, is added for the r.f. stage.

The relative values of the resistors forming the delay system may be found in the following manner. If e_1 is the required i.f. stage bias at which control on the r.f. stage should commence and, under maximum signal conditions the i.f. stage bias should be e_2 when the r.f. stage bias is e_3 in order to avoid overload of the early receiver stages, then we may write:—

$$Ae_1 - Be_0 = 0$$

and

$$Ae_2 - Be_0 = e_3$$

where

$$A = \frac{R_6 + R_7}{R_7}$$

$$B = \frac{R_8}{R_8 + R_9}$$

$$e_0 = \text{h.t. voltage}$$

These equations yield:

$$A = \frac{e_3}{e_2 - e_1}$$

and

$$B = \frac{1}{e_0} \cdot \frac{e_1 e_3}{e_2 - e_1}$$

Curves showing the effectiveness of the system as applied to a complete receiver are given in Fig. 6 and it can be seen that for an average setting of the contrast control (the curve marked $V_k = 14.5$) a change of 60dB in input signal is reduced to only 2.5dB at the cathode-ray tube. At a higher contrast setting ($V_k = 15.2$) the control is not quite so good but even so a change of 60dB in input causes only 8dB change in video voltage.

Fig. 7 shows the way in which the control over the total receiver gain is divided between the r.f. and i.f. stages. This clearly demonstrates how the r.f. gain is maintained at a high level for weak signals in order to achieve a good signal-to-noise ratio, while with strong signals the majority of the gain reduction occurs in the r.f. stage in order to avoid overloading the mixer stage or first (uncontrolled) i.f. amplifier.

Information Theory

Widening Fields of Application Discussed at London Conference

THE third symposium on information theory to be held in London* was housed this year at the Royal Institution. The change of address from the Institution of Electrical Engineers, where the last one was held, certainly reflected the different character of this year's proceedings, which seemed to have kicked away the ladder of mere technology by which information theory rose to fame. Whereas the I.E.E. symposium was mainly concerned with practical applications of Hartley's and Shannon's work and had a direct appeal to communications engineers, the Royal Institution offered such a miscellaneous collection of scientific subjects that any engineers present could have been forgiven for asking themselves what they were doing there at all. Welsh spelling rubbed shoulders with nerve mechanisms, randomizing machines with the cochlear nucleus and games strategy with optical transmission, not to mention statistics, translating machines, codes, linguistics, clerical operations and extra-sensory perception.

There were, however, a few topics that could be said to represent our own sphere, and one of particular interest was concerned with coding information to increase the efficiency of communications channels. This term "coding" is often used loosely to describe a process by which the signal is converted from one physical variable into another (for example, from amplitude changes to frequency changes, as in f.m.) without altering its essential structure or pattern. What "coding" should really mean is a process which takes into account the statistical nature of the signal, so that less time or signalling power is given to representations which occur frequently, and therefore convey little information, and more to those which occur infrequently and give a good deal of information. A familiar example is the Morse code, where the letters which have the greatest probability of occurring in English text, like E and T, are given the shortest symbols.

A good deal of research is being done to apply this kind of coding principle, not only to "telegraphic" signals but to continuous ones like speech and television waveforms, in order to reduce the bandwidth or signalling power required in communications channels. It becomes particularly valuable when the "conditional probabilities" are taken into account. For example, in English text when the letter Q occurs it is almost certain to be followed by U, so that when the U actually comes up in these particular circumstances it conveys very little information and should be given less time or signalling power than it normally gets. Again, this principle can be applied to signals of a continuous nature.

A more recent offshoot of this work has been on special codes for detecting and correcting errors, and these are used mostly for "telegraphic" signals such as the trains of pulses in digital computers or telephone dialling systems and, of course, in telegraphy itself. The term "errors" here refers to changes in the signals caused by noise, intermittent faults or any other kind of interference with the transmission channel. In a digital computer, for example, a single noise pulse added to a train of binary digit pulses representing a number could make a difference of thousands or millions in the result of a calculation. The general principle of detecting and correcting such errors is to add some extra symbols to the "message" to act as a check on the accuracy of what is received, rather like the tally of words sent in a telegram. This entails some redundancy in the code and its efficiency is thereby reduced, so the aim of the "information theorists" is to design effective codes with minimum redundancy. The methods used for detecting the errors are complex, but in the binary system of signalling (with which the codes are mostly concerned) the process of correction is simplicity itself. Since there are only two symbols used, 0 and 1, once it has been determined that an error exists at a particular position in a train of digit pulses it is only necessary to reverse the digit in that position from 0 to 1 or from 1 to 0 as the case may be.

Speech Recognizing Machine

Papers concerned with various aspects of binary coding at the symposium were "The Synthesis of Linear Sequential Coding Networks" by D. A. Huffman, "A General Class of Codes and their Physical Realization" by A. E. Laemmel and "Coding for Noisy Channels" by P. Elias. The notion of error correction and that of "conditional probabilities" mentioned above also came into an interesting description by D. B. Fry and P. Denes of their experimental work in building an automatic speech recognizer—a machine that will produce typewritten versions of words spoken into it. The main problem here is that a machine cannot recognize words simply by their acoustical properties, which vary considerably with pronunciation, intonation and quality of voice. This is also true of *homo sapiens*, of course. It is necessary for the machine, like the human being, to have a store of linguistic information to act as a check on the acoustical frequency patterns and modify them when they seem to have an improbable structure. In the recognizer described by Fry and Denes this is done on an elementary level by using the "conditional probabilities" with which certain sounds occur after other sounds in a given language.

First of all, the purely acoustical patterns are "recognized" by a series of filters, which divide up the frequency spectrum into adjacent bands. Most phonemes give rise to characteristic spectral patterns which can generally be identified by coincident peaks of energy in particular pairs of filters. The outputs of the various pairs of filters are multiplied together and this gives a series of voltage products which vary in relative magnitude as changes in the applied speech wave move the energy maxima from filter to filter. An electronic circuit then detects the greatest of these products and indicates the occurrence of the corresponding phoneme.

The linguistic information on "conditional probabilities" is stored in the form of slider adjustments on

* Organized by Dr. Colin Cherry, of Imperial College.

sets of potentiometers. Each set is associated with a particular phoneme and the various sliders give voltage outputs proportional to the probabilities of the other phonemes which may follow it. What happens in operation is that when a particular phoneme is recognized by the filter-pair system, say *i*, this information is stored in a corresponding memory circuit until the next phoneme occurs and then used to switch the voltage indicating the occurrence of this next phoneme to the *i* set of potentiometers. The "probability voltages" from the sliders are then sent to the filter-pair system, and here each phoneme acoustical output voltage is multiplied by its corresponding probability voltage. Thus the acoustical recognition of the phoneme following the *i* is biased or weighted according to the probability of its occurring in the language. So if the filter-pair system has a tendency to produce the largest voltage for a phoneme which is similar to the one spoken but not actually correct, the weighting by the probability voltages will most likely swing the balance and cause the correct acoustical output to have the largest voltage. This is then selected by the electronic circuit mentioned above and used to operate an electric typewriter.

Some interesting and amusing typewritten results were shown by Fry and Denes which clearly demonstrated the greater accuracy of recognition obtained with the aid of the store of linguistic information.

Applications of Computers

In one sense mechanical speech recognition can be regarded as a coding problem since the actual structure of the information is altered. A rather different type of coding, though again for transformation of language information, was described in a paper by A. D. Booth and J. P. Cleave—the "programming" of a digital computer to transcribe ordinary alphabetic text into Braille. The technique was similar to that outlined in the article on language translation in a recent issue* except that with Braille the transcription was in terms of individual letters and simple groups of letters (or simple words) called "contractions." There is not, however, a simple one-to-one correspondence between printed characters and the Braille signs, for the particular signs used depend upon the context. Transcription into contracted Braille, in fact, is almost as complex as translation into a foreign language, except that the words in real language are replaced by "letters" in Braille and the word groups or idioms by Braille letter groups.

Computing machines are also being used in another field of information theory to investigate the transmission of information in the animal (or human) nervous system, which can be regarded as a kind of communications network. The general idea is to organize the machines to imitate the external patterns of behaviour produced by the nervous system in the hope of throwing some light on the actual physiological mechanism of the system, which is very difficult to investigate by other means. One paper, by O. G. Selfridge, described the adaptation of a digital computer to give recognition of visual patterns. Here, there was no attempt to make the machine imitate the nervous structure directly—only its functions. Another paper, however, by W. K. Taylor, described a network more in the nature of an analogue computer which was built up from model neurons having electrical properties similar to those of living nerve cells and sensory receptors. Each model cell contained electronic circuitry using seven valves. Experiments were described in which the correct "physiological" response to a pattern of stimulation could be "learnt by association" by the network.

In particular the sense of hearing offers a challenge to information theory because of the complexity of the path from air to brain and because of its incredible sensitivity. It has been calculated that at the threshold of hearing the displacement of the eardrum is less than the diameter of a hydrogen molecule. If the total energy available is divided by the observed number of sensory cells in the inner ear it turns out that the signal is well down into the thermal noise level. This results in a constant random "firing" of nerve threads which is to some extent ordered by interconnection, feedback and autocorrelation in the presence of even the weakest sound stimulus.

A detailed investigation of the function of the cochlear nucleus, reported by J. T. Allanson and I. C. Whitfield, confirms this view and shows that the pattern of response to a pure tone is modified from a Gaussian or humped-back distribution of activity in the ingoing fibres, to a steep-sided, flat-topped band-pass response in the outgoing fibres. This sharpening of the region of neural activity is thought to account for the observed degree of discrimination of pitch, and it was suggested that the width of the "pass-band" might prove to be related to the perception of intensity. Weight is lent to this hypothesis by the known dependence of subjective pitch on intensity.

Frequency analysis lies at the root of all theories of hearing and a comprehensive survey of the present state of our knowledge was made by J. C. R. Licklider who pointed out that the "place" theories of Helmholtz and Bekesy, which identify specific regions of excitation in the cochlea with different frequencies, were insufficient to explain the subjective recognition of a low-pitched fundamental residue when the ear is stimulated by high harmonics only of that fundamental. Schouten's work on this subject had made it clear that the low pitch remained after any combination tone due to non-linearity in the ear had been balanced out by a variable-phase search tone.

An alternative demonstration was given by Prof. Licklider in which short bursts of a sine-wave fundamental were interspersed with tones consisting of the higher harmonics only. A random low-frequency masking noise was then introduced, which completely suppressed the sine wave but left the sensation of low pitch from the harmonics untouched.

These results could not be explained by any existing simple "place" theory. There was the possibility that a transformation from time to place might occur in the cochlear nucleus or at high levels in the path from ear to brain, and the main part of his paper was devoted to a detailed description of a "triplex" mechanism which might fit the facts so far observed.

It seems, then, that the principal role of information theory in all these different fields has been to throw a new light on old problems. Channels of communication have been found to exist in situations which were never considered in this way before. At the same time one cannot escape the conclusion that many of the researches described at the symposium might have gone on quite successfully without information theory! However, the world of communications must take it as a compliment from the rest of science that such attention is being paid to the subject.

* "Language Translation by Electronics," by J. P. Cleave and B. Zacharov, *Wireless World*, September, 1955.

Measurement of "Wow" and "Flutter"

Basic Circuitry of a Test Instrument

By
O. E. DZIERZYNSKI

BEFORE the subject of measurement can be considered it is necessary to form a clear picture of what exactly is meant by "wow" and "flutter," as misunderstandings often arise where terminology is concerned.

Wow or flutter is a periodic or non-periodic frequency deviation (occurring mostly when reproducing from magnetic tape or disc records) expressed as a percentage of the mean frequency. For example, if a recorded signal of 3,000 c/s varied on reproduction between 2,970 and 3,030 c/s, wow or flutter in this case would be:

$$\frac{3{,}030-3{,}000}{3{,}000} \cdot 100 = \frac{3{,}000-2{,}970}{3{,}000} \cdot 100 = \pm 1\%$$

We are here dealing with peak-to-peak values, as we should in the case of slow deviations, but for higher rates the mean value of frequency deviation is usually considered. Consequently, if flutter were given as, say, 1% without saying that this referred to peak-to-peak deviation, it would be safer to take the maximum frequency range as being approximately ±1.5%, assuming that the waveform is nearly sinusoidal.

A second term (entirely different in meaning from percentage wow or flutter) is wow/flutter *frequency*. As we mentioned previously, change of frequency may often occur in a periodic way. This period of frequency variation can be from a few cycles/sec (or even less) up to a few hundred cycles/sec, and can be divided into two ranges, i.e.: "wow"—corresponding to frequencies within the limits 0-20 c/s and "flutter"—covering all frequencies between 20 and 200 c/s. Wow itself could be divided again into a "very slow" wow, 0.2 c/s* (not so audible), and "normal" wow within the limits 2-20 c/s. It is significant that "very slow" and "normal" wow and flutter are different not only audibly but also from the measuring equipment point of view; a "very slow" wow has to be measured by different circuitry.

Choice of Carrier (Test) Frequency. Frequency variation when occurring with the same percentage deviation over a wide range of carrier frequencies has different audible effects depending upon carrier frequency, rate of change (wow/flutter frequency) and individual hearing characteristics. It can be assumed, however, that a carrier frequency lying between 2,000-5,000 c/s is most vulnerable to wow and flutter and consequently 3,000 c/s has been chosen internationally as the test frequency.

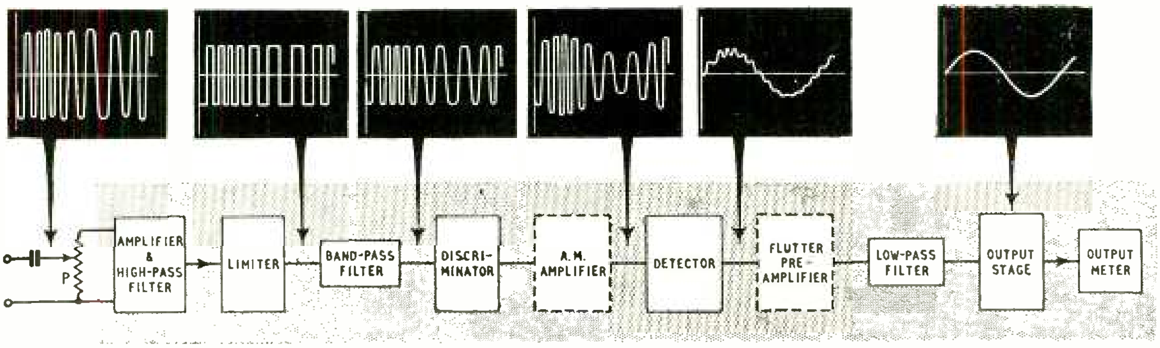
Purpose of Wow/Flutter Measurements. There are two main reasons for this sort of measurement. First, to check the percentage of frequency variation to ensure that it does not exceed the allowed limit; and, if this is the case, to make necessary adjustments and repairs in the apparatus under test. Secondly, to establish an objective figure of merit which can be used also for equipment with frequency deviations which are difficult of detection by the average human ear. For instance it can be generally assumed that equipment with w/f (wow or flutter) higher than 0.5% represents poor performance and below 0.05% is associated with best-quality reproducers. As flutter meters are most used for fault finding, it often happens that not only percentage of w/f has to be checked, but also w/f frequency estimated—the chief reason being to find the cause of the trouble. This certainly complicates matters, particularly as the flutter waveform is generally of a complex nature. We shall return to this subject later in the article.

Principle of Flutter Meter. Fig. 1 is a block diagram of a w/f analyser. Flutter phenomena are similar to frequency modulation in r.f. circuits. Consequently the flutter meter has similar stages to those of a f.m. receiver, the chief difference being, of course, an audio-frequency carrier (3,000 c/s) and very low deviation. This latter factor has an important influence on the design of the limiter and output stages.

Let us consider stage-by-stage how a flutter meter works. The signal of nominal frequency 3,000 c/s, from the output of, say, a tape recorder, is fed through an amplifier to a limiter. The purpose of the limiter is to reduce the minimum amplitude

*British Standard 1988:1953 recommends the use of the term "drift" for deviation of frequency "below about 0.1 cycles per sec." [Editor.]

Fig. 1. Block schematic diagram of wow/flutter meter.



modulation, and to provide a reasonably constant input to the discriminator.

The limiter is followed by a band-pass filter which restores the sinusoidal waveform which was lost in the limiter stage. The level here is of the order of 100-500 mV.

The discriminator is designed as an amplifier with a linear (or close to it) characteristic of gain with frequency within the limits 2,700-3,300 c/s. An ordinary parallel-tuned L-C circuit in the anode circuit of the discriminator is good enough for this purpose and this circuit should be tuned to approximately 3,400 c/s (peak) (see Fig. 4). Under these conditions, the discriminator amplifier would have only about half of the available gain from the carrier of 3,000 c/s (working on the slope of resonant curve).

If a frequency-modulated 3,000 c/s signal is applied to the grid of V3 the output from the anode will be an amplitude-modulated carrier (incidentally still partly frequency modulated). This produces an amplitude-modulated carrier which should, if necessary, be amplified to at least 10 V before detection.

Diode detection is usually employed and the output from it, after removal of the d.c. component, contains the w/f frequency plus the remains of the carrier and carrier-harmonic frequencies.

As the flutter component is often a matter of only a few millivolts, a low-frequency amplifier has to be introduced between detector and a.c. output meter. The gain of this amplifier is of the order of 35-40 dB to ensure that the a.c. output meter (about 10 V f.s.d.) is working on the linear part of its scale.

A low-pass filter (cut-off frequency about 300 c/s) is often inserted between detector and output meter, to reduce carrier-frequency components.

As we shall see later, provision can be made to measure very low frequency wow (or frequency drift) by inserting a d.c. microammeter in series with the diode load resistor R_L (Fig. 4 (a)). Variations of frequency will be followed by the instrument pointer, provided that they are slow compared with its natural period, i.e., below about 2 c/s.

Circuit Details

Input Stage. Fig. 2 gives more details of the input circuit. The reproduced test signal of 3,000 c/s is passed through the pre-amplifier V1A, cathode follower V1B and high-pass filter. All lower frequencies (including hum) present in the output of the tape recorder are removed, as they can otherwise affect the final reading of the output meter. The purpose of the cathode follower is to match the low input impedance of the filter (3,000 ohms) to the high output impedance of the pre-amplifier. The choice of a low filter impedance has the advantage of making the design of the filter much easier, also of reducing hum pick-up at the input of the limiter.

Limiter. Two types of limiter circuit were considered during the development of the meter described in this article. The first employed a ECC81 working as an overloaded cascade amplifier with additional clipping action by diodes. A square valve was ob-

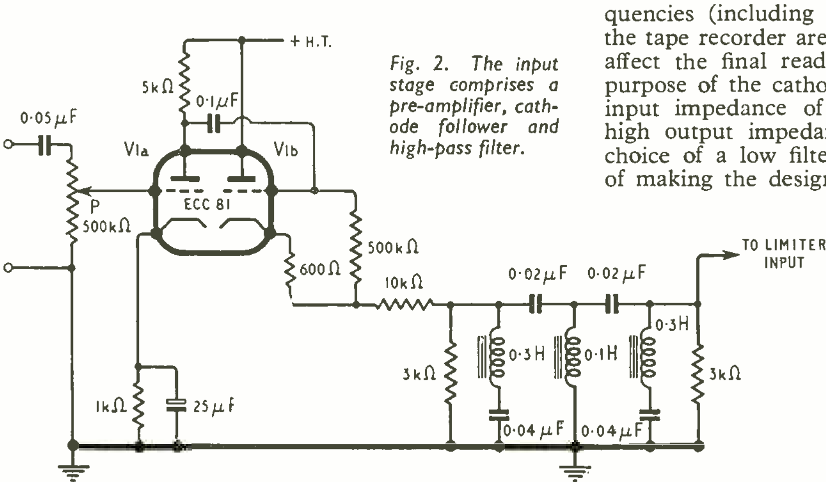


Fig. 2. The input stage comprises a pre-amplifier, cathode follower and high-pass filter.

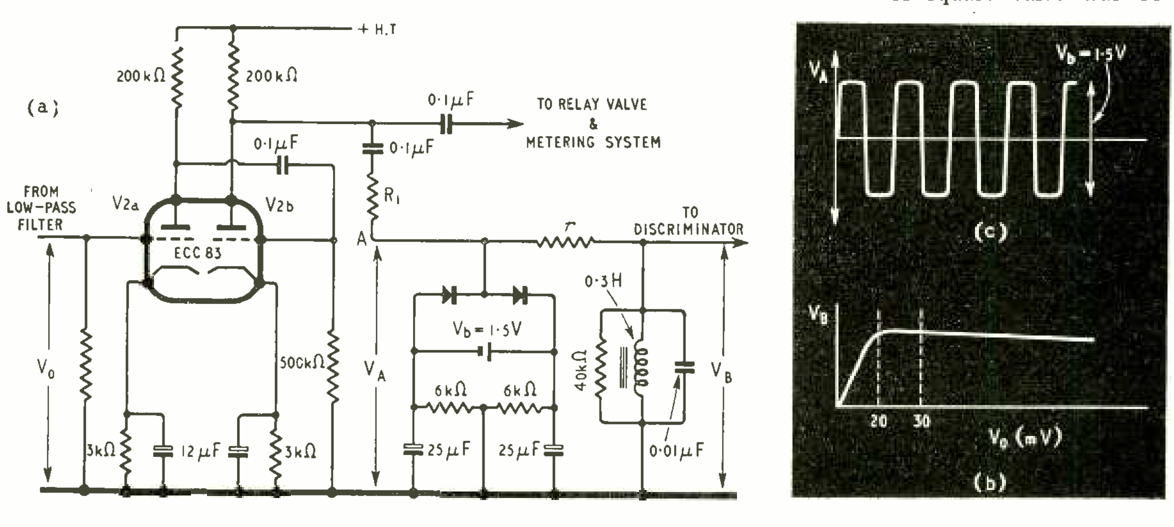


Fig. 3. (a) Circuit of limiter and band-pass filter stage; (b) input/output characteristic; (c) waveform at A when V_A exceeds the bias V_b.

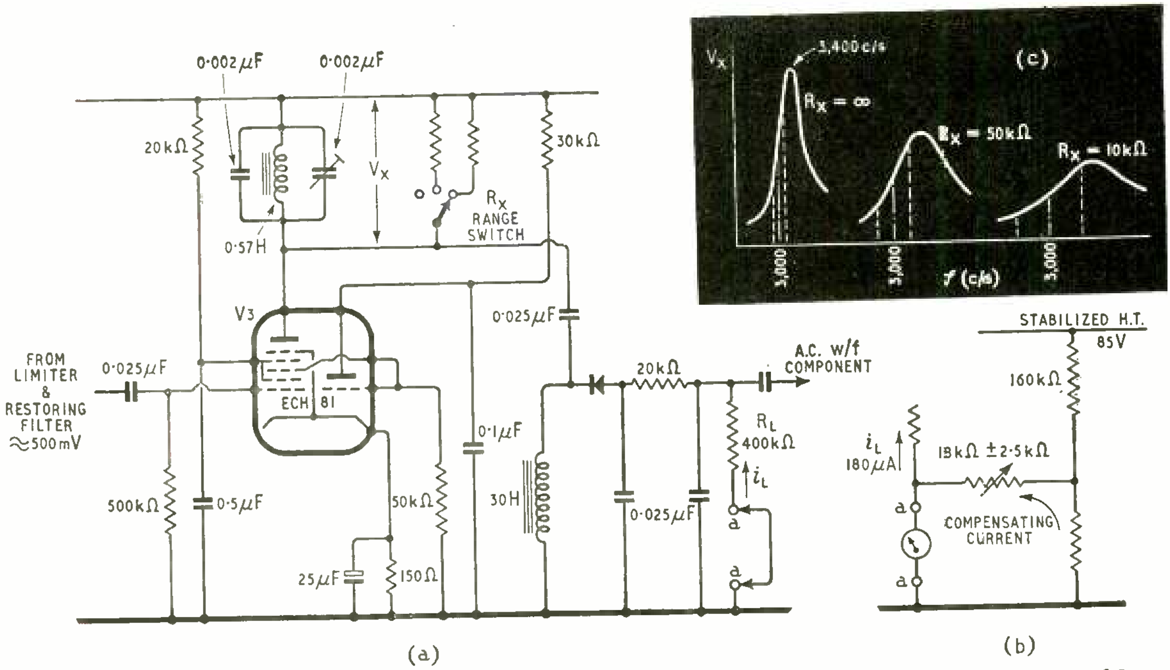
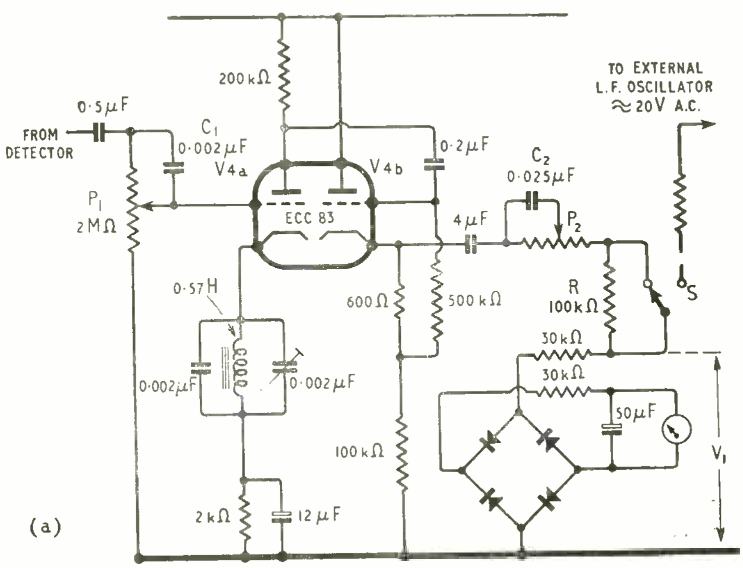


Fig. 4. (a) Discriminator and detector circuit; (b) Microammeter connections for measurement of drift; (c) Effect of R_x on slope of discriminator curve.

tained of peak value 75 V, approximately constant for all values of input voltages within the limits 80 mV-10 V. Fig. 3 (a) shows the second system which was finally adopted. Two negatively biased diodes are fed symmetrically with the a.c. signal through resistor R_1. At A the waveform is sinusoidal until the peak value of the signal exceeds the bias when the output takes the form shown in Fig. 3 (c). The amplitude remains substantially the same for inputs varying within similar limits to those quoted for the first system.

Band-pass (Sine-wave Restoring) Filter. Several systems have been considered and for simplicity and efficiency a single tuned circuit was chosen fed by resistor *r*. Damping of this tuned circuit had to be chosen very carefully, as sidebands within the limits 3,000±200 c/s had to be passed without appreciable attenuation. At the same time attenuation of the second and third harmonics (6,000 and 9,000 c/s) should be 20 dB at least. Fig. 3 (b) represents the limiter and filter characteristic, i.e., how the output of this stage depends upon input. There is a broad maximum for the input values 20-30 mV and it is clear that the optimum input for minimum amplitude modulation is about 25 mV.

Discriminator and Detector. Any r.f. pentode with sufficient gain could be employed for the discriminator, which is coupled to the detector stage. In the circuit of Fig. 4(a) the discriminator is the heptode section of an ECH81, which is of the variable mu-type



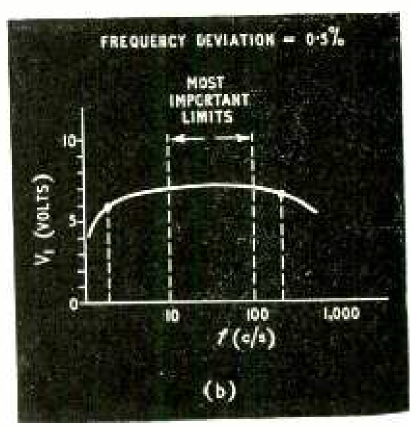


Fig. 5. (a) Circuit of output stage and (b) typical frequency response.

To stabilize the gain the triode section is connected to the h.t. to increase the cathode current so that a lower value of cathode bias resistor can be used.

It is important that the slope of the resonance curve should be sufficient to produce about 1 volt of flutter frequency across the detector load R_L for an input to the grid of V3 of about 500 mV with a frequency deviation of 0.5% (of 3,000 c/s). By shunting the resonant circuit (R_x) it is possible to reduce the discriminator efficiency very considerably. In this way it is possible to obtain a change-over to different ranges (see Fig. 4(c)). In this particular case resistors of 45 kΩ and 12 kΩ would cause a reduction of slope of 3 and 10 times respectively, while 1 volt a.c. of detector output could still be obtained from frequency variations of 1.5% and 5% respectively (with a signal of 500 mV fed to the discriminator grid). It will be seen from Fig. 4(c) that the value of rectified carrier current i_L) will be different in each range.

Very slow wow is measured with a microammeter (Fig. 4(b)) inserted in the detector load circuit. With a load resistor of 0.25 MΩ current i_L is approximately 180 μA, and a frequency change of ±0.5% would give a current change of approximately ±5 μA. Employing a meter with f.s.d. 100 μA, it is possible to compensate 130 μA from an external source to obtain neutral indication exactly in the middle of the scale. If the scale is calibrated in cycles, peak-to-peak measurement of the slow swing can be made. This method has the advantage that large slow variation of frequency can be measured, without range-changing facilities, as, even with wow up to ±5%, movement of the needle would be within the limits of the scale.

Output stage. As explained previously, a low-frequency amplifier and filter for carrier components must be included in the last stage of the flutter meter. Fig. 5 shows how this problem was solved in a simple and satisfactory way. The first half of the ECC83 is a R-C amplifier while the second triode serves as an output cathode follower feeding the output meter through a special network. A cathode rejector circuit tuned to 3,000 c/s was employed to reduce any remaining carrier signal (it was found that second and third harmonics were negligible at this point in the circuit).

The frequency response of the amplifier was given a strong lift towards 200 c/s (pre-set potentiometers P_1, P_2; condensers C_1, C_2) to compensate considerable loss of "higher" frequencies (in a band 5-200 c/s) through attenuation of sidebands in the discriminator circuit and smoothing capacitances in the detector circuit. The resulting frequency response (Fig. 5(b)) is more or less uniform: there is some loss at frequencies between 100-200 c/s and 5-10 c/s, but experience shows that the most important flutter frequencies are within the limits 10-100 c/s.

Oscillator and Ancillary Circuits. In Fig. 6 the EF86 is a stabilized 3,000-c/s oscillator with one half of the ECC81 as a buffer valve, while the second half works as a relay valve (see later). There are also some facilities for setting the exact level and for analysing flutter frequency contents. The oscillator circuit is a conventional Colpitts electron-coupled oscillator with automatic limitation of amplitude (see *Wireless World*, March 1954, p.110). The output is fed to a capacity attenuator which is used to maintain good waveform on lower ranges. Output voltages are in decade steps ranging from 1 mV to 1 V.

The second section of the ECC81 (V6b) is used as a relay valve. It is found that the oscillator, unless well screened, introduces a beat note with the played-back signal which upsets the accuracy of measurement. Consequently, it was arranged that while the recorded signal is played back, the oscillator is automatically switched off. This was achieved by applying a positive bias to the grid of the relay valve, this bias being derived from rectification of the 3,000 c/s played-back (fed from anode circuit V2b—see Fig. 3(a)). Only when signal is being passed through the limiter of sufficient level to give an anode current in

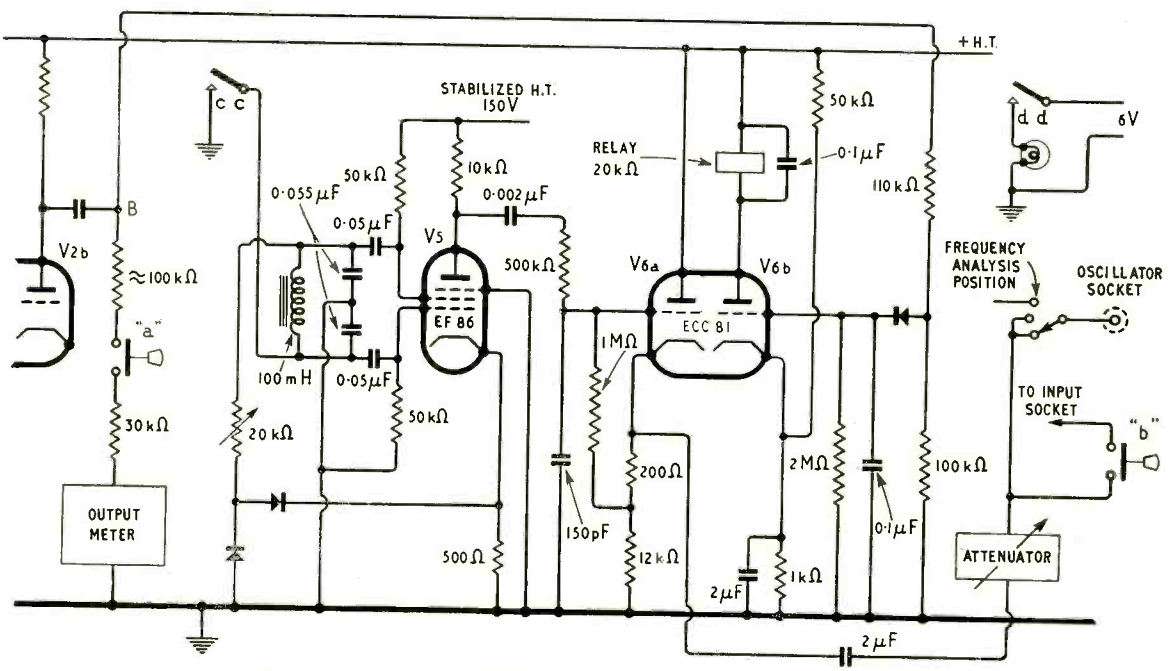


Fig. 6. Test oscillator (3,000 c/s) and other auxiliary equipment.

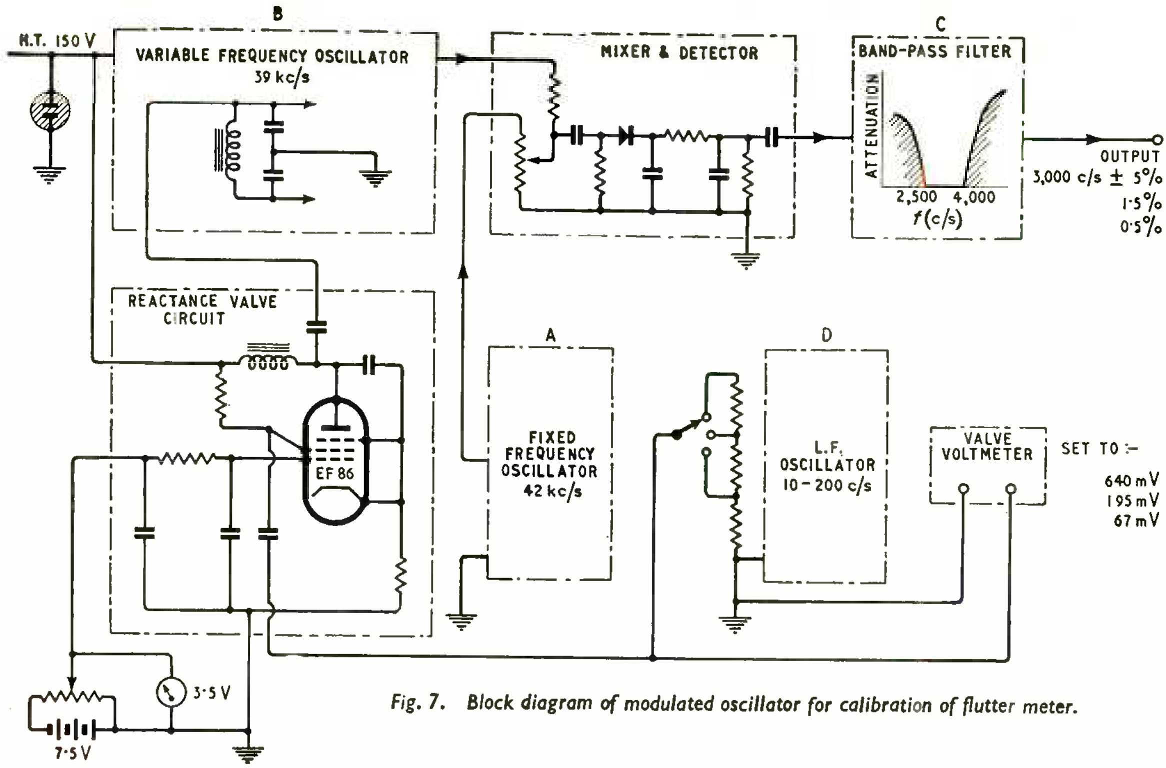


Fig. 7. Block diagram of modulated oscillator for calibration of flutter meter.

the relay of about 3 mA, does the armature of the relay close contacts c-c, shorting to earth the grid of the oscillator. Another pair of contacts b-b lights up a pilot bulb, indicating that the test signal is of approximately the right level. Accurate adjustment of level (to minimize a.m.) can be made by switching the output meter to the anode circuit of the limiter (point B), where the signal should be 3 volts, and setting the input potentiometer P (Fig. 2). This adjustment of level is recommended when making an ordinary test of flutter, and essential when frequency drift is checked. We shall return to this subject later.

Flutter Analysis. Flutter wave form is usually complex and irregular. It often happens that one frequency is predominant and it is desirable to estimate this frequency. Fig. 5 shows how this frequency may be found by using an external calibrated low-frequency generator. On the reduced flutter output (say 1/5 of f.s.d.) is superimposed about 20 V a.c. from the external generator, resulting in a deflection of the instrument to some point near the middle of the scale. Switching over to the external oscillator is carried out by switch S which simultaneously reduces the flutter level by introducing resistor R.

If now the frequency of the external generator is slowly changed from 10 to 200 c/s, the deflection will not change until one of the flutter frequencies approximates the external frequency. The needle of the instrument then indicates a slow beat with the search frequency. This is well known as the simplest method of analysing a complex wave, but in our case, a search often has to be repeated several times, as flutter usually has varying amplitude and it is easy to miss the beat frequency.

Frequency Drift. In tape recorders very slow frequency drift is sometimes experienced. This can be checked and measured by comparing the rectified 3,000-c/s carrier from the test oscillator and the played-back recorded note with the auxiliary meter of Fig. 4(b). Levels of both signals have to be identical and the following procedure in this test has to be observed (see Fig. 6). While testing, the level of the played-back note has to be adjusted by potentiometer P (Fig. 2) with button "a" depressed (output meter set to f.s.d.). Then, depressing buttons "b" and "a" simultaneously, the output from the oscillator is fed to the input socket of the flutter meter and f.s.d. adjusted by fine control of the attenuator. In this way both levels are set identically. Then with push buttons "a" and "b" off and recorded tone 3,000 c/s still going through, the reading should be noted on the microammeter (Fig. 4(b)). By depressing only button "b" the carrier from the oscillator is in turn measured. If both frequencies are the same (no frequency drift), both readings should be the same; the usual procedure is to make a note of the second reading (oscillator), switch back to the signal from the recorder and observe subsequent drift. The microammeter scale can be calibrated to read directly in cycles per second of drift.

Calibration of Flutter Meter. Although initial alignment can be made using a convention a.f. signal generator, calibration of gain requires the use of a flutter generator. For our purpose the flutter generator should produce a frequency-modulated 3,000 c/s carrier, with frequency deviation continuously controlled up 10%, at repetition rates within the limits 2-200 c/s.

As a general guide Fig. 7 gives a block circuit of the calibrating arrangements. This is basically a beat-frequency oscillator with a fixed frequency 42 kc/s supplied from oscillator A (small amplitude) and variable frequency from oscillator B (39 kc/s large amplitude). After mixing and detection the resulting beat note (3,000 c/s, frequency modulated) is passed through band-pass filter C. The chief purpose of this filter is to remove from the output traces of superimposed modulating frequency and to suppress higher frequencies derived from oscillators A and B. Frequency deviation is achieved by a reactance valve circuit in which deviation limits are controlled by the l.f. oscillator D (voltage measured by V.V.). In this case the reactance valve, with initial bias 3.5 V, would produce a change of frequency in oscillator B within the limits ±150 c/s with a modulating voltage of 640 mV r.m.s. Consequently the output would be 3,000 ±150 c/s—which represents 5% flutter (peak-to-peak). For deviations of 1.5 and 0.5%, 195 mV and 67 mV r.m.s. respectively were required from the modulator.

Commercial Literature

Junction Transistor Circuits for home construction using Mullard OC70 and OC71 types. Brochure giving basic circuit configurations, operating instructions, explanation of data, characteristic curves and various practical circuits from Mullard, Century House, Shaftesbury Avenue, London, W.C.2.

Wire-wound Potentiometers and rheostats, including ganged and concentric types. Specifications and mechanical details in an illustrated catalogue from the British Electric Resistance Company, Queensway, Enfield, Middlesex.

Amplifier Printed Circuit for the Osram "912" audio amplifier. Instructions for assembling the components on the printed circuit and details of a suitable chassis given in an illustrated technical bulletin from The Telegraph Condenser Company, North Acton, London, W.3.

Light-weight Flexible Cords for hearing-aids, headphones, microphones, etc. Table giving details of cores, coverings, resistances, current ratings and other information on the range produced by Amplivox (Industrial Products Division), 2, Bentinck Street, London, W.1.

U.H.F. Communications Receiver covering 150-500 Mc/s (a.m. and f.m.) in six positions of a miniature tuning turret, with sensitivity of 10 μV for 15-dB signal/noise ratio. Can be powered from batteries as well as mains, and facilities are provided for use as a test instrument. Illustrated leaflet on the Eddystone Model 770U from Stratton & Co., Alvechurch Road, Birmingham, 31.

Special-purpose American Valves.—A list giving type numbers and descriptions of the types available from Industro, 649, Broadway, New York 12, N.Y., U.S.A.

Aluminium Soldering Tool using a vibrating steel-wire brush in the centre of the soldering bit. Descriptive leaflet from the Belark Tool and Stamping Company, 130, Mount Street, London, W.1.

High-quality Audio Amplifier with 12 watts output, frequency response of 20 c/s-25 kc/s within 0.2 dB and total harmonic distortion of less than 0.1% at 10 W and 700 c/s. Disc record compensation and variable l.s. damping factor. Also a pre-amplifier control unit. Leaflet from R.C.A. Photophone, Lincoln Way, Windmill Road, Sunbury-on-Thames, Middlesex.

Gramophone Turntable Unit of "transcription" quality for three-speed operation, claimed to have no wow, flutter, rumble or hum induction. Descriptive leaflet from Woollett Sound and Wireless Equipment, Wells Park Road, London, S.E.26.

Distributor's List of products stocked and manufacturers. Available to trade, research and industrial organizations from Holiday and Hemmerdinger, 74-78, Hardman Street, Deansgate, Manchester, 3.

Plastic Extrusions for insulation purposes, mostly in P.V.C. Leaflet outlining manufacturing facilities available, from Creators, Plansel Works, Sheerwater, Woking, Surrey.

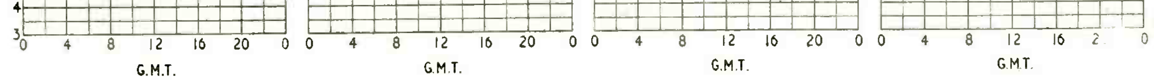
R.F. Induction Heaters, bench type, with continuously variable heat output over a 20:1 range. Two models available: 1 kW and 3 kW. Specification on a leaflet from Radio Heaters, Eastheath Avenue, Wokingham, Berks.

Transcription Gramophone Unit with speed continuously variable from above 78 r.p.m. to below 16 r.p.m. Also vertical-edge driving pulley claimed to eliminate rumble. Leaflet from The Goldring Manufacturing Company, 49-51A, de Beauvoir Road, London, N.1.

Multi-pole Changeover Relays; sealed types suitable for aircraft installations, with novel wiping action of contact surfaces and higher voltage contact blocks. New developments in Pullin relays described in a leaflet from Measuring Instruments, Electrin Works, Winchester Street, Acton, London, W.3.

Secondary Cell, 2-volt, for use with vibrator power supplies of portable equipment. Notable improvements in plastic container and combined gas vent and acid trap. Information from Chloride Batteries, Exide Works, Clifton Junction, Swinton, Manchester.

SHORT-WAVE CONDITIONS *Predictions for November*



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 November.

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

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

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

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

Polarization of Waves

By "CATHODE RAY"

What it Means and How it Can be Used

I HAVE a feeling that wave polarization is one of those things that the non-specialist tends to regard as too difficult to be worth trying to understand. When he comes across the news—as he may easily do nowadays—that radar is being rendered more effective by the use of circularly or elliptically polarized waves, does he have a clear picture of what this means? Or is there a certain amount of mental haze?

Many explanations of the polarization of radio waves conveniently assume that polarization of light is already understood. But so far as we are concerned it will probably be easier to understand the polarization of light in terms of polarization of radio waves, rather than vice versa. So I shall assume only a reasonable basis of radio, and then anybody who does happen to know about optical polarization will be able to amuse himself by looking out for the analogies.

First of all, then, let us refresh our memories about the main features of radio waves.

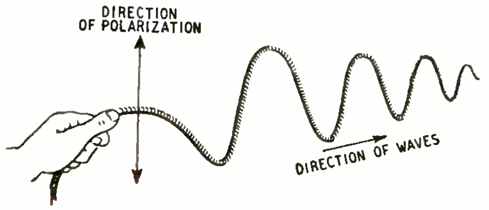


Fig. 1. Time-honoured procedure for generating transverse rope waves, in this case vertically polarized.

Unlike sound waves, they are transverse waves. That is to say, they consist of vibrations or alternations *across* the direction in which they are travelling. So they can be pictured quite aptly by the juvenile pastime of waving a long outstretched rope from side to side or up and down (Fig. 1). This process causes waves to travel along the rope—in spite of the fact that the movement which causes them is at right-angles to that direction. These rope waves could be called positional waves, because the thing that alternates is the position of each bit of the rope. If the rope's end is waved up and down, the position of that and every other bit of the rope alternates vertically and the resulting waves could be described as vertically polarized. If it is waved from side to side, they are horizontally polarized. The meaning of polarization is as easy as that!

The corresponding thing about radio waves is a little less easy, because it can't actually be seen. Moreover, in radio waves two things are alternating at once—electric field and magnetic field—both of them across the path of the wave, but at right angles to one another (Fig. 2). So although even the most perverse scientist could hardly refer to the polarization of his son's up-and-down rope wave as other than vertical, there is room for difference of opinion on what constitutes a vertically polarized radio wave. And where there is room for difference of opinion in scientific terminology, believe me, full advantage is almost invariably taken of it, to the confusion of all concerned. This case is no exception. In defining the direction of polarization there is a natural choice between two alternatives: making it the same as the direction of the electric field or of the magnetic field. Which has been chosen? *Both*! Electric for radio waves and magnetic for light waves, though radio and light are identically the same things except for frequency!

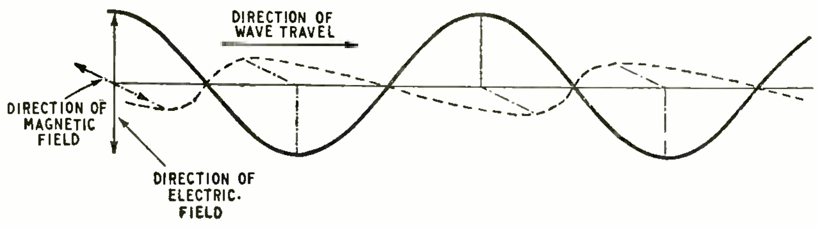
We radio people can argue, in favour of our choice, that it is so convenient to be able to say that a vertical dipole radiates and receives vertically polarized waves. The optical types, on the other hand, can retort that they were first in the field (even before anyone realized that there *was* a field!) and how could Mr. E. T. Malus (who invented "polarization") have foreseen in 1808 what TV fans would find convenient in 1955, and that it would have anything to do with the peculiar optical effects he was noticing in crystals of Iceland spar?

Anyway, from now on let us simplify matters by taking the "field" of radio waves to mean their electric field. Although we know the magnetic field is there too, for the present purpose we can leave it out of account.

Unlike generators of light—commonly called lights—generators of radio waves usually start the waves off with a definite direction of polarization. Although we have mentioned only two varieties—vertical and horizontal—because these are the only two in popular use, the angle of polarization can, of course, be anything between these two extremes.

Now because an electric field is invisible, the direction of its polarization is not obvious—unless perhaps one is within sight of the aerial responsible for it. But by connecting an alternating voltage between the top and bottom ("Y") deflection plates of a cathode-ray tube, so as to set up a vertical alternating electric field between them, the direction of that field is shown as clearly as could be by the vertical trace on the face of the tube, as in Fig. 3(a). Connecting instead to the "X" plates gives a horizontal line, as at (b). Any intermediate direction can be obtained by turning the

Fig. 2. In a radio wave two things are alternating at the same time, at right angles to one another and to the direction of travel. It is customary to regard the direction of polarization as that of the electric field. The magnetic field in this diagram is supposed to be at right angles to the paper.



tube around so that the direction between the plates in use is neither vertical nor horizontal.

But users of oscilloscopes will know full well that there is an alternative method of getting an oblique direction, without shifting the tube. If equal voltages are applied simultaneously to both pairs of plates the line appears at an angle of 45°, (c) or (d) according to which "X" plate is connected to the top "Y" plate. The vertical and horizontal fields combine to cause a single diagonal field. And conversely this—or any other—single field can for purposes of calculation be imagined as split up into two fields at right angles to one another—resolved into its orthogonal components, to put it technically. If one wants the angle to be something other than 45°, it can easily be done by making the vertical and horizontal components unequal.

In the same way, diagonally polarized radio waves could be produced by combining vertical and horizontal waves. But seeing that the same result can be achieved much more simply by mounting a single aerial at the appropriate angle, why should one want to? Well, supposing one wanted to vary the polarization, it might be easier to do it by an electrical control than by moving the aerial itself. To be honest, however, my only reason for introducing this idea was as an intermediate step in the argument. When I said that alternating voltages were applied *simultaneously* to the two pairs of deflectors, I meant to imply that they were in phase. But suppose next that we insert a variable phase delay in the connection to one pair. When the delay is zero the results are as already shown in Fig. 3. Shifting the phase causes the diagonal line to open out into an ellipse, then into a circle, then into an ellipse sloping the other way, and so on, as shown in the examples in Fig. 4, which are taken at intervals of 45° phase difference. At 360°, or one whole cycle, we are back at the starting point and the whole thing begins again

Fig. 3. Oscilloscope traces when a single alternating voltage is connected in phase to one or both pairs of deflector plates.

Fig. 4. Traces when the same alternating voltage is connected to both pairs of deflection plates, but with a variable phase delay in the connection to one of them.

This shows us that if we combined two sets of radio waves, one polarized vertically and the other horizontally, we could get other kinds of polarization than diagonal by introducing a phase difference between them. It should surprise nobody to learn that the kind of polarization that results when the phase difference is 90° (or any odd multiple thereof) is called circular, and all the others—except the special cases at 0°, 180°, etc., which are called linear—are elliptical. Even when the phase difference is exactly 90° (quarter of a cycle or wavelength) the polarization is not necessarily circular; it is only so if the two components are exactly equal. When they are unequal, the polarization is horizontally or vertically elliptical, as at Fig. 5(a) and (b). And having studied the matter so far you will probably be the first to guess that a combination of unequal components with other phase differences yields ellipses at all sorts of angles, such as Fig. 5(c) and (d).

The full possibilities have even yet not been seen. The reason is that at any frequency above a very few cycles per second the eye sees a complete trace on the oscilloscope screen, whereas in fact there is only a single spot moving around it. There are two ways it can move around—clockwise and anti-clockwise—and only when the frequency is very low indeed can these be distinguished. But the two directions exist, whatever the frequency; and so do these two varieties of any elliptical polarization of waves. The difference between the two depends on which component is delayed relative to the other.

Another thing to remember about the oscilloscope picture is that it represents no more than a cross-section of a radio wave. It is a very valuable representation, nevertheless, because it shows so clearly the significance of terms such as "linear polarization," "circular polarization," and "elliptical polarization." (By the way, the first two are often regarded as special cases of elliptical polarization.) But if now we are sure that all is clear so far, let us pass on from a wave marking time, as it were, in two dimensions, and give it the order "quick march"—at rather more than Army speed, say 186,000 miles per second. If the polarization is vertical, the oscillograph spot ceases to move up and down across the face of the tube and shoots out to meet us at that speed. Stepping smartly to one side to avoid it, we catch a glimpse of it broadside on; the combination of the up-and-down and the forward movement results in the familiar wave shape, Fig. 2. The spot is not now confined to a vertical *line*, but moves in a vertical *plane*; that is why the wave it represents is often called plane polarized (instead of linearly polarized), especially by optical characters.

Of course a radio wave doesn't consist of a travelling spot; the spot is just something to help us to visualize a rapidly moving wavelike pattern of electric field. We can (I hope) easily see that a circularly polarized wave is represented by a corkscrew path moving forward in such a way that it traces out a cylinder. If we can't see this, then perhaps we had better take the clothes line out into the back garden and turn one end rapidly round in a circle at right angles to its length. Then, if we can still face the comments of the family and/or the neighbours, we might care to demonstrate the flattened corkscrew-cylinder of elliptical polarization.

But what, you may ask, is the practical outcome of all this? The wayfaring man, though a fool, can see that some short-wave radio aerials are horizontal and some are vertical. If not quite a fool, he might wonder why. We, with our knowledge of radio and

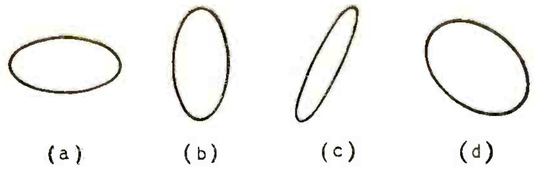


Fig. 5. Traces resulting from unequal voltages; in (a) and (b) they are 90° out of phase, and in (c) and (d) have other phase differences.

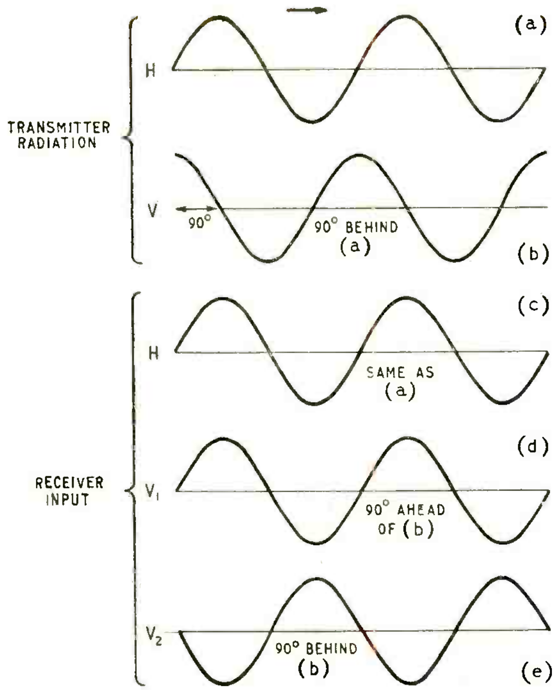


Fig. 6. (a) and (b) represent respectively the horizontal and vertical radiations of a circularly polarizing aerial system; (c) and (d) or (e) represent what is received by a similar aerial system after the signal picked up by the vertical portion is advanced or delayed relative to that from the horizontal portion.

now of polarization, may be quick to guess one reason, especially if we are familiar with the optical analogy of crossed Nicol prisms or Polaroid sheets. Reception of a vertically polarized wave is a maximum when the receiving dipole is vertical, and decreases to zero as it is turned horizontal. So it would appear that this supplies a method of completely separating two transmissions on the same wavelength. In practice it doesn't usually work out quite perfectly, but it does give a very useful degree of discrimination, which presumably is why the B.B.C. uses both vertical and horizontal on the same television channels.

The reason why discrimination is seldom perfect, and the reason why for some purposes vertical polarization is chosen and for others horizontal, are bound up together, and are due to the fact (familiar to optical students) that polarization is affected by the things that happen to it on the journey of life—transmission, reflection, refraction, and so on. For instance, in some circumstances vertically polarized waves are reflected less from the surface of the sea than are horizontally polarized waves. One of the troubles in certain kinds of radar is that the "targets" one wants to detect are liable to be concealed by reflections from the sea. This is the sort of thing that must be taken into acount when choosing which polarization to adopt for any particular system. But it is not always easy to make a quick decision, for the influence of polarization on wave behaviour is a very complicated subject in practice, necessitating a vast amount of experiment under working conditions.

Just now there is a good deal of interest in adopting circular polarization instead of linear, and I'm going to use the rest of the space explaining why.

The fact that an aerial arranged for, say, horizontal polarization is "blind" to vertically polarized waves, which is useful if one wants to separate two transmissions on the same frequency, is a disadvantage if one wants to receive signals on that frequency whatever their angle of polarization. True, an aerial at 45° would be equally responsive to horizontal and vertical waves—the loss as compared with a perfectly aligned aerial would be, as you have probably already worked out, nearly 30 per cent, or 3dB—but it would be totally unresponsive to waves polarized at 135°. You might think that nobody would be so silly as to radiate waves at 135°, but what about banking aircraft? Apart from that, the vicissitudes of travel sometimes (as I have mentioned) play tricks with the polarization, so that a wave starting off at 90° may be nearer 135° by the time it arrives.

If the aerial were made in two parts, one vertical and the other horizontal, both joined to the receiver in phase, it would be equivalent (as our oscilloscope showed) to a single diagonal aerial, so we would be no better off. But the use of a two-part aerial is on the right lines, for we have only to introduce a 90° phase delay in the connection from one of the parts to give the receiving system a circularly polarized characteristic. It is then equally responsive to waves linearly polarized at any angle; there are no blind angles.

The oscilloscope experiments should have made clear how the 90° phase difference between the outputs of the two aerial elements should give these results, but there is no harm in thinking of it a little differently. The reason why the straightforwardly connected outputs of a horizontal and a vertical aerial combine to give diagonal polarization is that the outputs, being in phase, are always present together and combine just like forces or winds or velocities acting in different directions. But when one is 90° out of phase with the other, its maximum occurs when the other is zero and cannot affect it; similarly the other can have its undisturbed say at least twice per cycle. Now, whatever the angle of the incoming wave may be, it can't be totally without horizontal *and* vertical. So some of it is bound to be received.

Now that we have thoroughly convinced ourselves that a circularly polarized receiving aerial yields an output from waves linearly polarized at any angle, we may be unprepared for the news that there is one kind of polarization to which it is blind. But there is no contradiction; the exception is not *linear* polarization, but circular polarization of the opposite direction of rotation. To prevent the mental haze from rolling in again it may be advisable to stop a minute and think this one out.

In doing so, we must be careful what kind of diagram we use; if we were to try vector diagrams, in which differences in phase (involving *time*) are represented on paper by differences in angular *position*, the chances of getting muddled in this problem, which involves differences of both phase and angular position, would amount almost to a certainty. But I think there will be no danger if we regard the vertical and horizontal transmitting and receiving aerials as two independent channels of communication, in which (under ideal conditions) the vertical receiving aerial responds only to the vertical sending aerial, and similarly for the horizontal ones.

Fig. 6 (a) represents a brief sample of the radiation from the horizontal transmitting aerial. In order to cause circular polarization, the radiation from the vertical aerial must be 90° different in phase, so (b) shows what is going on there at the same time if the output is delayed 90°.

Supposing, for the sake of simplicity, that the receiving aerial is exactly a whole number of wavelengths distant, (c) shows what is being received by the horizontal part; it has the same phase as (a). That being so, what is received by the vertical part will have the same phase as (b). But because this is a circularly polarized receiving aerial system, it is provided with a 90° phase shift between its two parts. If the vertical part is advanced 90° relative to the horizontal (in practice this would be done by delaying the horizontal) the result is shown at (d), and this exactly reinforces what is being received on the horizontal part (c). But if the phase delay happened to be in the vertical part, the result would be as at (e), which would exactly cancel out (c) and give no reception.

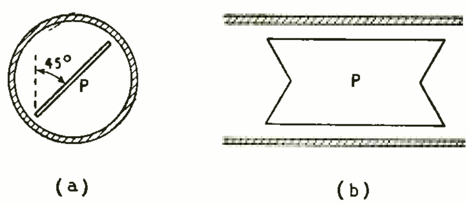


Fig. 7. (a) End view and (b) side view of section of circular waveguide containing dielectric plate P for converting vertical (or horizontal) linear polarization to circular, or vice versa. The ends of the plate are fish-tail shaped to avoid impedance mismatching which would cause part of the wave to be reflected.

I have gone into this in some detail, not so much to show how one can very ingeniously invent a receiving aerial that doesn't receive, but to lead up to another use for circularly polarized waves. One of the biggest problems in radar is to distinguish one thing from another, especially when they are both at the same place at the same time. For example, aircraft to be located may be in the midst of a heavy fall of rain which entirely blots them out on the receiving screen by sending back a permanent echo. Can the rain echo be eliminated without eliminating the aircraft echo?

One feature that distinguishes raindrops from aircraft is their shape. A spherical drop, being symmetrical around its centre, behaves equally to the horizontal and vertical components of a circularly polarized wave, so the wave reflected from it is also circularly polarized. But in the reversal of direction, the rotation of the polarization is also reversed; so if (as is usual) the aerial that sent out the original wave is also used for receiving the echo, it is blind to the echo. An irregularly shaped body such as an aircraft, however, (or even a flying saucer edge-on) is practically certain to reflect a little more at one angle than at another, the result being that the echo wave is elliptically polarized and does not entirely cancel out at the receiver.

This idea is not particularly new; it goes back to somewhere near the end of the war, and various trials then and since have shown a reduction in rain echoes of up to 26 dB, whereas the echoes from "targets" are only 4-8 dB weaker. Provided that the target echoes are strong enough to stand this weakening and still be visible, the result amounts to a practically complete victory over the rain.

There are other uses for circular polarization; for example, radar and other microwave aerials usually have to be capable of being turned around freely, and if it is not convenient for the whole station to turn with them this means that somewhere along the waveguide feeding the aerial there must be a rotating joint. If the waves carried by the guide were circular throughout, this would hardly be a problem. But there are reasons for preferring rectangular (linearly polarized) waves, and if nothing were done about it the transmission would vary from a maximum to zero as the aerial system turned through 90°. The solution to the problem is to convert the linear wave into a circular one when it comes to the joint, and then back into a linear wave directly afterward.

And how, you may ask, does one convert linear into circular polarization and vice versa? In the circular-polarization aerial systems we considered earlier we assumed that two linear polarizations (horizontal and vertical) were laid on, but here in the wave guide there is only one. And even when we have two, how is one of them delayed 90°?

As regards the first point, we have already noted that any one linearly polarized lot of waves is absolutely indistinguishable from two in-phase lots, polarized 90° apart. For instance, one lot polarized at 45° may be, for all anyone can tell, really two lots polarized at 0° and 90°. (A south-west wind can be regarded as a south wind and a west wind blowing at the same time.)

If one had the two linear polarizations in different feeders, the phase difference could easily be introduced by making one feeder quarter of a wavelength longer than the other. The only snag would be if one wanted to work over a band of wavelengths.

Where there is only one feeder, conveying what might be a single lot of linearly polarized waves, the trick is to insert in its path something that slows waves of one polarization more than another. A simple something of this kind is a thin sheet of dielectric such as polystyrene. Fig. 7(a) is an end view and (b) a side view of a piece of circular waveguide with such a plate (P) in position. Let us suppose that the wave going in is vertically polarized. Then it can be regarded as consisting of two equal components, one parallel to the plate and the other at right angles to it. The former is slowed and the latter not, so if the length of the plate is designed to cause the parallel component to fall quarter of a wavelength out of step, the outgoing wave is circularly polarized.

A second plate at right angles to the first delays the other component so that it comes into step again and the polarization is vertical once more. By setting it at any other angle, the polarization can be made linear at some other angle. In the rotating joint the plate, being fixed in the rotating part, automatically turns to the correct angle for setting the linear polarization in line with the remaining run of rectangular guide.

Electronic Digital Computers

1. *Basic Arithmetic Circuits*

By W. WOODS-HILL *

ALTHOUGH an electronic computer forms an impressively complex device when viewed as a whole†, the circuits used are in many cases simpler than those of a superhet receiver or a television time base. This simplicity is essential to the success of a computing machine in many applications. The machine may, for example, form an essential part of an industrial concern's wages and accounting organization, and for such work it must have much greater reliability than apparatus intended for entertainment. Generally it consists of five hundred or more valve circuits linked together into a working whole, and the failure of any one part can put the entire machine out of operation.

To achieve this reliability it is common practice for individual circuit " bricks " to be developed and used over and over again in their original form. Connection of the " bricks " to other circuits is done via isolating amplifiers and cathode followers to prevent any possibility of the circuits they are feeding from affecting their stability. Opportunistic juggling of special characteristics of the same circuit element when used in different parts of an apparatus, though quite legitimate in a television set or reflex superhet, has to be kept to a minimum in the computing machine. It distracts from the margin of safety of the circuit as originally designed and increases the variable factors to a point where servicing becomes difficult if not impossible.

Before coming on to the actual arithmetic circuits of the computer it is necessary to look at some of the " bricks " from which they are composed. The two main ones are (a) a bi-stable element, usually an Eccles-Jordan relay or trigger circuit and (b) a gate circuit. The Eccles-Jordan trigger is well known, but there are one or two points about it worth noting. In the circuit of Fig. 1 if V1 (a) is conducting then its anode voltage has fallen from 135 V to 45 V and the grid voltage has risen from −30 V to +2 V, measured at the circuit end of the grid stopper. Exactly the converse has happened to triode (b). The source impedance of the anode circuit is low but the grid impedance is high.

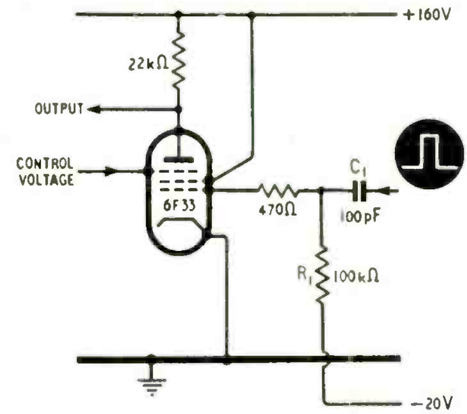
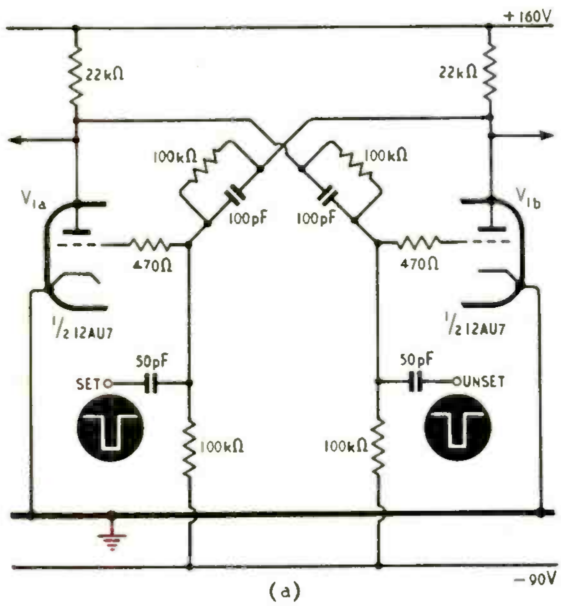


Fig. 2. Pentode gate circuit.

When triode V 1 (a) is conducting the circuit is said by convention to be " unset " or " off ". A negative pulse applied to the terminal marked SET will drive the V 1 (a) grid negative, effectively cutting it off, and the circuit will be unbalanced into the other state where V 1 (a) is cut off and V 1 (b) conducting. In this condition the circuit is said to be " set " or " on " and will maintain this condition indefinitely as long as the power is connected. Applying a negative pulse to the terminal marked UNSET will cut off V 1 (b) and restore the circuit to its original " off " state. The functional diagram for this trigger circuit is shown in Fig. 1 (b).

The gate circuit is not so well known and has many forms, but the simplest and easiest to design, though by no means the cheapest, is the pentode gate shown in Fig. 2. This is maintained cut off by connecting the grid through R_1 to −20 V. The suppressor " control voltage " is held at about earth potential. If positive pulses of 20 V or greater are applied to the grid through C_1, the valve will act as an amplifier inverter and the pulses will appear in the anode with a peak-to-peak amplitude of about



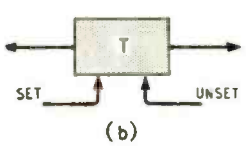


Fig. 1. (a) Eccles-Jordan trigger circuit, used for various purposes in digital computers, and (b) its functional diagram.

* British Tabulating Machine Company.

† For a broad introduction to the subject see " Computors " by " Cathode Ray," *Wireless World*, October, 1951.

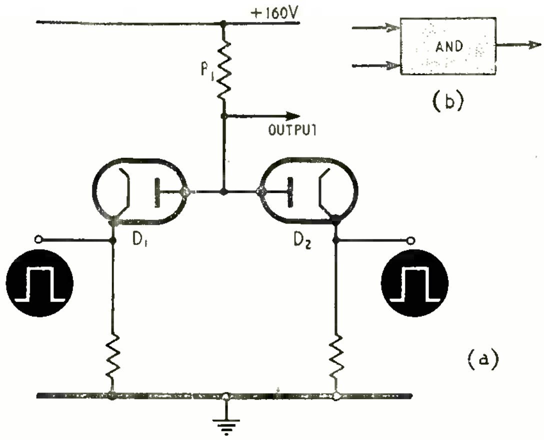


Fig. 3. Diode gate circuit (a) with functional diagram (b) of its use as a logical " AND " element.

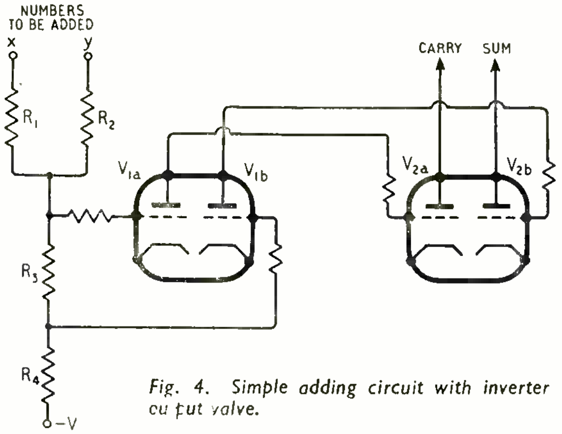


Fig. 4. Simple adding circuit with inverter output valve.

110 V. If the suppressor voltage is now brought down to −30 V the electron stream will be prevented from reaching the anode and the amplified grid waveform will no longer appear there. This is a very attractive way of controlling a pulse stream, because the circuit is extremely tolerant to varying parameters. For example, the grid waveform can vary any amount from 20 V amplitude upwards and the suppressor voltage anywhere from −30 V downwards, short of insulation breakdown, without interfering with the proper gating action.

If a gate circuit can be tolerated which requires the upper and lower limits of the voltage swings to be well defined then the diode circuit of Fig. 3 will cost considerably less. The output lead, though connected to h.t. via R_1, will not rise more than a few volts above earth because both diodes are conducting. If a positive square wave is applied to one diode, say D_1, this produces no change because the diode will cut off, as its cathode is driven more positive than its anode (negative anode volts). If, on the other hand, a positive pulse is applied simultaneously to both cathodes, then the output lead voltage will rise to the level of the highest square wave, because neither of the diodes will be conducting for the duration of the pulse. D_2 has effectively controlled the waveform from D_1. With germanium or selenium diodes the square waves are of 25 V–45 V amplitude and must be derived from a low impedance source such as a cathode follower or pulse transformer to minimize breakthrough via the finite (500 kΩ) back resistance or capacitance of the diodes.

The diode circuit in Fig. 3 illustrates another use of the gate—as a " logical " element which produces an output pulse only when two pulses are applied simultaneously to its inputs. In this sense it is known as an " AND " gate (because it needs a signal at one input *and* another signal at the other in order to operate) and the corresponding functional diagram is shown in Fig. 3 (b). Other versions with different methods of operation are " OR " and " NOT " gates.

In most computers the arithmetic is performed in binary notation. This is a " scale of two " notation, in which there can be only two possible symbols used as against the ten in conventional arithmetic. The carry, or point at which the same symbols are used over again, occurs after the tenth in decimals but after the second symbol in binary. The effect of this is such that one added to one $(1 + 1 = 2)$ causes a carry to occur because it is in effect adding half the radix value‡ to half the radix value. In decimals 5 is half the radix value, and $5 + 5$ is written $1 \leftarrow 0$, or more conventionally 10. In the case of binary notation 1 is half the radix, so that $1 + 1 = 1 \leftarrow 0$ or 10, which has a value of two decimal units.

It follows that binary two (or 10) plus binary two (10) will produce four as 100, four plus four will give eight as 1000, and so on, each binary place having double the value of the previous one. Thus we have:—

Decimal	0	1	2	4	8	16
Binary	00000	00001	00010	00100	01000	10000

Odd numbers are expressed as combinations of the above; for example, 5 in binary is produced by adding the symbol for four, 00100, to the symbol for one, 00001, and this gives 00101.

Because only two symbols are needed in binary notation they can be electrically represented in a computer as a voltage, say −100 V, being either present or absent at some point in a circuit, or by a switch being either closed or open, or by any other two-state device such as a trigger or a gate. The next thing to consider is how such electrical equivalents of binary notation can be manipulated by electronic circuits to perform arithmetic operations. To begin with take the simplest case—addition. Here, the circuit will have to obey the following rules of binary addition:—

Condition A	$0 + 0 =$	0
Condition B	$1 + 0 =$	1
Condition C	$0 + 1 =$	1
Condition D	$1 + 1 =$	$1 \leftarrow 0$ (or 10)

All that is necessary, then, is to devise a circuit that will give outputs corresponding to the right-hand column of answers when inputs corresponding to the two left-hand columns of numbers to be added are applied to it. We may not be able to follow the arithmetic operations of such a circuit in the same way as we can, for example, the operations of a decimal adding machine, but that is simply because our minds are more accustomed to decimal notation. As long as the circuit obeys the binary rules, however, we can be sure that it will produce the right answers, and that is all that really matters.

‡ The radix value is the number on which the system of numeration is based. In the decimal system it is 10, in the binary system 2.

There are a number of different types of adding circuits, but a simple one that will give the answers for conditions A, B and C and partly for D is shown in Fig. 4. If by convention a binary digit (that is, a 1) is represented by a fall in voltage of 100 V, say from + 150 V to +50 V, then condition A (0 + 0 = 0) means that the voltage at both x and y is +150 V and both halves of V1 are conducting, because both grids are going positive with respect to earth. This results in no output from the anodes of V2 (which is actually an inverter to counteract the phase reversal produced by V1). Condition B (1 + 0) means that the voltage at x is low while y is still high, so the junction of R_1 and R_2 falls approximately 50 V. This results in the grid of triode (b) going negative because it is connected low down the voltage-divider chain R_3R_4. The grid of triode (a) is still positive because it is connected higher up the chain. That is, (a) is conducting and (b) is cut off. After inversion by V2 this results in a fall of voltage (representing a 1) from the "sum" output (V2(b) conducting) but nothing from the "carry" output. Condition C produces the same result as B because the junction of R_1 and R_2 again falls 50 V as before.

Condition D (1 + 1) means low voltage on both x and y, which caused a fall of 100 V at the junction of R_1 and R_2. Section V1(b) is driven even farther negative with the same result as in conditions B and C, but V1(a) grid is now driven below cut-off for the first time and its anode voltage rises. The output after inversion now shows a digit (fall in voltage) on both lines, which is *not* correct. Only a "carry" digit should be present (1 + 1 = 1 ← 0) and V2(b) should not be conducting. A further valve must therefore be added to suppress the "sum" output for condition D. This takes the form of V3 in Fig. 5 which shows the complete adding circuit. The grid of V3 is fed from the anode of V1(a) which, as just described, is low under all conditions except the last, so that normally V3 is cut off and has no effect; but under condition D the anode of V1(a) rises, causing V3 to conduct, thereby shunting the anode of V1(b) and effectively suppressing the "sum" output.

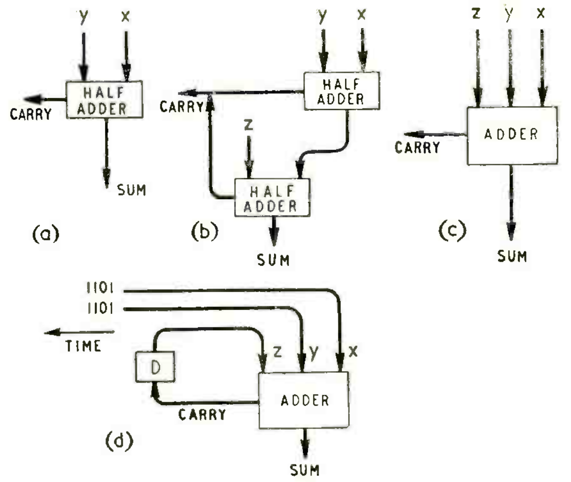


Fig. 6. Functional diagrams of (a) half adder, (b) complete adder with (c) its abbreviated form, and (d) an adder with a storage device for holding the "carry" output.

The type of circuit just described has become known in the computing world as a "half adder" and can be symbolized as in Fig. 6(a). The name springs from the fact that it will perform the addition of two binary numbers quite correctly but does not provide a means of accepting a "carry" produced by the addition of lower digits. For example, when one goes through the motions of adding 25 + 26 like this:—

$$\begin{array}{r} 25 \\ +26 \\ \hline 51 \end{array}$$

one says "six plus five equals eleven; one down, and carry one." Then, "two plus two, *plus one carried*, is 5." Not only has 2 + 2 been added to form a temporary answer of 4 but a second addition must be immediately performed to add the one and clear the "carry." Quite logically, then, a second identical circuit can be included in series with the first "half adder" to cope with the third input for the incoming "carry" digit. The symbolic circuit for an adder then becomes Fig. 4(b) with z as the third input, and this in turn can be abbreviated to Fig. 6(c).

The explanation will not be clear until it is realized that this adder will deal with, say, two 10-digit binary numbers presented simultaneously to the two inputs x and y in pairs in serial form, starting with the lowest value digit. For example, 13 + 13 would look like

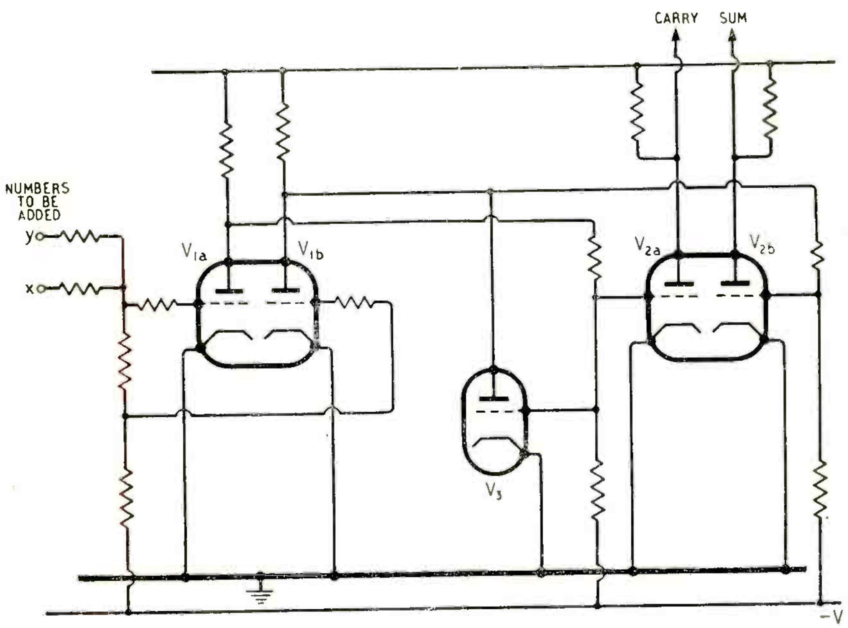
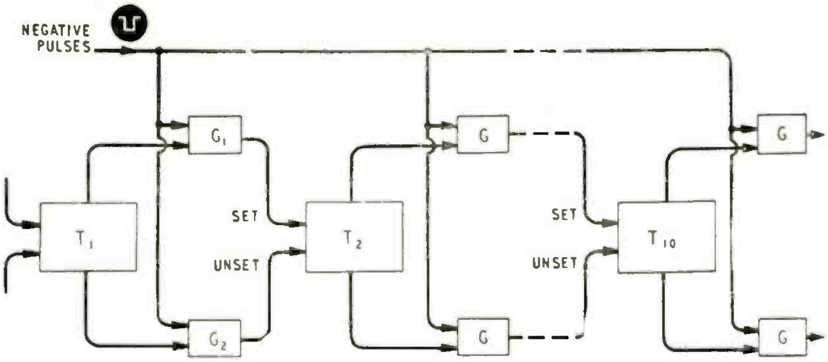
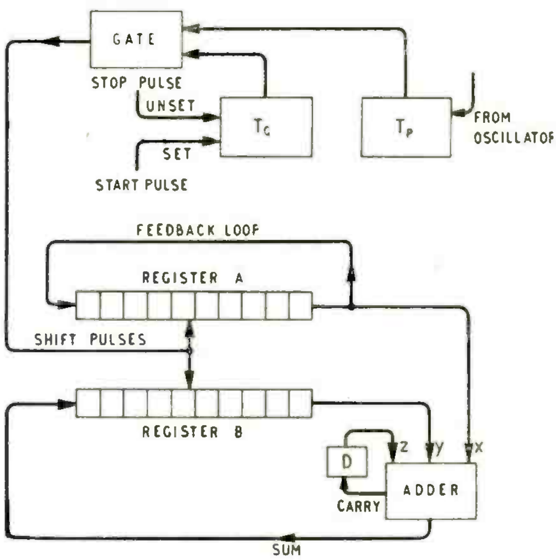


Fig. 5. Complete "half-adder" circuit developed from Fig. 4.



Left: Fig. 7. Shifting register for temporary storage of numbers necessary in adding.



Below: Fig. 8. Block diagram of system for adding numbers held in two shifting registers.

1101 + 1101 and would be presented to the x and y inputs in the form shown in Fig. 6 (d). As each pair of digits is presented the addition may or may not form a "carry," but if one is formed it must be stored until the next higher value digit pair is presented and then added to the sum of this next pair via input z. The storage, represented by the device D in Fig. 6(d), need consist of nothing more complicated than a lumped-inductance delay line with a delay time equal to one digit period, or a trigger circuit (similar to Fig. 1) which would be "set" by the carry pulse.

In most digital computers the numbers to be added are held in a storage system, say a magnetic drum, and they emerge in some kind of sequence as the drum rotates. In the ordinary way, then, the two numbers in Fig. 6(d) would not arrive simultaneously at the adding circuit. To achieve this type of presentation it is necessary to use an additional temporary store which will hold the first number until the second one arrives and then feed them both, a pair of digits at a time, into the adder. Such a storage system is usually known as a "shifting register."

If, as depicted in Fig. 7, ten trigger circuits are set up in a row they will store (by their states of operation) any discrete pattern representing a binary number of not more than ten digits. To get a number to shift along this row requires the addition of two gates between each trigger and a source of negative pulses. Trigger 1 controls two gates G_1 and G_2 such that G_1 is open and G_2 closed when T_1 is "set" and the reverse if T_1 is "unset." The gates are connected to the next trigger T_2 so that a pulse from G_1 will "set" T_2 while a pulse through G_2 will "unset" it.

Because T_1 governs which gate is open, then on the application of a negative pulse to both gates only one gets through and causes T_2 to assume whatever state T_1 was in at the instant of applying the pulse. Similarly T_2 influences T_3, T_4, and so on up to T_{10}. Thus the application of one negative pulse to all the gates will cause whatever pattern was in the register to shift one stage along. Applying ten pulses will shift the pattern right off the end unless the end pair of gates is connected back to the first stage, in which case the pattern will have recirculated back to its starting position.

It is now possible to assemble in one block diagram (Fig. 8) all components needed to perform the addition of two binary numbers. The sequence of events is as follows. Trigger T_P is continuously triggered by pulses derived from an oscillator. The resulting pulses from T_P are applied to a gate. A "start" pulse "sets" T_G which opens the gate. The output of the gate causes both registers to shift their contents into the adder. The adder then sums each pair of digits and takes care of the "carrys" as it goes, returning the sum to register B. Notice that register B loses its initial contents (if any) which are replaced by the sum, but on the other hand register A has a feedback loop so that not only does it present its digits to the adder but preserves them for future use. At the end of ten pulses T_G receives a "stop" pulse, becomes "unset", closes the gate, and stops the action just as the digits in register A have returned to their initial positions and the sum is complete in register B.

The same equipment can be used to do multiplication. To multiply, for example, $3 \times 4 = 12$ the binary equivalent of 3 is inserted in register A, zero into register B, and the circuit is made to perform four addition cycles. The 3 will then be added four times to the contents of register B (initially zero), which gives:

$$0 + 3 + 3 + 3 + 3 = 12$$

How the machine causes the value of the multiplier factor to control the addition cycles will be explained later.

Before continuing it may be of interest to look at the practical circuitry of the part of Fig. 8 comprising triggers T_G and T_P and the gate. In Fig. 9, trigger T_G (V1) is providing a controlling voltage from its grid circuit via a cathode follower, V2, to the suppressor of gate V3. The grid of V3 is supplied with a train of square waves derived from trigger T_P (V4). It is assumed that V4 is being triggered by some externally generated stream of pulses at, say, 30 kc/s. As the grid swing of a trigger is − 30 V to + 2 V then if V1 is "set" the pentode gate V3 is open (suppressor at + 2 V) and the amplified inverted pulses will appear in the pentode anode circuit; but if V1 is "unset" then the gate is closed because its suppressor is at − 30 V. Notice that there is no isolating cathode follower between trigger V4 and gate V3 because the grid is the first element in the pentode electron stream and contains very little modulation which might accidently upset trigger V4.

To return to arithmetic operations, subtraction can be achieved, apart from building a subtractor, by using the adder to add numbers in complement. A complement is the difference between a number and its radix value. In decimals they are:—

Number	1	2	3	4	5	6	7	8	9	10
Complement	9	8	7	6	5	4	3	2	1	0

which is ten variations and would be quite difficult to produce automatically; but binary comes to the rescue once again because there can only be two:—

Number	1	0
Complement	0	1

which in practice simply means inverting the voltage swings with a valve so that a falling voltage becomes a rising voltage.

Why *adding* a complement is tantamount to *subtracting* a true, will be easier to understand in decimals. Take for example the subtraction 6 − 3. The complement of 3 is 7, so if we add 7 to 6 we get 6 + 7 = 1 ← 3. Ignoring the "carry" the answer is correctly 3.

It will now become clear how the cycles of multiplication mentioned above can be controlled by a number. If our example 3 × 4 is taken, then the figure 4 is placed in complement (6) into some counter whose capacity is exactly 10. At the end of each cycle of addition the counter is arranged to advance one step, so that at the end of the 4th cycle the counter will "spill over" (because 6 + 4 = 10) and this "spill over" can be used as a "stop pulse" in Fig. 8.

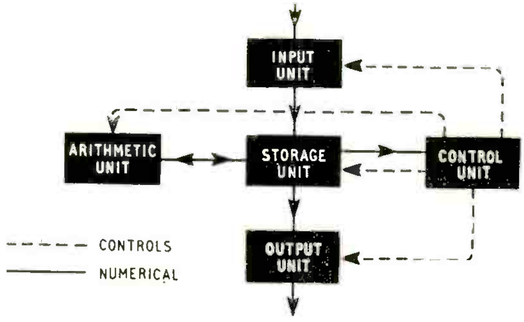


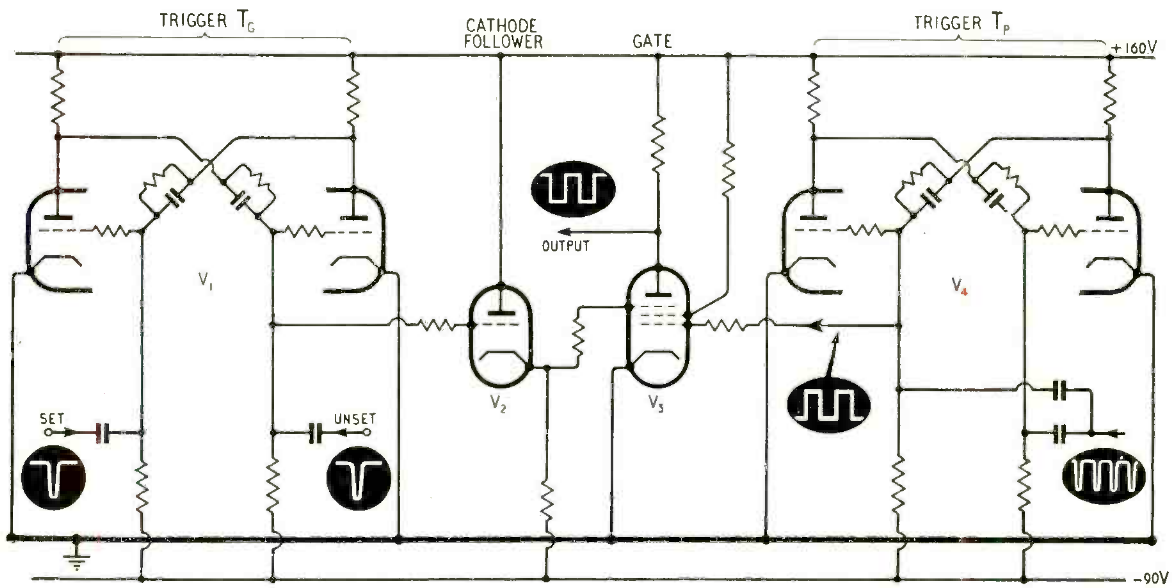
Fig. 10. Simplified block diagram of complete computer.

Division is very much the reverse of multiplication in that one factor is repeatedly subtracted from the other, and a tally of the number of times a subtraction is successfully achieved is accumulated in a counter. For example 8 ÷ 2 is performed as 8 − 2 − 2 − 2 − 2, the answer being 4 subtractions of two. The action is stopped as soon as 8 is reduced to zero or, in the case of an imperfect divisor, becomes a negative value.

To describe all the other circuits of a digital computer would be outside the scope of this article, but it may be helpful to glance at the general organization of a typical machine. The block diagram Fig. 10 gives some idea of this. The whole of Fig. 8 and some other circuits for doing arithmetic operations have been condensed into the block marked "arithmetic unit." The other blocks contain equipment built from similar "bricks" but connected to perform different functions.

First of all the "control unit." The job of this unit is to feed out to the whole of the rest of the machine trains of pulses and start/stop pulses as they may be required, also d.c. voltages to gates for routing numbers from one unit to another. It will activate these controls when instructed to do so by means of "program" numbers (instructions) delivered to it from a "program" section of the storage unit.

Fig. 9. Circuit of system for producing a predetermined number of shift pulses in Fig. 8.



This storage unit consists of two sections, usually of a magnetic drum, capable of storing 2,000 or more groups of binary digits, each group (known as a "word") containing approximately 32 binary digits. One section stores the numbers upon which arithmetic is to be performed while the other is the "program" section devoted to storing instruction numbers. The storage system as a whole will be capable of sending numbers to the control unit, sending to and receiving from the arithmetic unit, and sending to and receiving from the input and output units.

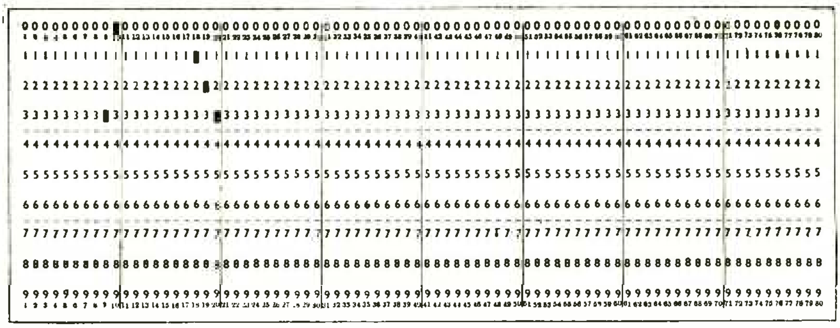


Fig. 11. Typical punched-card for feeding numbers into a computer.

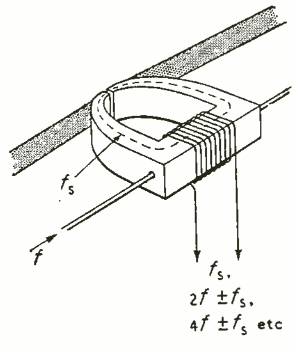
These input and output units can take many forms, from magnetic tape to typewriters, and they contain electronic circuitry for coding decimal numbers to binary notation and decoding back again. Punched-card reading and printing equipment is used a great deal, and a typical card for use with this is shown in Fig. 11. From the top to the bottom of the card there are ten possible places to punch a hole, 0 to 9, so that a hole punched three positions down will have a value 3. The column or position from the right-hand edge of the card will signify its decimal value, i.e., 3 punched in the second column will have a value of 30. As very few numbers require more than ten columns, lines are drawn down the card to segregate each number, the sections between lines being known as fields. Fig. 11 shows 30 punched in the first field and 123 in the second. These cards, when passed by means of rollers through the machine (usually at about 100 per minute), allow contacts to drop on to a sensing roller wherever a hole is punched. The impulses from these contacts are then fed via a coding device to the storage unit. The punched-card output unit consists of a printing machine in which 80 letters in a complete line of type can be printed simultaneously. This gives a rate of typing equivalent to 1,000 words a minute. Outgoing information from the storage unit feeds via a decoder to electromagnets controlling the setting of the type bars.

Finally, it is as well to recall that this article is an introduction to computer circuits in general and is not intended to represent any particular machine. Though it is quite feasible to build a computer with as few as 5 different types of circuit, most machines have 20 or more. The S.E.A.C. machine in the U.S.A. on the other hand is said to use only 3 types in its "logical" circuits.

VERY LOW FREQUENCIES FROM TAPE

IN the conventional magnetic tape reproducer the output voltage from the head is proportional to the rate of change of flux induced by the tape. Consequently, for a constant peak induction the output falls with frequency at 6 dB per octave and at very low frequencies the output may be little more than the hum and noise level of the amplifier. This is not likely to occur at audio frequencies but would preclude the use of magnetic tape for data recording which involves infra-sonic frequencies.

A special type of head has been evolved by E. D. Daniel (B.B.C.) for this type of work and is described in the *Proceedings of the Institution of Electrical Engineers*, Part B, No. 4, Vol. 102 (July 1955). The object of the design is to derive an output which is proportional to the magnitude and not to the rate of change of flux; the system can, in fact, be used to explore a transient slowly and in detail.



Simplified diagram of flux-sensitive, low-frequency magnetic reproducing head.

The basic principle is to cause the signal flux to modulate a high-frequency flux (which does not, in fact, reach the gap) and to pick up the resultant product by means of a search coil. There are points of similarity with a second-harmonic magnetic modulator and with a sensitive magnetometer described by T. M. Palmer (*Proc. I.E.E.*, Part II, October 1953).

In the accompanying simplified diagram it will be seen that the back leg of the magnetic core of the head encloses a single straight conductor, arranged symmetrically along the axis of a coil wound over the outside of the core. The latter is conveniently built up from pieces of one of the ferrite materials with grooves ground to fit on each side of the wire. A current of the order of amperes at a high frequency f in this wire generates a cylindrical flux inside the core, but as the linkage with the coil is small there is no significant output until a polarizing flux f_s due to the signal is applied in a direction at right angles to the high-frequency flux. The magnetic characteristics of the core material, which is being worked near saturation, will also no longer be symmetrical, and even-order harmonics, of which the second is the most important, will appear in the coil. After passing through a band-pass filter to select the second-term products, the output is fed to a balanced phase-sensitive detector in which the "carrier" frequency is balanced out by a variable-phase auxiliary oscillator ($2f$).

The head is sensitive to stray fields and must be well shielded. Any residual flux can be balanced by a d.c. current (of the order of microamperes) through the coil.

To take full advantage of the system the length of contact between tape and head should be at least half a wavelength of the lowest recorded frequency, but even with standard core shapes the published response shows no falling off below 1 c/s at a tape speed of 1 in/sec.

It is suggested that the system will find its chief application where low frequencies and long playing time are required as in cardiography or encephalography, when it may be necessary to keep observation of long periods for possible abnormalities.

Component Tolerances

By H. S. JEWITT, B.Sc.(Eng.)*

A Reminder of Their Effects on Circuit Performance

IT is often thought that the function of the circuit design engineer is to produce a circuit that will meet a given specification. This is, of course, quite correct, but one aspect of his job which tends to be overlooked is that he must also be what, for want of a better term, may be called a tolerance engineer. To produce in the laboratory a circuit to perform some operation may or may not be difficult according to the complexity of the required operation, but this is not enough: it is vital to ensure that the circuit can be reproduced in even small quantity production with an acceptable performance, as otherwise the design side of the work has been wasted. To this end, the effect of variation of the circuit components on the circuit performance must be examined, bearing in mind the fact that component manufacturers must, of necessity, be allowed some latitude in the values of their production components.

This examination must be practical in its approach. It is possible to specify highly accurate components in many places in a circuit and thereby produce a level of performance which may be unnecessarily high and will certainly be very costly. As an instance of this, the resistor may be considered. The ordinary composition resistor is a cheap component and is commonly available in tolerance ranges of ±5%, ±10%, and ±20%, the price varying, of course, with the tolerance demanded. The wire-wound resistor and the high-stability carbon type are both available with better tolerances, ±2% or ±1% or even better: but these components are much more expensive than the composition resistor, and replacement of a large proportion of the composition resistors in an equipment by the high-accuracy types might well double or treble the cost of the equipment. It may be that the level of performance demanded is such that this has to be accepted, but this is a rare case, and it should be the aim of the tolerance examination to make certain, not only that the circuit performs satisfactorily when component tolerances are taken into account, but also that high-accuracy components are called for only when it is strictly necessary that they should be used. A very practical point about the use of such components which probably lies within the experience of most design engineers of today is that delivery dates tend to be months later than those for the lower-grade components.

Another aspect of tolerance engineering is to determine what the circuit performance will be with specified components. It is well known that, for example, a wire-wound resistor is not a practical resistor for use in an i.f. amplifier at, say, 60Mc/s centre frequency, and neither, generally, is a spiral-track high-stability resistor. Thus, the designer of such a circuit must accept the fact that he has no option but to use composition resistors, and decide (a) whether his chosen circuit will give the desired performance with the tolerances of these components or (b) whether some other configuration would give a better performance with these tolerances.

It should be, but unfortunately is not always, realized that to find a resistor colour-coded 1000 ohms whose value is exactly 1000 ohms is a rarity, and that, for a ±10% tolerance, the value may lie anywhere between 900 and 1100 ohms. Nor is it correct to assume that the majority of a given batch of components will have values centred closely around the nominal value, particularly for the larger tolerances: they tend, rather, to have values which lie in two bands towards the two edges of the permissible range of values for the given tolerance. The circuit component which is an exception to this is the valve; a given batch of valves tends to have parameters centred closely about some value in the permissible range of those parameters, the value usually differing for different batches of valves. Thus, it is most important to know what the expected performance variation with component tolerance will be.

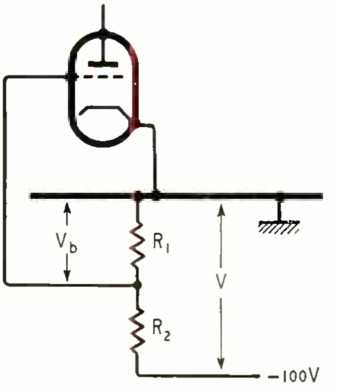


Fig. 1. Typical biasing circuit to illustrate the effects of component tolerances.

Practical Example

A simple example of this might be a biasing chain as shown in Fig. 1. In this circuit, R_1 and R_2 form a potentiometer network across the 100-volt negative supply to provide the correct bias voltage for the valve grid. Let it be assumed that the valve anode current is to be cut off; in some possible circuits a very small flow of anode current could cause the valve power dissipation rating to be exceeded so that this requirement is not a fictitious one. If the valve data is consulted, it may be found that the nominal cut-off voltage is −10 volts. Then R_1 and R_2 may be chosen to produce a little more than this minimum value: the values chosen might well be $R_1 = 5.6\ k\Omega$, $R_2 = 47\ k\Omega$, and the resultant bias is then −10.6 volts. But if these resistors are selected to a 20% tolerance, and R_1 is at its minimum value (= 4.48 kΩ) and R_2 at its maximum value (= 56.4 kΩ), then the bias might fall to 7.35 volts. It is very clear that the choice made, of a 20% tolerance, will lead to un-

* Decca Radar.

satisfactory performance in a large number of the sets built using this circuit. Reduction of the tolerance limit to 5% effects an improvement, and gives a possible minimum bias level of −9.73 volts. If the nominal bias level, that is, the level with both resistors at their nominal value, be now raised from 10.6 volts to a value of about 11 volts, the valve will always be cut off.

So far, attention has been focused on the potentiometer network, and it has been seen that the effect of resistor tolerance can be satisfactorily overcome. Now the valve itself must be considered. The manufacturer states that the cut-off bias is −10 volts for a nominal valve, and, in fact, if he is consulted, he will state that the possible spread of cut-off voltage for the valve type is from −7 to −13 volts (taking typical figures). In the light of this information, the whole problem has to be reconsidered, with a new minimum bias level of −13 volts as the target, requiring a nominal level of perhaps −14.5 volts. The alternative is, of course, to recognize that an equipment in which all parameters simultaneously assume their worst possible values will be rare, and that this equipment may be rejected: but this can be a dangerous practice, for it leads to a relaxation of standards and possibly to future servicing difficulties with the equipment. Whichever philosophy is adopted, these tolerance calculations must be done at a very early design stage if they are going to be done at all. This may be explained by slightly extending the example above. Let it be assumed that the valve is to be triggered by a positive trigger pulse which must drive the grid to zero grid voltage for satisfactory triggering. Then the original bias level requires a trigger pulse of 10 volts, and the final bias level one of 14.5 volts amplitude. Such a change in triggering pulse level is considerable: if the complete equipment had been designed and built without a consideration of tolerance effects, and it had been found, by experience, that this change was necessary to obtain a satisfactory performance, a complete redesign might well be needed to produce it.

Mathematical Approach

The example of tolerance effects considered above has been a simple one. It should be noted now that the use of the mathematical differential of the circuit equation will eliminate much laborious arithmetic, provided that it is realized that the differential approach only gives exact answers for infinitesimally small changes: but it is sufficiently accurate for this purpose over normal electronic engineering tolerances. Thus the bias voltage V_b of Fig. 1 may be expressed as

$$V_b = \frac{R_1}{R_1 + R_2} . V$$

This expression may be differentiated with respect to R_1, assuming R_2 to be constant, and then with respect to R_2, R_1 assumed constant, to produce two equations relating the change of V_b to the changes of R_1 and R_2. These equations are

$$\frac{dV_b}{dR_1} = \frac{R_2}{(R_1+R_2)^2} . V \qquad (R_2 = \text{constant})$$

$$\frac{dV_b}{dR_2} = -\frac{R_1}{(R_1+R_2)^2} . V \qquad (R_1 = \text{constant})$$

Then the change of V_b for a change dR_1 in R_1 is given by

$$dV_{b(R1)} = \frac{R_2}{(R_1+R_2)^2} . V \; dR_1$$

and similarly for $dV_{b(R2)}$, and, since interest here lies in the minimum value of V_b, this can be stated as

$$V_{b(min)} = V_b - dV_{b(R1)} + dV_{b(R2)}$$

The positive sign for $dV_{b(R2)}$ is necessary since the sign of the differential is negative, indicating that V_b decreases as R_2 increases.

This simple example indicates both the need for, and the solution to, tolerance engineering of electronic circuitry, and, in general, this may be done, circuit by circuit, for the whole of an equipment. The process tends to become laborious for a large equipment, but it is hoped that the necessity for it has been adequately established. In more complex circuits, the same method may be used to great effect; the circuit equation is generally known from the design process, and differentiation of it is not generally difficult, whereas the arithmetic involved in considering the variation as applying to each component in turn with numerical values is often staggering. It is not proposed to give an example of this, as every case is a special one in this work, and no useful purpose could therefore be served.

Preset Adjustments?

From what has been said so far, it will be clear that one method of solving the problem of performance variation with component tolerance is the use of preset adjustments. Thus, in the example above, a suitable portion of R_1 and R_2 could be inserted in the form of a variable potentiometer, which could be set on each individual unit to give a suitable cut-off bias for the valve. This seems, at first glance, to eliminate the whole need for tolerance engineering, but this is a false conclusion. The preset itself has tolerances, and its value must be so calculated that its range of adjustment covers the tolerance variation of R_1, R_2, the cut-off bias voltage, and itself, so that tolerance examination is still necessary. The whole of R_1 and R_2 could be made a potentiometer to avoid tolerance calculations (the brute force attack) but this must give only a rough control over V_b, and may also need a large component to dissipate the power involved.

The biggest objection to this solution to the problem is that, remembering the number of circuits involved in almost any piece of equipment, the numbers of preset controls needed would be fantastic. It is probable that some presets must be used, and indeed should be used to provide a good level of performance, but the number of these must be cut to the bare minimum, on both cost and convenience grounds. The cost angle needs little elaboration—a variable resistor is more expensive than a fixed one. Convenience is a factor affecting the ultimate user of the equipment. Adjustment of presets is necessarily a job for a skilled man, who is neither always available nor cheap to employ, so that his attentions should be needed as little as possible. The user himself rapidly gets a poor opinion of a set needing frequent skilled attention. Last, but not by any means least, it is surprising how many people, whether skilled or unskilled, cannot resist the temptation, if they see a knob or other means of adjustment, to twiddle it

So, presets must be reduced to the minimum and preferably be hidden away, with screwdriver slots rather than knobs and possibly locking devices in addition. In the process of hiding them away, however, it is as well not to forget that they do need adjustment, and to arrange things so that the preset and the indicator by means of which it is being set can be effectively used by people of normal proportions, with their eyes in the normal places. Few things are quite so irritating to the maintenance engineer as finding that the only person able to adjust a given preset is a dwarf with four-jointed 8-ft arms and eyes on flexible stalks.

It is usually possible to select the value and position in the circuit of a preset control so that it compensates for the effect of a number of component tolerances. Before presets are positioned in the circuit, therefore, their effects should be carefully considered to see whether their number can be reduced by altering their placing in the circuit.

It is hoped that this article will underline the need for tolerance engineering at a very early stage in the design process. The importance of this, and of its solution in terms of adequate performance and reduced cost, cannot be over-estimated in an industry in which ever-increasing circuit complexity poses new problems of economic manufacture and satisfactory use of equipment.

Modified A.F. Millivoltmeter

Reduced Switching Transients and a More Linear Scale

By R. SELBY*

THIS instrument is based on the design for an audio-frequency valve voltmeter by S. Kelly†, and incorporates additional features to meet specific requirements.

An instrument was first built to the published design, incorporating a meter having a full-scale deflection of 1 mA, with a copper-oxide bridge rectifier and a suitable series resistor. This performed quite well, but it soon became apparent that operation of the range switch was accompanied by switching transients in the meter.

Consideration showed this to be due to the fact that the range selection potential divider acts as such, not only to a.c., but also to the standing cathode current of the first valve. When changing, for example, from the ×1 to the ×0.1 positions, there is a change of about 30 volts in the d.c. potential at the moving arm of the switch, and, owing to the good l.f. response of the amplifier, this appears as a surge at the output.

In the modified design the cathode resistor is separated from the potential divider, feeding the latter through a large capacitor which blocks the d.c. but offers low impedance to a.f. No alterations to the values of the resistors are necessary. The cathode resistor may be of the order of 50 kΩ, and a high-stability type is unnecessary. The effective impedance of the cathode-follower load is approximately halved by this arrangement, thereby reducing the maximum signal which can be handled without distortion, but this will not usually be a material factor.

Some difficulty was experienced with the original design in securing a linear scale. This is, of course, a normal feature of rectifier-type voltmeters, due to the characteristics of metal rectifiers. The meter which it was desired to employ had a resistance of 50 ohms and a full-scale deflection of 1 mA. A curve was plotted (Fig. 1) showing the relationship between scale reading and applied voltage when used with an instrument-type bridge rectifier and a series resistor of 3,800 ohms. A further curve was taken with the same meter and a pair of germanium diodes in a half-bridge circuit as shown in Fig. 2. This curve (not reproduced) showed a higher degree of linearity owing largely to the higher current being drawn with this circuit.

A linear scale is obtained in commercial multi-

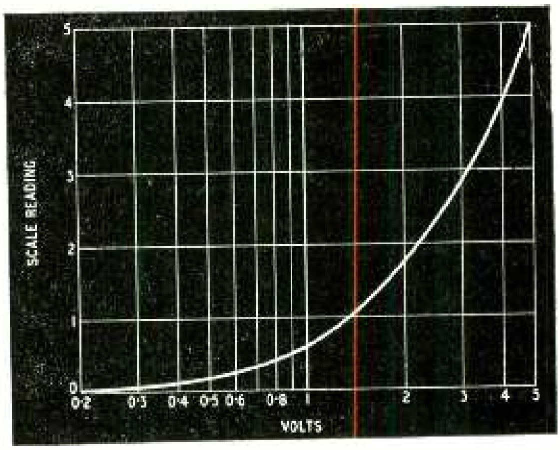


Fig. 1. Calibration using a 0 to 1-mA meter in a bridge rectifier with a 3800-ohm series resistance.

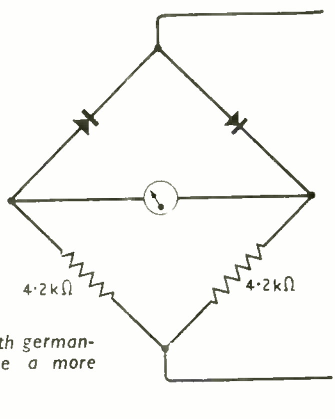


Fig. 2. Meter circuit with germanium diodes which gave a more linear calibration.

* Metropolitan Relays Ltd.

† *Wireless World*, June 1951.

purpose test meters, but only at the expense of lower resistance and higher consumption than on the corresponding d.c. range. For example, the latest model of a very widely used instrument consumes 10 mA at f.s.d. on the 10-V a.c. range and 40 mA on the 2.5-V range, whilst another model consumes 5 mA at 10 volts. The use of such meters externally as the indicating device in the original valve voltmeter circuit imposes certain restrictions on accuracy. At low frequencies the reactance of the coupling condenser becomes appreciable in relation to the meter resistance, whilst the impedance of the load presented to the cathode follower is so low as to reduce seriously the undistorted output.

One method of overcoming this difficulty is to employ a low-consumption meter with a specially calibrated non-linear scale. This course did not appeal to the writer who is more at home with a soldering iron than a draughtsman's pen. In the original version it was possible to overcome the difficulty to a reasonable extent by feeding the meter through a fairly high series resistor, so that variations in rectifier resistance represent only a small fraction of the total resistance in circuit. Clearly, sensitivity is lost. In many designs, the meter is fed from a pentode or high-impedance triode in order to improve linearity.

In the modified design, the cathode-follower output has been retained, but the meter has been placed in the negative feedback circuit, thereby substantially linearizing the scale shape. It was found that with this system there was no visible difference in linearity between the copper-oxide full bridge and the germanium half bridge types of rectifiers.

A further difficulty arose when attempts were made to modify the ranges. For the writer's purpose, the desired scales ranged from 0–50 mV to 0–5 V only, and it was hoped that this reduction in sensitivity, together with improved long-term stability, could be achieved by increasing the percentage of negative feedback. Unfortunately this was found to cause serious instability, the meter swinging violently at a periodicity of 2 or 3 c/s.

The circuit was therefore finally modified to that

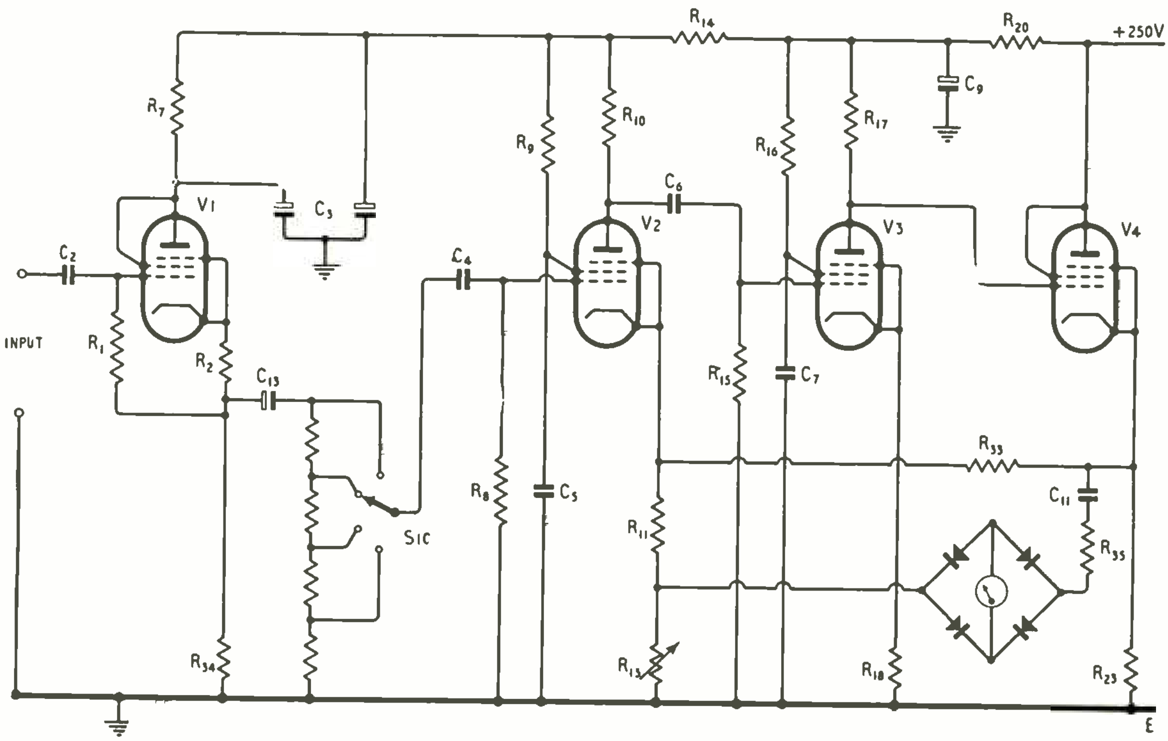


Fig. 3. Modified circuit in its final form. Components are numbered to conform with the original circuit (June 1951).

List of Components

R_1 2.2MΩ	R_{16} 390kΩ	C_3 16 + 16μF
R_2 3.3kΩ	R_{17} 100kΩ	C_4 0.5μF
R_7 50kΩ Wire-wound	R_{18} 680Ω	C_5 0.5μF
R_8 470kΩ	R_{20} 10kΩ Wire-wound	C_6 0.5μF
R_9 570kΩ	R_{23} 10kΩ Wire-wound	C_7 2μF
R_{10} 100kΩ	R_{33} 890kΩ High-stability	C_9 16μF
R_{11} 470Ω Wire-wound	R_{34} 47kΩ	C_{11} 8μF Metallized paper (or "Superlytic")
R_{13} 50Ω Variable	R_{35} 3.8kΩ High-stability	
R_{14} 20kΩ		C_{13} 8μF (T.C.C. " Superlytic ")
R_{15} 100kΩ	C_2 0.01μF	V1, V2, V3 6AM6 or EF91

shown in Fig. 3, from which it will be seen that the amplifier (V3) is now direct-coupled to the cathode-follower output stage, whilst a direct-coupled feedback path is now provided through R_{33} from the output valve cathode to the cathode of V2. Two sources of phase variations are thus removed and a very high feedback factor may be used without trouble, if required.

A second feedback path is provided by returning the meter also to the cathode circuit of V2. Apart from the normal overall improvement to the amplifier, this has two beneficial effects. The reactance of the coupling condenser C_{11} no longer introduces error at low frequencies and the meter scale becomes substantially linear, because variation in rectifier resistance introduces a compensatory variation in the gain of the amplifier. It was found, however, that there is a limit to the amount of feedback which can be used in this path without instability. This again showed itself as a surging or oscillation at very low frequency. The procedure in choosing component values is, therefore, to apply the maximum feedback in the meter circuit compatible with stability, after which selection of R_{33} may be made in accordance with the overall sensitivity desired. This will be determined by the ranges required and the particular meter used. The resistor values quoted relate to the meter and ranges referred to earlier. It should be noted that although the lowest range has been raised to 0–50 mV, this does not imply that the highest may be 0–50 V, since such a signal would overdrive the input cathode follower.

A few other small modifications should perhaps be explained. The cathode bias resistors of V2 and V3 have higher values than the 100 ohms shown in the original circuit. Using 6AM6 or EF91 type valves, 100 ohms gives only about 0.3 V bias. Further, the use of higher values, unbypassed, introduces some secondary feedback within the main loop, thereby improving stability. The screen feed resistor of V3 has been reduced from 470kΩ to 390kΩ in order to lower the anode potential of V3 and therefore the grid potential on V4. The suppressors of V1 and V4 have been strapped to the cathodes rather than the anodes, to conform with the valve makers' recommendations. The use of 0.5μF condensers for coupling and decoupling in place of 0.25μF has no significance—a quantity of 0.5μF condensers were available.

The grid resistor of V2 is returned to earth instead of to the lower end of R_{11} as in the original circuit, since it was found that this was one cause of the meter surging during range switching. This is due to the removal of feedback during the momentary break in the circuit when the switch arm is moving from one contact to the next. Hum and signal leakage (by stray capacitance) are temporarily amplified with the full gain of the amplifying stages. This can be seen more easily by re-drawing the essentials of this part of the circuit as in Fig. 4. This trouble would not arise with a switch which shorted adjacent contacts during rotation. It is desirable to screen C_4 and its associated wiring to reduce signal leakage by stray capacitance, when a non-shorting type of switch is used.

The condenser C_{13} coupling the cathode of V1 to the potential divider should be of large capacitance but small physically. A T.C.C. "Superlytic" 8μF, 150-V working type was used, and it was found possible to dispense with C_4, provided one remembered to leave the range switch on its least sensitive position for a minute or so after first switching on from cold, in order to allow polarization to become complete. This type of capacitor has an insulation resistance, after polarization, approaching that of paper types. However, as at the time of writing it is not yet widely available, a normal electrolytic may have to be used in many cases, when C_4 must be retained to isolate the grid of V2 from d.c. leakage. The calibration checking arrangements given in the original description may be retained, but have been omitted from the diagram for simplicity, as has the power supply section.

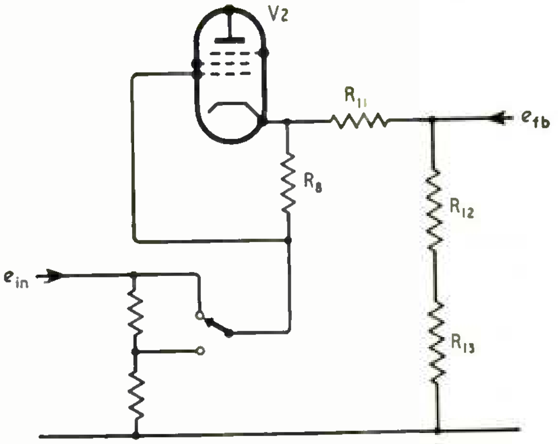


Fig. 4. Simplified detail of grid-cathode circuit of V2 to show possibility of hum and signal leakage amplification when the range switch breaks contact between adjacent positions.

One desirable feature not incorporated would be automatic protection against accidental meter overload. This might possibly be achieved to some extent by reducing the resistance of R_{23} to a figure which would cause the output to flatten off slightly above that required for full-scale deflection of the meter.

Television Interference

DURING some experimental work on a two-band television tuner it was found that some interference with Channel 1 was being experienced from Channel 9. The set had the new standard intermediate frequencies of 34.65 Mc/s vision and 38.15 Mc/s sound.

For Channel 1 the oscillator was at 45+34.65=79.65 Mc/s. Its second harmonic was thus 159.3 Mc/s. The difference frequency from Channel 9 was 194.75−159.3=35.45 Mc/s, which was within the vision channel i.f. pass band of 34.65-37.15 Mc/s. It thus produced a beat of 35.45−34.65=0.8 Mc/s with the Channel 1 intermediate frequency and a corresponding bar pattern on the picture.

This effect was experienced in a district near Alexandra Palace where the Band III signal is relatively weak. It would obviously be more likely to occur near the Channel 9 transmitter where the conditions would be reversed. It should be emphasized that the equipment used was experimental and that no difficulty was found in overcoming the interference. At the time an r.f. coupling circuit effective in both bands was being used as a temporary measure, so that the tuner had only one effective signal circuit to discriminate against the effects. Most commercial sets have tuners with three such circuits and conditions would have to be very unfavourable for it to occur with these.

Manufacturers' Products

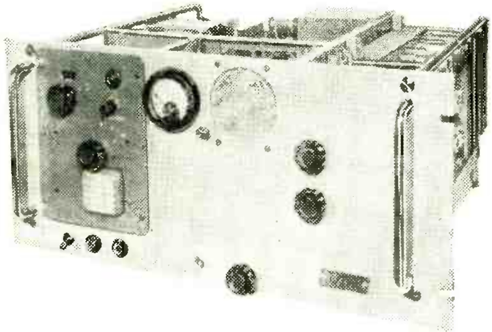
NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

New Single-sideband Receiver

THE receiver illustrated is the Racal Type RA9 which has been developed in conjunction with the R.A.E., Farnborough, for ground use in ground-to-air single-sideband radio-telephone communication in the frequency band 2.5 to 20 Mc/s.

Frequency control of the carrier re-insertion oscillator is facilitated, first, by employing a temperature-stabilized crystal oscillator and, secondly, by not entirely suppressing the carrier, but radiating one with an amplitude inversely proportional to the average depth of modulation. Thus in the absence of modulation the carrier is radiated at maximum transmitter power and reduced to a low level with full modulation. This system provides a strong, but intermittent, signal for operation of the a.f.c. circuits in the receiver.

The advantages claimed for single-sideband operation are: improved signal/noise ratio (about 9 db), freedom from selective fading and cross modulation and more economical operation of the transmitter. Some features of this particular receiver are: sensitivity 1 μV input for 25 db signal/noise ratio up to 10 Mc/s and 20 db over; unwanted sideband rejection better than 55 db; a.f.c. capture range (deviation from nominal transmitter frequency over which control is effective) 600 c/s with filter in and 3 kc/s without; a.f. output 2 watts (for 2.5% distortion) with 3 or 15 ohms load and 1 mW into 600 ohms load for P.O. lines. A self-contained monitor loudspeaker is operated at about 0.25 W.



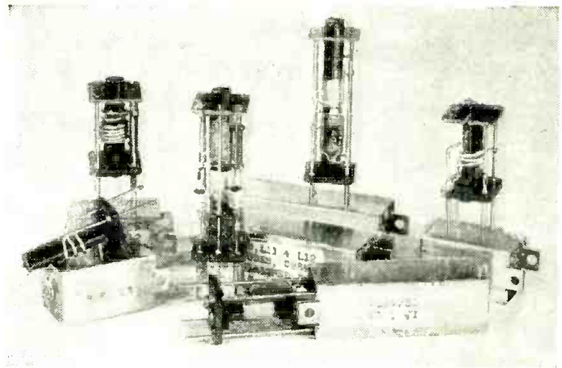
Racal Type RA9 single-sideband receiver for ground-to-air communications in the band 2.5 to 20 Mc/s.

The makers are Racal Engineering, Ltd., Western Road, Bracknell, Berks.

F.M. Tuner Coils

A SET of six coils for the f.m. tuner described by S. W. Amos and G. G. Johnstone in our April and May issues this year is now obtainable from Copy Windings, Healey Lane, Batley, Yorkshire, the price being 47s 6d. They are wound on the specified sizes and types of former with all windings correctly dimensioned and securely fixed in position.

The ratio detector transformer, together with two GEX34 crystal diodes and capacitors C_{28}, C_{30}, C_{31} and C_{32} are neatly packed into a 13/16-in square can measuring 2⅜in high. The two i.f. transformers are assembled in the same size of can and the capacitors C_{20}, C_{21}, C_{24} and C_{25} are actually of closer tolerance than specified, being ±2%, which is all to the good.



Set of coils for WIRELESS WORLD *F.M. Tuner made by Copy Windings.*

Oscillator, r.f. and aerial coils are each housed in 13/16-in square cans 1⅜in high, and in the samples sent to us C_1 was included with L_1 and L_2, but C_9 was omitted from the oscillator assembly.

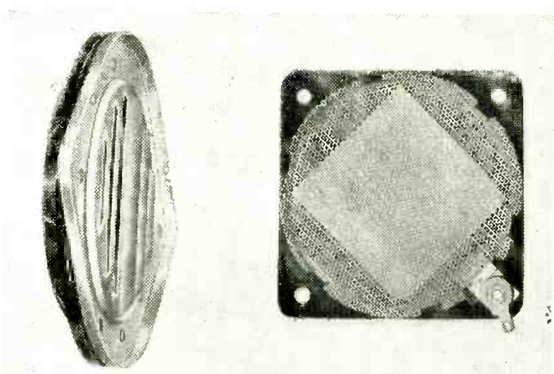
Electrostatic "Tweeters"

DESIGNED for frequencies from 5 to 20 kc/s, the LSH75 loudspeaker unit is of the two-electrode type with a gold-sputtered polythene diaphragm and perforated metal fixed plate. It measures 3in × 3in × ¼in and weighs 1¼ ounces. Normally it is connected to the anode of the output stage through a simple high-pass R-C filter and is polarized from the h.t. supply (max. working voltage 300). The capacitance is 800pF and the power-handling capacity in the designed frequency range is up to 6 watts.

For powers up to 10 watts, the LSH100 is recommended by the makers. This measures 5in × 4in × ¾in and is enclosed in a composite metal and plastic case with louvres for the sound outlet; the weight is 3½ ounces.

The price of the LSH75 is 12s 6d and of the LSH100, 21s. The units are handled by Technical Supplies Ltd., 63 Goldhawk Road, London, W.12.

Type LSH75 and (right) LSH100 electrostatic loudspeakers.



MICROWAVE HARBOUR BEACON

Navigational Aid Using Transistors for Small Craft

By A. L. P. MILWRIGHT*

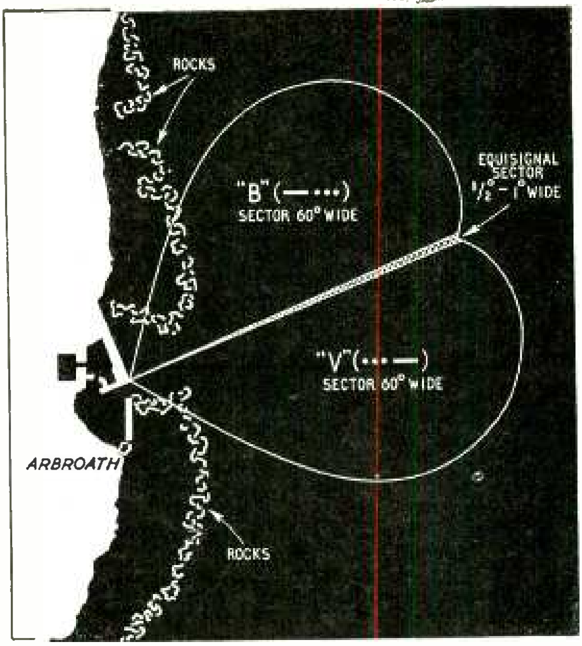


Fig. 1. Approximate coverage of the microwave harbour beacon showing the narrow equi-signal course path.

Fig. 2. The equi-signal course path arises from the overlapping of the B and V morse signals radiated by the two aerials.

THE beacon described here was developed for the Ministry of Transport and Civil Aviation by the Admiralty Signal and Radar Establishment as an aid to entering harbour in bad visibility for craft which are too small to carry a standard marine radar, such as are found in the herring drifter fleet. The system is an adaptation of the old Lorenz type of landing aid for aircraft and consists of a 3-cm radar type transmitter mounted at a harbour entrance and radiating from two aerials which have overlapping beams. The transmitter is so sited that the line of intersection of the two beams is along the safe course line for entering harbour, as shown in Fig. 1. The transmissions consist of pulses of approximately 0.25 μsec duration with a repetition rate of 1,000 p.p.s. The output of the transmitter is switched in turn to each of the aerials in such a sequence that the morse letter B (— · · ·) is transmitted from one aerial and the morse letter V (. . . —) from the other aerial. The characters of one letter are transmitted during the period of the space intervals between the other letter with the result that along the line of intersection of the two beams where the amplitude of the signals from each aerial is equal, a continuous signal is received as is shown in Fig. 2.

The shore-based transmitter and modulator unit are mounted immediately behind the aerial (Fig. 3) and consist of a free running blocking oscillator (CV73) which produces a 0.3-μsec pulse at 1,000 p.p.s. This is cathode coupled to a hard valve modulator (CV73) the output of which is capacity coupled to a magnetron (M503). The magnetron delivers a pulse of 0.25 μsec duration with a peak power of 7 kW and the output is fed to each of two aerials in turn *via* a waveguide switch. This switch consists of an H-plane four-arm cross junction with a vane mounted across the junction at 45°. In order to switch the power to each aerial in turn, the vane is pivoted about the centre of the junction through 90° by a solenoid and lever arm, and the solenoid is energized *via* a pair of contacts and a cam driven by a small synchronous motor. The cam is cut to operate the solenoid in the time sequence . . . — The fourth arm of the switch is terminated in a short circuit to absorb any leakage past the vane into the other aerial. A monitor of the power output is provided by a meter and thermistor bridge which is coupled to the magnetron output by a waveguide directional coupler.

The aerial consists of two vertical 2ft 6in linear resonant slot arrays mounted at one end and on each

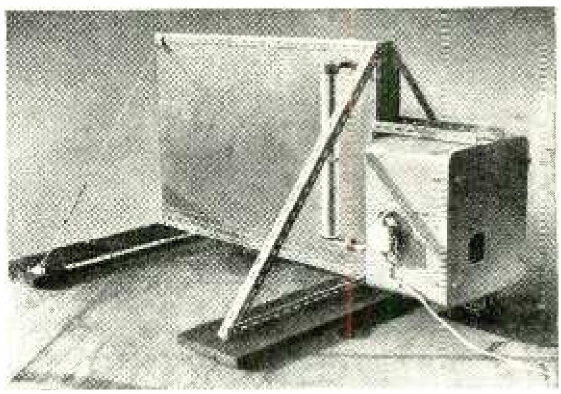


Fig. 3. Transmitter and aerial system (only one aerial visible) of the microwave beacon.

side of a separator plate measuring 4ft × 3ft. The horizontal radiation diagram consists of two lobes each 60° wide overlapping over a narrow sector.

The system involves an amplitude comparison between the transmissions from each half of the aerial and since the ear cannot detect changes in amplitude of less than 1db the effective angular width of the equi-signal sector is 1°. The vertical beam width is 2.6°.

The ship's receiver is a wide-band pre-tuned crystal receiver coupled to a small horn aerial having hori-

* Admiralty Signal and Radar Establishment.

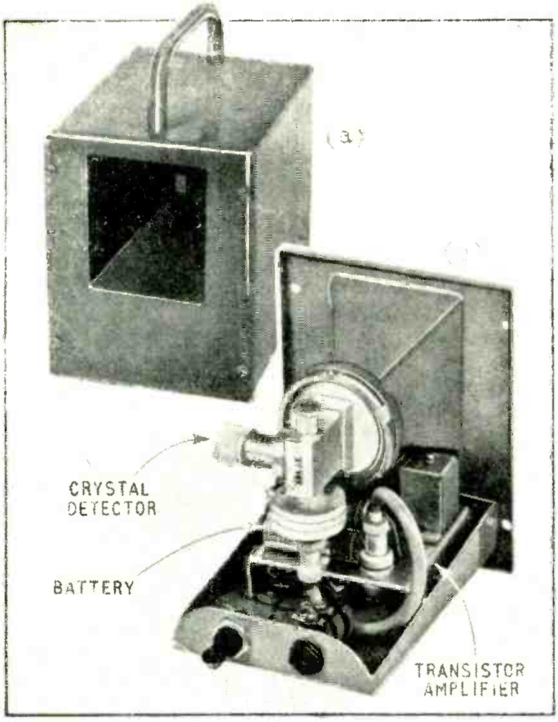
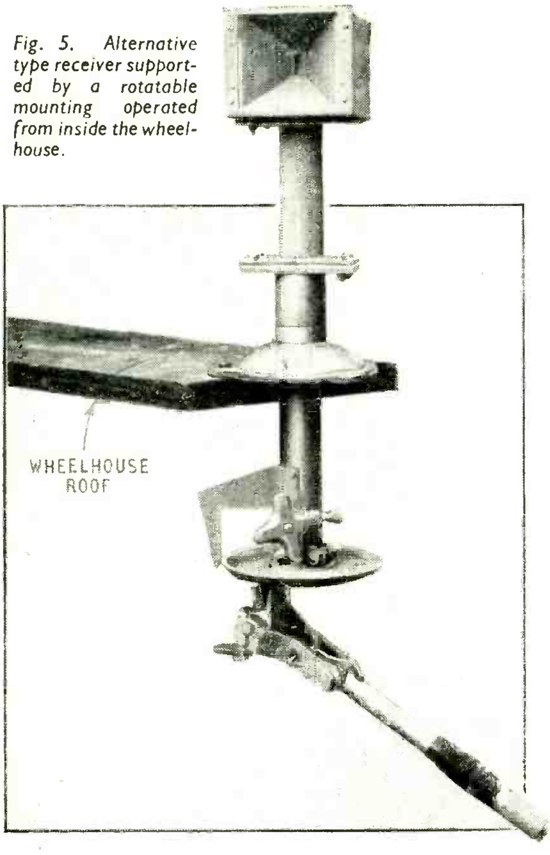


Fig. 4. The ship's receiver showing (a) the complete set and (b) chassis (with horn) removed from the case.

Fig. 5. Alternative type receiver supported by a rotatable mounting operated from inside the wheelhouse.



zontal and vertical beam widths of 25°. The receiver and its power supplies are built around the horn and measure 4in × 5in × 5in (Fig. 4a and b) and weigh 4½lb. The receiver's amplifier has a gain of 84db and uses four junction type transistors. The overall sensitivity is 10^{-8} watts, and reception is by means of headphones. The power supplies are provided by a 4½-volt flash-lamp battery and the current drain is 5 mA. An improved model of the receiver (Fig. 5) incorporates a horn having a horizontal beamwidth of 16° and it is supported on a rotatable searchlight mounting. This is intended for fitting through the wheelhouse roof of a small boat. The output of this receiver is brought out to a 'phone jack on the rotating arm into which a loudspeaker attachment may be plugged. The loudspeaker is a 3½in dia type and it is driven by two 100-milliwatt transistors in push pull.

Trials and demonstrations have been carried out at Frazerburgh and Arbroath and the equipment operated very satisfactorily out to a range of approximately seven miles.

[*A commercial version of the microwave beacon described is, we understand, being made by Elliott Bros., Ltd.*—Ed.]

Record and Stylus Wear

INCREASING the weight on a stylus point in contact with a record reduces the pressure. This apparent paradox is resolved when it is realized that plastic yielding of the record material increases the area of contact at a greater rate than the increase of force causing the deformation.

This point is made early in a paper by F. V. Hunt in the *Journal of the Audio Engineering Society* (Vol. 3, No. 1, January 1955) "On Stylus Wear and Surface Noise in Phonograph Playback Systems." Prof. Hunt makes a detailed mathematical analysis of the stress contours under a spherical indenter in contact with the plane surface of a plastic material and sets out the conditions for the onset of plastic yielding. This is influenced by the size of the point to the extent that a perfect specimen of a material, without flaws such as crystal lattice imperfections, has considerably greater strength, and the probability of finding such a specimen under the contact increases as its size is reduced. This effect is observed in the results of "micro-hardness" indentation testing of materials, and may account for the fact that microgroove records are not excessively damaged in spite of the fact that the 2:1 reduction in recommended playing weight reduction as compared with standard records is only half what is should be (the stylus *force* must vary directly as the square of the stylus radius to maintain constant stylus *pressure*).

The theory is extended to the case of real surfaces making contact only at a few high points or asperities, and it is shown that on this scale plastic yield is intermittent and accounts for much of the surface noise. A discontinuity in the load/wear curve of a stylus exists at low loading and spectacular increases in the life of records and styli can be expected if, for example, the playing weight on a point of 0.001 inch radius is reduced below 2 grams.

The rupturing of bonds of adhesion at points of contact between local asperities on the stylus and record groove surface is thought to account for the present irreducible minimum of surface noise. These bonds are often as strong as the cohesive forces of the materials themselves and the shear stresses required to break them combine to give the coefficient of friction of the material.

Choice of materials having low inter-facial adhesion (and a low coefficient of friction) should, on this argument, have very low surface noise, and the suggestion is made that "Teflon" (polytetrafluoroethylene) might be tried as a record material.

NOVEMBER MEETINGS

Institution of Electrical Engineers

Radio and Telecommunication Section.—November 3rd. "The new high-frequency transmitting station at Rugby" by C. F. Booth and B. N. MacLarty.

November 9th. "A transistor digital fast multiplier with magneto-strictive storage" by Dr. G. B. B. Chaplin, R. E. Hayes and A. R. Owens.

November 15th. "An electrolytic-tank equipment for the determination of electron trajectories, potential and gradient" and "A method of tracing electron trajectories in crossed electric and magnetic fields" by Dr. D. L. Hollway to be read by Dr. J. H. Westcott.

November 21st. Discussion on "The reception of Band I and Band III television programmes" opened by E. P. Wethey.

November 29th. "The specification of the properties of the thermistor as a circuit element in very-low-frequency systems" and "A vector method for amplitude-modulated signals" by Dr. C. J. N. Candy.

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

Cambridge Radio and Telecommunication Group.—November 8th. Address by H. Stanesby (Radio Section chairman) at 8.15 at the Cavendish Laboratory, Cambridge.

North-Eastern Centre. — November 14th. "A Transatlantic Telephone Cable" by Dr. M. J. Kelly, Sir Gordon Radley, G. W. Gilman and R. J. Halsey at 6.15 at the Neville Hall, Newcastle-on-Tyne.

North Midland Centre.—November 1st. "A Transatlantic Telephone Cable" by Dr. M. J. Kelly, Sir Gordon Radley, G. W. Gilman and R. J. Halsey at 6.30 at the Central Electricity Authority, 1, Whitehall Road, Leeds.

North-Western Radio and Telecommunication Group.—November 9th. "High-speed electronic-analogue computing techniques" by Dr. D. M. MacKay at 6.45 at the Engineers' Club, Albert Square, Manchester.

North Scotland Sub-Centre.—November 9th. "Thermionic valves of improved quality for Government and industrial purposes" by E. G. Rowe, P. Welch and W. W. Wright at 7.0 in the Electrical Engineering Dept., Queen's College, Dundee.

South Midland Radio and Telecommunication Group.—November 28th. "A radio position fixing system for ships and aircraft" by C. Powell at 6.0 at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Reading District.—November 28th. "The physics of transistors" by Dr. E Billig at 7.15 at the George V Room, George Hotel, King Street, Reading.

Tees-side Sub-Centre. — November 2nd. "The Manchester-Kirk o'Shotts television radio relay system" by G. Dawson, L. L. Hall, K. G. Hodgson, R. A. Meers and J. H. H. Merriman at 6.30 at the Cleveland Scientific and Technical Institute, Middlesbrough.

Graduates' and Students' Section.—November 2nd. "Communication of information—human, animal and machine" by Dr. E. Colin Cherry at 6.30 at Savoy Place, London, W.C.2.

November 15th. "An introduction to the transistor" by A. V. Bryant at 7.0 at R.E.M.E. Training Centre, Bailleul Barracks, Arborfield, Berks.

November 29th. "Colour television" by L. A. Harris at 7.0 at the Public Library, Chelmsford.

British Institution of Radio Engineers

London Section.—November 30th. "High-fidelity loudspeakers—the performance of moving-coil and electrostatic transducers" by H. J. Leak at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

Merseyside Section.—November 9th. "The Decatron tube in a digital transmission system" by G. Shand at 7.0 at the Chamber of Commerce, Old Hall Street, Liverpool, 3.

North-Eastern Section.—November 9th. "Turret tuners for multi-channel television reception" by R. Holland at 6.0 at Neville Hall, Westgate Road, Newcastle-upon-Tyne.

North-Western Section.—November 3rd. "Ground controlled approach and instrument landing system" by R. H. James and N. MacKinnon at 7.0 at the College of Technology, Sackville Street, Manchester.

Scottish Section.—November 10th. "Some applications of electronics to marine echo-sounding" by F. Baillie at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow, C.2.

British Sound Recording Association

London.—November 18th. "The development of professional recording equipment" by W. S. Barrell at 7.0 at E.M.I. Studios, 3 Abbey Road, N.W.8.

Television Society

London.—November 11th. "The application of semi-conductor diodes to television circuits" by J. I. Missen.

November 24th. "Interference with television reception: its causes and cures" by R. A. Dilworth.

Both meetings are to be held at 7.0 at 164, Shaftesbury Avenue, W.C.2.

Physical Society

Acoustics Group.—November 11th. "Acoustic interferometers" by Dr. E. G. Richardson at 5.30 at Imperial College, South Kensington, London, S.W.7.

British Kinematograph Society

London.—November 23rd. "The display of television pictures in the home" by E. P. Wethey at 7.15 at the Gaumont-British Theatre, Film House, Wardour Street, W.1.

Radio Society of Great Britain

London.—November 11th. "Compressed beams" by G. A. Bird (G4ZU) at 6.30 at the I.E.E., Savoy Place, W.C.2.

DO YOU KNOW?

HOW long the elements for a Band II or Band III aerial should be?

Where to apply for a licence to establish a mobile radio-telephone link?

What value of resistors to use for a television attenuator?

The address of each of the above societies?

The base connections for a PCF80?

The answers to these and very many other radio technical and organizational queries can be readily given by the owner of a *Wireless World* Diary. The 1956 edition—the 38th—is now obtainable from booksellers and newsagents, price 5s 10d (morocco leather) or 4s 1d (rexine).

In addition to the 80-page reference section, which includes details of base connections for 600 valves, there are the usual week-at-an-opening diary pages.

RANDOM RADIATIONS

By "DIALLIST"

Band III Aerials

INGENIOUSLY designed Band III and two-band aerials continue to appear and I expect there'll be lots more new ideas in months to come. Amongst the earliest to make their bow were the J-Beam single-slots and slot-beams for Band III. As "ghosting" is one of the big problems in that band the slot, either as a "single" or with reflector and directors, should be a help to good reception in difficult places. All kinds of clip-on attachments are being produced for converting a Band I aerial for two-band operation. Many will be useful only if the B.B.C. and I.T.A. transmitters lie in the same direction from the viewer. But there are also several clever ideas for enabling the two arrays to be oriented independently. One that interests me is the Antiference "electronic coupling." An arm carrying the desired number of Band III elements and the Band I dipole, critically spaced from the nearest of these, is mounted on the mast and turned in the direction of the I.T.A. station. A second arm carries the Band I reflector and can be swung so that it and the dipole are directed towards the B.B.C. station. Both arrays are thus properly oriented and only a single feeder, in which both signals appear, is needed.

Exhibition Prefabs?

THE bright suggestion has been made that stands for future wireless shows should be prefabricated. The idea is that each exhibitor would make his own stand in sections. Every section would be completely wired and the stand would be erected by the simple process of putting the sections in their right places and plugging each section into the next. All the wiring would terminate in a single heavy-duty plug and only one main electrical connection would then be needed for any stand. It seems quite a brilliant idea; but one wonders what kind of reactions it would provoke!

Lighting or Power?

A STORY came my way the other day which was declared to be true by its teller. It might well be, for there's no end to man's (and woman's) ignorance and folly about things electric. Anyhow, here it is. Into an electrical dealer's shop walked a man who had just moved into a house in the neighbourhood. "There are some wiring changes and additions that I want made," he said, "and I'd be glad if you'd take on the job." The dealer having replied suitably, his visitor went on: "Oh, by the way, could you lend me an ammeter for about half an hour?" Asked what he wanted it for, he replied that there were a good many sockets in the house and he wasn't quite sure which of them were for lighting and which for power. "But how will the ammeter help you?" "Oh, don't you know? It's quite simple. You just put the prods into the socket: if it's for lighting the meter reads 5 amps; if for power it reads 15."

Needlessly Scrapped

ONE of the things I'd like to know (though it's not likely that I or anyone else ever will) is the number of television c.r. tubes perfectly capable of giving good service that are scrapped in a given year. It would most certainly run to a largish figure. The two main causes of unnecessary replacement are cathode-to-heater shorts and low emission. Nothing can be done about the first of these if the mains supply is d.c. but if it is a.c., fitting an inexpensive isolating transformer for the heater puts things right. The owner of a c.r. tube with low emission has to take a chance if he's on d.c.; reactivation by running the cathode at high temperature for brief periods may be successful and give the tube a further lease of life, but it may also mean a burnt-out heater. It's a chance worth taking anyhow, for an otherwise useless tube may last for months if the reactivation is successful. The a.c. man can usually count on good results. All that he needs is a booster transformer for the heater. I know one c.r. tube which still gives an excellent picture 18 months after the fitting of a booster.

Steps Forward

AMONGST the improvements one has so far noticed this year in TV receivers is the increased adoption of flywheel sync. This should lighten the lot of viewers who live in places where interference of certain kinds is bad and those whose homes are in fringe areas with a poor signal-to-noise ratio. Another welcome improvement is the wider use of effective automatic gain control. It seems to me, too, that a good many new sets are making a better job of interlacing than did some of their predecessors. But I must say I'd like to see more rather than less genuine a.c.-only television sets with double-wound mains transformers in their power-packs. Diehard or not, I'll never become reconciled to the transformerless receiver, worked as it is more often than not from a two-point a.c. mains socket.

CLUB NEWS

Barnsley.—At the meeting of the Barnsley and District Amateur Radio Club on November 11th, W. Williams will speak on "Band II f.m. reception." A fortnight later F. Robinson (G3FLQ) will describe a superhet double conversion adaptor. Meetings are held at 7.0 at the King George Hotel, Peel Street, Barnsley. Sec.: P. Carbutt (G2AFV), 33 Woodstock Road, Barnsley, Yorks.

Birmingham.—The annual dinner of the Midland Amateur Radio Society will be held at the Imperial Hotel, Birmingham, on November 12th. Sec.: C. J. Haycock, 360 Portland Road, Edgbaston, Birmingham, 17.

Cambridge.—The Cambridge University Wireless Society (G6UW) meets at 8.15 each Tuesday of the full term in the Cavendish Laboratory. Sec.: A. Brunnschweiler, Pembroke College, Cambridge.

Cleckheaton.—During November the Spen Valley and District Radio and Television Society will be visiting the psychology department and seeing the electron microscope at Leeds University (2nd) and the medical physics department of the General Infirmary, Leeds (30th). On the 29th Mullard films will be shown at the Metropole Hotel, Leeds. Meetings commence at 7.30. Sec.: N. Pride, 100 Raikes Lane, Birstall, Nr. Leeds.

Edinburgh.—The first of a series of talks describing "A Beginner's Transmitter" will be given on November 3rd to members of the Lothians Radio Society. On the 17th J. W. Kyle (GM6WL) will deal with 70-cm reception. Meetings are held at 7.30 at 25 Charlotte Square, Edinburgh, 2. Sec.: J. Good (GM3EWL), 24 Mansionhouse Road, Edinburgh, 9.

Southend.—At the meeting of the Southend and District Radio Society on November 11th, H. Wilkinson will talk on "Current trends and developments in radio and television." On November 25th a representative of the Automatic Coil Winder Company will speak on 'Recent developments in test equipment for the electronic industry." Meetings are held at 7.15 at the Ekco Works, Southend-on-Sea. Sec.: P. C. Baldwin, 13 Inverness Avenue, Westcliff-on-Sea, Essex.

Swindon.—Regular meetings are now being arranged for the recently formed Swindon Amateur Radio Club, of which R. Reynolds (G3IDW) is chairman. Weekly classes of instruction in preparation for the amateur radio examination are being held at the College, Swindon, at which the instructor is G. R. Pearce (G3AYL), who is secretary of the club. His address is 102 Kingshill Road, Swindon, Wilts.

UNBIASED

By FREE GRID

Electronic Tapostat

IN the August issue of *Wireless World* the Editor demanded the invention of an electronic "bookmark" or tapostat for tape recorders so that a user could rapidly wind-on or rewind the tape until he found the particular section he desired to play.

Naturally, I replied by return of post detailing a scheme. This provided for the tape to have supersonic frequencies imposed on it at selected spots during recording. The great increase in tape speed on fast wind or rewind would naturally convert such supersonic frequencies into radio frequencies. These could be picked off the tape by a tuned r.f. head, amplified, rectified and used to actuate a relay-operated brake which would stop the mechanism at any desired spot on the tape.

The Editor rejected my idea on the ground that it was several years in advance of its time. Those were not his exact words but they were certainly implied in his answer. He told me that our sound-recording tapes have too noisy a background for my idea to succeed. It cannot be doubted, I think, that in time all tape recordings will have the same silent background as the tapes being used in the experiments for the recording of television and then, of course, my electronic tapostat will come into its own.

"Walter, Lead Me to the Altar"

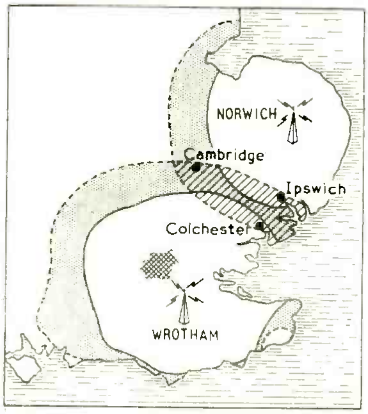
READERS of *Wireless World* will have heard of Dr. Grey Walter of encephalograph fame and be familiar with his important work in the field of neurological diagnosis and kindred subjects.

According to some sections of the daily press, however, Dr. Grey Walter has now started to trespass on the prerogatives of Madame Estelle by warning us of matrimonial pitfalls ahead. To give him his due, however, his matrimonial soothsayings, unlike those of Madame Estelle, are founded on the solid rock of science. He does not tell girls to beware of the buccolingual blandishments of sinister dark-haired men of the "Sir Jasper" type. Instead he advises them to demand that any would-be Romeo should produce his encephalogram.

Dr. Grey Walter advises that only those with compatible encephalograms should launch out together on the stormy seas of matrimony. It would seem advisable for all budding benedicks of either sex to carry around with them, like a passport, their personal encephalograms, duly authenticated by Dr. Grey Walter and his colleagues. Thus girls of the future will have as their theme song the same ditty which was so popular among their Edwardian sisters but with a slightly different meaning; "Walter, Lead me to the Altar."

Bi-Fi

IN my opinion the outstanding audio feature of 1955 has been the introduction by more than one firm of



East Anglian 2-channel broadcasting

stereophonic reproduction from records. The name "stereophonic," or any of its obvious variations, is rather a mouthful, however, and I think, following the tendency of modern jungle jargon, a better name would be bi-fi. The whole *raison d'être* of the thing is that it is not only binaural—for all listening is that—but "bi" everything else as two channels must be used throughout. It is also bi-fi in the hellenic sense of "bi," for the music and everything else does indeed appear to be living.

In view of the great success of recent bi-fi demonstrations, I hope that the director of technical services at the B.B.C. now takes a more enlightened view of bi-channel broadcasting than he did in his letter to *Wireless World* a few years ago (April, 1950). When the Norwich v.h.f. station opens in 1956 he will have a unique opportunity of experimenting with bi-fi.

According to the B.B.C.'s published map, those living between Ipswich and Colchester and in a corridor extending west beyond Cambridge will be able to receive both the Wrotham and Norwich transmissions. To make matters quite clear I reproduce part of the v.h.f. map on which I have shaded-in the corridor.

One or more of the three transmitters at these two stations will always be radiating the same programme and it will, therefore, be possible to experiment with bi-fi in that area at a minimum of expense as it would only be necessary for the B.B.C. to use separate mikes and associated gear to feed the two chosen transmitters. It could at least be tried out with the two transmitters radiating the Third Programme where bi-fi would be most appreciated. What about it, Sir Harold?

Strabismogenic TV

THE size of the screen in domestic television receivers has been growing steadily during the past few years to such an extent that many of the latest sets seem only suitable for baronial halls. Unfortunately the feeling that they must "keep up with the Joneses" forces people into the same foolish competition of "bigness" in which they once indulged in sound radio, when it seemed everybody's wish to compete with the bulls of Bashan.

To attempt to view some of these huge screens in the confines of an ordinary room leads only to strabismus, as I found out the other day when invited to a friend's house to view his latest "horror-scope." Eventually people will learn common sense as they did with sound radio.

Now even with a 17-in screen, lines are painfully evident. One or two firms do provide spot wobble in this and larger sizes but it is high time something was done about this problem, by the radio industry in general, without resorting to the drastic remedy of altering the British standard of 405 lines.

The disadvantages and complications of this latter remedy have been

405 hard lines

pointed out more than once in this journal, but surely it is not beyond the wit of our technological tycoons to tackle this problem with the same vigour and success as women remove the lines from their faces.

E180F

wide-band low-noise pentode

16mA/V

c_{in}=8pF c_{out}=3pF

PRINCIPAL CHARACTERISTICS

V_a	190V	g_m	16.5mA/V
V_{g2}	160V	r_a	35kΩ
V_{g1}	−1V	$\mu_{g1\text{-}g2}$	50
I_a	13mA	Heater	6.3V,0.3A
I_{g2}	3mA	Base	B9A

Input damping = 6kΩ (at f = 50 Mc/s and with cathode connections strapped).

The unusually high slope/capacitance ratio of this new Mullard pentode has been achieved by using very fine grid wire, the latest type of frame grid and the smallest cathode-grid clearance yet employed in large scale production.

Gold plating of the base pins ensures that, when mounted in a suitable socket, the E180F makes one of the best base connections obtainable.

This new valve is eminently suitable for wide-band amplifier applications such as radar i.f. amplifiers, camera and transmission equipment for high definition television, and telephone line and transmission equipment.

For low-noise input stages the valve may be triode-connected and very favourably employed in pre-amplifiers in radar i.f. and camera equipment.

Your enquiries on the E180F will be welcomed at the address below.

Mullard

Mullard Limited, Communications & Industrial Valve Dept., Century House, Shaftesbury Avenue, London, W.C.2.

MVT 174

TAILORED FOR THE JOB

Ferrograph

It is by no means accidental that the Ferrograph has achieved so high a reputation in every country to which exportation is possible, and at a price no greater than that of an ordinary home recorder.

One of the main contributory factors is that practically all component parts used in the Ferrograph are made in our own works at South Shields, **having been expressly designed for the function they are to perform**.

Thus, by purposeful design, adequate control during manufacture, and strict inspection, standards have been established to which all Wearite/Ferrograph components conform.

After assembly from such parts each Ferrograph is subjected to a multiplicity of tests, culminating in a pen-recorder trace of its response and wow.

Only thus has the **Ferrograph** set and maintained **the standard by which all other recorders are judged.**

Dealerships in several of the principal towns are still open and applications are invited.

BRIEF SPECIFICATION

Twin Track (to International standards)
Playing British and American pre-recorded tapes

Playing Time with 1,750 ft. Reel
45 minutes per track at $7\frac{1}{2}$ i.p.s. (other speeds pro rata)

Quick Rewind
in less than 60 seconds

Signal Level Meter
giving positive reading

Frequency Response
± 3 db 50/10,000 c.p.s. at $7\frac{1}{2}$ i.p.s.

"Wow" and Flutter
Less than 0.2% at $7\frac{1}{2}$ i.p.s.

Signal to Noise Ratio
Better than 50 db, 200/12,000 c.p.s. Unweighted, including hum, 45 db.

Longterm Speed Stability
Less than .5% variation

Output Power
$2\frac{1}{2}$ watts into 15 ohms

MODEL 2A/N
$3\frac{3}{4}$ and $7\frac{1}{2}$ i.p.s.
76 gns.

MODEL 2A/NH
$7\frac{1}{2}$ and 15 i.p.s.
86 gns.

WEARITE

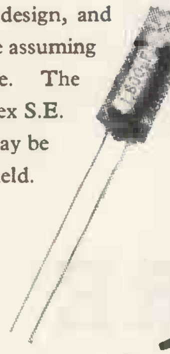
WRIGHT & WEAIRE LTD

131 SLOANE STREET · LONDON SW1 · Telephone: SLOane 2214/5 and 1510

The Suflex H.S. Type Polystyrene capacitor is already very well known at present. If, however, you have an eye to the future, it will pay you to look closely at these three new types, too.

SUFLEX and automation

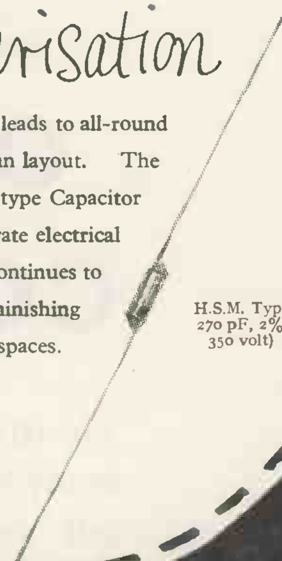
Automation is presenting new problems in design, and terminations are assuming a new importance. The *single-ended* Suflex S.E. type Capacitor may be invaluable in this field.



S.E. Type (1800 pF, 10%, 500 volt)

SUFLEX and miniaturisation

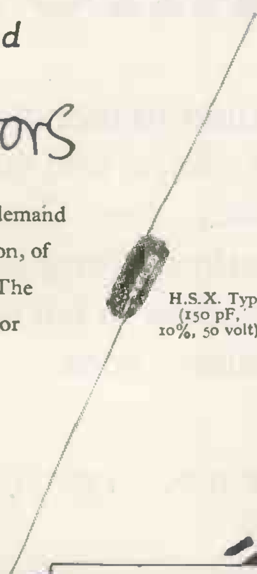
Miniaturisation leads to all-round economy and clean layout. The Suflex H.S.M. type Capacitor gives first-rate electrical performance and continues to fit into rapidly diminishing spaces.



H.S.M. Type 270 pF, 2%, 350 volt)

SUFLEX and transistors

Transistors are upon us and demand the utmost miniaturisation, of course with lower voltages. The Suflex H.S.X. type Capacitor will play an important part in I.F. and R.F. appli cations.



H.S.X. Type (150 pF, 10%, 50 volt)

These progressive Suflex components can play an important part in your new developments. May we co-operate with you in their application and send you samples?

SUFLEX Limited LONDON

SUFLEX LIMITED 35 Baker Street, London W1 *Tel* · Welbeck 0791 *Cables:* Suflex London

"Straightforward & Logical System of Control"

VOLUME CONTROL AND ON/OFF SWITCH

BASS AND TREBLE CONTROLS
Compensation for the environment in which the equipment is used

FILTER SLOPE
Adjusting the filter characteristic for the finest performance inherent in the programme

FILTER SWITCH
Setting the filtering range

PUSH BUTTONS
Selecting radio, microphone or tape inputs

PUSH BUTTONS
Selecting playback characteristic

QUAD II CONTROL UNIT—SPECIFICATION

FREQUENCY RESPONSE:
Cancel position.
Radio and Tape inputs: 20-20,000 c/s within 0.3db.
Microphone input: 20-18,000 c/s within 1 db.
Pickup Input (R.2): Within 0.5db of stated characteristics.
Other plugs, no significant change.
Bass and Treble controls: Within 1db of published curves.
Filter frequencies (ff): 5Kc/s, 7Kc/s 10Kc/s ± 250 c/s
Filter slope: Level to 50 db/Octave.

INPUT SENSITIVITIES (for 1.4 V.rms output):

Radio and Tape:	Internal impedance	100 KΩ:	100mV.
Microphone:	" "	100 KΩ:	1.5mV.
Pickup:	to suit pickup in use, adapted by plug-in unit.		

DISTORTION (1.4 V output):
All controls 'level,' Radio input or R.2 pickup input: 0.02% approx.
Least favourable arrangement of plugs and controls: less than 0.1%

POWER SUPPLY: The unit takes its power from the main amplifier.
330 V 2 mA } Plus currents taken by tuner units which may be
6.3 V 1 A } connected to sockets provided.
Maximum power available from tuner sockets:
330 V 30 mA (each tuner)
6.3 V 2.5 A (total) The heater supply is C.T. to chassis.

VALVES: 1 x EF.86 (Z.729 or 6267), 1 x ECC.83 (12AX7) (ECC.81, B309 or 12AT7 with changed bias resistor).

BACKGROUND:
—70 db or where applicable, approximately 6 db above equivalent thermal noise of input impedance.

MECHANICAL:
Front panel: Die-cast, stove finished silvered fawn, machine engraved.
Knobs: Aluminium, stoved matt brown, machine engraved.
Chassis and Cover: Steel, rust-proof processed, stoved steel grey.
The complete unit, electrically and mechanically is fully tropical and suitable for all climatic conditions.

DIMENSIONS: 10½" x 3½" x 6½".

WEIGHT: 7 lb. nett. (3.15 Kg.).

ACOUSTICAL

QUAD II

Send for illustrated brochure giving full details of the QUAD II Amplifier.

. . . for the closest approach to the original sound.

ACOUSTICAL MANUFACTURING CO. LTD. HUNTINGDON, HUNTS. Tel: Huntingdon 361

THYRATRONS

for Industrial Purposes

XENON-FILLED TRIODES

These valves are suitable for a wide variety of control applications. The inert gas filling ensures stable operation over a wide range of ambient temperatures.

HYDROGEN-FILLED PULSE MODULATOR TRIODES

Designed to discharge pulse-forming networks in high power, high voltage pulse generators. Short deionization time and low time jitter provide for precise triggering at high repetition frequencies.

Technical data sheets are available on request.

'ENGLISH ELECTRIC'

Type	Filling	Max. Dimensions: Length (mm)	Max. Dimensions: Dia. (mm)	Filament or Heater: Volts	Filament or Heater: Amps. (Approx.)	Max. Peak-Inverse Voltage (Volts)	Max. Peak-Forward Voltage (Volts)	Max. Peak-Current (Amps)	Max. Mean Current (Amps)	Approx. Tube Drop (Volts)	Peak Power Level (a)	American Equiv.	C.V. Number
AFX.212	Xe	54	19	6.3	0.25	350	350	0.11	0.025	11	—	6D4	1949
AFX.203	Xe	176	57	2.5	4.0	300	280	1.7	0.40	11	—	C1A	2868
FX.215	H_2	286	97	2.5	27.5	16,000	16,000	200	0.20	100(b)	2.0×10^9	—	2203
FX.219	H_2	222	65	6.3	10.6	16,000	16,000	325	0.20	100(b)	3.2×10^9	5C22	2520
FX.225	H_2	175	65	6.3	6.1	8,000	8,000	90	0.10	100(b)	2.0×10^9	4C35	1787
FX.227	H_2	132	40	6.3	2.25	3,000	3,000	35	0.045	100(b)	0.3×10^9	3C45	372

Xe — Xenon H_2 — Hydrogen

(a) — Product of peak forward voltage, peak current and pulse repetition frequency.

(b) — Under conditions of pulse operation.

ENGLISH ELECTRIC VALVE CO. LTD.

Waterhouse Lane, Chelmsford
Telephone: Chelmsford 3491

AP300/22

20 Mc/s FREQUENCY MONITOR

The Automatic Frequency Monitor (20 Mc/s) is but one of a series of high grade monitors now in course of manufacture for the accurate measurement of frequency.

Employing hard valve techniques throughout, it will measure any frequency in the range 10 c/s to 20 Mc/s to an accuracy within ± 1 part in 10^6.

The result, in decimal notation, is presented on eight panel mounted meters each scaled from 0 to 9 and the unknown frequency is automatically remeasured every few seconds.

This new equipment presents a considerable advance in frequency measuring techniques and apart from normal laboratory applications, is ideally suited for incorporation in production testing routines.

Full technical information on this and other frequency measuring equipment is available on request.

CINEMA TELEVISION LTD

A COMPANY WITHIN THE J. ARTHUR RANK ORGANISATION

WORSLEY BRIDGE ROAD · LONDON · S.E.26

HITHER GREEN 4600

SALES AND SERVICING AGENTS:

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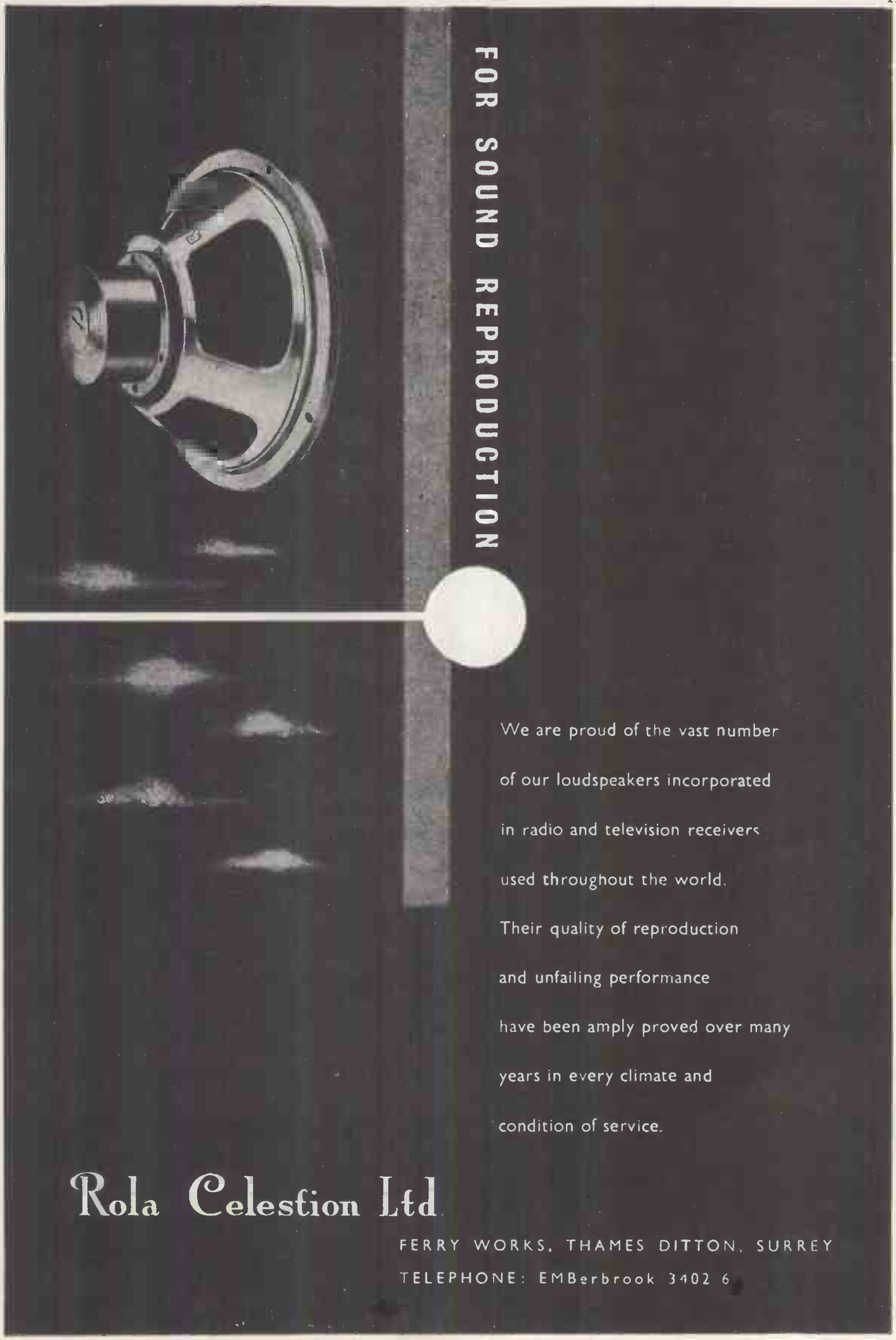
Atkins, Robertson & Whiteford Ltd., 100 Torrisdale Street. Glasgow, S. 2

F. C. Robinson & Partners Ltd., 122 Seymour Grove, Old Trafford, Manchester, 16


FOR SOUND REPRODUCTION
We are proud of the vast number
of our loudspeakers incorporated
in radio and television receivers
used throughout the world.
Their quality of reproduction
and unfailing performance
have been amply proved over many
years in every climate and
condition of service.
Rola Celestion Ltd
FERRY WORKS, THAMES DITTON, SURREY
TELEPHONE: EMBerbrook 3402 6

They say we make a perfect pair...

..with excellent connections

To be exact, this is the 12 pin version of the Multi-Way Plug and Socket range, which covers 4, 8, 12, 20 and 28 ways. The range features unusually low insertion pressures, and embodies considerable experience in meeting humid conditions. Designed to overcome as far as possible the difficulties encountered when using this type of connector in rack mounting applications, they have greater latitude in matching up than any comparable product, and are in use throughout the world in Radio, Television and Telecommunications equipment by such renowned firms as:—Messrs. Marconi's Wireless Telegraph Co. Ltd., The English Electric Co. Ltd. and Messrs. Standard Telephones & Cables Ltd.

A.I.D & A.R.B — APPROVED

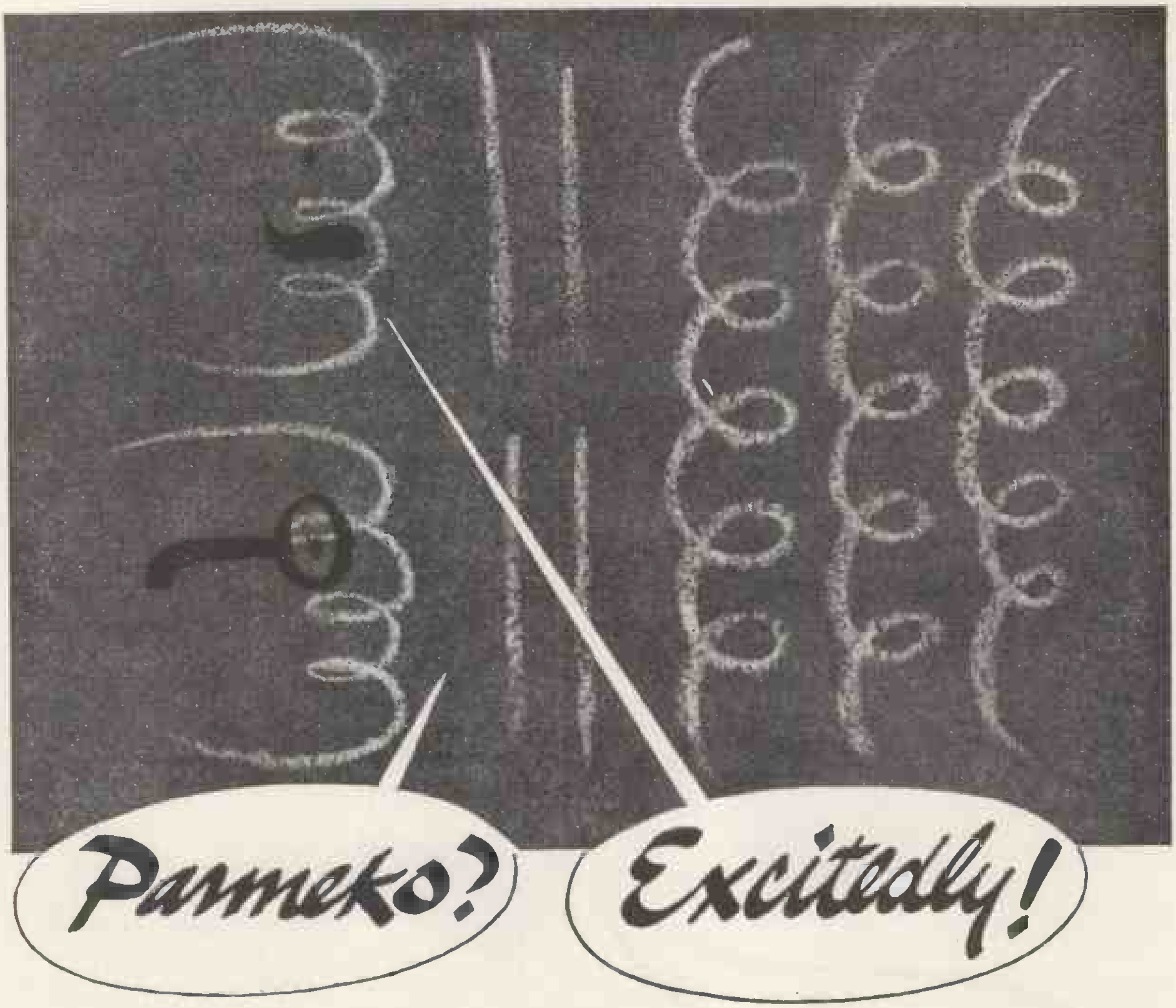
POWER CONTROLS

LIMITED

P.C. 2

EXNING RD., NEWMARKET

PHONE: NEW 3181/2/3



Are you the auto-excited type, old boy?

Very, George. I remember a straight-eight I used to have, with four synchronised carburettors and temperamental brakes, that once . . .

No, no—what I mean is, are your rectifiers connected in series with the output winding so that the output current automatically saturates the transductor . . .

Where do you get all this ' output ' on transductors, George?

From a Parmeko leaflet—it tells me that they have a standard range of 14 types for operation at supply frequencies of 400 and 1600 cycles and some for 50 cps.

Sounds very varied.

They are indeed—they're being used in magnetic amplifiers all over the place.

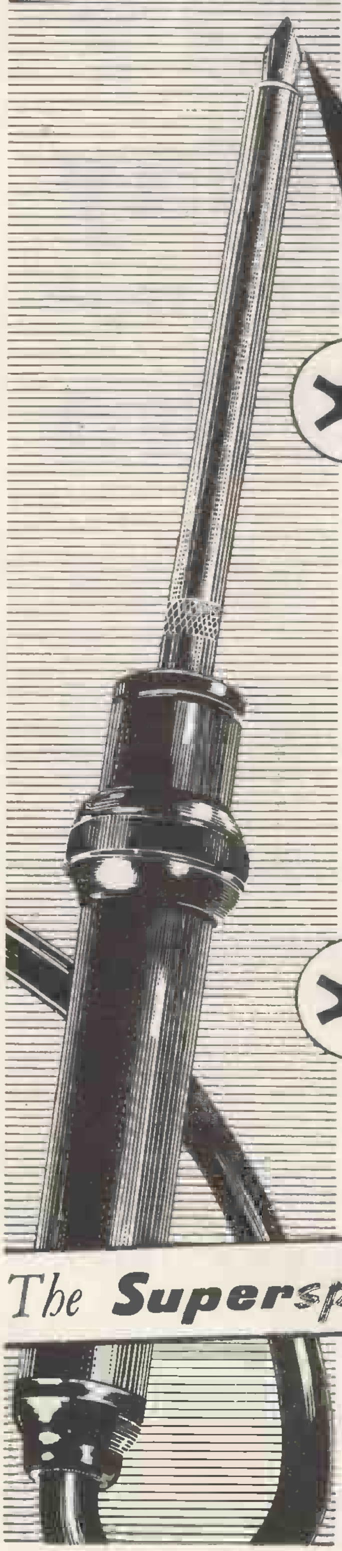
Do you think I could get one of these leaflets of theirs?

Yours for the asking, George. They're in Two Colours and Fully Illustrated, as they say . . .

PARMEKO *of* LEICESTER

MAKERS OF TRANSFORMERS FOR THE ELECTRONIC AND ELECTRICAL INDUSTRY

m-i-n-u-t-e-s *into seconds...*



with the brilliant NEW Superspeed SOLDERING IRON

MANUFACTURED FOR ENTHOVEN SOLDERS LTD. BY SCOPE LABORATORIES, MELBOURNE, AUSTRALIA

STAR FEATURES

★ Heats up from cold in 6 seconds—by a light thumb pressure on the switch ring.

★ When not in use, current is automatically switched off—thus greatly reducing wear of copper bit. Electricity consumption is correspondingly reduced.

★ It is 10″ long, weighs 3½ ozs., can be used on 2·5 to 6·3-volt supply. 4-volt transformer normally supplied.

★ More powerful than conventional 150-watt irons and equally suitable for light wiring work or heavy soldering on chassis.

★ Simple to operate, ideal for precision work. Requires minimum maintenance at negligible cost. Shows lowest operating cost over a period.

★ Can be used from a car battery.

★ It is by far the most efficient and economical soldering iron ever designed for test bench and maintenance work.

STAR APPLICATIONS

Designed on an entirely new principle, this light-weight, versatile iron is eminently suitable for soldering operations in the RADIO, TELEVISION, ELECTRONIC and TELECOMMUNICATION industries, particularly for all SERVICE work. For general purpose work the Superspeed Iron is the ideal stand-by soldering tool.

The Superspeed *soldering iron is available* NOW

Write for full particulars, including guarantee terms and free trial facilities, to the sole concessionaires in this country—

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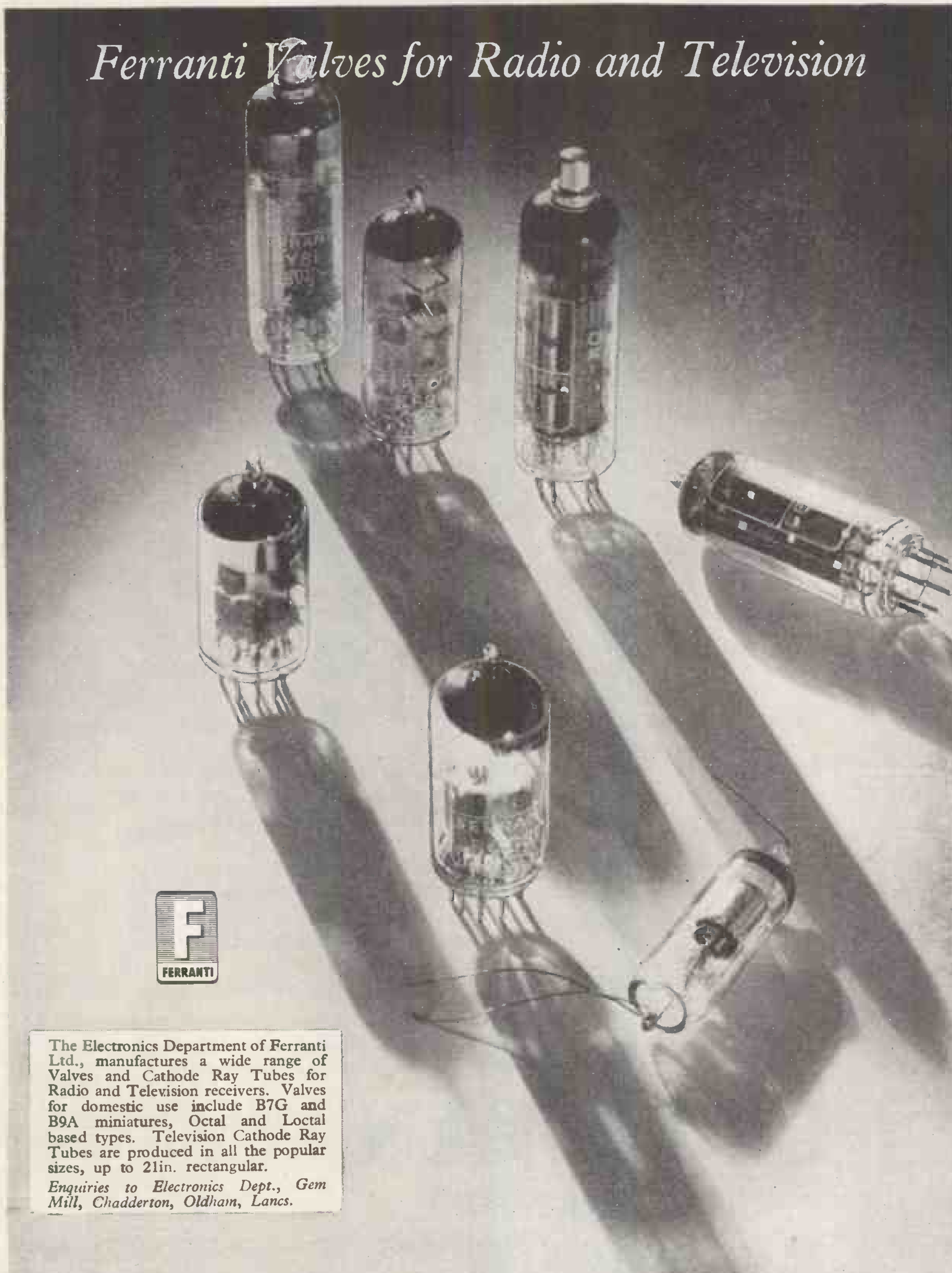
(Industrial Equipment Division), 89 Upper Thames St., London, E.C.4. Telephone: MANsion House 4533

Panton

Ferranti Valves for Radio and Television



FERRANTI

The Electronics Department of Ferranti Ltd., manufactures a wide range of Valves and Cathode Ray Tubes for Radio and Television receivers. Valves for domestic use include B7G and B9A miniatures, Octal and Loctal based types. Television Cathode Ray Tubes are produced in all the popular sizes, up to 21in. rectangular.

Enquiries to Electronics Dept., Gem Mill, Chadderton, Oldham, Lancs.

FERRANTI LTD · GEM MILL · CHADDERTON · OLDHAM · LANCS

London Office : KERN HOUSE, 36 KINGSWAY, W.C.2

FE.161

A new radiation cooled triode

Specially designed for Industrial R.F. heating equipment

TENTATIVE CHARACTERISTICS

V_f	10 volts
I_f	18 amps
V_a Max	5 kV
Max. operating frequency at full rating	40 Mcs.
μ	40
g_m	8 mA/V

The Ediswan ES.1001 is a radiation-cooled triode with rugged graphite anode and thoriated tungsten filament designed specially for use in Industrial R.F. heating equipment.
Its maximum anode dissipation is 1 kW, but being radiation-cooled no complicated cooling arrangement is required although an air flow is needed when the valve is used at full ratings.

Further information will be available shortly

A forced air cooled triode with thoriated tungsten filament and with a maximum anode dissipation of 12 kW at 40 Mcs. will also be available shortly.

EDISWAN

INDUSTRIAL AND TRANSMITTING VALVES

THE EDISON SWAN ELECTRIC COMPANY LIMITED 155 Charing Cross Road, London, W.C.2 & branches
Phone: Gerrard 8660 *Member of the A.E.I. Group of Companies* *Grams: Ediswan, Westcent, London*

C

60 Watt H.F. FIXED STATION

This completely new Pye equipment has been specifically designed for point-to-point communication and will fulfil equally well a ground-to-air role in air traffic control systems.

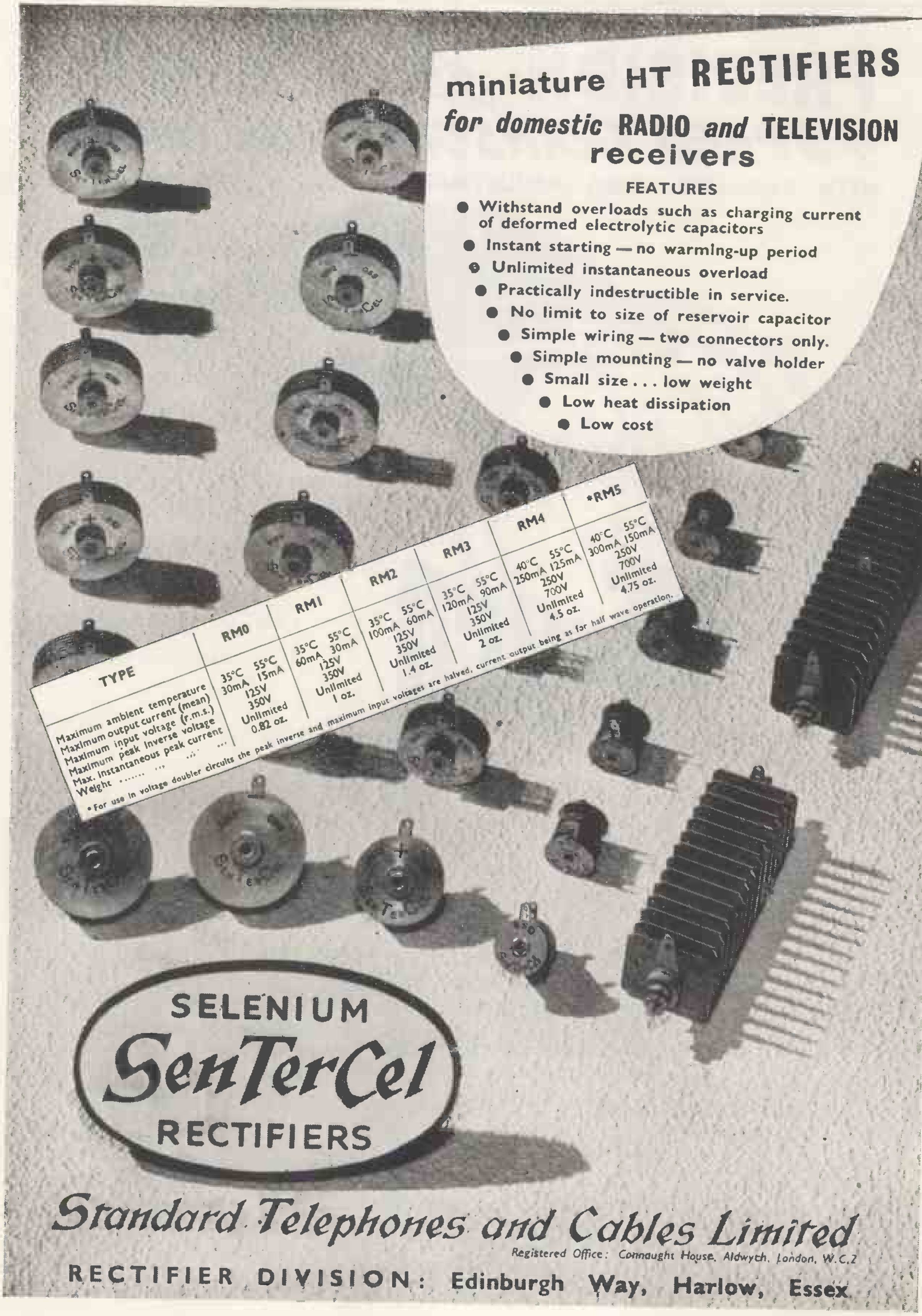
Push button control brings any one of four preselected channels into immediate operation; this facility is also available when the equipment is installed for remote unattended operation. The 60 watt Fixed Station Transmitter offers R/T, C/W, or M.C.W. operation with 'break-in' facilities on telegraphy.

The equipment is suitable for unattended operation in the tropics.

PYE Telecommunications
CAMBRIDGE ENGLAND

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

PYE LIMITED · CAMBRIDGE · ENGLAND

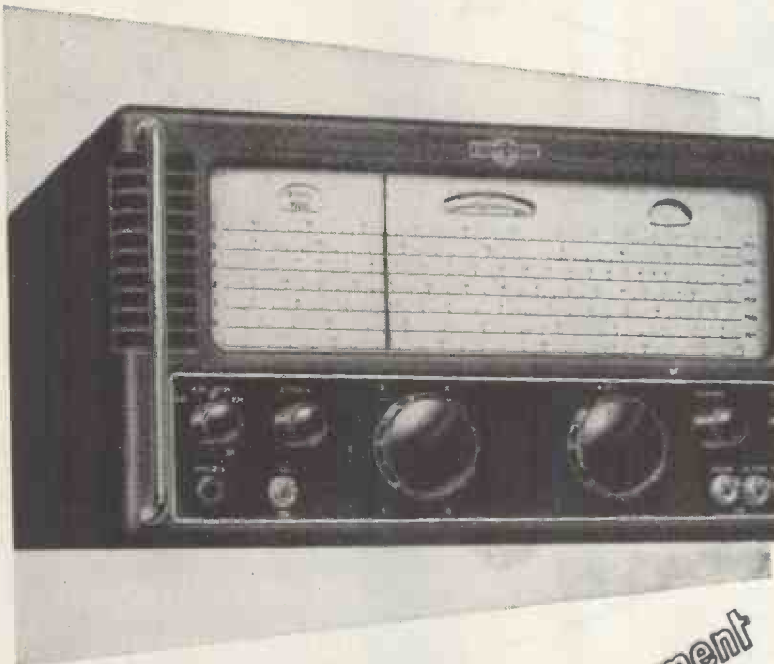

miniature HT RECTIFIERS
for domestic RADIO and TELEVISION receivers
FEATURES
● Withstand overloads such as charging current of deformed electrolytic capacitors
● Instant starting — no warming-up period
● Unlimited instantaneous overload
● Practically indestructible in service.
● No limit to size of reservoir capacitor
● Simple wiring — two connectors only.
● Simple mounting — no valve holder
● Small size . . . low weight
● Low heat dissipation
● Low cost

TYPE	RM0	RM1	RM2	RM3	RM4	*RM5
Maximum ambient temperature	35°C 55°C	35°C 55°C	35°C 55°C	35°C 55°C	40°C 55°C	40°C 55°C
Maximum output current (mean)	30mA 15mA	60mA 30mA	100mA 60mA	120mA 90mA	250mA 125mA	300mA 150mA
Maximum input voltage (r.m.s.)	125V	125V	125V	125V	250V	250V
Maximum peak inverse voltage	350V	350V	350V	350V	700V	700V
Max. instantaneous peak current	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Weight	0.82 oz.	1 oz.	1.4 oz.	2 oz.	4.5 oz.	4.75 oz.

*For use in voltage doubler circuits the peak inverse and maximum input voltages are halved, current output being as for half wave operation.
SELENIUM
SenTerCel
RECTIFIERS
Standard Telephones and Cables Limited
Registered Office: Connaught House, Aldwych, London, W.C.2
RECTIFIER DIVISION: Edinburgh Way, Harlow, Essex

Attention is drawn to the EDDYSTONE 770

V·H·F & U·H·F



Communications Receivers

Specially suited for

Monitoring
Field Tests
Laboratory
ETC.

for highest grade equipment

Superbly engineered and of advanced design, the two models offered possess excellent electrical characteristics and are robustly constructed for service in any climate. The "770R" has continuous AM/FM coverage from **19 Mc/s to 165 Mc/s**; the "770U" from **150 Mc/s to 500 Mc/s.** Both incorporate six-position turret tuning assemblies of unique design and giving high reliability. Self-contained when operated from AC mains and with provision for use on external power supplies. Fully descriptive literature with illustrations and performance curves available on request.

RADIO PRODUCTS EDDYSTONE TRADE MARK

Manufacturers: **STRATTON & Co. Ltd., Birmingham, 31.**

Lines of communication . . .

In June 1920 the first advertised sound radio programme was broadcast from the Marconi transmitter at Chelmsford. To-day Marconi high or medium power transmitters and high power aerials are installed in every one of the B.B.C.'s television transmitter stations and Marconi television systems are being supplied to countries in North and South America, Europe and Asia.

TELEVISION CAMERAS
STUDIO EQUIPMENT
RADIO LINKS AND TRANSMITTERS
AERIAL SYSTEMS
COLOUR TELEVISION
INDUSTRIAL TELEVISION

MARCONI

Complete Television and Sound Broadcasting Systems

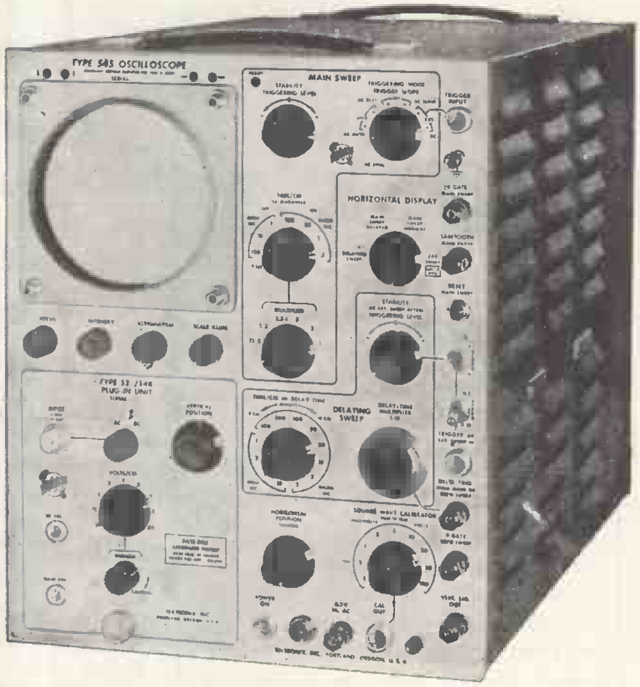
MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED · CHELMSFORD · ESSEX

LG 3

DC-to-30MC Oscilloscopes for FAST RISE applications

TYPE 545—This new high-speed laboratory oscilloscope, in combination with the new type 53/54K Fast-Rise Plug-In Unit...opens the way to quicker, easier analyses of fast-rising waveforms...providing faithful displays and accurate measurement facilities well beyond the range of previous oscilloscopes of its size and cost. The Type 545-Type 53/54K combination offers a vertical-amplifier passband of dc to 30 mc (12-millimicrosecond risetime) at calibrated sensitivities to 0.05 v/cm, with a full 4-cm linear vertical deflection. A wide range of calibrated sweeps, with calibrated sweep delay from 1 μsec to 0.1 sec, and high accelerating potential, 10 kv, fully complement this greatly extended vertical-amplifier range.

The Type 545 is the most versatile oscilloscope ever made, for it can be quickly converted to many other applications. By merely plugging in the appropriate Type 53/54 Plug-In Preamplifier you are ready for wide-band, wide-band high gain, dual-trace, high-gain differential, microvolt-sensitivity, or wide-band differential applications. It's a rare oscilloscope application that isn't easily handled by this modern method.



Vertical-Amplifier Characteristics with Type 53/54K Unit Plugged In

Transient Response—Risetime, 12 millimicroseconds.

Frequency Response—Passband, dc to 30 mc (down 3 db ± ½ db at 30 mc, only 6 db at 41 mc.)

Input Impedance 20 μμf, 1 megohm.

Sensitivity—0.05 v/cm to 20 v/cm in 9 calibrated steps.

***Price**—$125 (£48)

LOW INPUT CAPACITANCE

With Accessory Probes for Type 53/54K

Probe	Input Impedance	Maximum Sensitivity
P405	12.0 μμf, 5 megohms	0.25 v/cm
P410	8.0 μμf, 10 megohms	0.5 v/cm
P420	5.5 μμf, 10 megohms	1 v/cm
P450-L	2.5 μμf, 10 megohms	2.5 v/cm
P4100	2.5 μμf, 10 megohms	5 v/cm

Type 545 Oscilloscope Characteristics

Wide Sweep Range
24 Calibrated sweeps from 0.1 μsec/cm to 5 sec/cm, accurate within 3%. Accurate 5-x magnifier extends calibrated range to 0.02 μsec/cm. Continuously variable from 0.02 μsec/cm to 12 sec/cm.

Wide Sweep-Delay Range
Additional delaying-sweep circuitry provides conventional, or triggered jitter-free delay, 1 μsec to 0.1 sec in 12 calibrated ranges. Range accuracy within 1%. Incremental accuracy within 0.2% of full scale.

Versatile Triggering
Internal or external, with amplitude-level selection or AUTOMATIC TRIGGERING. High-frequency synchronization up to 30 mc.

Square-Wave Amplitude Calibrator
0.2 mv to 100 v in 18 steps, accurate within 3%.

New Cathode-Ray Tube
Tektronix T54P 5" precision metallized crt provides 4-cm vertical and 10-cm horizontal linear deflection. 10-kv regulated accelerating potential.

Balanced Delay Network
0.2 μsec vertical signal delay.

DC-Coupled Unblanking
Uniform unblanking at all sweep speeds and repetition rates.

Electronic Voltage Regulation
All voltages affecting calibrations are fully regulated.

CRT Beam Position Indicators

***Type 545—$1450 (£560)** plus price of desired plug-in units.

***Type 541—Same characteristics, less delayed-sweep facility—$1145 (£440)** plus price of desired plug-in units.

Prices f.o.b. Portland (Beaverton), Oregon
*Plus duty if applicable.

Represented in Great Britain by
LIVINGSTON LABORATORIES LTD.
Retcar Street, London N. 19
Archway 6251

Tektronix, Inc.

P. O. BOX 831D, PORTLAND 7, OREGON, U.S.A.
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This book gives details of how to modernise this popular Amplifier. Stage by stage wiring instructions are included for the improved '912', and there are many additional valuable features. By purchasing this book, you can read how to bring up-to-date your existing Osram '912' or obtain full details for constructing this versatile and remarkable Amplifier for High Quality Sound Reproduction. It costs 4s. 0d. from your dealer or by post 3d. extra from Osram Valve & Electronics Dept.

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2.

STABLE · ACCURATE · TEN RANGES

The new Pye "Scalamp" Megohm per Volt D.C. Voltmeter opens up fresh possibilities of measurement in a very wide variety of applications. It is of particular interest to electronic engineers in that it enables measurements of D.C. circuit potentials to be taken directly with higher accuracy than with any comparable instrument. Measurement of insulation resistance can be made with great rapidity and ease. On the upper ranges, the input resistance compares favourably with all but the most elaborate D.C. valve voltmeters, and this without any measurable drift and with complete independence from spurious variations caused by mains or battery supply. The comparative simplicity of construction enables the price to be set at only a fraction of that of instruments of similar performance.

Specification

14 cm (5½″); scale calibrated in two range 0-10 and 0-30. Ten-way switch giving full-scale ranges of 0.01, 0.03, 0.1, 0.3, 1.0, 3.0, 10, 30, 100 and 300 volts. Light Spot supply via built-in transformer from 200-250 volts A.C. or from 4-volt battery. Accuracy ±1%.

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1AC6	3C23	6B5	6N7GT	7H7	16A5	77	808	4020A	CMG28	DK92	EL91
1A3	3C24	6B6G	6P7G	7N7	17Z3	78	809	4021A	CMV6	DL63	EY51
1A5GT	3C45	6B7	6Q7G	7Q7	18	80	810	4033A	CMV28	DL66	EZ40
1A7G	3CP1	6B8	6Q7GT	7R7	19AQ5	80/S	811	4045A	CV3	DL82	FG17
1A7GT	3D6/129	6B8G	6R7	7S7	19E2	81	813	4046A	CV6	DL92	FG27A
1B26	3DP1	6B8GT	6R7G	7W7	19X3	82	814	4060A	CV24	DL93	FG67
1B27	3FP7	6BA6	6R7GT	7Y4	19Y3	83	815	4205E	CV43	DL94	FX215
1C5G	3LF4	6BE6	6S7	7Z4	21A6	83V	816	4212E	CV52	DRM1B	G650
1C5GT	3Q4	6BG6G	6SA7	8D2	23D	84	826	4260A	CV57	DRM2B	GDT4B
1D5	3Q5G	6BH6	6SA7GT	8D5	24G	88J	828	4313C	CV58	DRM3B	GEX00
1D6	3Q5GT	6BJ6	6SC5	9D2	25A6/G	89(Y)	929A	4328D	CV64	E444S	GEX34
1D8/GT	3S4	6BR7	6SC7GT	9D6	25A6GT	100TH	929B	4378	CV67	E1148	GEX35
1E7G	3V4	6BS7	6SD7GT	9HP7	25L6	117L7GT	830B	4690	CV72	E1155	GEX44/1
1E7GT	4C27	6BW6	6SF5	10	25L6GT	117N7GT	832	5763	CV75	E1190	GEX45/1
1F5G	4C29	6BW7	6SF7	10Y	25SN7GT	117Z6GT	832A	7193	CV83	E1191	GEX54
1G4GT	4D1	6BX6	6SG7	10D1	25Y5	210HL	833/833A	7475	CV85	E1192	GEX54/3
1G5G	4J53	6C4	6SH7	11D3	25Z4G	210SPG	836	8011	CV88	E1231	GEX54/4
1G6/GT	4THA	6C5	6SH7GT	11D5	25Z5	210SPT	837	8012A	CV92	E1248	GEX54/5
1H5G	4TPB	6C5G	6SJ7	12A6	25Z6G	210VPT	838	8013A	CV100	E1254	GEX55/1
1H5GT	5AP1	6C5GT	6SJ7GT	12A6GT	25Z6GT	212E	841	8016	CV101	E1265	GEX64
1H6G	5A/102D	6C6	6SJ7Y	12A8GT	27	215P	843	8019	CV118	E1266	GEX66
1L4	5B4G	6C21	6SK7	12AH7GT	28D7	215SG	850	8020	CV119	E1271	GEX69
1LA6	5B/502A	6CD6G	6SK7GT	12AH8	30	217C	860	9001	CV125	E1273	GL466A
1LC6	5BP1	6CH6	6SL7GT	12AT6	32	220B	861	9002	CV172	E1320	GL451
1LD5	5CP1	6D6	6SN7GT	12AT7	33	220P	863	9003	CV174	E1323	GT1C
1LH4	5CP7	6D7	6SQ7	12AU6	33A/100A	220RC	864	9004	CV179	E1359	GU20
1LN5	5C/450A	6E5	6SQ7GT	12AU7	35A5	220TH	865	9006	CV192	E1368	GU21
1N5G	5D21	6E6	6SS7	12AX7	35L6GT	231D	866A	AC4/PEN	CV415	E1379	GU50
1N5GT	5FP7	6F5	6ST7	12BA6	35T	250TH	866JR	ACP4	CV967	E1436	H30
1P5GT	5GP1	6F5G	6T7G	12BE6	35TG	262A/B	869B	ACT6	CV980	E1468	H63
1Q5GT	5JP4	6F5GT	6U5G	12BH7	35W4	279A	872A	ACT17	CV988	E1474	HD14
1R4	5L35	6F6	6U5/6G5	12C8	35Z3	282A	874	APP4B	CV1481	E1481	HF30
1R5	5LP1	6F6G	6U7G	12C8GT	35Z4GT	304TH. TL	875A	APP4C	CV1583	E1494	HL2
1S4	5R4GY	6F6GT	6V6	12DP7	35Z5GT	307A	876	APP4G	CV1588	E1496	HL2K
1S5	5T4	6F7	6V6G	12H6	36	310A	878A	AR12	CV1598	EA50	HL4
1T4	5U4G	6F7E	6V6GT	12J5GT	37	310B	884	AR13	CV6008	EB34	HL23
1U5	5V4G	6F8G	6W2	12J7GT	38	311A	905A	AR300A	CY31	EB91	HL41
1V	5X4G	6F8GT	6W7G	12K7GT	39/44	313C	923	AR4101	CY32	EBC3	HP210
2A3	5Y3G	6G5G	6X4	12K8	40	323A	931A	ARP3	D1	EBC33	HR210
2A4G	5Y3GT	6G6G	6X5	12K8GT	41	327A	954	ARP4	D15	EBC41	KMV6
2A5	5Y4G	6H6	6X5G	12Q7GT	41MP	328A/4328A	955	ARP13	D41	EC54	KR3
2A6	5Z3	6H6G	6X5GT	12SA7	41MPT	337A	956	ARP38	D42	ECC81	KR6/3
2A7	5Z4	6H6GT	6Y6G	12SA7GT	41MTL	354V	957	ARS6	D43	ECC82	KRN2
2B7	5Z4G	6J5	6Y7G	12SC7	41MXP	357A	958A	AT4	D63	ECC83	KT2
2C26	5Z4GT	6J5G	6Z5	12SG7	41STH	368A	959	AT15	D77	ECC91	KT8
2C26A	6A3	6J5GT	7A2	12SH7	42	380A	991	AT40	DA30	ECH22	KT24
2C34	6A6	6J6	7A4	12SJ7	42SPT	388A	1299A	ATP4	DA60	ECH35	KT30
2C40	6A7	6J7	7A5	12SJ7GT	43	394A	1616	ATS70	DA90	ECH42	KT31
2C43	6A8G	6J7G	7A6	12SA7	45	450TL	1619	AU5	DA100	ECL80	KT32
2D21	6A8GT	6J7GT	7A7	12SK7GT	45SPEC	703A	1622	AU7	DAF91	EF22	KT33C
2E22	6AB7	6J8G	7B6	12SL7GT	46	705A	1624	AZ1	DDR25	EF36	KT44
2J21A	6AB8	6K6G	7B7	12SN7GT	50C5	707A/B	1625	AZ31	DET5	EF37	KT61
2J34	6AC7	6K6GT	7B7E	12SQ7	50CD6G	708A	1626	AZ41	DET9	EF37A	KT66
2J36	6AF6G	6K7	7BP7	12SQ7GT	50L6GT	709A	1629	B21	DET12	EF39	KT71
2J39	6AG5	6K7G	7C4	12SR7	50Y6GT	713A	1635	B30	DET16	EF41	KTW61
2J48	6AG7	6K7GT	7C5	12U5G	53A	714AY	1642	BL63	DET19	EF50	KTW62
2J54	6AJ7	6K8	7C6	12X3	53KU	717A	1648	BT45	DET25	EF54	KTW63
2J54B	6AK5	6K8G	7C7	12Y4	54	723A/B	1815	C5B	DF91	EF80	KTZ41
2X2/879	6AK6	6K8GT	7D5	14B6	57	724A	1851	C1C	DF92	EF91	KTZ63
2X2A	6AL5	6L5G	7D7	14E7	58	725A	1960	C9A	DH63	EF92	KTZ73
3A4	6AM5	6L6	7D8	14H7	59	726A	2050	CAG25	DH76	EF93	L2
3AP1	6AM6	6L6G	7D9	14K7	61P	800	2051	CAV25	DH77	EF94	L30
3B7/1291	6AQ5	6L6GA	7E5	14R7	71A	801	2151	CK1005	DH81	EF95	L63
3B24	6AT6	6L7	7E6	14S7	72	801A	3951	CL33	DH101	EL22	L77
3B26	6AU6	6L7G	7E7	15D2	73	803	4003A	CMG8	DH107	EL32	L610
3B/151A	6AV6	6N7	7F7	15E	75	805	4019A	CMG22	DK91	EL33	LD210
3BP1	6B4G	6N7G	7G7	15R	76	807	4019B	CMG25	DK91	EL41	LD410

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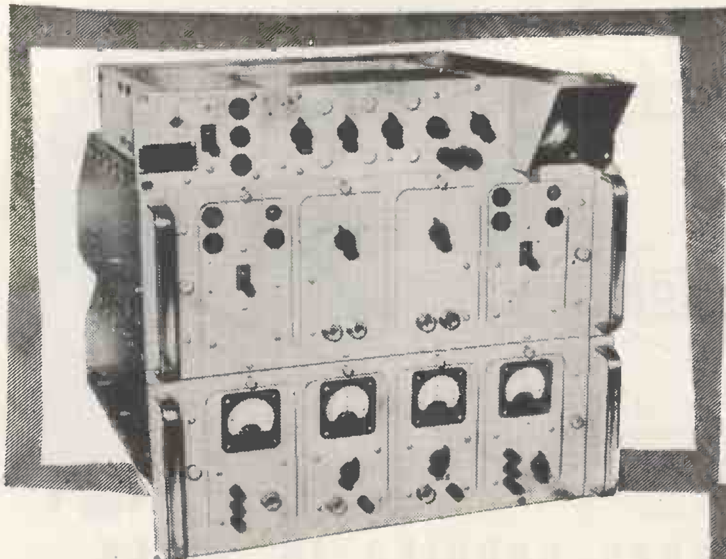
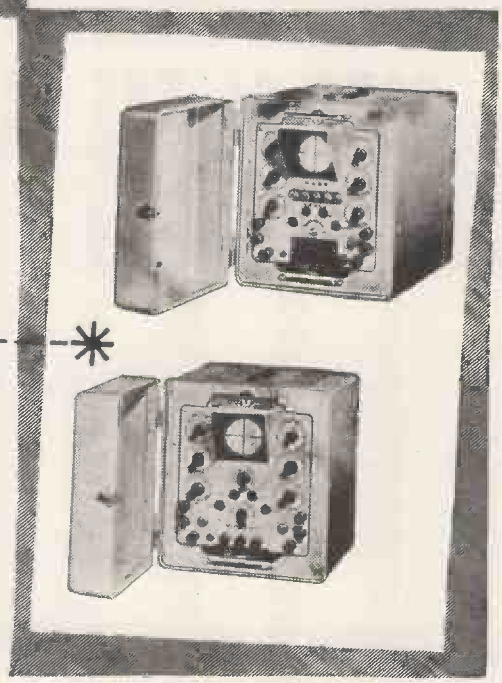


✱ FREQUENCY SHIFT TELEGRAPH TERMINAL EQUIPMENT

Designed to work in conjunction with conventional receivers for the reception in dual diversity, of wide or narrow band frequency-shift and on/off, or reversed on/off, hand or automatic radio telegraph and teleprinter signals. Up to 85 db of rapid variation in input signal level can be accepted with frequency-shift working, and up to 35 db with on/off or reversed on/off, working. Keying speeds up to 200 bauds can normally be handled—this range can be extended if required. This versatile receiver is also suitable for use with the new 50 c/s Pilot Carrier frequency shift system.

A.T.E. Telegraph Equipment



TELEGRAPH DISTORTION MEASURING SETS

This equipment is available either in portable form or arranged for standard width rack mounting. There are two units each 18½″ x 11½″ x 13½″, both mains driven, either may be used independently for certain tests or both may be used in combination to cover a comprehensive series of tests. These tests, which need not interfere with normal transmission, cover transmission and reception. The transmitting unit can send perfect or distorted signals at any speed from 20 to 80 bauds or up to 200 bauds with modification. It can generate reversals and character repetitions and incorporates a 100 character test message sender. An additional feature of this unit is its use as a relay tester.

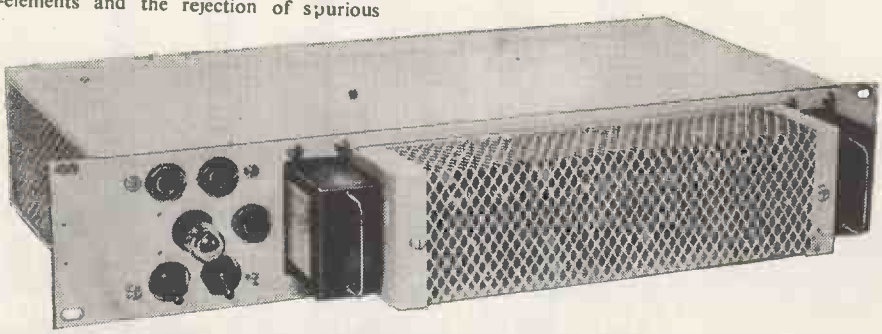
The receiver unit indicates the distortion on a *working circuit* without interrupting the service. Each element of a start-stop signal appears separately on the CRT which produces a spiral time base display. Adjustable speeds from 20 - 80 bauds or up to 200 bauds with modification.

✱ REGENERATIVE REPEATER

A mains operated, start-stop, five unit code equipment. Designed for use in both radio and line teleprinter circuits to regenerate and correct distorted signals, it also arranges for the automatic insertion of correct length stop-elements and the rejection of spurious signals.

Details of these and other telegraph equipments will gladly be sent on request.

REMEMBER POPPY DAY



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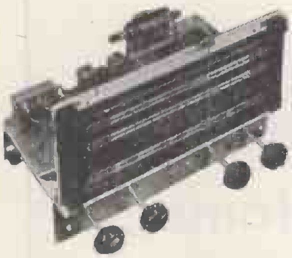
PURETONE



RADIO RECEIVER CHASSIS

Built to the highest specifications, these chassis offer the finest value to the enthusiast. Supplied with set of selected knobs. Socket panels for aerial, earth, speaker, pick-up and gram motor. 200/250/50 cycles only.

TYPE A 5 VALVES

TYPE A: 5 valves 3-wavebands Superhet with full negative feedback and A.V.C. Built-in Ferrite antenna. Full range tone control, **£9/19/6**

TYPE B 7 VALVES

TYPE B. 7 valves 3-wavebands Superhet with specially designed push-pull output stage. Separate Bass and Treble control, **£15/4/6**

SPECIAL F.M. CHASSIS

A six-valve pure F.M. chassis with single waveband only, covering all existing and projected B.B.C. FM transmissions. Highest degree of I.F. amplification making it ideally suitable for fringe areas. Output stage specially designed around an EL 41 output valve ensuring a really wide audible frequency range. Permeability-tuned circuit with high stability factor. Special wide-range tone control. Output 4 watts. A.C. 50 cycles only. Provision for external speaker. Co-axial socket for dipole aerial. **13 Gns.**

A.M./F.M. CHASSIS

A nine-valve A.M./F.M. chassis with 4 wavebands (Long, medium, short and F.M.) push-pull output stage and magic eye for precision tuning. Specially designed, with permeability-tuned F.M. circuit and a very high degree of I.F. amplification for fringe-area reception, it offers the finest quality regardless of price. Automatic volume control and a special wide-range tone control. Push-pull output stage and compensated network for electrostatic treble speaker, with an output of 5 watts and the widest possible audible frequency range. Special large 10in. high flux-density F.M. Speaker with hyperbolic cone plus matched high-tone electrostatic Speaker. Co-axial socket for dipole aerial. A.C. 50 cycles only. Provision for external speaker. **23 Gns.**

A.M. CHASSIS

5-valve Superhet, 2 wavebands (medium and long). AC/DC 200-250 volts. Output 4 watts. Controls—tuning, on/off volume, wave change. Developed to meet the demand for an inexpensive instrument with no sacrifice in the quality of its reproduction and output. **8 Gns.**

Packing and carriage for all Chassis 12/6.

CABINETS

The magnificent Bureau type Cabinet illustrated is in specially selected walnut veneered exterior with light Sycamore interior with matching Rexine lining. Two full-sized compartments. Overall measurements: 34in. x 17in. x 33in. high. Price **£17/0/0**

Other high-quality cabinets are available at prices ranging from 10 Gns.

Packing and carriage 15/-.

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DISC PLAYER

Specially designed for the amateur builder, these Disc Players consist of the latest 3-speed Automatic Record Changers, complete with crystal turnover pick-up head for long-playing and standard records, mounted on Sycamore lines base. Supplied complete with fitted Mains lead and screened pick-up lead, ready for connecting up. Price **£10/16/0**

Packing and carriage 7/6.

AUTOMATIC RECORD CHANGERS

Cat. No. RC/A—B.S.R. Monarch, or latest Collaro, 3-speed	£9 15 0
Cat. No. RC/B—GARRARD RC.80, 3-speed, automatic A.C. Mains	£13 0 0
Cat. No. RC/C—GARRARD RC.80, 3-speed, automatic AC/DC, Universal	£26 10 0

Packing and carriage 7/6.

UNBEATABLE VALUE

TAPE RECORDER

In a superbly fitted Moroccan grained carrying case, this instrument is the very finest of its class, regardless of price.
Latest type TRUVOX twin-speed Tapedeck. Input for radio, Gram, and Microphone. Built-in selected elliptical Speaker of the very finest quality. Recording (with recording level indicator) or Play-back. 200/250 volts, 50 cycles, A.C. Mains only.

Supplied complete with selected Microphone and Recording Tape. **42 Gns.**

TAPE DECKS

TRUVOX 2-speed, twin track, Tape Deck of the latest type, with push-button controls. **£23/2/0**

Packing and carriage 5/-.

Tape Recorder, Amplifier only. Built to the highest standards, magic eye for indicating recording level. **12 Gns.**

Packing and carriage 7/6.

LOUDSPEAKERS

Cat. No. LS/10—10in. Standard	£1 5 0
Cat. No. LS/E74—7in. x 4in. ELLIPTICAL	19 6
Cat. No. LS/5—5in. Standard	17 6
Electrostatic Loudspeaker LSH75, for treble response	11 6

Packing and carriage 3/-.

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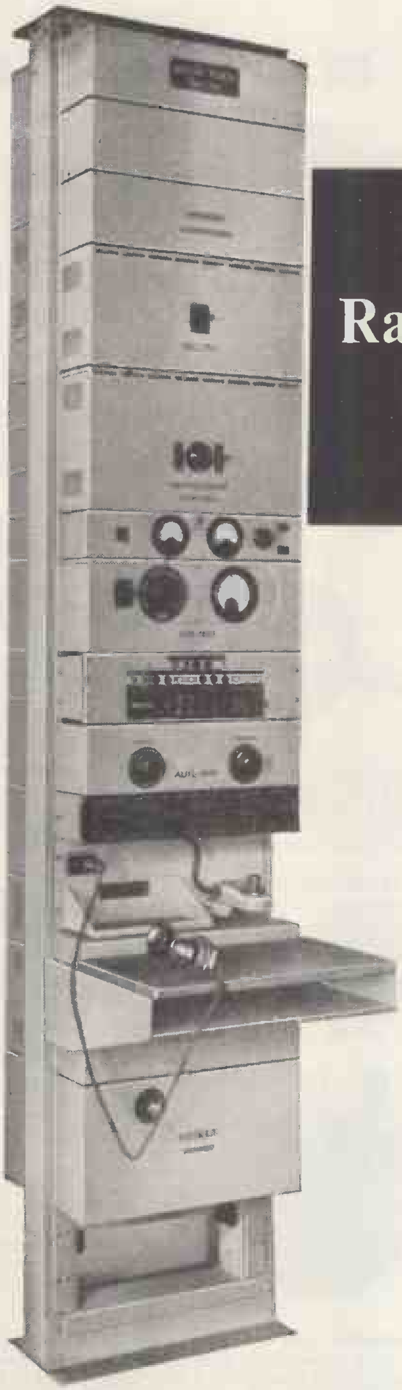

MARCONI-SIEMENS

Radio Telephone Terminal

TYPE B
(HW 21)

The type B (HW 21) terminal provides a satisfactory junction of HF radio with line or cable telephone and telegraph circuits. Its primary function is to eliminate the unstable conditions due to the inherently high gain in the radio link by ensuring that the radio circuit is operative in one direction only at any one instant. It also provides facilities for controlling the signal levels to the line or to the radio transmitters for discriminating against line and radio noises, and for simple privacy working. Its features include semi-automatic operation, two or four-wire line connection, electronic VF switching, radio calling facilities, and centralised test and monitoring facilities. It is self-contained for AC mains supply.

Marconi

THE LINK BETWEEN RADIO AND LINE COMMUNICATIONS

SIEMENS BROTHERS

Full details of this and other Marconi-Siemens equipment, which provides completely integrated radio and line telegraph and telephone systems may be obtained from either—

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX
OR SIEMENS BROTHERS & CO., LIMITED, WOOLWICH, LONDON, S.E.18

MS 1

A new Armstrong Radiogram

Specialists in High Quality Reproduction for over 20 years

The Super

We guarantee that this will be the FINEST Radiogram you have ever heard

A beautifully styled and well-made cabinet finished in Mahogany or Walnut veneer.

Twin speaker system with cross-over network incorporating the WHARFEDALE Golden 10in. (cloth suspension) and special TWEETER unit with aluminium voice coil in a heavily lagged acoustic chamber.

The ARMSTRONG 8-watt push-pull chassis incorporating negative feedback and independent Bass and Treble lift and cut controls—a worthy successor in the long line of tried and proven Armstrong radio chassis

The latest COLLARO RC54 High Fidelity Autochanger with Turn-over Crystal Pickup and Sapphire Stylus.

82 guineas

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TRIAL IN YOUR OWN HOME. Your money will be returned if for any reason you are not satisfied after 7 days' trial.

and FM

The ARMSTRONG F.M. 56 Tuner designed to give the FULL benefit of the superb V.H.F. transmission will be fitted if specified (£21 extra).

GUARANTEE: All our models are sold under full and unconditional money back guarantee of satisfaction. HIRE PURCHASE facilities are available.
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STANDARD 69 gns.
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UNIVERSAL VALVE VOLTMETER

Model VM853

- *WIDE RANGE OF VOLTAGE MEASUREMENTS*
- *HIGHEST POSSIBLE INPUT RESISTANCE ON ALL RANGES*
- *MEASURES FROM D.C. TO U.H.F*

On the lower D.C. ranges, this instrument approaches conditions of an electrostatic voltmeter and on A.C. ranges a measuring diode contained in an external probe, is provided. To minimize the effect of the metal body of the probe, the insulated terminal head can be replaced by a spike. All-range indicator consists of a 5-inch meter fitted with knife-edge pointer and mirror scale. Send for leaflet giving full specification.

	D.C. Ranges	*A.C. Ranges*
Volt Ranges -	0-300 *mV*. 0-1*V*- 0-300*V*	0-1*V* 0-3*V*- 0-100*V*
Accuracy	±2% *of f.s.d.*	±2% *of f.s.d.*
Input -	*For the first five ranges, 25 meg-ohms*	*20 megohms up to medium* R.F. *on all ranges*

BRITISH PHYSICAL LABORATORIES

Radlett, HERTS *Tel: RADLETT* 5674-5-6

dmBP31

STABILISED POWER UNIT

A32

Immediate delivery

This small, compact, general purpose unit is ideal for laboratory use or production testing where a stable D.C. supply is essential.

Input—210, 230, 250 V., 40—100 C.P.S.

Output—Stabilised, 120—400 V., 120—80 mA (in two ranges).
Unstabilised, 530—680 V., 150—0 mA.
3.15—0—3.15 V., 4 Amps. A.C.

Stabilisation—Less than 0.15 V. change in output voltage for 10 V. change in mains voltage.

Write for full details of the A32 and other stabilised Power Units of our comprehensive range to—

BOULTON PAUL ELECTRONICS

BOULTON PAUL AIRCRAFT LIMITED, WOLVERHAMPTON, ENGLAND

THE

Reflectograph R R SERIES 100

A new high quality Record/Reproducer utilizing separate record, and a transistor playback amplifier with full monitoring facilities during recording.

The transistor head amplifier and equalizing stages of the playback unit permit an extremely low hum level, while the playback quality from this amplifier is of the highest order.

The playback characteristics conform closely to the recommended C.C.I.R. specification, so that recordings made on this instrument, as well as the replay of tape records, require only that the "BASS" and "TREBLE" controls on the main amplifier be maintained in the "FLAT" position, to obtain the correct playback response.

For use in research and industry this instrument is available in multi-channel form (up to 16 channels) to special order; with a frequency response from 60-12000 cycles ±3 d B, and/or from D.C. levels to 100 cycles in conjunction with Model T sub-unit.

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All mouldings will accept ¼in. spindle.

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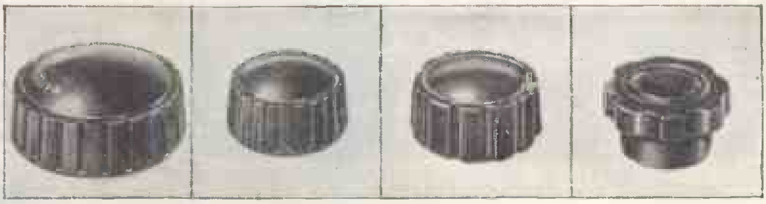


TYPE "A"
1⅝in. dia. × ⅞in. deep. Large ribbed knob in walnut, ivory or black. 4 B.A. grub screw and locknut fixing.
Can be engraved to suit your requirements.

TYPE "B"
1¼in. dia. × ⅝in. deep. Small ribbed knob in walnut, ivory or black. 4 B.A. grub screw and locknut fixing. Matches type "A."

TYPE 324
1¼in. dia. × ⅝in. deep. Medium-sized fluted knob in black or white. Brass insert and one 4 B.A. grub screw for fixing.

TYPE X5/P.1325
1¼in. dia. × ⅝in. deep. Black fluted instrument knob with brass insert. Fixing: two 2 B.A. grub screws.

TYPE X9/P.1375
1⅝in. dia. × ⅞in. deep. Identical to Type X5/P.1325. Ideal for test apparatus, etc.

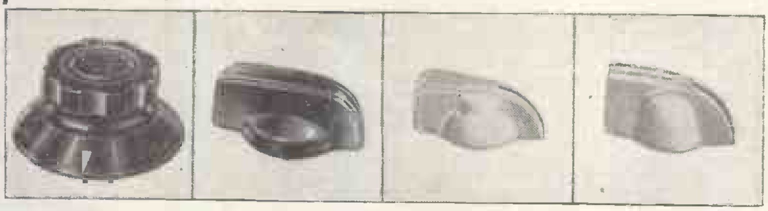
TYPE.1322/X7
Top 1⅛in. dia. Base 1⅝in. dia. ⅝in. deep. Flanged instrument knob with white pointer. Brass insert. Fixing: Two 2 B.A. grub screws.

TYPE P.1322/X11
Top: 1 5/16in. dia. Base 2⅛in. dia 13/16in. deep.

TYPE 5060
1½in. long, 1in. wide, 9/16in. deep. Useful pointer control knob in black with white nose marking. Fixing: grub screw and locknut.

TYPE 327
1¼in. long, ⅞in. wide, ½in. deep. Popular instrument knob in black or white with suitable nose marking. Moulded with brass insert. Fixing: one 4 B.A. grub screw.

TYPE D.2265
1¼in. long, ¾in. wide ⅝in. deep. A particularly attractive cream pointer knob with black nose marking. Positive fixing by means of one 4 B.A. grub screw.



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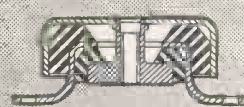

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Load ratings indicated for Mobile Applications (including shipboard installations) are such as to ensure a vertical natural frequency between 25 and 35 c.p.s. The design and assembly of the metal parts are such that they are self-captivating for maximum security.

Samples are available immediately ex stock

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- ★ MOBILE electronic and electrical equipment.
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- ★ PROVIDING the optimum combination of impact isolation, vibration isolation, noise reduction, stability for the mounted unit.

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"Barrymount" isolators are made in England under licence from Barry Controls Incorporated of U.S.A.

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CEMENTATION (MUFFELITE) LTD., 39 VICTORIA STREET, LONDON, S.W.1

CB2

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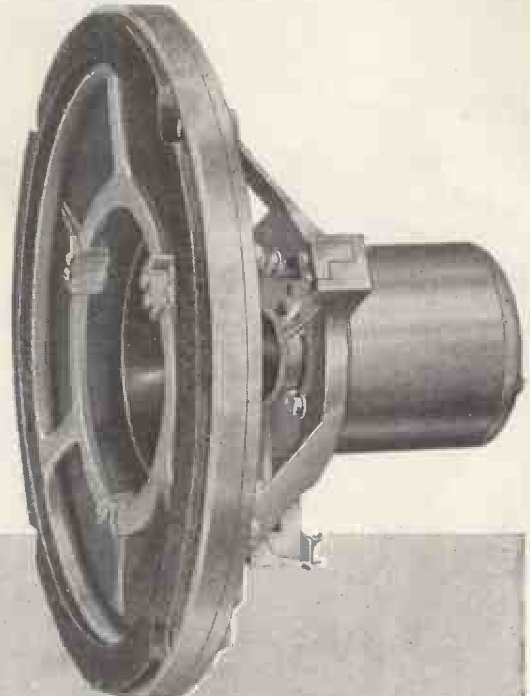

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Smooth response from 20 to 20,000 cycles.

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The most significant single contribut on to the superb performance of the AXIOM 80 lies in the unique method of cone suspension. Three counter biased pairs of cantilevers are employed at the rim and at the voice coil.

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Properly baffled, the AXIOM 80 provides smooth response from 20 to 20,000 cycles. The bass is crisp and clean with no trace of " hangover "—you hear the true fundamentals. The middle register is clear and articulate. The high frequencies are present without intrusion— adding character and timbre.

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Goodmans

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Poppy Day

FOR *High Fidelity* SOUND REPRODUCTION

The PYE Provost Amplifier and Proctor Remote Control Unit have been critically designed and produced with one end in view . . . to provide true high fidelity sound reproduction in a versatile, practical and attractive combination. An undistorted output of 25 watts provides ample power for high fidelity systems in the home, the school, the broadcasting studio or the social club.

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26db negative feedback and an output from 2 c.p.s. to 160,000 c.p.s. (over 16 octaves) ● Practically distortion-free response combined with the infinite damping factor gives a standard of reproduction formerly unobtainable ● The output transformer is specially designed to meet the exacting specification of the amplifier ● The amplifier can be controlled from a distance of up to 20 ft. (6m.) Cathode follower output from the remote control unit minimises cable losses.

PROCTOR REMOTE CONTROL UNIT HF25A

Smooth, highly flexible controls and facilities for record player, tape recorder, microphone and radio tuner inputs ● Five types of plug-in compensators are available, which match all known types of pick-up ● Four switched inputs and a choice of four record replay characteristics for U.S. COL. L.P., R.I.A.A. or EUR. L.P., U.S. 78, or EUR. 78 ● Continuously variable lift and cut controls for bass and treble with clearly marked level positions ● Treble filter control gives three sharp cut-off frequencies and an unrestricted response position.

PROVOST

POWER AMPLIFIER

HF25

PROCTOR

REMOTE CONTROL UNIT

HF25A

price complete:

40 GNS

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Pye (New Zealand) Ltd., Auckland C.I., New Zealand.	Pye Pty. Ltd., Melbourne, Australia.	Pye Limited, Mexico City.	Pye Limited, Tucuman 829, Buenos Aires.

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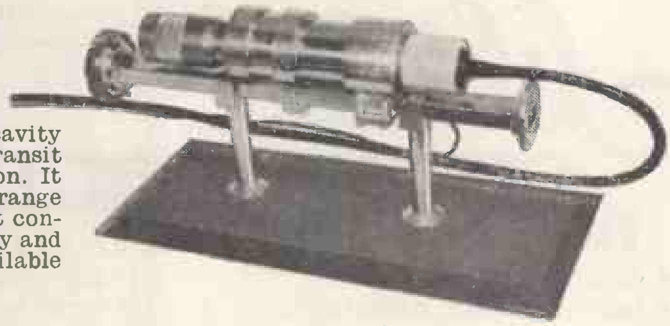
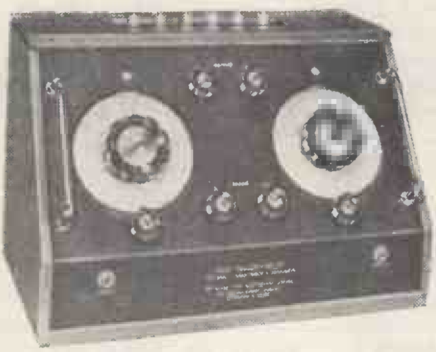
Wayne Kerr

Measuring Instruments



X BAND OSCILLATOR
Type S.381

The Oscillator employs a co-axial cavity $5\lambda/4$ long and operates in the $4\frac{3}{4}$ transit time cycle of the CV.2346 Klystron. It will operate over the wavelength range 3.0-3.55 cms with a power output constant within 2 db. Power Supply and Modulator Unit Type Z.121 is available for use with this oscillator.



RADIO FREQUENCY BRIDGE Type B.601

A wide range bridge for the measurement of resistance, capacitance and inductance between 15 Kc/s and 5 Mc/s. It will measure complex impedances balanced and unbalanced and between any pair of terminals in a three terminal network.

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Five decades of Minalpha wire resistors arranged in potentiometer form to give ratios between 0 and 1 in steps of .00001. For ratios between 0.1 and 1, the accuracy is better than .01%. Total resistance 100,000 ohms—applied input voltage 300V maximum. The assembly is specially aged for long-term stability.

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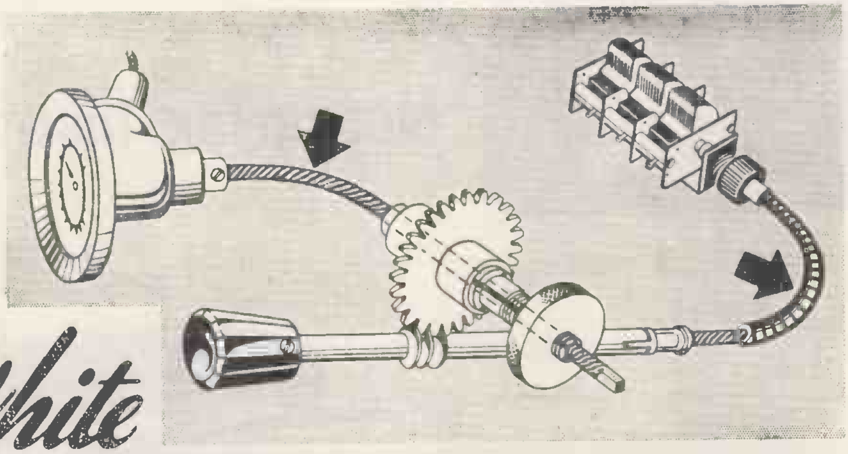

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FLEXIBLE SHAFTING

for *REMOTE CONTROL of ELECTRONIC EQUIPMENT*

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Flexible Shafts give freedom in design because they can be run between any two parts and eliminate alignment problems.

The S. S. White Company produce Remote Control Shafts to meet any requirement.

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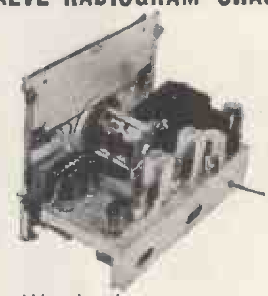
An extremely sensitive 5-valve tuner with internal power supply for AC Mains 200/250 volts. 2 position switch for Gram and F.M. (tuner switched off in Gram position).
Permeability tuned and temperature compensated against drift.
Geared drive with illuminated calibrated dial Valve line-up: ECC85 twin triode as grounded grid RF stage and mixer. 6BJ6 I.F. amplifier 6BJ6 limiter 6AL5 ratio detector 6V4 rectifier.
Your existing radio or amplifier converted to FM in a few minutes.

Price **£13 15 0** Complete
(including Tax)
Carriage and Packing 7/6 extra.

7 VALVE RADIOGRAM CHASSIS



Three Wavebands:—
SW 13.6 m. to 50 m.; M.W. 195 m. to 550 m.; L.W. 800 m. to 2,000 m.
7 latest type valves: 12AH8, 6BW6, 6AT6, 12Ax7, 2-6AQ5, 5Y3. Push Pull Output. AC Mains 200/250. Output transformer fitted. Large illuminated dial. Sockets for speaker and pick-up. 4 position wavechange switch. High Q RF and IF coils. Special detector circuit for high gain and superior A.V.C. Complete with knobs.

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You can now drive that AC record changer from your DC Mains using this effective 50 cycle electronic converter. Input 200/250 DC. Output 200/250 v. AC 25/30 watts. Variable frequency and output controls. Valves: Osram 277 and two KT55's. In Push Pull. Frequency stable with Mains Variations from 190 to 250 volts. Easily fitted. Full instructions.

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LINE OUTPUT TRANSFORMER

TYPE L.O. 352

"L.O.352" IS THE TYPE NUMBER OF AN ENTIRELY NEW ALLEN LINE OUTPUT AUTO-TRANSFORMER NOW AVAILABLE.

Note the following "Star" features:

★ E.H.T.: 14 to 18 KV.
★ E.H.T. Regulation: Better than 5 MΩ.
★ Audible Whistle: Negligible.
★ Application: Self-running, Square-wave or Sawtooth driven.
★ Associated Valves: PL81, PY81.
★ Associated Yoke: Allen Type DC605/C.
★ H.T. Rail: 190 volts for 14KV.
★ Core Material: Mullard Ferroxcube (earthed).
★ Scanning Angle: 72 degrees.
★ Suitable C.R.T.s: Any "wide-angle" tube, from 14 to 21in.

Manufacturers are invited to write for further details and prices. Home Constructors: Please send S.A.E. for recommended circuit diagram and details.

COILS FOR WIRELESS WORLD F.M. TUNER

FMC 102	Aerial Coil	7/- each
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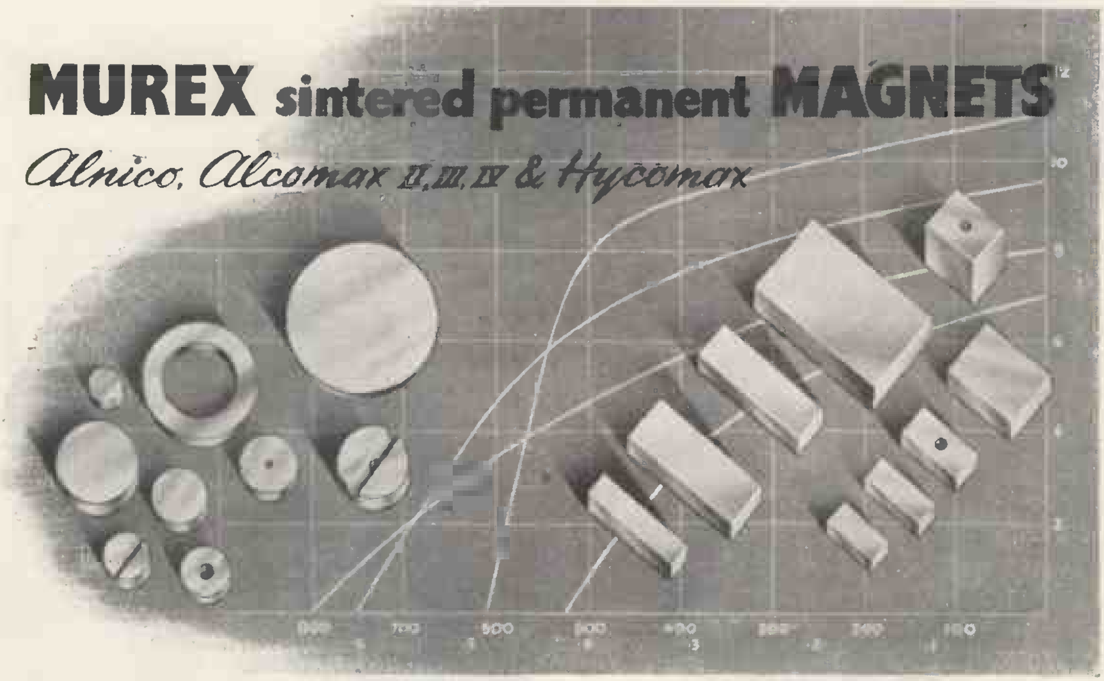
ALLEN COMPONENTS LTD. 197, LOWER RICHMOND ROAD, RICHMOND, SURREY



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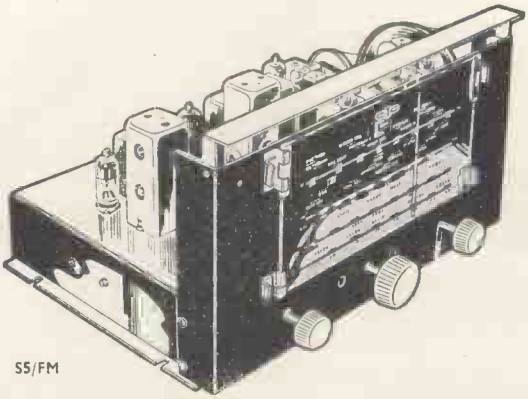

S5/FM

—TUNERS—

The combined V.H.F. Frequency and World Wide Amplitude Modulation Tuner uses a tuned R.F., self oscillating additive mixer, 2 x I.F. amplifiers, and Radio Detector on the V.H.F. band II with completely stable tuning. The AM section uses a tuned R.F. stage, F.C., High gain I.F. amplifier with variable selectivity, and delayed Amplified A.V.C. on all wave bands. A Cathode Ray tuning indicator is fitted and operates on all channels and bands. Available in two types.

S5/FM 16-50 m.; 195-550 m.; 800-2,000 m. A.M. 87.5-100 mc/s. FM
S5E/FM 12.5-37 m.; 35-100 m; 90-250 m.; 190-550 m. AM. 87.5-100 mc/s. FM.

For three years the FM81 has received the acclaim of the trade and private user alike. Completely stable tuning, distortionless output, high AM reject ratio, and tuning indicator are some of the many features that make it the most sought after FM tuning unit to-day! New valves and circuits now make possible the FM81 Mark II. Similar in size and appearance to its famous predecessor but with the following improved features.

- Increased gain at the aerial of over 20 db.
- Very low radiation into aerial.
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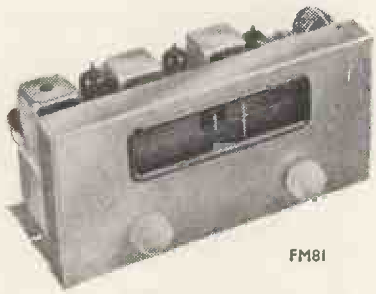
- Easier installation with choice of three escutcheons: Gold, Silver, Bronze.
- Improved A.V.C. characteristics.



FM81

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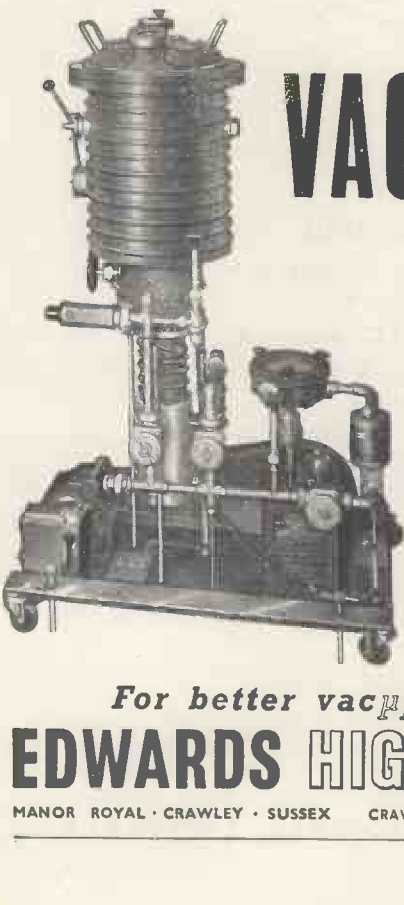

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½lb. Capacity

There is no need to emphasize the great technical advancements expected from the vacuum treatment of metals. Let us simply say, vacuum-cast ingots possess higher density because evolved gases are eliminated . . . higher tensile ductility . . . better stress and rupture strength . . . improved fatigue and creep properties . . . greater purity.

The EDWARDS ½lb. capacity model, illustrated, enables the research engineer to carry out sintering, melting and casting up to a temperature of 1,800°C.

For better vacuum service . . .

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limited space

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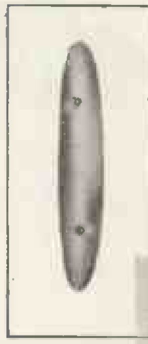

for **Plessey** "CASCAP"

CERAMIC DISC CAPACITORS

With the birth of CASCAP, many of the inherent difficulties in the design and production of certain types of Radio and Electronic equipment were instantly overcome. They were, of course, mainly considerations of space and economy in relation to the final product's performance. Compact, reliable and inexpensive, CASCAP capacitors ranging in value between 0.0005 mfd. and 0.01 mfd. are readily available. They are ideal for radio and electronic applications such as R.F. decoupling where precision of capacitance value is not of primary importance.

A NEWER APPLICATION. The present-day demands for compact items of electrically operated merchandise—mostly in the mass consumer field—give CASCAP a new and important role to play.

In view of the legal obligation to install suppressors in such products as electric razors, hair driers and the like and the space limitation factor in fabrication, CASCAP certainly provides a timely answer to what would otherwise have been a considerable problem to manufacturers.

Further information is supplied in Plessey Publication No. 728. A copy will be mailed, together with a sample Cascap capacitor, at your request.

Cascap Capacitors are produced by

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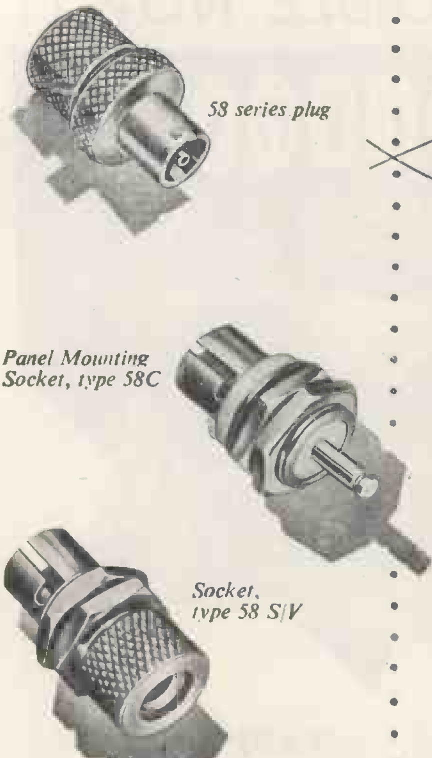
PC3b

TELCONNECTORS



58 series plug

Panel Mounting Socket, type 58C

Socket, type 58 S/V

co-axial plugs and sockets

The connectors illustrated are designed for use with the smaller diameter R.F. cables, such as Telcon PT.1.M, PT.11.M, AS.60.M, etc. Produced for instrument designers and general application, the 58 Series Plug and Socket has a capacitance of less than 7 μμF. The 58C panel mounting socket shown will accept any plug in the 58P Series.

All types are readily available in various sizes and combinations. Write for publication T/1.

TELCON RF cables

THE TELEGRAPH CONSTRUCTION & MAINTENANCE CO. LTD

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Connoisseur VARIABLE 3-SPEED GRAMOPHONE MOTOR

We present an entirely new three-speed unit operating at 33⅓, 45 and 78 r.p.m. The full 12in. turntable is lathe-turned and manufactured of non-ferrous material. The main spindle is precision ground and lapped to mirror finish and runs in phosphor bronze bearings. The synchronous motor is dynamically balanced and resiliently mounted, making it virtually vibrationless, with low noise level and low hum induction.

The speed change is arranged mechanically and gives a 2% variation on all speeds, the synchronous motor running at constant speed at all settings. No braking action is employed to obtain speed change.

It is suitable for playing standard transcription and microgroove recordings. Input voltages 200/250 v. A.C. 50 cycles or, as specified to order for 200/250 v. A.C. 60 cycles, or 110 v. A.C. 50 or 60 cycles. Mounted on ¼in. die-cast board 15¾in. × 13½in. with 3⅞in. clearance distance below motorboard. Speed selector turret is fitted at left rear of motorboard. On-off switch at left front also releases pressure on the rubber drive assembly. All motorboards are drilled to take Connoisseur Standard and Super Lightweight Pickups unless otherwise ordered. When used with these pickups mounted in position, 3¼in. clearance above motorboard is recommended.

Price: £20 + P.T. £7 2s. 6d. Total £27 2s. 6d.

NEW SUPER LIGHTWEIGHT PICKUP MARK II giving an extended frequency range on L.P. disc.

Head only (Standard or Microgroove) £7 + P.T. £2 9s. 10d Total £9 9s. 10d.

Pickup with one head £9 3s. 0d. + P.T. £3 5s. 2d. Total £12 8s. 2d.

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HARTLEY-TURNER SOUND EQUIPMENT

We should like once again to draw attention to the Hartley-Turner Super Control Pre-amplifier.
This unit is designed to feed the output from Tape recorders, Crystal and Magnetic Pick-ups and Radio Tuning Units to the main amplifier.
Employing sub-miniature valves and highest quality components throughout, this unit combines efficiency with simplicity of operation, reliability and compactness.

BRIEF SPECIFICATION:—
4 Switched input channels. Input sensitivity 1 volt, positions 1 and 2; 25 mV., positions 3 and 4 for 1½ V output from the Cathode follower output stage. Separate continuously variable Bass and Treble controls: Bass variable + 25 db at 40 c/s. Treble variable − 10 db to + 10 db at 10 Kc/s. Power requirements 250 V D.C. 3 mA. 6.3 V 0.9 A.
Whole unit completely screened and enclosed in metal case 10⅜in. × 3⅝in. × 3⅛in.

Full particulars sent free and post free on application to:

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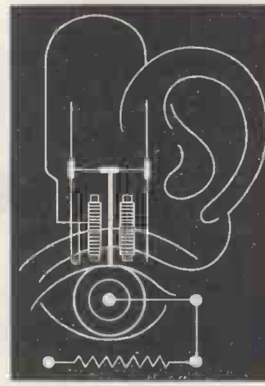

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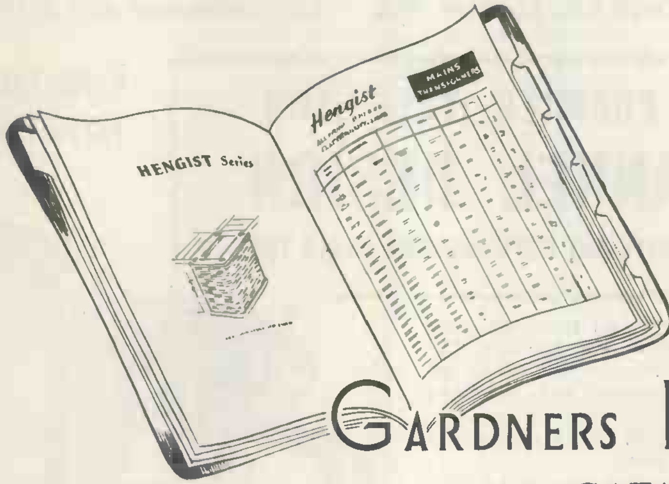

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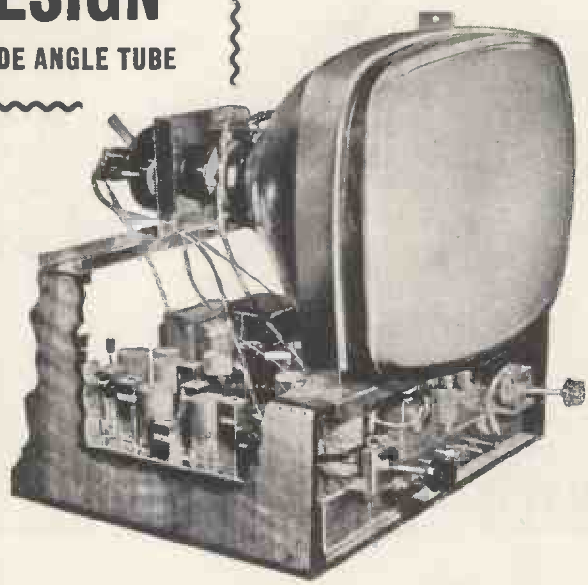

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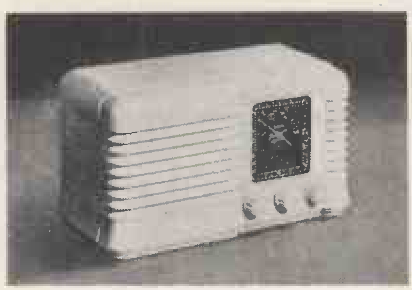

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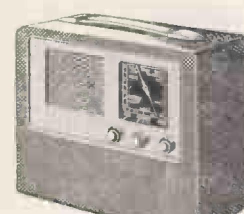

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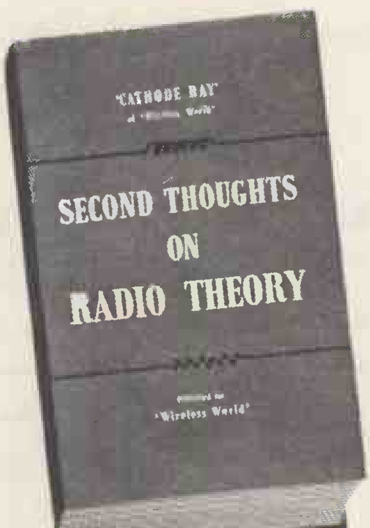

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RADIO, ELECTRONICS, TELEVISION

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Editor:
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NOVEMBER 1955

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PRICE: TWO SHILLINGS

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OF PUBLICATION

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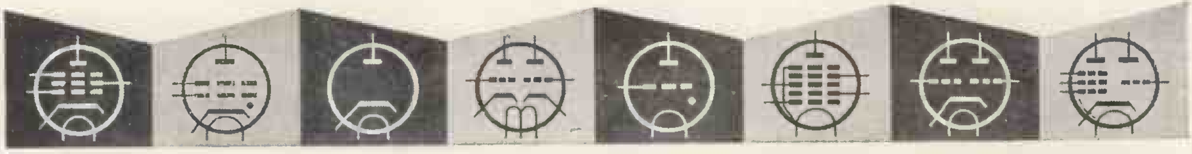


VALVES, TUBES & CIRCUITS

35. HIGH QUALITY SOUND REPRODUCTION

WIDE RANGE OF CIRCUITS

The high quality reproduction obtainable with modern audio valves at low cost has already been demonstrated by the circuit for a 5-valve 10-watt amplifier introduced last year. The '5-10' is now a firm favourite because of the easc with which it can be constructed and because it can be driven directly by many of the more popular and inexpensive types of crystal pickup.

Many constructors will, however, be interested in building a preamplifier for the '5-10' in order to use a pickup giving 40mV output, perhaps a magnetic type or a crystal pickup loaded for output proportional to stylus velocity. Suitable single-valve units of straightforward construction have been designed by Mullard engineers. There are two versions of the basic design. The first is referred to as preamplifier 'A', and is the one required by those who have already made a '5-10' in which the treble, bass, and volume controls are included in the main amplifier. The second version is known as preamplifier 'B', and is more suitable for those who are only just going to build the amplifier. Here the tone and volume controls are included in the preamplifier itself, giving more convenient access to the controls—particularly important if the equipment is to be assembled into a cabinet. The tone and volume controls in preamplifier 'B' are similar to those which can be incorporated in the main amplifier (as in the original design) but with the appropriate changes to component values. Both 'A' and 'B' are suitable for microphone input, or tape input with 30dB bass pre-emphasis at 120c/s.

Point-to-point wiring diagrams and chassis drawings are given in the booklet 'High Quality Sound Reproduction' for preamplifiers 'A' and 'B' and for the two corresponding versions of the '5-10' itself. The booklet also gives details of minor improvements and modifications made to the original amplifier circuit. Chiefly they are intended to take advantage of the high quality of the output transformers which have become available commercially and to give increased stability at the high and low frequency ends of the response. The rated output of the amplifier remains at 10 watts, but the overload point (onset of clipping with sine wave input) is now 14 watts: the hum and noise level is —75dB relative to 10 watts: and the basic sensitivity at the grid of the EF86 input stage is 40mV for 10 watts output with 26dB of feedback. The recommended rectifier is the Mullard EZ81, which has sufficient power reserve to supply the preamplifier and a radio feeder unit when either normal or low loading is employed in the output stage. The EZ81 has the same pinning as the EZ80 originally specified, but the *total* limiting resistance at each anode of the EZ81 must be at least 310Ω in this circuit.

Other Mullard circuits designed for high quality sound reproduction have been published recently in *Wireless World*. A 20-watt amplifier, sufficient for a small to medium-sized hall, was described in the May and June issues. The use of distributed load operating conditions in the EL34 push-pull output stage gives a total harmonic distortion of less than 0.05% at the 20 watts nominal output. A 3-valve preamplifier suitable for this and similar amplifiers was described in the July *Wireless World*, and the August issue contained an article on an f.m. tuner unit which can provide the input for the 10-watt or 20-watt amplifier. Point-to-point wiring diagrams and chassis drawings for these circuits, in addition to reprints of the *Wireless World* articles, are included in 'High Quality Sound Reproduction'.

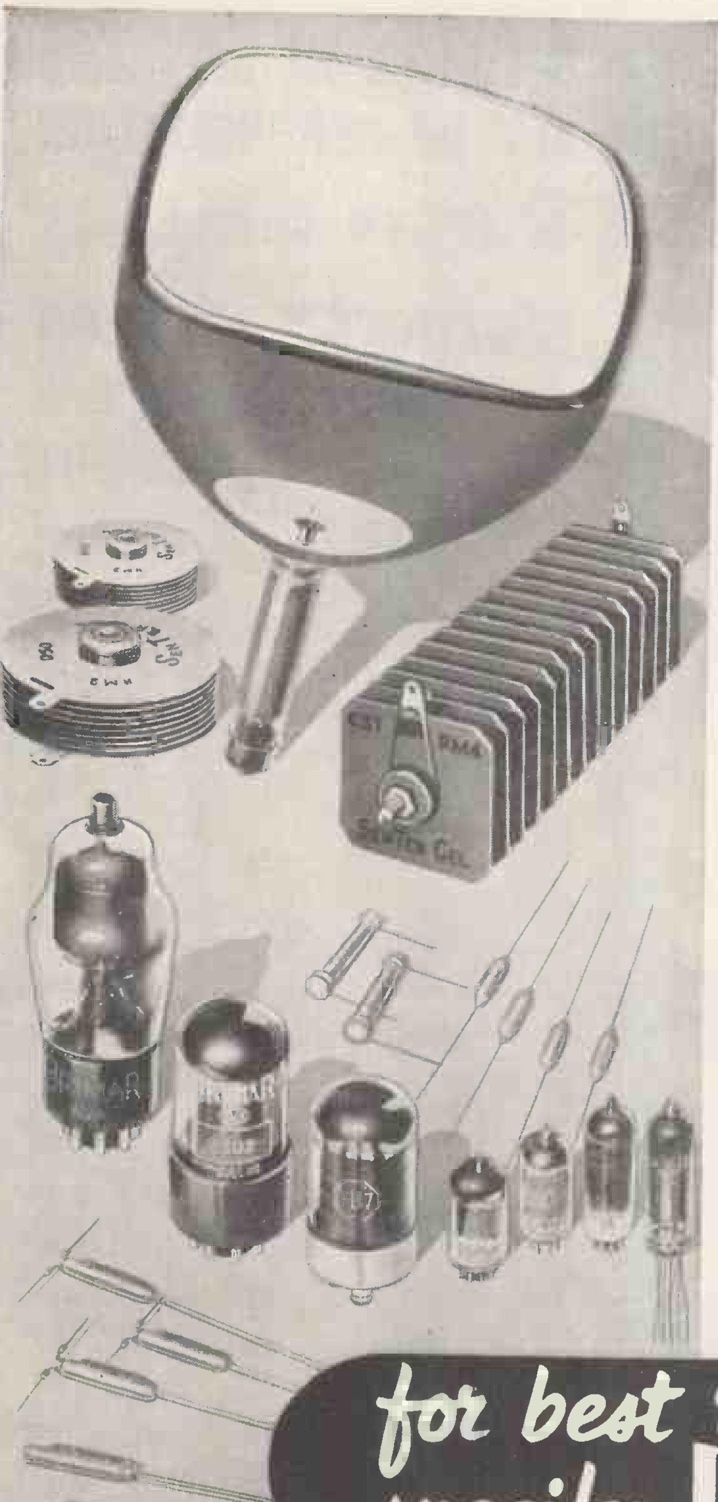
A 3-valve 3-watt amplifier has been designed for those who require reasonably high quality at low cost and with the simplest possible construction. The total harmonic distortion is 1.5% at 3 watts; the sensitivity is 100mV, and the amplifier is suitable for all types of crystal pickup. This amplifier can be driven by the f.m. tuner unit via a 5:1 attenuator. An EZ81 must be included to provide power for the f.m. tuner, and the mains transformer must then be rated at 90mA or 100mA. Preamplifier 'A', primarily designed for the 10-watt amplifier, is suitable here also; a 5:1 attenuator is required to preserve the original basic sensitivity. Without the attenuator the sensitivities are increased by a factor of 5. Details of the 3-valve 3-watt amplifier are available only in the form of a leaflet (free, from the address below).

NEW PUBLICATIONS

'High Quality Sound Reproduction' is available from radio retailers price 3s. 6d. It contains 48 pages, of which 44 are devoted to the designs described elsewhere on this page. There are 24 pages of information not previously published, including 14 pages of constructional drawings. The pages are 10 ins. by 8 ins.

The 'Mullard Maintenance Manual' is now on sale at radio retailers price 10s. 6d. It provides the information of most use to the service engineer for repairing and maintaining radio and television sets and audio amplifiers, and includes data on valves and tubes for maintenance purposes as well as on the latest types. Constructors and designers will also find this manual extremely useful as a quick reference guide to data. For the complete information required in designing new equipment the Mullard Technical Handbook (available on a subscription basis) should be consulted.

To help home constructors starting to experiment with transistor circuits a new leaflet is available free of charge entitled 'Junction Transistors for the Home Constructor'. It contains eight circuits using Mullard OC70 and OC71 junction transistors, which are now readily available. Background information is included for those who would like to go more deeply into the subject.



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"BELLING-LEE" NOTES

G9AED LICHFIELD

By the time this reaches the reader we hope that the G9AED test card will have been recognised by many hundreds of new viewers, and we do want everybody to know that every report received will be appreciated, and will be acknowledged by Q.S.L. card. Early reports are the most valuable, but please do not telephone, and please send reports to Enfield and not to the transmitter.

The transmitting equipment has been installed in the large trailer illustrated above, the power unit is a separate self-controlled 5 kW generator.

Regular transmissions should commence at 10 a.m. on Monday October 10th, and will be as follows:—Monday to Friday 10 a.m. -1 p.m., 3 p.m.-6 p.m. and 7.30 p.m. -8.30 p.m., Saturday 10.0 a.m. to 1 p.m. There will be no transmissions on Sundays or Bank Holidays.

From the results of our experience on London, we can tell you that it is a reasonable assumption that a locked picture of G9AED, in which all characters can be read, will secure a first class result for I.T.A. when it commences, and without any further major adjustment either to the aerial or receiver. A barely discernible and completely unlocked picture from G9AED will result in a picture of moderate entertainment value from I.T.A., but there will in all probability be some noise present on the picture. Please remember that a basis of comparison will exist, and viewers will expect to receive the I.T.A. programme as well as they have been accustomed to receive the B.B.C., and without constant re-adjustment of set controls.

Where indoor aerials are being tried, great care must be taken in siting as the problem of standing waves is very real. Correctly designed aerials for loft use are quite satisfactory when used in situations of strong signal.

INSULATED COAXIAL PLUG L781/P2

This plug is in every way interchangeable with our well known all-metal plug L734/P/AL. It is not generally known that the drive behind the design of this plug came from certain engineers of the British Electricity Authority who were unhappy regarding the safety aspect in the event of the breakdown of the isolating capacitor in the receiver. Provided that the receiver has been connected to the mains with a three-pin plug correctly wired through all stages, there is no possibility of danger of shock. If a two-pin plug and socket has been used, there is of course a 50% chance of connecting it the wrong way round. Even with

a three-pin plug, this might be wrongly wired at any one of at least three points:

(1) The socket (unlikely if competently installed). (2) The plug if it has been replaced by an incompetent amateur, or (3) If there has been an error within the receiver.

The insulator is not a brittle moulding, it is nylon, and even if stood on will come to no harm. It is more robust than those manufactured in metal.

Advertisement of

BELLING & LEE LTD.

Great Cambridge Rd., Enfield. Middx.

Written 24th Sept., 1955

HEAVY CURRENT LOW VOLTAGE FUSE LINK

for use on D.C. supplies in Aircraft, Battery Driven Vehicles, &c.

THE fuse is intended as a direct replacement for the American "Current Limiter" used on 28V d.c. aircraft power supplies, and for this purpose has received the approval of the Air Registration Board under their reference No. E.3217.

It is also suitable for the protection of battery operated vehicles, heavy current rectifier output circuits, low voltage furnaces and other similar d.c. applications.

SPECIFICATION: The fuselink is capable of breaking currents of up to 3,000 amperes at 30V d.c. (2,500 amperes at 30V d.c. for the 35A and 50A ratings) without any external disturbance. The arcing time does not exceed 0.003 seconds at 3,000 amperes.

RATINGS: 35A, 50A, 80A, 100A, 130A, 150A, 200A, 225A, and 275A. The range will be extended in four further steps to 500A maximum.

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Marconi Surveying Service

LEFT. Balloon operations on the Ipoh-Telok Anson route in Malaya.

RIGHT. The mast is up and the motor generator is running during the survey of the Nigerian multi-channel system.

BELOW. The V.H.F. mobile survey team erect their mast.

Before planning any communication system, and particularly a microwave or V.H.F. multichannel system, a survey of the propagation conditions over the proposed path or area is essential. Similar, but less exhaustive surveys, are also necessary before planning V.H.F. mobile systems. Such surveys are undertaken by Marconi's, one of the very few radio manufacturers who do so. The teams engaged in the work may be called upon to operate in desert, swamp and jungle, over which line and cable routes would be impractical, on windswept moorlands or in densely populated city and suburban areas. Surveys are being, or have already been carried out all over the world, including: Uganda, Kenya, Tanganyika, Nigeria, Gold Coast, Tangier, Azores Norway, Turkey, Greece, Malaya, Ceylon, West Indies, Sweden, and also, of course, in Britain.

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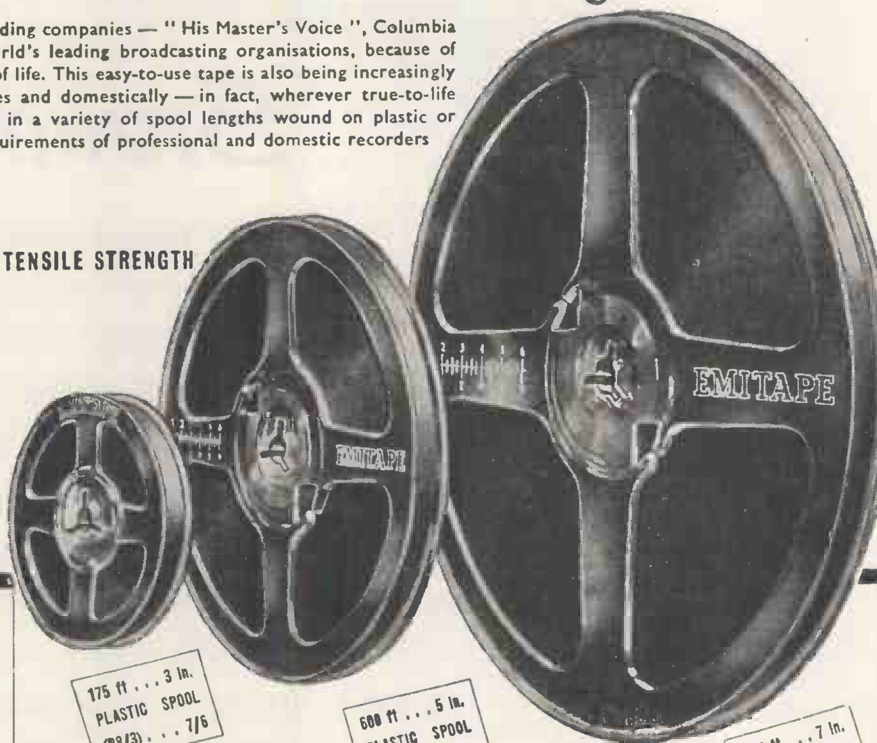

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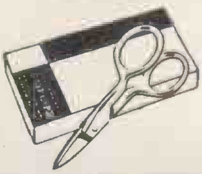

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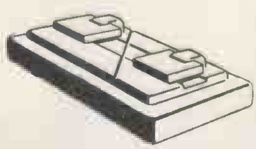

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Export Enquiries for products mentioned in this advertisement should be addressed to:
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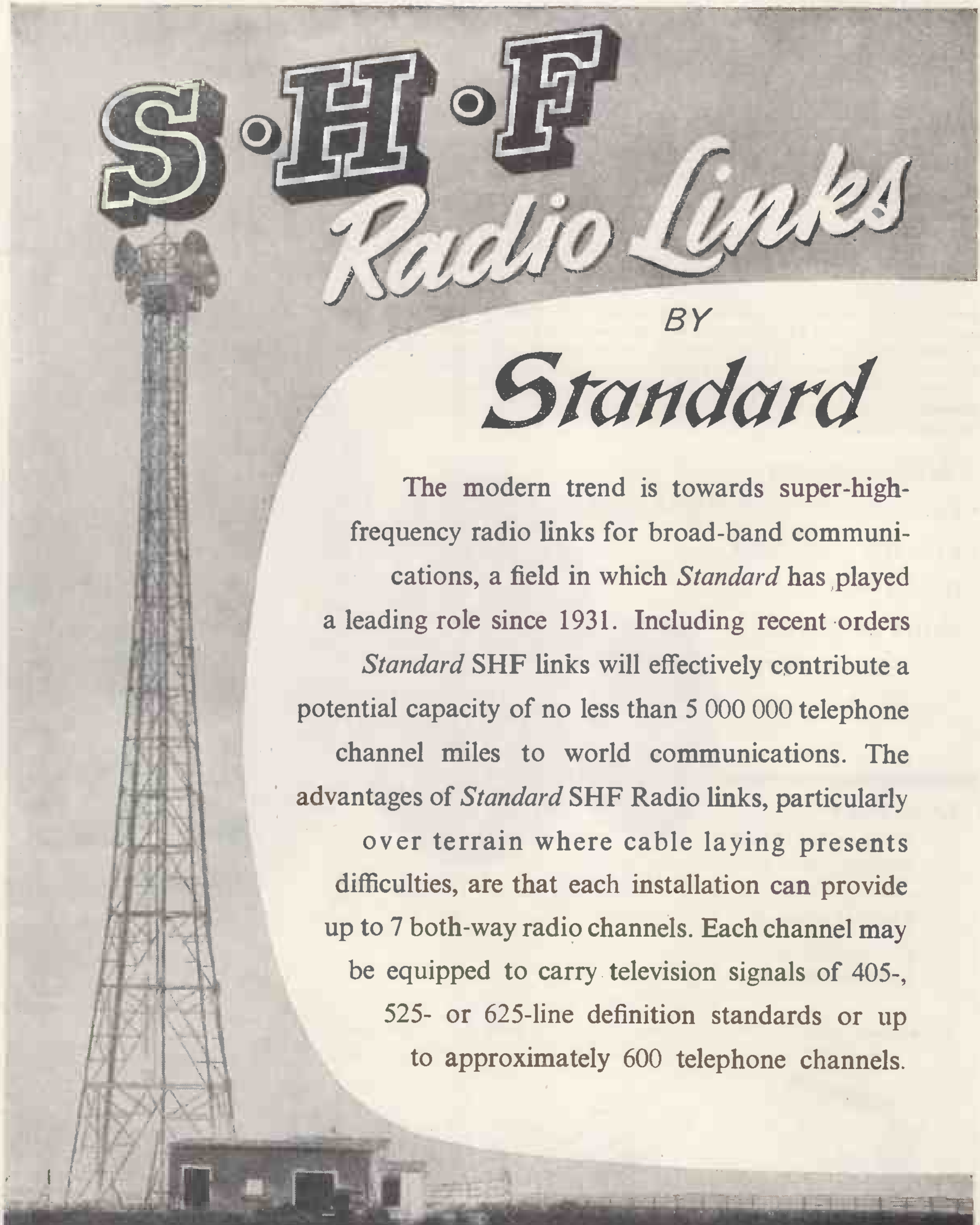
EB.85



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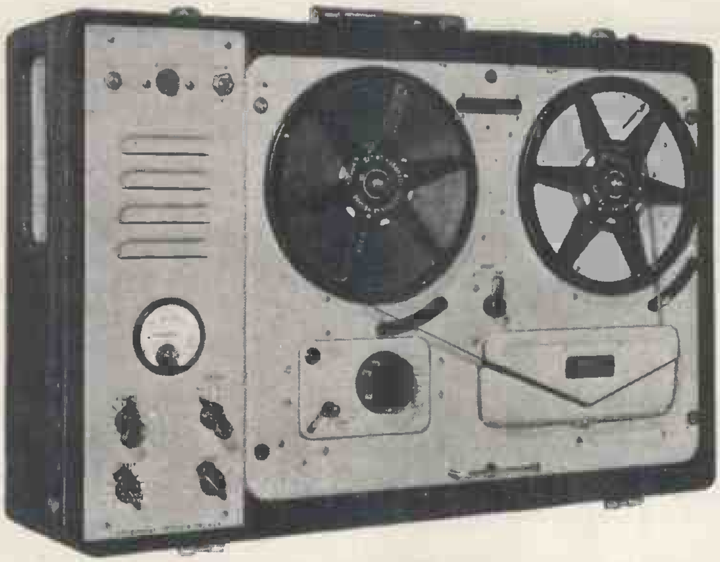
VORTEXION TAPE RECORDER



★ The total hum and noise at 7½ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

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

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

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

POWER SUPPLY UNIT to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE £18 0 0.**

We supply and recommend the Jason F.M. Feeder Unit. **PRICE £15 17 0,** including Purchase Tax.

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is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording.

It is recommended by a number of tape recorder manufacturers for this purpose.

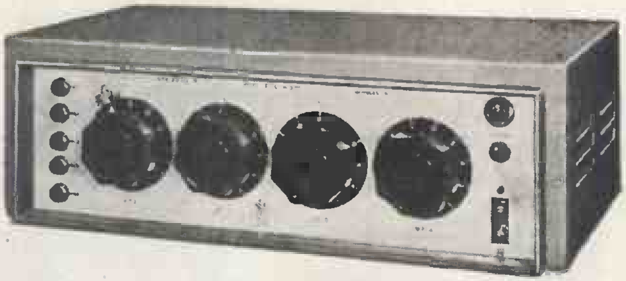
Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced.

The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.

The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.

An internal screened power pack and selenium rectifier feed the five low noise non-microphonic valves.

Used in many hundreds of large public address installations and recording studios throughout the world.



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THE RECORD DIVISION *of*
ELECTRIC & MUSICAL INDUSTRIES LTD
(*"His Master's Voice", Columbia, Parlophone, Marconiphone*)

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JUNIOR ENGINEERS and Technicians for work in the same field.

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EDITORS with experience of tape recording and a good musical knowledge.
MAINTENANCE ENGINEERS with experience of modern microphones, amplifiers and studio practice.

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A man is required with a scientific training, and with good editorial ability to prepare technical reports. Must be able to write lucidly and to be familiar with current sources of technical literature in communication engineering, physics and chemistry. Previous experience in sound recording would be an advantage.

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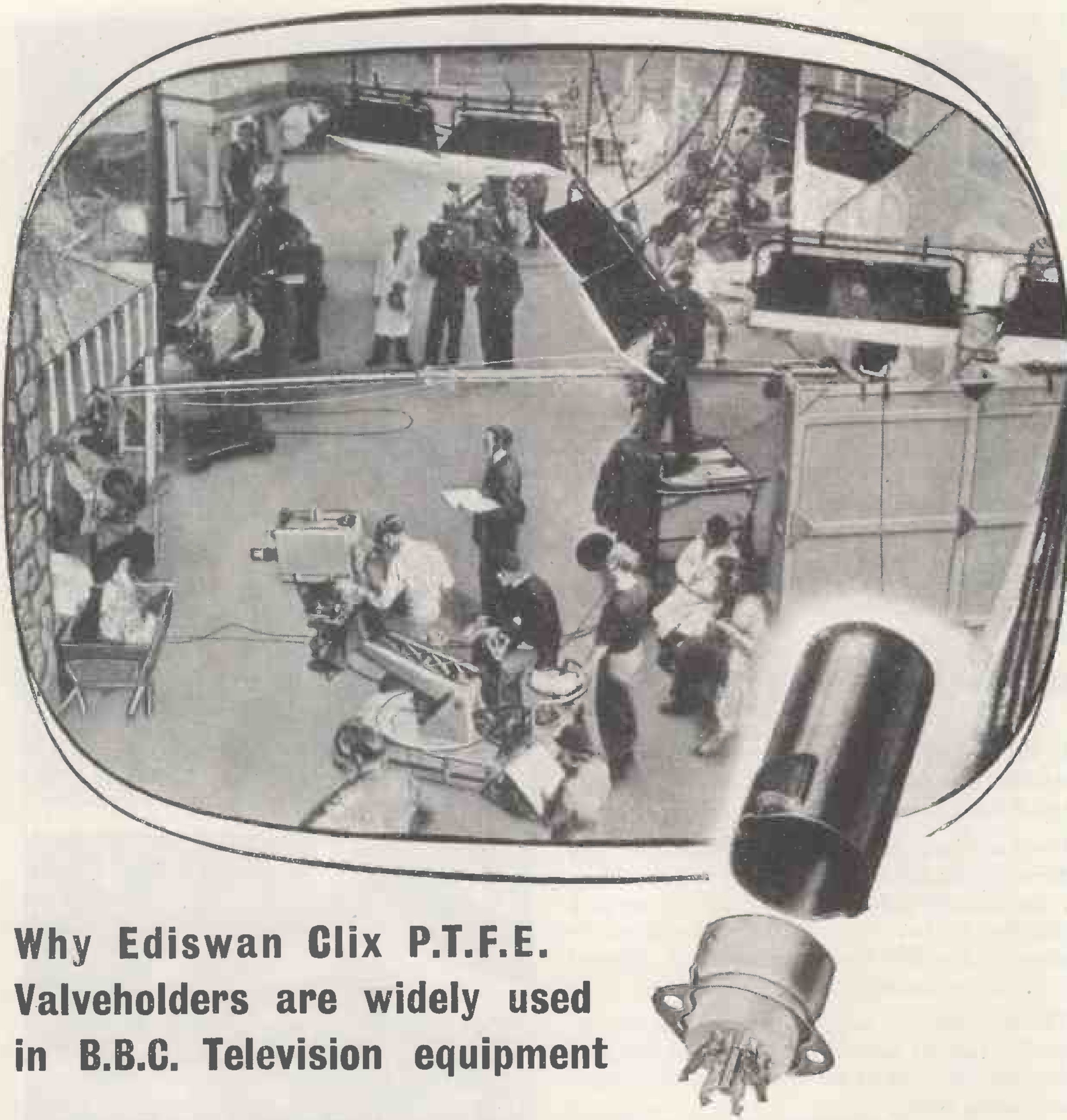
Many of its products carry trade marks which are household names including "His Master's Voice", Columbia, Parlophone, and Marconiphone.

ER.1



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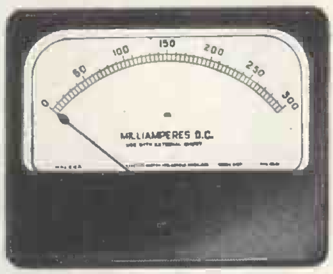
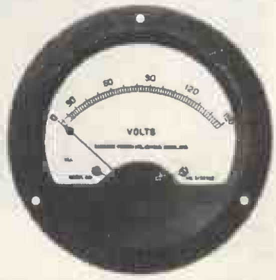


Rectangular panel instruments are available with scale lengths of 2.5", 3.2", and 4.2". These offer the advantage of an increase in scale length of approximately 50% over their equivalent round models, for which they can be used as direct replacements using the same panel fixing holes.

> Larger instruments, both round and rectangular and for switchboard or panel mounting are also available. These have scale lengths of 6" and 6¼" respectively.



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£12-10s.

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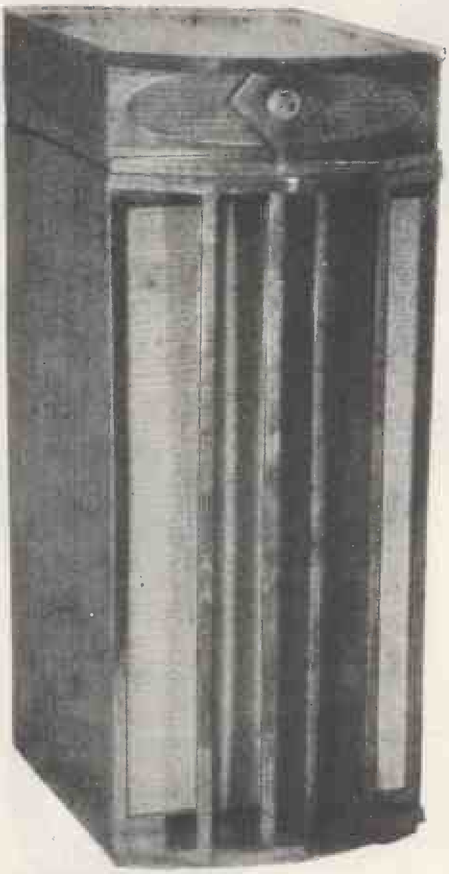

£16-10s.

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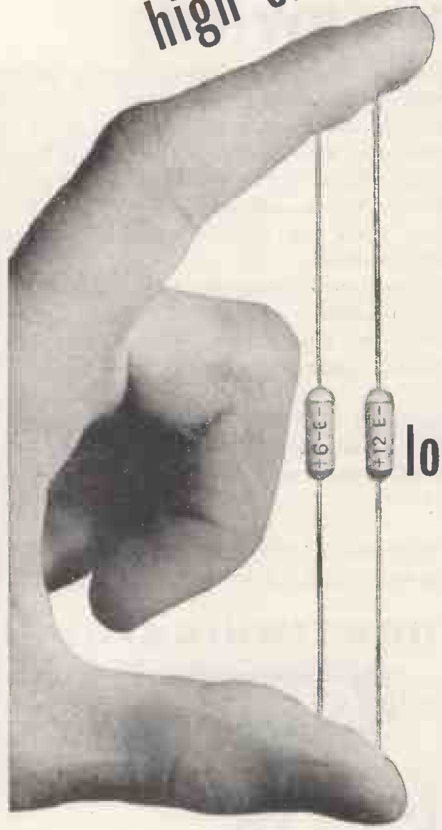

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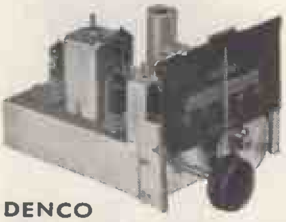

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All components and valves in stock. Uses 6AM6, 12AH8, EB91, and two 6BA6. COMPLETE PARCEL £6/7/6 Post extra. DATA BOOK, 1/6 post free. All components available separately.

DENCO F.M. COMPONENTS

Coils, each 3/11 I.Fs., each 7/-
Ratio Discriminator, 12/6
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Special Parcel containing Data Book, chassis, front end, dial, drive, tuning condenser, full set of coils, I.Fs, ratio detector, etc. 68/9. Post 2/6.

Book only, including our fully itemised price list, 2/- post free.

The above Tuner uses 4 6AM6 and 2 crystals, and can be built for £6/15/- plus 2/6 post.

We can also supply the above Unit built by the Jason Co., aligned and tested for £15/17/- including P. Tax.

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Electrostatic H.F. Speakers for use with amplifiers or sets.

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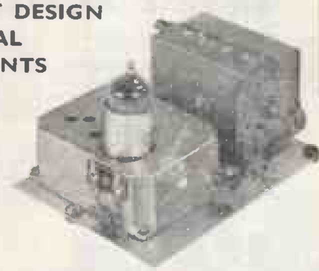
MICROPHONE BARGAINS

ACOS MIC22/2, with stand as illustrated. List 4 gns. LASKY'S PRICE 42/-.

Moving Coil Hand Type with switch, List 5 gns. LASKY'S PRICE 45/-. Post 2/6.

TABLE MIKE STANDS, Chrome, heavy base, 2 sections, 12/6. Post 2/6.

GORLER LATEST DESIGN CONTINENTAL F.M. COMPONENTS



UT.340 (as illustrated). A self-contained V.H.F. front end Unit incorporating a grounded grid amplifier, mixer oscillator (ECC85) and first I.F. amplifier. Completely wired and tested, 59/9. (Valve extra).

Ratio Discriminator Coils, URF, 10/- each.

10.7 mc/s. I.F. Trans. UF376, 7/- each.

Also in stock: P.B. Coil Packs and combined I.F. Trans., etc., for constructing AM/FM Tuner.

HI-FI SPEAKERS

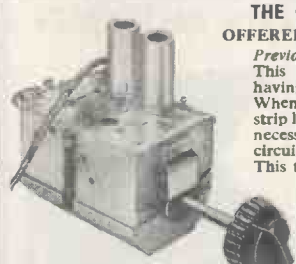
Full range, all sizes, 3-15 ohms. W/B type HF1012, now increased to £4/17/6. Available, while stocks last, at former price, 77/6. Post 3/5.

HI-FI AMPLIFIERS

Comprehensive range. Examples:
LEAK, Point One. . £28/7/0
R.D. Junior. . £26
R.D. Minor. . £12/17/6
UNITELEX. . 8½ and 9½ gns.

BAND III CONVERSION FOR ALL!

THE CYLDON TURRET "TELETUNER" OFFERED FOR THE FIRST TIME



Previously supplied to Set manufacturers only. This 12-channel Tuner consists of a turret having 12 clip-in aerial and mixer coil strips. When the turret is rotated the appropriate strip locates on a contact panel providing the necessary connections to the valves and circuit.

This type of tuner construction enables you to clip in pre-aligned coils for the reception of any station not already provided for in Bands I, II and III, at the same time affording for maximum gain, high stability and minimum noise, which are essential in a modern tuner.

Valves used: PCC84 R.F. double triode, cascode R.F. amplifier. PCF80. Triode pentode f.c. and mixer. Will work with most sets. Full instructions and circuit diagram supplied free.

99/6 Post 2/6.

Knob, 3/6 extra.

TELETRON BAND III CONVERTER COIL SET

For use with TRF and superhet Band I TV receivers. Uses two Z719. Circuit, wiring diagram, alignments, full details with each set. 15/-. Post 1/6.

TELETRON BAND III CONVERTER KIT

The complete Kit to build this Converter, including drilled chassis, condensers, resistances, coils, 2-ES80 valves etc. 48/6. Post 1/6. Full instructions and circuit diagram supplied. Drilled chassis only, 3/9.

VALRADIO BAND III TUNERS

Full range in stock. Price £6. Post extra.

THE "UNIVERTER"

Band III Converter for home-constructed and factory-made Band I receivers. Uses two 6AM6, one 12AT7, one 6X4. Contains its own power supplies. Complete unit in cabinet, £9/9/-. Post free.

The BOOK, containing circuit diagram, wiring instructions and components list, 3/6 post free.

All components and valves in stock, prices on request.

FAMOUS MAKE 12 CHANNEL TUNER

Covers Bands I and III. Complete with valves EF80 and ECC81, Ceramic valveholders, finest quality components, precision made. Switch and fine tuning. I.F. output 20-25 and 40-50 Mc/s. Freq. coverage 50-87 Mc/s and 175-215 Mc/s. Supplied with full details and circuit diagram.

LASKY'S PRICE **89/6**
Post 3/6. Knob 2/9 extra.

DULCI AM/FM Chassis, F.M. Feeder and Band III Converter also available.

SENTERCEL METAL RECTIFIERS

RM1	RM2	RM3	RM4
3/8	4/3	5/6	16/-

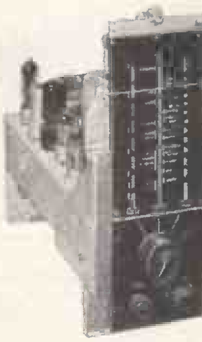
Post extra.

SENTERCEL E.H.T. RECTIFIERS

K3/40	K3/45	K3/50	K3/100
6/-	8/2	8/8	14/8

Post extra.

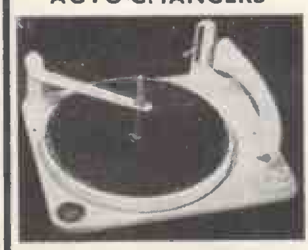
SPECIAL OFFER!



6 VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES

Famous Manufacturer's Surplus. 6 valve 3-wave Superhet, 13-50 m. short, 200-550 m. medium, 1,000-2,000 m. long. Brand new Mullard valves: ECH42, EF41, L63, EB41, 6V6 g.t., EZ40, and finest quality components. Gram. switch, 465 Kc/s I.F., tone control, three-colour dial. Overall size: 13½×5in., height 12½in. Aperture required for dial and controls 11 × 3½in. Complete with valves, output trans., knobs, etc. LASKY'S PRICE £10/19/6. Carriage and packing 7/6 extra.

B.S.R. MONARCH 3-SPEED AUTO-CHANGERS



LATEST 1955 MODEL, NEW AND UNUSED

Takes 10 records of all sizes (mixed) in one loading. HGP.37 crystal turnover pick-up. Handsome cream finish. Supplied complete in maker's carton.

LASKY'S PRICE £7/19/6. Post 3/6.

★ **CABINET** to take above Radiogram Chassis and Auto-Changer, attractive design, oak veneer. £8/15/-. Carriage 17/6.

AERIALS of all types stocked, TV, Band III, F.M.

300 ohms FEEDER, per yard, 9d. 80 ohms Co-axial, dozen yards, 7/6. Co-axial Cable, air cored, yard 9d. Any length supplied.

L.V. RECTIFIERS

12v., all types in stock.
1 amp., ½-wave, 3/6. 2 amp., ½-wave, 4/11. 4 amp., full wave, 15/-. 6 amp., full wave, 21/-. Post extra.

● **HIRE PURCHASE TERMS** on certain items. Write stating requirements ●

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

FAMOUS AMPLIFIERS BUILT ON T.C.C. PRINTED CIRCUITS

The latest advance in Amplifier design. We can now supply from stock two famous Amplifiers, the Osram 912 and Mullard 5/10, built on the new printed circuit technique. All specified components, T.C.C. condensers, Lab. resistors, etc., are used and you have your choice of transformers and chokes by Partridge, Haddon, W/B or Ellison. Demonstrations given any time.

The MULLARD 510 AMPLIFIER, built on T.C.C. printed circuit, supplied fully assembled complete with valves, ready for use. Price, depending on make of transformers used, 15 gns.

Printed Circuit separately 22/6.

New Mullard Amplifier Book, 3/6.

All Components for either above Amplifiers supplied separately, for printed circuit or conventional construction. Price Lists on request.

The OSRAM 912 AMPLIFIER, built on T.C.C. printed circuit, supplied fully assembled complete with valves, ready for use. Price, depending on make of transformers used. 19 gns.

Printed Circuit separately, 50/-.

Book of the Osram 912, price 4/-.

3-WATT MIDGET A.C./D.C. AMPLIFIER. PUSHPULL. VERY HIGH GAINS. 4 valves; 2 UL41 in push pull, 1 UCH42 and 1 UAF42. Input voltage 100/100 AC/DC Very easily converted to 230 volts. Supplied with circuit diagram and all details. Size 9×4×4in. Uses two metal rectifiers, one each RM2 and RM3. Ideal for ships, record players, tape recorders, home record players, baby alarms, etc., etc. Supplied complete fully assembled and wired, with four valves.
LASKY'S PRICE 65/-. Carriage free.

LASKY'S 4-WATT A.C. AMPLIFIER KIT

Uses 1 each 6SL7, 6V6, 5Z4. All components, chassis, valves, output trans., mains trans., £4/5/-.

Carriage and packing 2/6.

INSTRUCTION BOOK and shopping list, 1/- post free.

P.M. SPEAKERS

6½in...17/6. 8in...19/6. 10in ..19/- Plessy H.D. 10in...25/- 6×4 Elliptical 18/6. Plessy 12in...37/6. Post extra.

LATEST COLLARO RC.54

3-speed High Fidelity Mixer Changer, Studio crystal turnover p.u., in leatherette covered carrying case. £13/5/-.

RECORD PLAYING UNITS

3-speed, auto and hand change. All types in stock—Garrard, Collaro, B.S.R., etc.

HEAVY FLYWHEELS

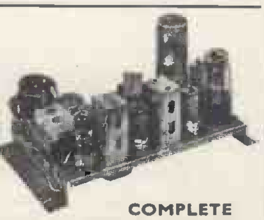
For Tape Decks, ⅜in. hole. 2/6, post 1/-.

COLLARO TAKE DECK MOTORS

Anti-clockwise, shaded pole.
LASKY'S PRICE 25/-, post extra.

EX-GOVT. ACCUMULATORS.

2 volt, 10 a.h. Size 1⅞in. square×5⅛in. high. Made by Canadian Exide.
LASKY'S PRICE 4/6. Post 1/-.



COMPLETE 5-VALVE RADIO CHASSIS

Brand new and unused. A.C./D.C. 200/250 volts. I.F. 465 kc/s, A.V.C., 4 watts output, 3-station pre-set, frame aerial, fully aligned, chassis 10×5½in., max. height 5¼in. Completely wired and ready for use, with the addition of a speaker and output transformer. Two controls, volume and station switch. Valves used; 10C1, 10F9, or UF41, 10LD11, 10P14, U404 or UY41.
LASKY'S PRICE 69/6 less valves. Post 3/6 extra. With valves £5/19/6.

SPECIAL OFFER OF TAPE DECK CASES

As illustrated. Will take Truvox Tape Deck with space for amplifier, feeder unit and speaker. Overall dimensions with lid closed, 19in.×14in.×13in.
LASKY'S PRICE 59/6
Carriage 5/-.

TRUVOX TAPE DECKS

Latest model Mk. III NU, twin track, two-speed, three motors, press button control. **£23/2/-**

SPECIAL COMBINED OFFER

The Tape Deck Case as illustrated above, together with the above Truvox Tape Deck, Carriage paid. **£24/10/-**

LANE TAPE DECK

Mk. VI, 2-speed, 7½ and 3¾in. per sec. Three high-grade motors. £18/10/-

LATEST GRUNDIG Tape Recorder. In stock, 45 gns.

TELETRON FERRITE ROD AERIALS

Medium wave, 5in. long, 8/9
Long wave, 8 in. long, 12/6

IGRANIC JACK PLUGS

Standard type, aech 2/6

RECORDING TAPE

Kraft base, length 1,200 ft. Cyldon metal spools, 12/11. Post 1/-.
All makes of Tape stocked—Scotch Boy, EMI, Grundig, Puretone, Ferrograph, Basf, Agfa, Gevaert, etc., and the new Scotch Boy Thin Tape 190M and Grundig Long-playing Tape. All types of Spools stocked.

CYLDON TAPE SPOOLS

5in. each, 1/6

LATEST BRENNEL TAPE EQUIPMENT

The DECK. Three-speed, 3¾, 7½ and 15in. per sec., three motors, record and play-back. All latest refinements. **18 Gns.**

The AMPLIFIER. 4 watts, for use with 3 ohms speakers. Magic eye, high fidelity. **16½ Gns.**

The CARRYING CASE, £5/18/-.

Write for full details.

TRANSCRIPTION MOTORS in stock. Collaro 2000 and 2010, Garrard 307, Connoisseur, etc.

DRILLED CHASSIS AND DIAL ASSEMBLY

Size 13½×7×2½in., drilled for five latest type miniature valves, mains trans., I.F., etc. Dial 13×14in., for horizontal or vertical mounting. Spin wheel tuning. All pulleys and spindle supplied. **LASKY'S PRICE 19/6**
Post 3/-.

ALUMINIUM CHASSIS

18 S.W.G., undrilled, 4 sides, reinforced corners. Depth 2½in.

6×4 4/-	12×8 7/-	16×10 8/3
8×6 5/-	14×9 7/6	12× 3 4/9
10×7 6/-	16×9 8/-	12× 6 6/6

Post 1/- per chassis extra

DULCI RADIO CHASSIS

Full range 3 and 6 wave, £6/19/6 to 21 gns.

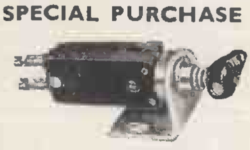
GANG CONDENSERS

.0005, less trimmers.
2-gang, standard, 5/6, min., 6/6.
3-gang, standard, 7/6, min., 10/6.
4-gang, standard, 10/6.
With Trimmers:
2-gang, standard, 7/11, min., 7/6.
Post extra.

SPECIAL OFFER OF PICK-UPS

Standard play. Offered at ALMOST HALF PRICE. Goldring Bantam magnetic, or Acos Crystal, type GP10. post free. **25/-**

SPECIAL PURCHASE



ACOS TURNOVER CRYSTAL CARTRIDGES, complete with styli GP29. List 42/11.
LASKY'S PRICE 18/6
Post 1/-.

PICK-UPS, HEADS, ARMS

L.P. or standard, by Collaro, Garrard, Goldring, Acos, B/J, Decca, etc., all types. Full stocks of all styli.

SPECIAL PLASTIC COVERED WIRE, stranded copper, B07. All colours in 100ft. lengths. Per coil 2/6. Post 9d.

YOU CAN BUILD THIS PROFESSIONAL TYPE TAPE RECORDER FOR LESS THAN £39, using the Truvox Tape Deck. Write for full details and list.

● **HIRE PURCHASE TERMS** on certain items. Write for particulars ●

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN

LASKY'S RADIO

SPECIAL OFFERS OF CABINETS

TABLE RADIOGRAM CABINETS
Solidly made of ½in. laminated wood. Walnut-veneer finish. Panel (3in. × 16in.) for dial and controls, baffle for 8in. speaker, gold finish metal grille, fully hinged lid. Overall size: 18in. deep. 18in. wide, 13in. high. Slightly soiled.
LASKY'S PRICE **79/6**
Carriage 7/6.

BUREAU RADIOGRAM CABINETS
Handsome design, solidly constructed, beautiful Walnut veneer finish, generous record storage space. Further details and illustration on request.
LASKY'S PRICE 14 gns. Carriage 17/6. Available on H.P. Terms.

OCTAGONAL SPEAKER CABINETS. Special design for use with the G.E.C. metal cone Speaker. Exactly per specification £12/10/-. Carriage 6/6.

PORTABLE CASES. Solidly made of laminated wood, inside dimensions 17½ × 14 × 6½in. deep. Originally made for portable radiogram, with space (14 × 5 × 5in.) for radio or amplifier and speaker. Motor board size 14 × 12½in. Takes any standard size gram unit. Rexine type finish in various colours. Fitted handle and locks, 2 keys supplied.
LASKY'S PRICE **25/-**
Post 3/6.

AERIAL MASTS, 2 teles. section, extending to 15ft. Complete with guys, etc., 25/-. Carriage 3/6.

AERIAL RODS, steel, heavily copper-plated. Any number fit together. 12in. long, 2/6 doz., post free.

MAINS TRANSFORMERS
All 200-250 v. 50 c.p.s. primary finest quality, fully guaranteed.
MBA/3. 350-0-350 v. 80 mA, 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 volts. 18/-.
MBA/6. 325-0-325 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. 22/6.
MBA/7. 250-0-250 v. 80 mA. 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. 18/-.
MBA/10. 500-0-500 v. 150 mA. 6.3 v. 4 a., 5 v. 3 a. 32/6.
AT/3. Auto trans. 0-10-120. 200-230-240 v. 100 watts. 17/6.

OUTPUT TRANSFORMERS
Min. type (3S4, etc.)..............3/6
Midget, 3/3.......... Multi ratio 3/11
Standard pentode, 4/6.
All other types by Partridge, Ellison, etc., in stock.

FILAMENT TRANSFORMERS
6.3 v., 1.5 amp................5/11
6.3 v., 3 amp..................9/6
200-250 v., special 0-30 v. tapped, 17/6

BRIMISTORS

CZ1	CZ2	CZ3	WX6
2/6	1/6	6d.	1/6

ARMOUR PLATE GLASS
12in., actually 13 × 10½ × ¼in., 3/6.
14in., actually 13½ × 10½ × ¼in. 5/6.
17in., actually 17½ × 15 × ¼in., 7/6.
Post extra.

HIRE PURCHASE
Terms available on certain items. Write stating your requirements.

OVER 50,000 VALVES
One of the largest stocks in England. All makes and types, B.V.A. and ex-Govt. Also C.R. Tubes.

LASKY'S RADIO CONSTRUCTOR PARCELS

With your choice of Cabinets as illustrated

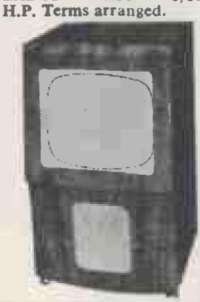
PARCEL No. 1
Contains everything to build a 4-valve, 3-wave superhet for 200/250 A.C. mains. Uses 6K8, 6K7, 6Q7, 6V6 valves. Attractive wood cabinet, walnut veneer, or plastic cabinet as illustrated. Size 12 × 6½ × 5½in. deep. CAN BE BUILT FOR £7/19/6.
Carr. and packing 2/6.

PARCEL No. 2
Contains everything to build a T.R.F. 3-valve set for 200/250 A.C. mains. medium and long wave. Uses 6K7G, 6J7, 6V6, and metal rectifiers. Neat plastic cabinet, walnut or ivory finish, or wood cabinet. Size 12 × 6½ × 5½in. deep. CAN BE BUILT FOR £5/10/-.
Carriage and packing 2/6.

INSTRUCTION BOOK for either above sets, 1/- post free. CABINETS ONLY, plastic or wood, 17/6. Carriage 2/6.
All components available separately

VALUE IN MAGNIFICENT TV CABINETS

THE DE LUXE. Complete with mask, glass, castors, shelf, bearers, C.R.T. neck end protector, back, speaker fret and baffle board. Finished in beautiful figured medium light or dark walnut veneer, with high polish. Suitable for most home constructor TV Receivers, including the "Viewmaster", "Practical Television", "Tele-King", "Magnaview", "Wireless World", etc. Supplied with cut-out for 14in., 16in. and 17in. C.R. tubes at no extra cost. An allowance of 4/6 will be made if the mask is not required.
Inside dim.: Depth 16½in., width 17¾in., Height 28in. Overall height 32in. Width 18¾in. Adaptor frames for fitting 9in. or 10in. C.R. tubes available if required.
LASKY'S PRICE £8/10/-. Carriage 12/6. H.P. Terms arranged.



THE ROTHESAY. Outstanding contemporary design. Absolutely rigid construction throughout with the finest laminated woods, veneered in walnut, polished light, medium or dark shade. Fitted with gold anodised speaker grille. C.R.T. aperture frame is detachable, supplied to suit any size tube to order. NOTE THESE GENEROUS SIZES:
Outside dim.: 34½in. high, 21⅝in. wide, 21½in. deep. Inside dim.: 18⅞in. wide, 19¾in. deep. Size of top: 22½ × 21⅝in. Thickness ½in.
LASKY'S PRICE £9/19/6. Carriage 15/- extra. WITH FULL-LENGTH DOORS veneered both sides, polished to match the cabinet and mounted with full-length piano hinges. Price £14/9/6. H.P. Terms arranged.

MAKERS' SURPLUS TV COMPONENT BARGAINS

WIDE ANGLE 38 mm.

Line E.H.T. trans., ferrox-cube core, 9-16 kV	25/-
Scanning Coils, low imp. line and frame	25/-
Ferrox-cube cored Scanning Coils and Line Output Trans., 10-15 kV, EY51 winding. Line Trans. incorporates width and linearity control. Complete with circuit diagram, the pair	50/-
Frame Output Transformer	10/6
Scanning Coils low imp. line and frame	17/6
Frame or line blocking osc. transformer	4/6
Focus Magnets Ferrox-dure	25/-
P.M. Focus Magnets, Iron Cored	19/6
Duomag Focalisers	29/6
300 m/a. Smoothing chokes	15/-
Electromagnetic focus coil, with combined scan coils	25/-

STANDARD 35 mm.

Line Output Transformers. No E.H.T.	12/6
Line Output Transformers 6-9 kV. E.H.T. and 6.3v. winding. Ferrox-cube	19/6
Scanning coils. Low imp. line and frame	12/6
Ditto by Igranic	14/6
Frame or line blocking oscillator transformer	4/6
Frame output transformer	7/6
Focus Magnets: Without Vernier	12/6
With Vernier	17/6
Focus Coils. Electro-magnetic	12/6
200 m/a. Smoothing chokes	10/6

MIN. CRYSTAL DIODES glass type, wire ends, each 1/6. GEX.45 and equivalent types, various makes. 3/6.

C.R.T. MASKS
12in. rubber, complete with armour plate glass. Dustproof. Black, 7/6. White, 10/-.
Plastic Masks. 14in., 6/6. 17in., 7/6. De Luxe, 17in.. 15/-.
E.E. 16in. polystyrene. List 42/-. LASKY'S PRICE 29/6. Post extra.

12in. MOULDED IMPLOSION GUARDS, 7/6. Post extra.

CONDENSERS AND RESISTORS
Full range of types in stock.

TRANSITORS and GERMANIUM DIODES
All types in stock.

SPEAKER FRET
Large selection. Plastic, tygan, cloth, expanded metal.

R1155 RECEIVERS
Now available on Easy Terms

Five frequency ranges: 18.5-7.5 Mc/s.; 7.5-3.0 Mc/s.; 1,500-600 kc/s.; 500-200 kc/s.; 200-75 kc/s. Supplied in maker's original wood transit case.

	LASKY'S PRICE
BRAND NEW	£11 19 6
Secondhand. Grade 1	£9 19 6
Secondhand. Grade 2	£7 19 6

Carriage 17/6 extra, including 10/- returnable on packing case.

ASSEMBLED POWER PACK-OUTPUT STAGE FOR R.1155 RECEIVER
For use on 200-250 v. A.C. mains. Complete with two valves. In metal case, size: 12 × 7 × 5½in. 79/6. Carriage 5/-.
Power Pack for above. Fitted with 6½in. p.m. speaker. £5/5/-. Carriage 5/-.

LASKY'S RADIO

LASKY'S (HARROW RD.) LTD.

TWO ADDRESSES FOR PERSONAL CALLERS
Open all day Saturday. Early closing: Thursday.

42 TOTTENHAM COURT ROAD, W.1.
Between T.C.R. and Goodge St. Stns.
MUSeum 2605.

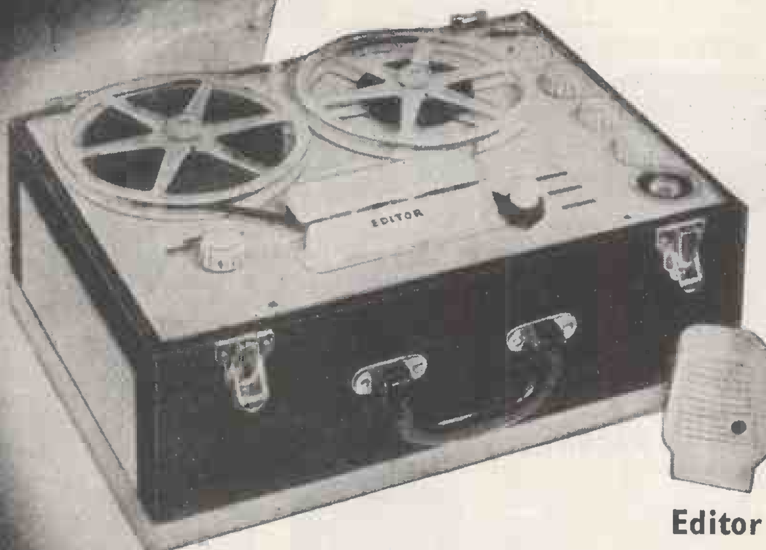
370 HARROW ROAD, PADDINGTON, W.9.
(Opposite Paddington Hospital)
CUNningham 1979/7214.

ALL MAIL ORDERS TO HARROW ROAD PLEASE

New worlds of entertainment for YOU!

Now available from stock

. . . any one of these popular Tape Recorders



Editor Super

Complete with Microphone and Tape

A truly superb British-made recorder, rich in range and tonal qualities, for home and business recording. This de luxe version of the "Editor" incorporates mixing and monitoring facilities and single knob control super tape deck. IDEAL FOR USE WITH PRE-RECORDED TAPES. For 200/250v. A.C. mains. In padded simulated crocodile case. Two speeds 3¾ i.p.s. and 7½ i.p.s.

Price **55 gns.**

Editor

Complete with Microphone and Tape

The smallest mains-operated fully automatic two-speed portable tape recorder with 7″ spools on the market. Two hours' full playing time. Fitted in handsome two-tone case with attractive gilt fittings.

Price **45 gns.**

Tape Recorders by Tape Recorders (Electronics) Ltd., Grundig, Vortexion, Ferrograph, etc., can be purchased on easy deposit terms of 15% with repayment of balance plus small service charge over 12 or 18 months.

Playtime Plus

THE ONLY COMPLETE TAPE RECORDER AT 35 GNS.

by Tape Recorders (Electronics) Ltd.

Complete with Microphone and Tape.

Complete and ready to use with a self-contained wide range amplifier and high flux elliptical loudspeaker. Simple to operate—*joystick control for all operations.* Fitted in an elegant 2-tone suitcase only 12½″ × 10″ × 5½″ and weighs less than 17 lbs. For A.C. mains. A completely BRITISH MADE Tape Recorder. One hour's Playing Time.

EASY H.P. FACILITIES

£5. 10. 0. deposit and 12 monthly payments of 57/4 or any period up to 18 months.

Complete with High Fidelity Microphone and One-Hour spool of tape.

FOR HIGH-FIDELITY PLAYBACK

The "PLAYTIME" at 26 gns. still reigns supreme. Self-contained for recording playback through any radio or amplifier; the frequency response being limited only by that of the playback medium.

See it at the RADIO CENTRE

Something better *at the Right Price!*

The Editor SUPER Hi-Fi Models

These superb British made Dual Track recorders, rich in range and tonal qualities, incorporated an additional High Fidelity 10 in. Loudspeaker in the lid, which can be detached and used in any position desired for public meetings, concerts, dances, etc. They are powerful enough to meet any volume requirements, yet maintain crystal clear quality reproduction at all volume levels. **IDEAL FOR PRE-RECORDED TAPES.**

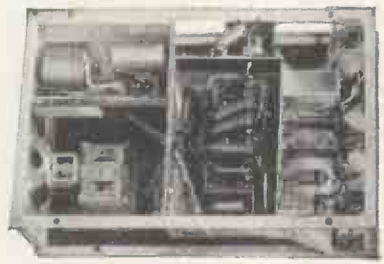
- ★ *Two speeds—$3\frac{3}{4}$ in. and $7\frac{1}{2}$ in. per.sec.*
- ★ *Two hours recording or three hours with the new Long Play Tape.*
- ★ *Instantaneous braking.*
- ★ *Instantly ready to record or playback.*
- ★ *Built-in speaker is additional to 10 in. high flux speaker in detachable lid, giving greater versatility.*
- ★ *Easily removable chassis built on unique steel frame, ensuring ease of inspection.*

EDITOR HI-FI *(illustrated above).*

Fitted in elegant leathercloth suitcase with gilt fittings. Complete with High Fidelity desk microphone and 1200 ft. spool of Emitape. **49 gns.**

EDITOR SUPER HI-FI

Fitted in padded simulated crocodile case with continental gilt fittings and locks, with elegantly styled super tape deck. Completely automatic simple interlocked control; MIXING and MONITORING facilities. Complete with microphone and spool of Emitape. **60 gns.**



The unique lightweight custom built chassis of the Editor Hi-Fi and Editor Super Hi-Fi embraces the latest techniques of recorder construction.

At this time of the year, we have a look round our warehouses and any items we wish to clear are offered at very low prices. Here is a selection — there are very few of each — so order now to secure a bargain!

AMPLIFIERS Lowther A15F	£31. 19. 6.
Rogers Baby de Luxe with pre-amp	£19. 19. 0.
AUTOCHANGERS Plessey	£6. 19. 6.
BOSTICK CEMENT	12 for 5/-
BALLAST RESISTORS C9266, K55H, K55B, K52H, all	5/- each
CABINETS Record Player (GU4) Polished	£2. 2. 0.
DIALS, Ivorine MW, LW, SW,	2/3
FILTERS, Coloured T.V. 12" or 15"	5/-
HEADPHONES, Type K, S.G. Brown	£4. 4. 0.
I.F. TRANSFORMERS, 465 Kc/s per pr.	5/-
KNIVES, Multi-purpose	3/6
LOUDSPEAKERS, 8" M.E. less transformer	12/6
with transformer	15/-
PANELS, tag, 14 point	1/3

PICKUPS, Ronette lightweight. High Fidelity with 2 heads	39/6
POTENTIOMETERS, 1 ohm., 1 watt	2/6
RECORD PLAYBACK or **ERASE HEADS, TAMSA**	35/-
SWITCHES, Rotary 2P., 2 way, 4 bank, A.B. metal	8/-
SOLDER GUN BITS, Burgoyne	12 for 5/-
TRANSMITTING VALVES, Type 860	7/6
TAPE RECORDER AMPLIFIER CONTROL PANELS	3/-
TAPE OSCILLATOR COILS	4/3
TONE CONTROLS, Goodsell F/TC	£7. 19. 6.
TRANSMITTING CONDENSER, 100 pfd. variable	3/11
TORCHES, 2 cell focussing, adjustable, Type C	4/6
TRANSFORMERS, HEAD LIFT, Type T6	9/11
VIEWMASTER MANUALS	2/6
WIRE, Twin Screened	Min. 5 yds. 3/-

E. & G. MAIL ORDER SUPPLY CO.

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The Radio Centre

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how large are large stocks ?

As long as a piece of string? As high as up? There is an answer. Stocks should be large and varied enough to satisfy any customer's order. Even we find this difficult to achieve, but we come so near to it that very few people are disappointed. That's why Hi-Fi enthusiasts all over the world rely on Classic to supply their equipment.

Just to illustrate how comprehensive our stocks are, here is a small random selection of the scarce equipment which we had on the premises at the time of going to press.

TRANSCRIPTION MOTORS

21	Garrard 301	£25 3 6
9	Connoisseur 3-speed	£27 2 6
24	Collaro 2010	£18 11 11
4	Lenco 4-speed	£20 15 5

AUTO-CHANGERS

9	Garrard RC110	£13 19 7
7	Garrard RC111	£14 8 0
9	Collaro RC54	£13 9 6

AMPLIFIERS

3	Goodsell PFA	£20 0 0
3	Goodsell Williamson "C" Core	£40 0 0
6	Pye PF91 and 91A	£42 0 0
3	Leak TL12	£28 7 0
3	Leak Varislope Mark II	£16 16 0
10	Leak TL10	£17 17 0
7	Leak Point one pre-amp.	£10 10 0
7	Goodsell MAS/UL	£14 17 6
5	Pam 1001 pre-amp.	£42 0 0
7	Goodsell ULF TC	£12 12 0
8	Quad amp. and control unit	£42 0 0
3	Lowther amplifier	£60 0 0
3	Tannoy amplifier	£63 0 0

LOUDSPEAKER UNITS

4	Tannoy 15in.	£35 12 0
4	Tannoy 12in.	£29 5 0
9	Wharfedale Super 12 C/SAL	£17 10 0
12	Wharfedale Golden CSB	£8 6 7
5	Wharfedale W10 CSB	£12 16 8
24	Wharfedale Super 8 C/SAL	£6 13 3
12	Wharfedale Super 5 C/SAL	£6 13 3
7	Wharfedale Super 3 C/SAL	£6 13 3

Which all goes to show that you're more likely to get what you want off the shelf if you come to Classic.

CLASSIC

ELECTRICAL COMPANY LIMITED

THE HI-FI SPECIALISTS

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Completes a standard work for Television Engineers

Television Receiver Servicing: Volume 2

Receiver and Power Supply Circuits

By E. A. W. Spreadbury, M.BRIT.I.R.E. Volume 2 of this unique work follows on logically where Volume 1 left off. It covers the video circuits, vision tuning and detector circuits and includes methods of multi-channel tuning, the sound channel and power-supply circuits. There is also a chapter on television aerials and another on the technique of circuit alignment.

With Volume 1 this book provides the experienced service engineer a complete picture of the problems likely to be encountered in television service work.

8¾" × 5½", 308 pp., **21s. net.** By post 21s. 8d.

Universal praise for Volume 1.

"... worth double its cost. This book is highly recommended."—*The Practical Radio Engineer.*

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Dorset House, Stamford Street, London, S.E.1

RADIO TUNING UNITS A.M. & F.M. DESIGNS — "High Fidelity Reproduction" — AMPLIFIERS ASSEMBLED or KITS OF PARTS

"STERN'S" HIGH QUALITY 8-10 WATT AMPLIFIER

Having a front panel which is very attractively finished in deep gold, and on which the controls are clearly identified. The ideal amplifier for general home use and for small halls, etc.

Price of COMPLETE KIT including Valves and Drilled Chassis, etc. (Plus 2/6 carr. and ins.). **£7/10/-**

We will supply it Completely Built for (Plus 5/- Carr. & Ins.). **£9/10/-**

H.P. Terms £2/10/- Deposit, 8 months at 19/9.

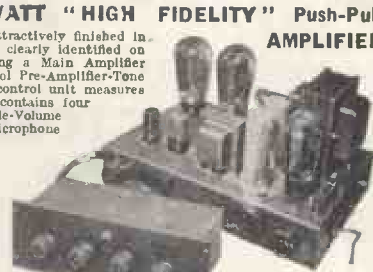
Designed for high-quality reproduction up to an output level of 10 watts, having 6V6s in Push-Pull and incorporating negative feedback. It is suitable for use with all types of Pick-ups and most types of microphones and the output transformer provides for use of 3 and 15 ohm speakers.

BRIEF FEATURES

- Valve line-up 6Z5, 6SN7, 5Z4, with 6V6s in push-pull.
- The undistorted output level of up to 10 watts is produced from an input of .25 volts.
- First-class reproduction of Radio (where a Tuning Circuit is used) and Record Playing.
- Separate Bass Boost and Treble Controls provide an excellent range of frequency control.
- Very satisfactory results are obtained with an average type of high impedance Moving Coil or Crystal Microphone, a clear speech level of approx. 5 watts output being obtained.
- Power supplies (HT and LT) are available for a Tuning Unit.
- For operation on A.C. Mains 200-250 volts 50 cycles.

THE ASSEMBLY MANUAL is available for 1/- and includes detailed layouts and component Price List

"STERN'S" 12 WATT "HIGH FIDELITY" Push-Pull AMPLIFIER



A very high quality Unit attractively finished in deep gold with each control clearly identified on the front panel. Comprising a Main Amplifier Chassis and a Remote Control Pre-Amplifier-Tone Control Unit. The remote control unit measures only 9 × 4 × 2½in. and contains four controls, being: Bass-Treble-Volume and a Radio, Gram, Microphone Switch control. It incorporates its own feedback circuit on the Bass Channel. Loop negative feedback is employed on the Main Amplifier which has a valve line-up of 6J5-6N7-5U4 with two PX25s in push-pull and 6J5 and 6SN7 are used in the remote control unit.

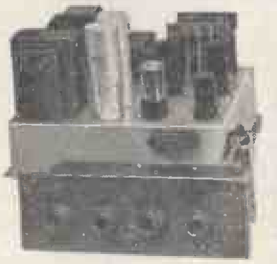
THE COMPLETE KIT IS AVAILABLE FOR (Carr. & Ins. 6/- extra). **£14/0/0**

THE COMPLETE UNIT ASSEMBLED AND READY FOR USE **£17/0/0**

H.P. Terms £4/5/- Deposit, 12 Months at £1/3/5. (Carr. & Ins. 7/6 extra).

The measured frequency range of the amplifier with this unit shows an excellent reponse from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore, that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV and 6.3 volts at 2 amps. and 30 mA. H.T. is provided for tuning unit, etc. This Amplifier compares well with the Williamson and similar designs at a fraction of their cost. The complete set of assembly instructions is available for 2/-.

A COMPLETELY ASSEMBLED "HIGH FIDELITY" PUSH-PULL AMPLIFIER.



Supplied Complete with THE STERN'S DUAL CHANNEL TONE CONTROL PRE-AMPLIFIER UNIT FOR ONLY **£13/13/-** (plus 7/6 Carr. & Ins.)

H.P. TERMS: DEPOSIT £3/8/- and 12 monthly payments of 18/10.

We are able to offer this equipment at such an attractive price only because of a bulk purchase of PARMEKO TRANSFORMERS, CHOKES, etc.

It is designed for really good reproduction employing two 6F6s in push-pull for approximately 10 watts output. A total of 7 valves are employed, the main Amplifier having 6J5—6SN7—two 6F6s and 5 volt Rectifier and the separate Control Unit, which is identical to that supplied with the 12 Watt "Hi Fi" Amplifier described above, has types 6J5 and 6SN7. Loop Feedback is employed over the whole of the main Amplifier and the PARMEKO OUTPUT TRANSFORMER ensures really good reproduction. Power take-off socket is provided for an external Radio Tuning Unit, the POWER SUPPLY AVAILABLE being 200 to 250 Volts at 45 mA. and 6.3 Volts at 1½ amps.

WHEN ORDERING PLEASE STATE WHETHER FOR 3 OR 15 ohm SPEAKER.

The NEW "LEAK" TL/10 AMPLIFIER and "Point One" PRE-AMPLIFIER

This Amplifier has a maximum output of 10 watts and maintains in every respect the world renowned LEAK reputation for precision engineering, fine appearance and fastidious wiring. The Pre-Amplifier will operate from any make or type of pick-up. A continuously variable input attenuator at the rear of the Pre-amp. permits the instantaneous use of crystal, moving iron and moving coil pick-ups. H.T. and L.T. supplies are available for a Radio Tuning Unit. An input attenuator is fitted. S.A.E for descriptive leaflet.

PRICES:

(a) The COMPLETE AMPLIFIER WITH PRE-AMPLIFIER: £28/7/-; or £7/2/- Deposit and 12 months at £1/19/-.

(b) The TL/10 MAIN AMPLIFIER ONLY: £17/17/-; or £4/7/- Deposit and 12 months at £1/4/9.

(c) The "POINT ONE" PRE-AMPLIFIER ONLY: £10/10/-; or £2/12/6 Deposit and 9 months at 19/6.

The DULCI F.M. TUNER

A self-contained Tuning Unit providing complete F.M. coverage. Performance is really outstanding and is equal to many Units offered at far higher prices.

PRICE **£16/16/0** (plus 7/6 carr. & ins.)

H.P. TERMS DEPOSIT £5/12/8 and 12 monthly payments of £1/0/5.

BRIEF DETAILS

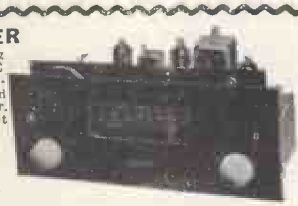
(a) Designed to operate with any make of Amplifier and most Radio Receivers.
(b) Incorporates its own Power Supply.
(c) Has the highly efficient GERLER INDUCTANCE TUNING HEART.
(d) A "Magic Eye" TUNING INDICATOR is incorporated.
(e) Employs the latest Valve line up: EABC80, ECC85, two EF89's, 6 × 4 (Rectifier) and EM80 Indicator.
(f) A very attractive Dial (size 10½in. wide × 6in high) is incorporated and the overall size of Chassis is 6in. deep × 9in. wide × 5½in. high.

WE RECOMMEND THE W.B. STENTORIAN P.M. SPEAKERS

They have the NEW CAMBRIC CONE and a matching device for 3 ohms-7.5 and 15 ohms outputs.

(a) 5in. Model HF510	£2	6	6		(d) 9in. Model HF912	£4	7	3
(b) 6in. Model HF610	£2	12	6		(e) 10in. Model HF1012	£4	17	6
(c) 8in. Model HF810	£4	2	9		(f) 12in. Model HF1214	£9	15	6

The GOODSELL F.M.I. TUNER



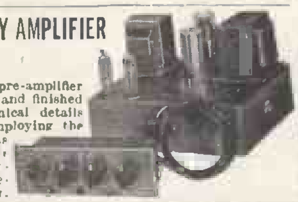
A 5 Valve Superhet Unit incorporating the NEW MULLARD INDUCTANCE type TUNING HEART. A really excellent Tuner giving full F.M. coverage and incorporating a "Magic Eye" Indicator. Requires Power Supply of 250 volts at 25 m/a. and 6.3 volts 2 amps.

PRICE **£18/14/8** (plus 7/6 carr. and ins.).

H.P. TERMS: Deposit £6/5/- and 12 monthly payments of £1/2/11.

The NEW "W-B." HIGH FIDELITY AMPLIFIER

MODEL WB.12



The WB.12 Amplifier with separate pre-amplifier Tone Control Unit is attractively styled and finished in hammered gold, incorporating technical details to satisfy the most critical user. Employing the most recently developed valves, it has a low noise input circuit feeding the double triode phase splitter and a push-pull output stage using a specially designed Whitely Output Transformer. Overall 2 db negative feedback is taken over the main Amplifier. Switched pick-up matching is incorporated to an extremely flexible compact and easily mounted control unit.

BRIEF MAIN AMPLIFIER SPECIFICATION—

(a) Power Output	12 watts
(b) Distortion 400 c/s	0.2%
1,000 c/s	0.12%
(c) Frequency response	± 15 db 20-20,000 c/s
(d) Output Tappings	3-4 ohms and 15 ohms

(e) Valve line-up: GZ32, 2 × EL84, 2 × ECC83
(f) Power supply available for Tuner, etc.; 6.3 v., 1.5 a., 50 mA @ 300 v.

TONE CONTROL
(a) Input Sensitivity for 10W 50 mV
(b) Hum and Noise relative to 10W – 72 bd
(c) Bass Control—continuously variable from + 11 db to – 11 db at 30 c/s.
(d) Treble Control—continuously variable from + 10 db to —10db at 10 Kc/s
(e) Switched Input for Radio Feeder, Pickup and Tape Recorder.

PRICE COMPLETE **£25/0/0** (plus 7/6 carriage and insurance).
H.P. TERMS: Deposit £8/6/8 and 12 monthly payments of £1/10/6.

109 & 115 FLEET ST. LONDON, E.C.4.

Phone: CENTRAL 5812-3-4

Stern's Tape Recorder

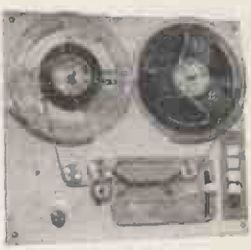
HOME CONSTRUCTORS
Build it for £40/-/-
! ! IT ONLY NEEDS CONNECTING UP ! !

H.P. Terms are shown below.

Buy it assembled and ready for use for £43/-/-
(Plus £1/10/- carriage and insurance £1 is refunded when packing case is returned to us.)

H.P. terms. Deposit £11 and 12 monthly payments of £2/18/8.

We are completely satisfied that this Tape Recorder, although supplied at a genuinely low price, provides absolute Fidelity Recordings and, in addition to being completely dependable, has a performance at least equal to recorders marketed at a far higher price. The actual assembly of the Tape Recorder is extremely simple and only involves a few connections. The Truvox Tape Deck and the Quality Amplifier are supplied tested and ready for use, and all that is required to complete the Recorder is to connect the two together (a connection chart is supplied for this purpose) and secure them by the screws provided into the Attache Case. The items illustrated and described below form the complete equipment.

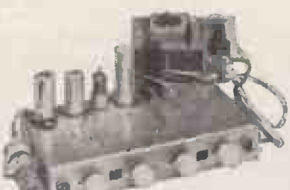


SEND S.A.E. FOR DESCRIPTIVE LEAFLET

THE NEW TRUVOX MODEL TR7U TAPE DECK
THE NEW TRUVOX MODEL TR7U TAPE DECK. 3 Shaded-Pole motors. Drop-in Tape Loading. Push Button Control. Separate Push Button Brake. Fast forward and fast reverse. Silent drive eliminating Wow and Flutter. Half Track working and 2 speeds, 3¾in. and 7½in. per sec. Positive Azimuth Adjustment. Overall size only 14¼ × 12¾in.

- WILL TAKE ALL STANDARD TAPES UP TO 1,200ft.
- WILL PLAY THE NEW PRE-RECORDED TAPES.
- WILL PROVIDE 2 HOURS' PLAYING AT 3¾in. or 1 hour at 7½in. per second.
- INCORPORATES AN ELLIPTICAL P.M. SPEAKER 7 × 4in., with EXTENDED FREQUENCY RANGE.

MODEL T.R.I./F. QUALITY AMPLIFIER
This amplifier has been expressly designed to meet the requirements of enthusiasts for fidelity reproduction, and in particular to CORRECTLY operate the above TRUVOX DECK. It is supplied complete with a matched Elliptical 3 ohm P.M. Speaker, it incorporates an efficient Tone Control arrangement and has a Magic Eye Level Indicator (Operative on Record). In addition it can be used as a general purpose Amplifier for high quality reproduction of gramophone records direct from a Gram Unit.



GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS)

ACOS CRYSTAL MICROPHONE MODEL MIC.33.1

1,200 ft. REEL OF SCOTCHBOY MAGNETIC RECORDING TAPE.

PRICE SUMMARY
WE WILL SUPPLY ALL FIVE UNITS LISTED ABOVE, i.e., THE COMPLETE BUT UNASSEMBLED RECORDER FOR £40/-/-. H.P. Terms: Deposit £10 and 12 monthly payments of £2/15/- or in two parts as follows:—

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK MODEL TRIF AMPLIFIER WITH SPEAKER, 1,200ft. REEL OF TAPE	£33 10 0	£8 10 0	£2 6 4
	See note below re packing charge		
(b) ATTACHE CASE AS ILLUSTRATED — ACOS CRYSTAL MICROPHONE —	£6 10 0	—	—

NOTE: Please send 30/- to cover cost of packing, carriage and insurance. We will refund £1 if the packing case is returned to us intact.

EACH UNIT IS AVAILABLE SEPARATELY AS FOLLOWS:

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK	£23 2 0	£5 17 0	£1 12 0
(b) AMPLIFIER MODEL TRIF WITH SPEAKER	£14 14 0	£4 16 6	18 4
(c) PORTABLE ATTACHE CASE	£5 0 0	—	—
(d) ACOS CRYSTAL MIKE "33"	£2 10 0	—	—
(e) REEL OF TAPE 1,200ft.	£1 15 0	—	—

Please include £1 when ordering (a) or (c) for packing charge, this whole amount will be refunded if case is returned to us intact.

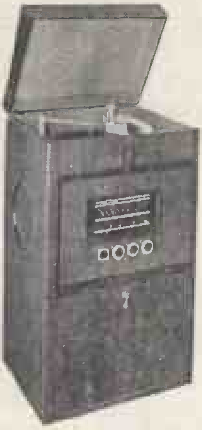
PORTABLE ATTACHE CASE
This, as may be judged from the illustration above, is a neat, compact and attractively finished case, being covered with maroon rexine and having an ivory coloured speaker escutcheon. It contains concealed pockets to accommodate the Microphone, Mains Lead and a spare 1,200ft. reel of tape.

STERN RADIO LTD.

BUILD A COMPLETE RADIOGRAM

THE 'W.B.' PREFABRICATED CONSOLE CABINET

!! HOME CONSTRUCTORS !!



YOU CAN BUILD A GENUINELY HIGH QUALITY RADIOGRAM for only **£33/10/0**

For this amount we will supply

- THE MODEL B3PP RADIOGRAM CHASSIS (illustrated and described on page 112).
- THE B.S.R. "MONARCH" 3-SPEED AUTO-CHANGER (also illustrated and described on page 112).
- A MATCHED 10in. P.M. SPEAKER.
- THE "W.B." PREFABRICATED CABINET.

Carriage and Insurance on all above equipment is 15/- extra and H.P. TERMS ARE DEPOSIT £11/3/4 (plus 15/- carr. and ins.) and 12 monthly payments of £2/0/11.

The illustration (left) shows the Cabinet containing the B3PP Chassis and B.S.R. Changer and for Radiogram Constructors we supply it in its PRE-FABRICATED form, but we cut the side panels for the Speakers and we CUT THE FRONT PANEL to accept the B3PP Chassis; we also supply a template to enable the Constructor to easily fit the B.S.R. Changer on to the Gram Baseboard.

THIS IS AN OUTSTANDING OFFER.

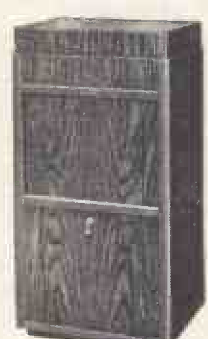
A COMMERCIALLY MADE RADIOGRAM OF SIMILAR HIGH QUALITY WOULD COST ABOUT £65.

The COMPLETELY ASSEMBLED CABINET

Ideally suitable for "Hi Fi" equipment where a separate Speaker is used, but also equally suitable for a RADIOGRAM or as a TAPE RECORDER CABINET.

PRICE **£12/12/0** (plus 7/6 carr. and ins.)

H.P. TERMS DEPOSIT £3 3/- and 12 monthly payments of 17/6.



An attractive and robustly designed Cabinet which is supplied in sections for home assembly for which Assembly drawings are supplied and it really is simple to put together. "Hi Fi" enthusiasts will find it ideal for the accommodation of a high-quality Amplifier, together with a Tuning Unit and any type or make of Record Player (excluding Connoisseur).

The attractive high-polished Walnut finish gives the Cabinet a very pleasing appearance and it has:—

(a) Hinged lid under which is uncut polished board for mounting the Record Player.

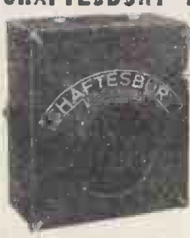
(b) Uncut Front Panel—into which the Tuning Unit Dial and Amplifier Control Panel can be mounted, or similarly any Radio Receiver.

(c) Sectionalised Record Storage space is provided at the base of the Cabinet.

(d) Overall size of Cabinet 19½in. wide × 15in. deep × 35in. high.

A polished Walnut-finished PREFABRICATED BASE REFLEX CORNER FITTING SPEAKER CABINET for 10in. or 12in. Speakers also available—size 18½in. deep × 35in. high. PRICE £11/11/-. H.P. TERMS DEPOSIT £2/19/- and 11 monthly payments of 17/6.

SPECIAL PRICE REDUCTION OF THE FAMOUS SHAFTESBURY PORTABLE AMPLIFIER



Suitable for home use and small Halls. Has matched inputs for both Record Players and Microphone. Also provides for the "mixing" and "fading" of both Gram. and speech as required

COMPRISING:

(a) A 4-Valve High Gain Amplifier for use on A.C. or D.C. mains. 200-250 volts with 5 watts output. Incorporating independent Volume Controls for Mike and Gram., either of which can be faded at will, a variable Tone Control and independent input sockets for Mike and Gram.

(b) A Transverse Carbon microphone which obtains its polarising current from the amplifier—no batteries are necessary.

(c) An 8in. Goodmans P.M. Speaker with the "Ticonal" magnet for first-class reproduction.

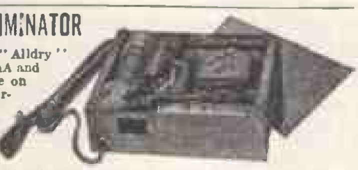
THE COMPLETE EQUIPMENT is all contained in the **PORTABLE CARRYING CASE £18/0/0**

Having been reduced from £30/9/-. HIRE PURCHASE TERMS. DEPOSIT £4/10/- and 12 monthly payments of £1/4/9.

A DUAL-CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

Attractively finished in "Old Gold" and providing full control of BASS and TREBLE in conjunction with a main volume control. It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-ups and all natures of recordings, i.e., English, American and long-playing, without recourse to pick-up correction. The extreme flexibility of the bass and treble control is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier. Response characteristics are given in 12 watt amplifier advt. The unit measures only 9in. × 4in. × 2½in., including self-contained power supply and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price including drilled chassis, valves (6SN7 and 6J5), £3/16/9. Complete assembly data are available separately for 1/-. Completely assembled and ready for use, £5/5/-.

"PERSONAL SET" BATTERY ELIMINATOR



A complete Kit of parts to build a Midget "Alldry" Battery Eliminator, giving approx. 69 volts at 10 mA and 1.4 volts at 250 mA. This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver, requiring H.T. and L.T. voltage as above or approx. to 69 volts. The Kit is quite easily and quickly assembled and is housed in a light aluminium case size 4½in. × 1½in. × 3½in. Price of complete Kit with easy-to-follow assembly instructions, 42/6 (plus 1/6 carriage and insurance). In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts at 10 mA. and 1.4 volts at 250 mA. Size of assembled unit 7in. × 2½in. × 1½in. Price 47/6 (plus 1/6 carriage and insurance).

THE DENCO F.M. FEEDER UNIT

INCORPORATING AN R.F. STAGE

A 5-VALVE SUPERHET DESIGN having a frequency coverage of 88 to 100 mc/s. This F.M. Receiver is designed to operate with any type of Amplifier and most Radio Receivers. It incorporates R.F.—F/Changer and two I.F. Stages followed by a Ratio Discriminator, the valve line-up being 6AM6—12AH8—two 6BA6s and 6AQ5. Overall size of assembled Chassis 7in. × 5½in. × 4½in. high excluding power supply, or 7in. × 8½in. × 4½in. high with power supply. The CONSTRUCTOR'S MANUAL, containing Circuit Diagram and Component Layout, etc., is available for 7/6 and WE CAN SUPPLY ALL SPECIFIED COMPONENTS including Valves and Drilled Chassis for **£6/13/6** (plus 2/6 carriage and ins.) or for £7/2/6 with Dial Assembly as illustrated.

WE WILL ALSO SUPPLY IT...

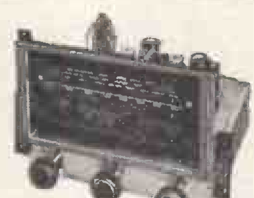
(a) Assembled and Ready for use, excluding Dial Assembly, £8/17/6.

(b) Assembled and Ready for use including Dial Assembly (as illustrated), £9/10/-.

(c) Assembled and ready for use, with Dial Assembly and "Magic Eye" indicator mounted in centre of Dial, £10/10/-.

(d) We can also supply (a), (b) and (c) with and including an HT/LT Power Supply for an additional £2/17/6. The Supply Unit is also available as a separate Unit, size 6½in. × 3in. × 5in. high. Provides 250 volts at 50 mA. and 6.3 volts at 2 amps.

"STERN'S" MODEL CP3G/AM 3 WAVEBAND SUPERHET TUNING UNIT



A highly sensitive A.C. Mains Tuning Unit providing for excellent reception of stations on the short wavebands (16-50 metres) medium waveband (200-550 metres) and the long waveband (800-2,000 metres).

- Valve line-up: 6K8G (Frequency Changer), 6SK7g (I.F. Amplifier), 6H6 (Detector, and A.V.C.) and 5Z4g (rectifier).
- A gramophone position is incorporated with the wavechange switch.
- This tuner is normally supplied with four controls—Tuning, Volume, Tone and the Wavelength Switch (Tone and Volume operate as both Radio and Gram.)—but if your Amplifier already has the Tone and Volume Controls we can omit both. When ordering please state what is required.
- Overall chassis dimensions are 12in. × 8½in. × 8in. including the full vision dial. Size 8½in. × 4½in. Price completely assembled and including built-in power supply £10/10/-. H.P. Terms. Deposit £3/10/-. 8 months at 19/9. Price completely assembled excluding Power Supply £9. Carriage and Insurance 7/6 extra. (Dial Escutcheon is 1/6 extra.)

109 and 115 FLEET ST.

LONDON, E.C.4.

Phone: FLEET ST. 5812-3-4

COMMERCIAL T/V CONVERTERS

Completely self-contained Units designed to operate with commercially made Television Receivers to enable the immediate reception of both the B.B.C. (Band I) and the Commercial (Band III) programmes. No actual fitting and no alteration is required to your present receiver, it simply being a matter of connecting the Mains Supply, Band I and Band III Aerials to the sockets provided on the Converter, which is then connected to your T/V Receiver by a lead which is plugged into a Socket on the Converter and then into the T/V Receiver Aerial Socket. The Controls on the Unit are:—(a) Station Selector Switch which immediately selects either Transmitting Station. (b) An On-Off Switch which also switches the T/V Receiver on or off. (c) Band III Station Tuning Control. THESE CONVERTERS ARE AVAILABLE:—1. THE AERIALITE MODEL TA3. Contained in a brown crackle finished case size 9½in. long × 4in. high × 4½in. deep. Price £9/10/-. 2. THE DULCI T/V CONVERTER. In polished walnut case size 9½in. long × 6½in. high × 4½in. deep. Price £9/9/-. 3. VALRADIO TUNER. A turret type Converter (without case) for direct incorporation into an existing T/V receiver. In this instance it is essential that, when ordering, we are advised of either the I.F. frequency or the make and model number of the T/V receiver. Price £6.

SELENIUM RECTIFIERS

L.T. Types		H.T. Type H.W.	
2/6 v. ½ a.h.w.	1/9	120 v. 40 mA.	3/11
6/12 v. ½ a.h.w.	2/9	250 v. 50 mA.	5/9
F.W. Bridge Types		250 v. 80 mA.	7/9
6/12 v. 1 a.	4/11	250 v. 150 mA.	9/9
6/12 v. 2 a.	8/9	RM4 250 v. 250 mA.	11/9
6/12 v. 6 a.	19/9	300 v. 275 mA.	12/11
6/12 v. 10 a.	35/-		

CO-AXIAL CABLE. 75 ohms ¼in., 7d. yard. Twin screened feeder, 10d. yard.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000 pfd. (.001μF), .002 mfd. (2,000 pfd.). All at 5d. each, 3/9 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.2 a., 6/9 doz.; 6.5 v. 0.3 a., 6/9 doz.; 4 v. 0.3 a., 5/9 doz.

ELECTROLYTICS (current production). NOT ex-Govt.

Tubular Types		Can Types	
8μF 450 v.	1/9	16 mfd. 350 v.	1/11
8 mfd. 500 v.	2/6		
16μF 350 v.	2/3	16μF. 450 v.	2/9
16μF 450 v.	2/9	32μF 350 v.	2/11
16μF 500 v.	3/9		
32μF 350 v.	3/9	32 mfd. 450 v.	4/9
32 mfd. 500 v.	5/9	64 mfd. 450 v.	3/11
8-16μF 500 v.	4/11		
25μF 25 v.	1/3	100 mfd. 450 v.	4/9
50μF 12 v.	1/3	8-8μF 450 v.	2/11
50μF 50 v.	1/11	8-16μF 450 v.	2/11
100 mfd. 12 v.	1/9		
100 mfd. 25 v.	2/3	16-16μF 450 v.	3/11
Can Types		16-32μF 350 v.	4/9
8 mfd. 350 v.	1/3		
8 mfd. 600 v.	2/11	32-32μF 350 v.	4/9
16 mfd. 500 v.	3/9	32-32μF 450 v.	5/9

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

R.S.C. TRANSFORMERS

FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS

Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

- 250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a., Midget type, 2½-3-3in. .. 17/6
- 350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. .. 19/9
- 250-0-250 v. 100 mA., 6.3 v. 4 v. 4 a., c.t., 0-4-5 v. 3 a. .. 25/9
- 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. .. 23/9
- 250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion .. 31/-
- 300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. .. 23/9
- 300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. .. 26/9
- 350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. .. 23/9
- 350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a. .. 26/9
- 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. .. 33/9
- 350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. .. 33/9
- 425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a., suitable Williamson Amplifier, etc. .. 49/9
- 450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a. .. 69/6

TOP SHROUDED DROP-THROUGH TYPE

- 250-0-250 v. 70 mA., 6.3 v. 2.5 a. .. 13/9
- 260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. .. 16/9
- 350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a. .. 18/9
- 250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. .. 22/9
- 300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. .. 23/9
- 350-0-350 v. 100 mA., 6.3 v. 4 a., c.t., 5 v. 3 a. .. 22/9
- 350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. .. 23/9
- 350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. .. 29/11
- 350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. .. 29/9

E.H.T. TRANSFORMERS. 2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 .. 36/6

FILAMENT TRANSFORMERS

Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.	5/9	0-4-6.3 v. 2 a.	7/9
6.3 v. 3 a.	8/11	0-2-4-5-6.3 v. 4 a.	16/9
12 v. 1 a.	7/9	6.3 v. 6 a.	17/6
6.3 v. 2 a.	7/6	12 v. 3 a. or 24 v. 1.5 a.	17/6

CHARGER TRANSFORMERS

All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 0-3.5-9-17 v. 4 a., 18/9. 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.

ELIMINATOR TRANSFORMERS

- Primaries 200-250 v. 50 c/s. 120 v. 40 mA. 7/11
- 130 v. 50 mA., 6.3 v. 3 a. .. 14/9
- 120 v. 40 mA., 5-0-5 v. 1 a. .. 14/9
- 90 v. 15 mA., 6-0-6 v., 250 mA. .. 9/11

OUTPUT TRANSFORMERS

- Midget Battery Pentode 66:1 for 3S4, etc. .. 3/6
- Small Pentode, 5,000Ω to 3Ω .. 3/9
- Standard Pentode, 5,000Ω to 3Ω .. 4/9
- Standard Pentode, 8,000 to 3Ω .. 4/9
- Battery Pentode, 10,000 ohms to 3 ohms .. 4/9
- Multi-ratio 40 mA. 30:1, 45:1, 60:1, 90:1, Class B Push-Pull .. 5/6
- Push-Pull 8 Watts 6V6 to 3 ohms .. 8/9
- Push-Pull 10-12 Watts 6V6 to 3Ω to 15Ω, sectionally wound .. 16/9
- Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω .. 16/9
- Push-Pull 15-18 Watt, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms .. 21/9
- Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω .. 47/9

SMOOTHING CHOKES

- 250 mA., 5 H., 100 ohms .. 11/9
- 150 mA., 7-10 H., 250 ohms .. 11/9
- 100 mA., 10 H., 150 ohms potted .. 9/9
- 100 mA., 10 H., 200 ohms .. 8/9
- 80 mA., 10 H., 350 ohms .. 5/6
- 60 mA., 10 H., 400 ohms .. 4/11

WIRE WOUND POTS: 20 ohms, 500 ohms, 5K, 20K, 100K (medium length spindles), 2/9. 220 ohms, 2K, 10K, 20K. Preset type, 1/9 each.

VIBRATORS. Wearite 12 v. 4 pin. Non-synchronous, 6/9. Oak 2 v. 7 pin, synchronous, 7/9.

EX GOV. E.H.T. CONDENSERS

- .25 mfd., 4,000 v. Blocks .. 4/9
- .5 mfd., 2,500 v. Blocks .. 3/9
- .5 mfd., 3,500 v. Cans .. 3/3
- .1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated) .. 9/6
- 1.5 mfd., 4,000 v. Blocks .. 5/9

EX GOVT. METAL BLOCK PAPER CONDENSERS

2 mfd. 800 v.	1/9	6-6 mfd. 450 v.	5/9
4 mfd. 500 v.	2/9	8 mfd. 500 v.	5/9
4 mfd. 1,000 v.	4/3	8-8 mfd. 500 v.	5/11
4 mfd. 1,500 v.	4/9	15 mfd. 500 v.	7/9
4 mfd. 400 v. plus 2 mfd. 250 v.			1/11

EX GOVT. VALVES. VR137 11d., EA50, EB34, SP61 1/11, VS110 11d.

EX GOV. UNITS. type RF26 in original sealed cartons 29/6. Transmitter Receivers type TR9D complete with all valves 45/-. Carr. 6/6.

CONTROL PANEL with 1 six-position 3-wafer Yaxley switch, 1 pointer knob, 2 S.P.S.T. switches, various plugs and sockets. Only 1/6.

M.E. SPEAKERS. All 2-3 ohms, 8in. R.A. field 600 ohms, 11/9. 10in. R.A. field, 1,000 ohms, 23/9.

MANUFACTURERS SURPLUS TRANSFORMERS

Fully shrouded upright. Primary 200-230-250 v. Sec. 425-0-425 v. 150 m.a. 6.3 v. 3 a. 5 v. 3 a. 37/9. Clamped type 250-0-250 v. 70 mA., 6.3 v. 2.5 a. 9/9, post 1/9.

HEAVY DUTY BATTERY CHARGER

For normal 200/250 v. A.C. mains input. To charge 12 v. battery. Variable charge rate of up to 10 amps. Fitted Meter and Fuses. Guaranteed 12 months. Carr. 10/-. £6/19/6.

OIL FILLED BLOCK CONDENSERS

Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT with louvred crackle finished case. Mains input 200-250 v. Output 120 v. 40 mA., and 2 v. ½ a. Price with circuit, 29/6. Or in working order, 37/6.

THE SKY FOUR T.R.F. RECEIVER

A design of a 3-valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

P.M. SPEAKERS. All 2-3 ohms. 6½in. R.A. 15/9. 8in. Rola Heavy Magnet, 19/9. 10in. R.A. 25/9. 10in. Rola 27/9

R.S.C. BATTERY CHARGER KITS. For mains input 200-250 v. 50 c/s. To charge 6 v. accumulator at 2 amps., 25/9. To charge 6 v. or 12 v. battery at 2 a., 31/6. To charge 6 v. or 12 v. battery at 4 a., 49/9. ABOVE KITS CONSIST OF GREEN CRACKLE LOUVRED STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSES, FUSE-HOLDERS AND CIRCUIT. Any type assembled and tested for 6/9 extra.

R.S.C. 6 v. or 12 v. BATTERY CHARGER

For normal A.C. mains input 200-230-250 v., 50 c/s. Selector panel for 6 v. or 12 v. charging. Variable charge rate of up to 4 AMPS. Fused, and with ammeter. Well ventilated metal case with attractive crackle finish. Guaranteed for 12 months, 69/6. Carriage 2/6.

BATTERY CHARGER KIT. Consisting F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans. 200-250 v. input, 0-9-15 v. 6 a. output and variable charge rate. Rheostat with knob 45/9.

EX GOVT. MAINS TRANSFORMERS

All 230 v. 50 c/s. input.

- 8.8 v. 4 a. 9/9 48 v. 1 a. .. 9/9
- 978 v. 200 mA. 7/9 24 v. 1 a. .. 7/9
- 750 v. 4 times (high ins.) .. 19/9
- 6.3 v. 10 a. .. 16/9
- 120-0-120 v. 40 mA. .. 5/9
- 300-0-300 v. 150 mA. 4 v. 3 a. .. 9/11
- 250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a. Potted .. 11/9

Carriage on following types 5/- extra.

- 0-11-22 v. 30 a. .. 72/6
- 0-16-18-20 v. 35 a. .. 79/6
- 7.7 v. C.T. 7 amps., 4 times .. 25/9
- 460 v. 200 mA., 6.3 v. 5 a. .. 27/9
- 400 v. C.T. 150 mA. 4 v. 5 a., 6.3 v. 6 a., 6.3 v. 0-6 a., 4 v. 6 a., 4 v. 6 a., 4 v. 3 a., 4 v. 3 a., 5 v. 2 a. .. 22/9
- 325-0-325 v. 150 mA., 6.3 v. 4-6 a., 5 v. 2-3 a. 27/9

EX GOVT. AUTO TRANSFORMERS

- 15-10-5-0-195-215-235 v. 500 Watts .. 27/9
- Double wound 10-0-200-240 v. to 10-0-275-295-315 v. Series connection will make suitable for 110 v. to 230-250 v. or reverse. 1,000 watts .. 59/6
- Double wound 0-110-240 v. to 0-130-140-150-160-170 v. 1,500 watts .. 69/6

Carriage on any of above 5/- extra.

EX GOVT. SMOOTHING CHOKES

- 250 mA., 10 H., 50 ohms .. 14/9
- 250 mA., 3 H., 50 ohms .. 8/9
- 150 mA., 10 H., 50 ohms .. 10/11
- 150 mA., 10 H., 150 ohms, Tropicalised .. 6/9
- 100 mA., 10 H., 200 ohms, Tropicalised .. 3/11
- 50 mA., 50 H., 1,000 ohms .. 9/9
- 90/100 mA., 10 H., 100 ohms, Potted .. 8/9
- L.T. type 1 amp., 2 ohms .. 2/9

SPECIAL OFFERS

Filament Transformers. Primaries 230-250 v. 50 c/cs. 2 v. 2 a. 4/9. 4 v. 2 a. 4/9. 6.3 v. 1 a. 4/9

CHASSIS

18 s.w.g. undrilled aluminium amplifier type (4-sided).
- 14in. × 10in. × 3in. 7/11
- 16in. × 10in. × 3in. 8/3

18 s.w.g. aluminium receiver type.
- 6in. × 3⅜in. × 1½in. 2/6
- 7⅜in. × 4½in. × 2in. 3/3
- 10in. × 5½in. × 2in. 3/9
- 11in. × 6in. × 2½in. 4/3

16 s.w.g. aluminium receiver type.
- 12in. × 8in. × 2½in. 5/3
- 16in. × 8in. × 2½in. 7/6
- 20in. × 8in. × 2½in. 8/11

16 s.w.g. aluminium amplifier type, 4-sided.
- 12in. × 8in. × 2½in. 7/11
- 16in × 8in. × 2½in. 10/11
- 20in. × 8in. × 2½in. 13/6
- 14in. × 10in. × 3in. 13/6

R.S.C. HIGH FIDELITY 25 watt AMPLIFIER A4

A NEW DESIGN FOR 1955

HIGH GAIN "PUSH PULL OUTPUT". BUILT-IN PRE-AMP. TONE CONTROL STAGES. INCLUDES 7 valves, sectionally wound output transformer, block paper reservoir condenser, and reliable small components. **AN INPUT OF ONLY 20 millivolts IS REQUIRED FOR FULL OUTPUT. THIS MEANS THAT ANY TYPE OF MICROPHONE OR PICK-UP IS SUITABLE.** Two separate inputs controlled by separate volume controls allow simultaneous use of "Mike" and Gram., or Tape and Radio, etc., etc. Individual controls for Bass and Treble "lift" and "cut". Six negative feedback loops giving total of 24 D.B. Frequency response ± 3 D.B. 30-20,000 c/s.

Hum level 66 D.B. down. Certified total harmonic distortion of only 0.35% measured at 10 watts. Comparable with the very best designs. **SUITABLE FOR SMALL HOMES OR LARGE HALLS, CLUBS, GARDEN PARTIES, DANCE HALLS, etc., etc. For ELECTRONIC ORGAN OR GUITAR. For STANDARD OR LONG PLAYING RECORDS.** Size 12 × 10 × 9 in. For mains A.C. 200-250 v. 50 c/s. Power consumption 175 watts. Outputs for 3 and 15 ohm speakers. The kit is complete in every detail. Chassis is fully punched. Easy to follow point-to-point wiring diagrams are supplied. EXTRA HIGH SENSITIVITY, HIGHEST QUALITY for **9 GNS.**
Or assembled ready for use **50/-** extra.

H.P. Terms on assembled units. Deposit 26/- and 12 monthly payments of £1. Plus carr. 10/-.
Terms to include cover, microphones, speakers, etc., on request. Cover as illustrated if required, price **17/6** extra.

COLLARO HIGH FIDELITY 3-SPEED MIXER AUTO-CHANGERS, TYPE RC/54. Latest model fitted with Studio "O" Turnover Pick-up Head. Very limited number. Brand New. Guaranteed. Only **10 gns.** carriage 7/6. Or Deposit 4 Gns. 7 monthly payments 1 Gn.

COLLARO HIGH FIDELITY MAGNETIC PICK-UPS. Low impedance with matching trans. brand new, boxed at fraction of normal price. Only **35/-**.

A PUSH PULL 3-4 WATT HIGH GAIN ASSEMBLED AMPLIFIER FOR £3/19/6.
For mains input 200-250 v. 50 c/s. Amplifier can be used with any type of feeder unit or pick-up. This is not A.C./D.C. with "live" chassis but A.C. only with 400-0-400 v. Trans. Output is for 2-3 ohm speaker. Supplied ready for use. **£3/19/6.** Leaflet **6d.**

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). Speed 33⅓ r.p.m. **BRAND NEW, CARTONED.** Only **£3/19/6** (approx. half price). Carr. 5/- (for 200-250 v. A.C. Mains).

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER
A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only **£3/15/-**.

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

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads, in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 25 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate), with green crackle finish, and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-**, or assembled ready for use **25/-** extra, plus 3/6 carriage.

MICROPHONES. High fidelity crystal types. Acos 33-1 hand or desk type **50/-**. Piezzo with heavy floor base and telescopic stem **£6/19/6**.

GOLDRING MAGNETIC PICK-UPS. Due to a fortunate purchase we can offer these popular high impedance pick-ups. Brand new, boxed, at only **23/9**

BRAND NEW B.S.R. MONARCH 3-SPEED MIXER AUTO-CHANGERS. With crystal pick-up and dual point sapphire styli for standard or long playing records. Plays ten 7in., 10in. or 12in. inter-mixed. For A.C. mains 200-250 v. 50 c/cs. Supplied in sealed cartons with template and operating instructions. Only **9 gns.** plus 6/6 carr., or 4 gns. deposit and 6 monthly payments 1 gn.

COLLARO 3-SPEED AUTO-CHANGERS. New guaranteed units. Fitted 'Plug in' crystal pick-up heads for standard or long playing records. Very limited number available at approx. half price. For A.C. mains 200-250 v. 50 c/cs. Only **£7/19/6**. Carr. 7/6

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

BAKER SELHURST QUALITY SPEAKERS. 12in. 15 ohm 15 watt Stalwart **£5/15/-**. 12in. 15 ohm 20 watt Standard **£7**.

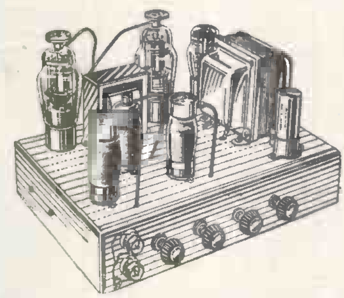
R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen-Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. Supplied with walnut veneered wood or brown bakelite cabinet. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. **CHASSIS IS NOT "ALIVE."** Ideal for use as "Baby Alarm." Sound amplification 4 watts. Price only **7 gns.**, carr. 5/-. "Listen-Talk Back Unit" in bakelite or walnut veneered cabinet can be supplied at **35/-** each.

ALL DRY RECEIVER BATTERY ELIMINATOR KIT

All parts for an "All Dry" Battery Eliminator, complete with case. Completely replaces 1.4 v. and 90 v. batteries where normal mains supply of 200-250 v. 50 c/s. is available. Price with circuit, **38/9** Or ready for use, **45/6**
Size of unit 5¾ × 4¼ × 2¼in. Suitable for receivers with L.T. loads of 125 mA. to 250 mA., thereby covering latest low consumption types.

BATTERY SET CONVERTER KIT. All parts for converting any type of battery receiver to all mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed H.T. of 120 v., 90 v. or 60 v. at up to 40 mA., and fully smoothed L.T. of 2 v. at 0.4 a. to 1 a. Price complete with circuit and instructions only **48/9**. Supplied ready for use for **8/9** extra.

R.S.C. A3 10 WATT "PUSH-PULL" HIGH FIDELITY AMPLIFIER
With Self-Contained Pre-amplifier and Tone Control



Large safety factors in every component A.C. and H.T. fuses, punched chassis with baseplate, screened input plugs, 6 valves, and with easy-to-follow point-to-point wiring diagrams. Everything supplied to last nut. Two independent inputs are provided with two associated independent volume controls so that programmes can be mixed together if desired, such as microphone announcements superimposed on a musical programme, or two independently controlled microphones, or even just gramophone/radio, fading over from one to the other. Varjable base lift and cut with variable treble lift and cut tone controls are fitted, giving full long playing record equalisation for uncorrected pick-ups. They are also provided so that the user can alter the tonal value to suit his personal taste and surroundings. Terminals are provided for 3 ohm and 15 ohm loudspeakers. H.T. and L.T. available for the supply of a Radio Feeder Unit.
Six Negative Feedback Loops.
130 millivolts input only required for full output.
Frequency response 50-20,000 cycles.
Negligible hum and distortion.
For A.C. mains input 200/230/250 v. 50 c/s.

COMPLETE Kit of Parts **7 GNS.** (carriage 7/6).
Supplied, assembled and tested for **45/-** extra.
Cover as for A4 amplifier **17/6** extra if required.
H.P. TERMS on assembled units. Deposit **23/6** and 9 monthly payments **21/-**.

FOUR-STAGE RADIO FEEDER UNIT

Design of a **HIGH FIDELITY** L. and M. wave T.R.F. Unit with self-contained heater supply and thorough H.T. decoupling. Only 250-400 v. 15-20 mA. H.T. required from main amplifier. Three valves and Low Distortion Germanium Diode Detector. Flat topped response characteristic. Loaded H.F. coils. Two variable Mu controlled H.F. stages. 3 gang condenser tuning. Cathode follower output stage. Switch position for Gram. and Gram. input and output sockets. Performance comparable with the best in Feeder Units. For A.C. mains 200-230-250 v. operation. Size 11-6-7½in. Illustration, full set of easy-to-follow wiring diagrams and instructions and individually priced parts list **2/6**. This unit can be built for only **£3/15/-**, including Dial and Drive Knobs and every item required.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS, HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required we highly recommend this unit with an amazing performance. **£4/2/9.**

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS. 2.

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/- extra under 10/-, 1/6 extra under £2, 2/6 extra under £3. Full Price List 6d. Trade List 5d.
Open to Callers: 9 a.m. to 5.30 p.m. Saturday until 1 p.m.

CLYNE RADIO LTD.

18, TOTTENHAM COURT ROAD, LONDON, W.1.

MUSeum 5929/0095.

(50 yards only from Tottenham Court Road Tube !)

All post orders please to :— **24-26, HAMPSTEAD ROAD, LONDON, N.W.1.**

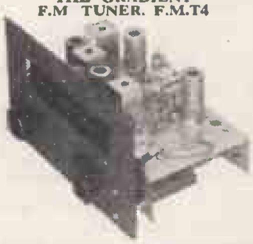
EUSton 5533/4/5.

HIRE PURCHASE

We are pleased to announce advantageous hire purchase facilities on any single item over £5. Ask for details, mentioning what you are interested in. We regret we cannot extend this facility to kits.

F.M. !! (Frequency Modulation)

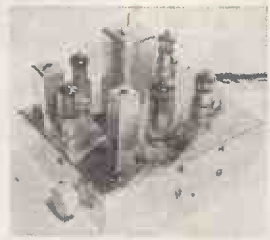
THE GRADIENT F.M TUNER. F.M.T4



Introducing our latest F.M. Tuner. Of advanced design, employing new technique. *Tuned resonator R.F. Stage. *Ultra-stable co-axial oscillator. *High sensitivity. *Gorler I.F.T's and discriminator.

This tuner is completely stable with no warm-up drift. Easy to construct and align. The ready-drilled chassis not only includes dial and drive assembly complete, with tuning condenser, but volume control ready mounted. Attractively finished in bronze, black and gold, dial ready calibrated in megacycles. Front panel measures 8½in. × 5in., dial 5½in. × 1½in., chassis 7½in. × 4½in. × 1½in. Valve line-up is 4-6AM6 or equivalent. Illustrated comprehensive instruction booklet with individually-priced component list 1/6 post free. Or, the kit complete right down to the last nut and bolt £6/19/6, plus 2/6 P. & P.

We are pleased to announce our complete Kit for the "Denco" F.M. Feeder Unit. This unit provides an A.F. output suitable for feeding into the audio section of a standard broadcast receiver where triode/pentode output are available. Within an average of 30 miles from a V.H.F. transmitter one I.F. stage should be adequate, but our complete Kit supplied includes all components and valves for an extra I.F. stage if necessary, or if the unit is used at greater distances. Full Constructional details, theoretical circuit and point-to-point wiring diagram can be supplied for 1/6 post free, or the complete Kit right down to the last nut and bolt at only £6/7/6, plus 2/6 packing and postage. This unit can be supplied, if desired, ready assembled, aligned and tested, at £8/10/-, plus 2/6 packing and postage. If required we shall be pleased to align this unit for constructors not possessing the necessary equipment for a charge of 7/6. N.B.—Valve line-up is 6AM6, 12AH8, 2-6BA6 and 6AL5. Chassis measures only 6¼ × 5¼ × 1½in. Demonstrations at 18 Tottenham Court Road ! !



The Jason F.M. Tuner Kit!

This kit has been based on the booklet by Data Publications, price 2/- post free. With each booklet is enclosed our individually priced parts list. The construction and alignment of this tuner are no more difficult than a normal medium wave tuner. It is highly sensitive and free from drift. Incorporates 4 valves type 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in megacycles, and attractive bronze stove enamelled front plate already mounted (as illustrated) front plate size 8in. × in., chassis size 7in. × 4½in. × 1½in.

N.B. The standard model is at present operating satisfactorily up to 80 miles from Wrotham. Our price for the complete standard kit is £6/15/- only ! Plus 2/6 p. & p. Fringe area model including extra valve, coil, etc. (results could be expected up to 150 miles from Wrotham!), is £7/15/-, plus 2/6 p. & p. The Standard Model Tuner can be supplied ready built, aligned, tested and manufactured by the Jason Motor and Electronic Company at a price of £15/17/-, purchase tax paid.

N.B.—THESE TUNERS ARE BEING DEMONSTRATED AT 18 TOTTENHAM COURT ROAD.

F.M. AERIALS. Indoor two-element type by Lumex. Brand new 11/6 each only, plus 2/- postage and packing. Other types available.

F.M. POWER PACK KIT.—We can now supply complete kit for power pack suitable for either of the above F.M. tuners or any other similar type. Price for the complete kit is 37/6 only, or 52/6 for ready assembled unit. This pack is extremely small incorporating valve rectifier type 6X4 and built on chassis size only 6in. × 4in. × 1½in. Optional extra for power pack, Bulgin Octal Plug 2/3.

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 2in.	M.C.	R.P.	50/-
50 microamp	D.C. 2½in.	M.C.	F.R	65/-
100 microamp	D.C. 2½in.	M.C.	F.R.	45/-
500 microamp	D.C. 2in.	M.C.	F.R.	18/6
1 mA.	D.C. 2in.	M.C.	F.R.	17/6
1 mA.	D.C. 2in.	M.C.	F. Sq.	22/6
1 mA.	D.C. 2½in.	M.C.	F.R.	27/6
1 mA.	D.C. 2½in.	M.C.	Desk Type	30/-
5 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
200 mA.	D.C. 2½in.	M.C.	R.P.	10/-
.5 amp.	R.F. 2in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2½in.	M.C.	F.R.	10/-
20-0-20 amp.	D.C. 2in.	M.C.	F. Sq.	7/6
150 amp.	A.C. 4in.	M.I.	R.P.	45/-
1 amp.	R.F. 2½in.	Thermo	R.P.	7/6
3 amp.	R.F. 2in.	Thermo	F. Sq.	6/-
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
6 amp.	R.F. 2½in.	M.C.	Thermo F.R.	7/6
20 amp.	D.C. 2in.	—	R.P. (with shunt)	10/6
25 amp.	D.C. 2½in.	M.I.	F.R.	6/6
30 amp.	D.C. 2½in.	M.I.	F.R.	12/6
15 volt	A.C. 2½in.	M.I.	F.R.	10/-
20 volt, (5 mA.)	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
300 volt	A.C. 2½in.	M.C.	F.R.	35/-

SPECIAL. U.S.A. 0-1 mA. 2½in. taken from equipment but perfect. 22/6 each.

R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.

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

U.S.A. PACKARD-BELL PRE-AMPLIFIER. Incorporating valves. 6SL7GT, 28D7GT, relay-plugs, sockets, condensers, etc. Brand new, with instruction booklet, 12/6 only.

MAINS TRANSFORMER BARGAINS ! Limited quantities. Manufacturers' Surplus 350-0-350, 80 mA., 6.3 v. 3 a., 5 v. 2 a. Half shrouded, drop-through, 14/6 only, plus 1/6 P. & P. 110/210/240 v. Input. 350-0-350, 120 mA., 6.3 v. 6 A., 6.3 v. 1.5 A., 5 v. 3 A., tropicalised drop-through type, 21/- only, plus 2/6 P. & P. 110/210/240 v. Input, 250-0-250 120 mA., 6.3 v. 4 A., 5 v. 2 A. Upright mounting, 21/- plus 2/- P. & P. 230 v. Input, 300-0-300 80 mA., 6.3 v. 3 A., 4 v. 2 A. Tropicalised drop-through type, 9/6 only, plus 1/6 P. & P. Input 110/230 v. Auto load 230 v. 750 mA. 350-0-350 130 mA. Tapped filament winding 6 v. 3 A., 15 v. .3 A., 21.5 v. .6 A., also 5 v. 2 A. Tropicalised drop-through type, 21/- plus 2/6 P. & P. 270-0-270, 100 m/a. 6.3 v. 3 a., 5 v. 2 a., 200/250 v. Input universal mounting 16/6, plus 1/6 P. & P.

L.T. TRANSFORMER. Manufacturer's surplus. Input 180/200/220/250 v. Output 6 v. 2 a. and 6 v. 6 a., 15/- only, plus 1/6 P. G P.

TELESCOPIC AERIAL MAST. Ex-R.A.F. dinghy transmitter mast. Total length when extended, 17ft. Collapses into two sections each approx. 24in. Complete with dies and lashings, lightweight duralumin construction, dia. at thickest point, 1½in. approx., tapering to ½in. New condition, 32/6, plus 2/- post and packing.

EX-W.D. CATHODE RAY TUBES. Guaranteed full picture. VCR97 at 40/-. VCR517C at 35/-. Also VCR139A—ideal for oscilloscope 2½in. screen at 35/-. We also have VCR97 with slight cut-off very suitable for oscilloscope, testing purposes, etc., at 15/- only. All these tubes are brand new, in original packing, and tested before despatch. Please add 2/6 packing and carriage for any of the above tubes.

TRANSISTORS. Mullard Type OC71 available from stock, 40/- post free.

AMERICAN INDICATOR UNIT TYPE BC929A. Brand new incorporating 3in. tube 3BP1, with mu-metal shield 2-6SN7GT, 2-6H6GT, 6X5G, 2X2, 6G6G, 9 potentiometers 24 v. aerial switch motor, transformer and a host of small components. The whole unit which measures only 8½in. × 8½in. × 13½in. is brand new, enclosed in black crackle box, and can be supplied at 65/-, plus 5/- P. & P.

R1155A RECEIVERS guaranteed serviceable in original packing cases, £7/19/6. Fully assembled Power Pack and output stage, to plug straight into R1155 for A.C. 200/250 volts at 79/6. We have a few brand new R1155A at £11/19/6, also in original packing cases —Deduct 10/- if purchasing either receiver together with power pack. Plus 10/- packing and carriage.

R1124 RECEIVER UNIT. Coverage 30-40 Mc/s. Including 6 valves—3 type 9D2, 1 each 8D2, 15D2 and 4D1—6 valve screening cans, 24 ceramic trimmers, 6 ceramic valve holders, resistors, condensers, I.F.T.'s coils, etc. In very good condition, a bargain at 16/6 each only, plus 3/6 packing and postage.

RECEIVER TYPE 25/73. (The receiver section of TR1196). Supplied complete with full data for conversion to 3-wave-superhet receiver. Unit is complete with 6 valves 2-EF39, 2-EF36, FK32 and EBC33, also standard I.F.T.'s 465 Kc/s. Price 27/6 plus 2/6 P. and P.

TR1196 TRANSMITTER PORTION. We can also supply the transmitter portion of the above receiver incorporating valves, EL32, EF50, CV501. Type 600 relay transformer, coils, switches, etc. Limited quantity at 12/6 only, plus 2/6 P. and P.

CRYSTAL MIKE INSERTS. Brand new by Cosmocord. Price 7/6 each only. Post free.

22 SET POWER UNITS No. 4MK1 ZA10478—Complete with 4 metal rectifiers each 250 v. 60 mA. 2-12 v. 4 pin Mallory Vibrators, transformers, condensers, resistors, signal 1 amp. indicator, etc., etc., in good condition. Complete in metal box size 10½in. × 6in. × 8in. Weight 19lb., 27/6, plus 5/- P. & P.

L.T. RECTIFIERS. A newly manufactured range guaranteed 12 months.

6 or 12 v. 1 a. F.W. bridge type . .	7/6
6 or 12 v. 1.5 a. F.W. bridge type	9/6
6 or 12 v. 2 a. F.W. bridge type . .	11/3
6 or 12 v. 2.5 a.	12/6
6 or 12 v. 4 a. F.W. bridge type . .	19/6
6 or 12 v. 6 a. F.W. bridge type . .	30/-

CHARGER TRANSFORMERS, Input

230 v. 6/12 v. 1 a.	9/9
2/6/12 v. 2 a.	14/6
2/6/12 v. 4 a.	17/6

METER SPECIAL ! We have a limited quantity of aircraft electrical thermometers. Brand new, by Weston, 2in. moving coil meter, flush square fitting. These meters have a luminous scale graduated 40-140 degrees centigrade, but the full-scale deflection is approximately 150 microamps ! Price 12/6 each only, plus 1/- P. & P.

VIBRATOR PACK. Brand new, by Mallory, 12 volt input, 150 v. 40 mA. output. Complete with synchronous vibrator, 27/6.

DECCA LIGHTWEIGHT PICKUPS. Complete with either standard or L.P. Crystal Cartridge Insets. Complete with Rest and Tracking instructions, 32/6 plus 1/6 P. & P. Also their very latest type, as above, but with turn-over head. 47/6 only ! Plus 1/6 P. & P.

6-VOLT VIBRATOR PACK. Ex-W.D. 6-volt input, output 140 v. 30 mA. Fully smoothed and rectified, incorporating Wearite 6 volt 4 pin vibrator type NSB6. Unit size only 6½in. × 5in. × 2½in. Price 15/- plus 1/- P. & P. New condition.

R.F. UNITS. All new condition and complete. Case size 9½in. × 7½in. × 5in. Type 24, 20-30 Mc/s. 15/-. Switched Tuning. Type 25, 40-50 Mc/s, 19/6. Switched Tuning. Type 27, 65-86 Mc/s. 45/-, Variable Tuning. Type 26, 50-65 Mc/s. Variable Tuning 35/-. We have a limited supply of RF27 new condition and complete, but tuning dial damaged. Price only 30/- each. ALL these units Post Free !

I.F. TRANSFORMERS SPECIAL OFFER. All iron-cored 465 Kc/s. By Invicta — Cylindrical 2½in. × 1⅜in. diam., 8/6 pr. Also our own special ultra midget size 1½in. × 13/16in. × 13/16in. Only 9/9 pr. By Wearite, Type 501 and 502 12/6 pr. Type 551 and 552 12/6 pr. M800 12/6 pair.

COIL PACKS. Manufacturers' Surplus. Miniature size, only 2½in. × 2½in. × 1½in. deep. Iron-cored. For L.M. and S.W. with gram. position. Switch has 2-inch spindle. Absolutely brand new, complete with circuit. Price only 25/-, plus 1/6 P. & P. A snip !

HEADPHONES. Brand new, ex-Govt., by S. G. Brown. Type CLR. Low resistance. 7/6 per pair. Type CHR high resistance. 12/6 per pair.

No. 38 TRANSMITTER/RECEIVER WALKIE-TALKIE. Range approx. 5 miles. Coverage 7.4-9 Mc/s. The set only complete with valves at 30/-, in very good condition.

Please add postage under £1, C.O.D. or Cash with order. C.O.D. charge extra—open 9 a.m. to 6 p.m. Monday to Friday. Sorry, but we close at 1.0 p.m. on Saturday.

THE R.C. 3/4 WATT AMPLIFIER KIT. — Just released ! Compare the advantages ! Treble bass, AND middle tone controls ! For crystal or magnetic pickup ! A. C. Mains. 200/250 v. Valve line-up, 6V6GT, 6SG7, metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 4in. × 1½in. Four engraved cream knobs are included in the price of the complete Kit with all necessary practical and theoretical diagrams, at £4/5/- only, plus 2/6 packing and post, or Instruction Book, fully illustrated, for 1/-, post free ! This amplifier can be supplied assembled, tested, and ready for use at £5/5/-, plus p. and p. Hearing is believing !

The R.E.P. ONE-VALVE BATTERY RECEIVER KIT. Simple one-valve all dry battery receiver for headphones, easily built in one evening. All required components including headphones, can be supplied at inclusive cost of 42/- plus 2/- p. and p. Operated by Ever-Ready B114 type battery available at 7/9. Full assembly details available separately at 9d. plus 3d. post.

T.S.L. ELECTROSTATIC LOUDSPEAKERS ! A much-wanted need in High Fidelity reproduction! Model LSH75. Size only 3in. × 3in. × ¼in. Weight 1½oz. only. Capacity 800 pf. D.C. voltage 300 max. Tone frequency A.C. voltage, 60 volts max. effective. Test voltage at 50 cycles, 440 volts. Price only 12/6, plus 1/- p. and p. Model LSH100. Size 5in. × 4in. × ¼in. Capacity 1100 pf. Response identical to LSH75. Weight 3½oz. Price 21/-, plus 1/- p. and p. Fitting an electrostatic speaker to an ordinary loudspeaker system merely entails the use of two condensers and two resistors. These speakers have a high efficiency in the range of 5,000-20,000 cycles, and are a must for F.M., high quality recordings, and T.V. sound ! Each speaker is supplied with full technical data, response curve, and wiring diagram.

COLLARO RC/54 PLAYER ! Just released. Fawn leatherette covered portable case incorporating very latest Collaro 3-speed mixer-changer. Cream finish. Lightweight turn-over crystal pick-up head. Only £13/5/- cash, plus 5/- p. and p. complete, or 65/- deposit plus p. and p. and 12 monthly payments of 18/7.

PLAYING DESK! Two-speed 33 and 78 r.p.m. player by famous manufacturer. Complete with turn-over crystal pick-up. Already mounted on platform, ready to use, £5/19/6 only, plus 5/- P. and P.

B.S.R. MONARCH. The very latest cream 3-speed mixer Autochanger. Complete with turn-over crystal pick-up. Complete in original manufacturer's cartons, fully guaranteed. Price only £7/19/6. Buy now ! Quantity at this price strictly limited.

TABLEGRAM CABINETS. Manufacturer's Surplus ! Handsome dark walnut finish. Size 16½in. × 13½in. × 11½in. high. Motor-board already cut for latest type B.S.R. Monarch Autochanger. Provision at side for amplifier controls. Price 79/6, plus 5/- P. & P. Baffle fitted for 7in. × 4in. Elliptical speaker for which we can supply latest ROLA at 21/6.

RECORD PLAYER CABINETS. Specially made to house any type of single record unit. Finished in dove-grey leatherette. Baseboard measures 14½in. × 12½in. Clearance above and below board 3in. 45/- plus 3/- P. & P. We can also supply equally attractive dove-grey cabinet to house any standard autochanger at 69/6 plus 3/- P. & P. We carry a large selection of cabinets for all purposes. A stamp will bring illustrated cabinet leaflets.

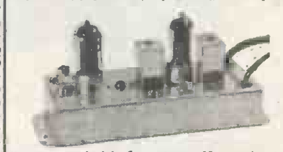
VALVES

We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list but the following is a selection only of brand new imported valve types, fully guaranteed. Purchase Tax Paid.

EABC80	10/-	DAF96	10/6	PY80	10/6
EAF42	10/-	DF96	10/6	PY81	10/-
EB41	7/6	DK92	10/6	PY82	9/6
EB91	7/6	DK96	10/6	PY83	11/6
EBC41	10/-	DL96	10/6	UBC41	10/6
EBF80	11/6	or 39/6 per set of four.		UCH42	11/6
ECC81	9/-	EL41	10/6	UF41	10/6
ECC82	9/-	EL84	11/6	UL41	10/6
ECC83	9/-	EM80	9/-	UY41	9/-
ECC85	10/-	EY51 (large)	11/-	6AQ5	8/6
ECH42	11/6	EZ40	8/6	6AT6	8/-
ECH81	11/6	EZ80	8/6	6AU6	9/6
ECL80	11/6	PCF80	12/6	6BA6	8/6
EF41	10/6	PCF82	12/6	6BE6	9/-
EF80	10/6	PCC84	12/6	6BW6	8/6
EF85	10/6	PL81	13/6	6X4	7/6
EF86	12/6	PL82	10/6	35W4	7/6
EF89	10/-	PL83	11/6	50B5	10/-
				50C5	10/-

In addition we naturally have all usual surplus types available such as 6V6GT, etc. All in our valve price list !

THE "TELETRON" BAND III CONVERTER ! ! !
This converter which is built around two valves type EF80 (Z719) is for use with most T.R.F. or Superhet band I Television receivers. Complete set of TELETRON coils only, with practical and theoretical wiring diagram 15/- post free. Chassis measuring 7in. × 3in. × 1½in. ready drilled to specification, 3/9 plus 9d. packing and post. Alternatively construction details only with separate individually priced parts list, 6d. post paid. The complete kit as specified, including all the above, valves, etc., down to the last nut and bolt, can be supplied at 48/6 only, plus 2/- packing and post.

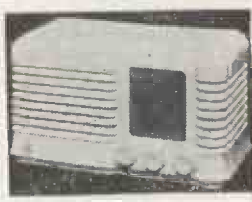


Power pack kit for above if required—complete price 22/6 only. N.B. We are demonstrating this converter at Tottenham Court Road.

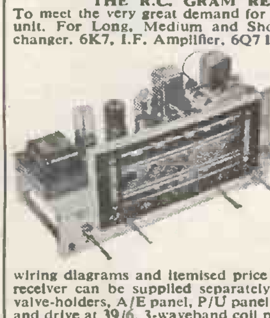
THE "SUPERIOR" FOUR KIT. Our new four-valve receiver. A.C. mains, 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6SG7, 6 X5GT and 6 V6GT. Chassis ready drilled. Cabinet size, 10½ in. × 10in. wide. Maximum depth at base 5in. tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6 post free. Our price for complete kit, £6/9/6 ! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wavechange switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at 45/-, plus 2/6 packing and carriage. N.B.—Our kits are even supplied with sufficient solder for the job.

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

THE "ECONOMY FOUR" T.R.F. KIT
A three-valve plus metal rectifier receiver, A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up 6K7 6J7 and 6V6. Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown Bakelite, or wooden, walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/10/- complete—Remember this set is being demonstrated at our shop premises ! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver — Booklet available at 1/6 post free. This is allowed if kit is purchased later. Please, 2/6 packing and carriage for complete kit.



THE R.C. GRAM REPLACEMENT CHASSIS KIT
To meet the very great demand for this type of receiver, we have produced this unit. For Long, Medium and Short Waves. Valve line-up: 6K8 Frequency changer, 6K7, I.F. Amplifier, 6Q7 1st Audio Detector and A.V.C. 6V6 Output, 6X5 Full-wave rectifier. For A.C. mains 200/250 volts. 4 watts output. Excellent quality. High sensitivity. Provision for gram. Attractive illuminated black, red, green and gold dial for horizontal tuning. Four controls are: Tuning, L/M/S. Gram. Vol./on/off. Tone (variable). Chassis size: 13½ in. × 5½in. × 2 in. Dial size: 10in. × 4½in. Assembly is simplified by the use of a 3-waveband coil pack, and pre-aligned 465 Kc/s. I.F. transformers—high-grade drop-through half-shrouded Mains Transformer, with voltage adjuster panel. This chassis can easily be assembled in one evening. Illustrated pamphlet with full assembly instructions, practical and theoretical wiring diagrams and itemised price list, 1/6 post free. The main items for this receiver can be supplied separately, as under. Drilled chassis, complete with valve-holders, A/E panel, P/U panel, tuning condenser and ready-assembled dial and drive at 39/6. 3-waveband coil pack with gram position, 39/6, tax paid. Pair of 465 Kc/s. I.F. Transformers, 9/6 pair. Half shrouded drop-through Mains Transformer, 22/6. The total cost of ALL items purchased separately is nearly £10, but we shall be pleased to supply all the required components right down to the last nut and bolt at a special inclusive price of £8/8/-, plus 2/6 packing and postage. A set of four small brown and cream engraved knobs to suit is available at 1/2 each knob. This chassis is a professional job in every respect and can be seen and heard at our premises. This chassis can also be supplied, ready assembled in very limited quantities at £9/19/6, plus 5/- carriage and packing.



ARMSTRONG F.C.48. Their very latest high quality replacement chassis having provision for F.M. feeder unit, 8 valves, 4 wavebands. Independent bass and treble with unique thermometer visual indicator. Ready for use £23/18/- plus 5/- package and postage or £5/18/- deposit and 12 monthly payments at 33/9. Illustrated leaflet available.

DULCI RADIO/RADIOGRAM CHASSIS. All latest models including F.3 and F.3 push-pull are in stock. Cash or H.P. Ask for illustrated leaflet.

COLLARO 2010. Transcription motor with Studio Pick-up. This very popular unit can now be supplied from stock. £18/5/3 cash or 95/3 deposit, and 12 payments of 25/8.

London's largest selection of Amplifiers, Recording equipment, etc., etc.

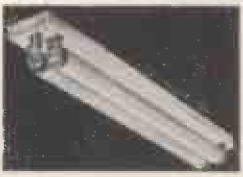
THE R.C. RAMBLER ALL-DRY PORTABLE KIT
Full assembly details with practical and theoretical diagrams can be supplied at 1/6 post free. This is a truly professional 4-valve superhet —all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, adds to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attache-case type cabinet; measuring only 9in. × 7in. × 5½in. Weight less batteries 4½lb., with batteries 6½lb. This set really has everything ! Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up 3V4, 1R5, 1S5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of £7/7/- plus 2/6 p. and p. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at 9/3. Also L.T. 1.5 v. A.D. 35 at 1/4.

RAMBLER MAINS UNIT! At last we are able to offer our special mains units kit for using our popular all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits snugly into battery compartment, can be supplied at 47/6, plus 1/6 packing and postage. Price includes all required components, and full assembly instructions. N.B.—This unit is completely self-contained in a metal box measuring 7in. × 2½in. × 1½in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 v. L.T.

SUPER-QUALITY 6-VALVE RADIOGRAM CHASSIS
Very limited quantity by Britain's leading quality manufacturers, 3 waveband, superhet, valve line-up, 6V6G, EZ40, ECH42, L63, EF41, and EBC41. Combined pick-up amplifier and A.F. amplifier on Radio and Gram. Employs a special circuit for gramophone pre-amplification. Large glass dial horizontal tuning measuring 11in. × 3¾in. Chassis measurement: 14½ × 9 × 8in. This is a superior chassis designed to sell originally in a Radiogram costing £79. Our price is £12/19/6 only, tax paid, plus 5/- packing and carriage. We will gladly demonstrate this chassis or any other working item from our stocks, to personal callers !

REGAL. A well-made cabinet in medium coloured walnut veneer. Size 29½ × 14½ × 29½in. Uncut motor-board measures 25½ × 13½in. Record or tape storage aperture alongside motor-board measures 3½in. wide × 12in. deep. Price £9/19/6 plus 10/- p. and p. H.P. terms available.

CLYNE RADIO LTD.
18, Tottenham Court Road, London, W.1.



THE TWIN 20 This is a complete fluorescent lighting fitting. It has built-in ballast and starter—stove enamelled white and ready to work. It is an ideal unit for the kitchen, over the work-bench, and in similar locations. It uses two 20-watt lamps. Price, complete less tubes, 29/6, or with two tubes, 39/6. Post and insurance 2/6. Extra 20-watt tubes, 7/6 each

RECORD PLAYER FOR £4/10/-.

3-SPEED INDUCTION MOTOR

3-speed motor with metal turntable and rubber mat. Latest rim drive with speed selection by knob at the side. No auto. stop, but there is a stop position on the selector. Small mod. makes speed variable for special effects and dance work.

HI-FI PICK-UP

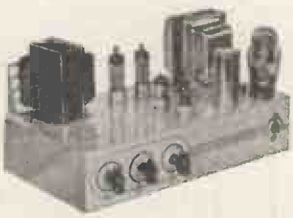
Using famous Cosmocord Hi-G turnover crystal. Separate sapphire for each speed. Neat bakelite case with simple adjuster for weight compensation.

SPECIAL SNIP OFFER THIS MONTH

The two units for £4/10/-, or 30/- deposit and four payments of 18/-, post and insurance, 5/-.

AMAZING MINI-RADIO

Uses high-efficiency coils—covers long and medium wavebands and fits into the neat white or brown bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, £4/5/-, plus 5/- post. Constructional data free with the parts, or available separately 1/6.



MULLARD AMPLIFIER "510"

A High Quality Amplifier designed by Mullard engineers. Robust high fidelity with a power output exceeding 10 watts and a harmonic distortion less than ·4% at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 20,000 C.P.S.—three controls are provided and the whole unit is very suitable for use with the Collaro Studio and most other good pick-ups. The price of the unit completely made up and ready to work is £12/10/-, plus 10/- carriage and insurance. Alternatively, if you wish to make up the unit yourself we shall be glad to supply the components separately. Send for the Mullard amplifier shopping list.

A WONDERFUL CHRISTMAS PRESENT

Non-Mains, absolutely safe

Children of all ages enjoy playing records and will be overjoyed to own the fine portable illustrated alongside. This uses the Garrard spring motor and a 2-valve battery amplifier. The case is in two-tone imitation crocodile/lizard skin. Special price £7/19/6, carriage 7/6 extra.

THE ELPREQ ADDITA

MIDLANDS ADDITA NOW AVAILABLE

Our ADDITA Band III convertor which is enjoying such a huge success in the South is now available for Midlands viewers who will have heard that test transmissions are about to commence. Please be advised and order early, price is as for London model.

BETTER THAN FROM FACTORY BUILT SET

Other constructors report better results from the convertor than from factory-built Band III televisors. At Eastbourne, one of the latest models by a very famous maker would not receive the commercial signal on its own proper channel circuit despite trimming. However, with the ADDITA a reasonably clear and loud signal was received on Channel I without any adjustment.

ADDITA & T.R.F. TELEVISORS

Certain technicians have been of the opinion that our ADDITA would not be suitable for T.R.F. receivers. Full power transmissions seem to have disproved this theory, however, for we have heard from many viewers with the Viewmaster and other T.R.F. sets that they are getting good results. For instance, in today's post we heard from Mr. L. Campling, of Tolworth, Surrey, as follows:—"I would like to inform you that I have tested one of your convertors on both adapted Band I and on Band III aerials. The reception was 100%. These tests were carried out on low power conditions and the aerials were only about ten feet from ground level. The set was the home-made 'Electronic.'"

AVAILABLE AS A KIT OR READY BUILT

The price of the complete kit to build the ADDITA including valves, ready wound coils, drilled and prepared chassis, handsome stove-enamelled case, in fact everything, including transfers to decorate the front and identify the controls is £4/5/- or £5/5/- if mains components are also required. Post and insurance is 2/6 in each case. Data is included free with the parts or available separately price 2/6. When ordering please state whether for Midlands or London area. Made up models for either area available price £7/10/-, plus 3/6 post and insurance.

"WIRELESS WORLD" BAND III CONVERTOR

One of the most successful circuits for Band III conversion was published in the "Wireless World," May 1954. We offer a complete kit of parts including the specified EF80 valves, wound coils, drilled chassis, in fact, everything including a copy of the circuit diagram. Price only 42/6, post 2/6 extra. Mains components, if required, 25/- extra.

BAND III AERIAL KIT

An interesting aerial, "The Folded V," was described in the July number of a T.V. magazine. We tried this and found it to be most efficient. It is simple to make. Kit comprises alloy elements and connectors, plastic centre piece and saddle for mounting. Price 8/6, plus 1/- post.

BAND III AERIALS

AERIALS

BAND III Aerials—These aerials have quick fitting alloy elements and polythene low-loss insulators.

BAND III DOWN-LEAD. 8½d. per yard, or super low loss 1/4 and 1/9 per yard.

3-element array with swan-neck mast with "U" bolt clamp for fitting to existing masts from ⅞in. to 2in. dia.	41/6
3-element array with cranked mast and wall mounting bracket	42/6
3-element array with cranked mast and chimney lashing equipment	65/-
5-element array with swan-neck mast and "U" bolt clamp for fitting existing mast from ⅞in. to 2in. dia.	52/6
5-element array with cranked mast and wall mounting bracket	53/6
5-element array with cranked mast and chimney lashing equipment	67/-
8-element array with swan-neck mast and "U" bolt clamp for fitting to ⅞in. 2in. dia. mast	69/-
8-element array with cranked mast and chimney lashing equipment	83/6
8-element array with 1½in. mast cap, 10ft. mast and heavy duty single chimney lashing equipment	134/-
10-element array with cranked mast and chimney equipment	94/6
10-element array with 1½in. mast cap, 10ft. mast and heavy duty single chimney lashing equipment	145/-
10-element array with 2in. mast cap, 12ft. mast and heavy duty double chimney lashing equipment	178/6

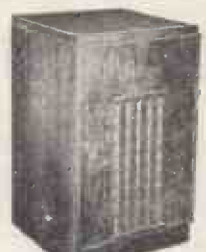
CABINETS FOR ALL

WE CARRY A VERY VARIED STOCK PLEASE CALL

The one illustrated is the "Empress," it is undoubtedly a beautiful piece of furniture. It is elegantly veneered externally in figured walnut, internally in white sycamore. The radio section is raised to convenient level but is not drilled or cut. The lower deck acts as the motor board, again is uncut, it measures 16 x 14 and has a clearance of 5in. from the lid. There is a compartment for the storage of recordings.

Overall dimensions of this essentially modern cabinet are 3ft. wide, 2ft. 9in. high, and 1ft. 4½in. deep.

Price £14/14/-, carriage and insurance 20/-.



THIS IS ON OFFER AT APPROX. HALF COST TO MAKE

An impressive costly looking cabinet originally designed for T.V but simple modification makes the cabinet suitable for radiogram, amplifier, tape recorder, or reflex speaker—size 23in. wide, 22in. deep and 37½in. high. Limited quantity at £8/15/- each, carriage 12/6.

CORNER CONSOLE

A massive cabinet but being corner fitted is not out of place even in a modern small living room. Overall dimensions of this cabinet are 47in. wide x 31in. (deep to corner) x 50in. high. Made to house 15in. Televisor, Radio Unit, Amplifier, Tape Deck, etc. Originally £18. Our Price £10 plus 30/- carriage.

F.M. TUNER

This tuner is based upon the very successful circuit in the booklet published by Data Publications. We have made up models at all branches and will be glad to demonstrate.

Cost of all parts including valves, prepared metal chassis, wound coils and stove enamelled scale, slow motion drive, pointer, tuning knob, in fact everything needed to make the complete unit, is £6/12/6. Data is included free with the parts or is available separately price 2/-.

THE INFRAY MAJOR

This is a new type of overhead heater which in the main warms only the area within its radiant rays, and by so doing effects a very considerable saving of fuel. One user in fact claims that in his office he receives more benefit from The Infray Major than from a standard convector type costing three times as much to run.

Perhaps one of the best points about The Infray Major is that its benefits are felt immediately, there is no warming-up period. It is essentially a personal type of heater, having its controls within easy reach of the operative. The controls give four variations of heat and "off."

At maximum heat the unit consumes 1 kW., which means that overall cost of heating can be controlled at 1d. per hour per operative (based on the average cost of electricity, 1d. per unit).

The Infray Major is of particular use:—

(a) In large rooms, warehouses, lofts, machine shops, etc., where the cost of heating the whole room to a comfortable level would be too great.
(b) In airy rooms, garages, even in the open where ordinary heating is almost impossible.
(c) In rooms which in the main have to be kept cool, e.g., food storage chambers, beer cellars, etc.
(d) For cubicle heating particularly in hospitals and clinics where spasmodic but immediate heating is required.
(e) In any situation where local heating is required occasionally but quickly.
(f) In the sick bay, over the emergency couch, where immediate radiant heat is required in cases of shock.

The unit has its uses in production for warming, drying, processing, etc. One special use being for warming through a glass screen, where for some reason or another the substance cannot be warmed in free atmosphere.

Price is £6/10/-, plus carriage and insurance 10/-.

COMMUNICATIONS RECEIVER R1155

This set is considered to be one of the finest communications receivers available today. The frequency range is 75 kc/s to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Used but completely overhauled and guaranteed in perfect working order. PRICES: Grade 2 **£7/19/6.** Grade 1 **£9/19/6.** Or will be sent against deposit. If you cannot call to collect please include an additional 15/- to cover cost of transit and case carriage.

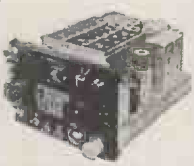
MAINS POWER PACK FOR R1155

With Pentode output stage. Plugs into socket on receiver so no internal modifications are required. Price **£5/10/-** complete with speaker ready to work, carriage 3/6. Or in cabinet **£6/15/-.** Carriage 5/-.

BENDIX RA-IB COMMUNICATIONS RECEIVER

This fine receiver, designed to receive C.W. or R.T. uses probably the finest Vernier tuning and band spreading arrangement possible. It covers the following bands:—

Band 1	15 to	.315 mc.		
Band 2	.315 to	.680 mc.		
Band 3	.680 to	1.5 mc.	i.e. 20 to 200 metres.	
Band 4	.18 to	3.7 mc.		
Band 5	3.7 to	7.5 mc.		
Band 6	7.5 to	15.0 mc.		



The sensitivity is 4 microvolts for full output. It uses 8 valves and operates from batteries (12 or 24 volt) or from the mains through a power pack. It has built-in output stage with a jack socket for phones. Controls, all of which are brought to the front panel, include: aerial switch, aerial compensating condenser, main tuning condenser, band selector, C.W. switch, power on/off switch, and volume control.

Very compactly built in crackle finished case, these sets are brand new having never been used and in perfect working order—special price this month is **£14/10/-** each—carriage and insurance 10/-. Circuit diagram and component data given free with sets, or available separately price **2/6,** post free.

Mains Power Pack for Bendix RA-1B, **£3/10/-.**

A NEW APPROACH

to an almost universal problem . . . .

An electronic computor to indicate football results is the subject of our latest publication. The computor uses 3 valves and information is fed into 12 ratio arms. The result 'home,' 'draw,' or 'away' is indicated on a centre zero-meter, suitably scaled.

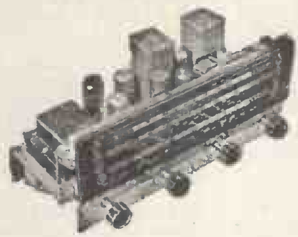
The information to be fed into the ratio arms can be derived from the operator's own pet methods, or alternatively the data freely available in newspapers and popular magazines can be used. The circuit is quite an interesting one but is not at all difficult to construct or operate. When complete the unit is entirely self-contained and mains operated.

The price of all components needed, excluding metal and chassis, is **£3/10/-,** plus 2/6 post. Our Publication "A New Approach" is given free with orders, alternatively will be supplied separately at **2/6,** post free.

ENTIRELY NEW CIRCUIT

Redesigned and now built by the Cleveland Company—very good reports received.

THE "WINDSOR 5"



This is a 5-valve A.C. superhet covering the usual long medium and short wavebands. It has a particularly fine clear dial with an extra long pointer travel. The latest type loctal valves are used and the chassis is complete and ready to operate. Chassis size 15 x 6 x 6in. Price **£9/19/6,** complete with 8in. speaker. Carriage and insurance 10/-. H.P. terms if required.

FINSBURY TAPE RECORDER

This is a fine instrument using the now-famous Truvox Model TR7U tape deck, in conjunction with a 4-valve amplifier specially designed for tape work.

It will provide recording and play-back of the highest fidelity. Its performance is superior to most proprietary recorders of similar price level and as good as many marketed at much higher prices.

It will take all standard tapes up to 1,200ft. providing up to two hours playing. It will also play new pre-recorded tapes.

The instruments are carefully checked before dispatch and can be heard working at any branch.

Price, complete and ready to work, **£43,** plus £1/10/- carriage and insurance, partly returnable.

FOR HOME CONSTRUCTORS wishing to build equipment into their own cabinets the amplifier and tape deck are available separately, prices as follows:—

Truvox TR7U Tape Deck	£23 2 0	plus 10/- carriage
Finsbury Hi-Fi Amplifier, complete with 8in. Speaker	£14 14 0	" "
Acos Crystal Microphone	£2 10 0	
Reel of Tape	£1 15 0	

Special Offer This Month. Tape Deck, Amplifier, Speaker, and Reel of Tape, **£33/10/-,** plus £1 carriage and insurance.

P.V.C. HEATER WIRE

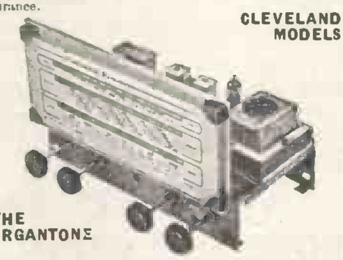
This has a resistance of 16 ohms per ft. It is wound on non-hygroscopic insulation and covered over with P.V.C shrunk sleeving. Quite suitable for use underground or under water. Ideal also for twisting around pipes to stop freezing or to preheat liquid. Price **1/-** per yard.

WE ALWAYS HAVE A GOOD SELECTION OF CHASSIS

THE "ARMSTRONG" FC48

Among high class radio chassis, the name Armstrong is probably the most famous, and their new model FC48 certainly lives up to tradition. It is virtually a 10-valve circuit, for among its eight valves two double triodes are employed. Special features of this chassis are (a) 8 watts output in a push-pull circuit with ample negative feed-back to ensure the highest fidelity, (b) provision for using F.M., e.g., power brought out to sockets and indicator on dial: (c) independent bass and treble controls with visual indication of setting: (d) four wave bands covering 16-51, 50-120, 190-550, and 1,000-2,000 metres. The size of this chassis is 12½ x 9 x 9½in. Price **£23/18/-,** plus 7/6 carriage and insurance.

CLEVELAND MODELS



THE ORGANTONE

5-Valve 3-wave band superhet covering long, medium and short wave.

Osram miniature valves are employed and low loss iron cored coils account for an excellent signal-to-noise ratio. Full A.V.C. is applied to both frequency changer and I.F. stages.

The output stage utilises variable negative feedback. A gram. position is provided and reproduction of records is particularly good.

Chassis size is 12 x 7 x 7in.—scale size is 10½ x 4½in. This receiver has been tested in particularly difficult areas and its stability and noise rejection have produced exceptional results.

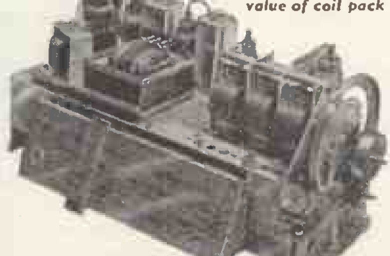
Price **£11/10/-** or **£3** deposit—carriage, etc., 7/6.

THE "TREMENDO"

This one is really superb. It has a 7-valve circuit with 6 watts output, fitted with independent bass and treble controls. It is really an efficient R.F. circuit coupled to a high-fidelity amplifier. The chassis size is the same as the Organtone, namely 12 x 7 x 7 with the 10½ x 4½ multi-coloured scale, and it is built to the same exacting specification as the Organtone. Price **£15/10/-,** carriage and packing 7/6. H.P. terms if required. Ditto but with ferrite rod aerial coil. **£16/10/-.**

—THIS MONTH'S SNIP—

offered for less than value of coil pack



This set, a product of one of our famous manufacturers, has H.F. stage, covers 5 wavebands including short waves to 11 metres. Offered less valves, power-pack, scale and drive, otherwise complete and unused.

Price £1/15/-, plus 7/6 carriage.

ELECTRONIC PRECISION EQUIPMENT LTD.

249 Kilburn High Road, Kilburn	42-46 Windmill Hill, Ruislip, Middlesex	152-153 Fleet St., E.C.4	29 Stroud Green Road, Finsbury Park, N.4
Phone: MAI 4921	Phone: RUISLIP 5780	Phone: FLEET 2833	Phone: ARCHWAY 1049
Half-day Thursday	Half-day Wednesday	Half-day Saturday	Half-day Thursday

Post orders should be addressed to E.P.E. LTD., M.O. Dept 2, 123, TERMINUS ROAD, EASTBOURNE.
All enquiries to Eastbourne address and please enclose S.A.E., terms are cash with order.

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit or for C.R. Tubes with falling emission. Type A. Low leakage windings. Ratio 1 : 1.25 giving a 25% boost on Secondary.

2 volt	10/6 each	With Tag
4 volt	10/6 each	Panel and
6.3 volt	10/6 each	Solder Tags
10.8 volt	10/6 each	
13.3 volt	10/6 each	

Ditto with mains primaries 12/6 each.
Type B. Mains input 220/240 volts. Multi Output 2, 4, 6.3, 7.3, 10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for most Cathode Ray Tubes. With Tag Panel 21/- each.
Type C. Low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 230/240 volts. Output 2-2½-2¾-2⅞-3 volts at 2 amps. With tag Panel 17/6 each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.

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

	WIRE-WOUND RESISTORS	
5 watt		1/3
10 watt	25 ohms—10,000 ohms	1/6
15 watt		2/-

15,000 ohms—50,000 ohms, 5 w., 1/9; 10 w. .. 2/3
WIRE-WOUND POTS. 3 WATT LAB. COLVERN ETC. Pre-Set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 Meg., 3/-. Standard Size Pots, 2¼in. Spindle High Grade. All Values, 100 ohms to 50 K., 5/6; 100 K., 6/6. W/W EXT. SPEAKER CONTROL 10Ω 3/-.
O/P TRANSFORMERS. Heavy Duty 50 mA., 4/6. Ditto, tapped primary, 4/9. Multiratio, push pull, 6/6. Tapped small pentode, 3/9. Miniature 3S4, etc., 3/9.
L.F. CHOKES 15/10 H. 60/65 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H. 120/150 mA., 12/6.
MAINS TRANS. 350-0-350, 80 mA., 6.3 v. tapped 4 v. 4 a., 5 v. tapped 4 v. 2 a., ditto 250-0-250, 21/-.
MIDGET TRANS. 250-0-250 v. 50 mA. 6.3 v. 2 a., 12/6.
HEATER TRANS. Tapped prim., 200/250 v. 6.3 v. 1½ amp., 7/6; tapped sec. 2, 4, 6.3 v., 1½ amp., 8/6.

CRYSTAL MIKE INSERT. Famous make, precision engineered. Size only 1⅛ × 3/16in. Bargain price 6/6. No transformer required.

EXT. L.S. Switched Socket, on/off and parallel switching, complete with plug, 2/-.
COPPER PLATED AERIAL RODS. ½ × 12in. push fitting. 2/6 doz., p. & p. 9d.
AERIALITE EARTH RODS, 4/-.
ALADDIN FORMERS and cores. ¼in., 8d.; ⅜in., 10d.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYANA. Midget Soldering Iron. 200/220 v. or 230/250 v., 14/11. TYANA TRIPLE THREE. Complete with detachable bench stand. 19/6. 200/220 v. or 230/250 v.
NEW SOLON MIDGET IRON. 25 w., 22/-. IDEAL FOR RADIO CONSTRUCTORS. 200/220 v. or 230/250 v.
MIKE TRANSF. Ratio 50 : 1, 3/9 ea., new and boxed.
MAINS DROPPERS. 3 × 1½in. Adj. Sliders, .3 amp. 750 ohms., 4/3. .2 amp., 1,000 ohms, 4/3.
LINE CORD. .3 amp., 60 ohms per foot, .2 amp., 100 ohms per foot, 2 way 6d. per foot, 3-way 7d. per foot.
LOUDSPEAKERS P.M. 3 OHM. 5in. 16/6. 6½in. 17/6. Goodmans Elliptical 7 × 4 18/6. 8in. 19/6. 10in. 25/-. 6½in. Goodmans with trans. 21/-. Plessey 12in. P.M., 3 ohm, voice coil, 30/-. 8in. energised 2.5 K. or 2 K. ohm field, tapped output trans., 24/6; less trans., 21/-.
CRYSTAL DIODE. G.E.C., 3/6. Circuit Book 1/-.
H.R. PHONES. (Hi-grade Amer.), 15/6 pr.
HEADPHONES. 4,000 ohms., 15/6 pr.
COPPER ENAMEL WIRE. ½lb. 16 to 20 s.w.g., 2/-; 22 to 28 s.w.g., 2/6; 30 to 40 s.w.g., 3/6.
SWITCH CLEANER Fluid, squirt spout, 3/9 tin.
TWIN GANG TUNING CONDENSERS. .0005 mfd. midget with trimmers 8/6; 375 pf. midget less trimmers 6/6; .0005 Standard size with trimmers and feet 9/-; less trimmers 8/-; ditto, soiled, 2/6.

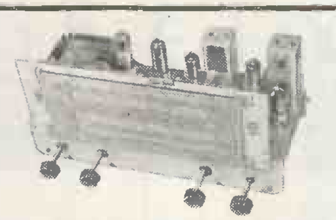
RECORDING TAPE

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

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

2/6 SPECIAL CLEARANCE. BRAND NEW SUB MINIATURE VALVES **2/6**
Ex Deaf Aid Apparatus.

RF PENTODES		L.F. PENTODES
0.625 v. FIL		1.25 v. FIL
DF70	MULLARD	DL72
505AX	RAYTHEON	503AX, 507AX



ALL WAVE RADIOGRAM CHASSIS

THREE WAVEBANDS
S. W. 16 m.—50 m.
M. W. 200 m.—550 m.
L. W. 800 m.—2,000m.

FIVE VALVES
LATEST MULLARD
ECH42, EF41, EBC41, EL41, EZ40.

12 month Guarantee, with 10in. P.M. Speaker, A.C. 200/250 v. 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative feedback. 4.2 watts. Chassis 13½in. × 5½in. × 2¼in. Glass Dial 10 × 4½in., horizontal or vertical available. 2 Pilot Lamps, Four Knobs, Walnut or Ivory, aligned and calibrated. Chassis isolated from mains. PRICE £10/15/-. Without 10in. Speaker, £9/15/-. Carr. & Ins. 4/6.

RECOMMENDED FOR ABOVE CHASSIS

(Limited period) **£8 . 19 . 6**

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

FAMOUS MAKE. 3-speed Single Record unit with Acos 37 Turnover Head, each Sapphire Stylus plays 2,000 records. Starting Switch Automatically places Pick-up on records, 7in., 10in. or 12in. Auto Stop. Baseplate 12 × 8½in. Height 2½in. Depth 1½in. Price £7/15/6, post free.

B.S.R. MONARCH 3-SPEED MIXER CHANGER. ACOS G.P.37 XTAL HEADS. Baseboard 14 × 12in. Height 5½in. Brand new in Makers' Boxes. £9/19/6, post free.

£4/19/6. CONVERT YOUR RADIO. Playing desk 15 × 22 × 7in. Walnut finish, drawer front with 78 r.p.m motor, turntable and pick-up. Press lever start places High Impedance Magnetic pick-up on records 10in. or 12in. Auto Stop. Brand new in original makers' boxes £4/19/6. carr. free.

SUPERHET COIL PACK 27/6. Miniature size 2¼ × 2¼ × 1½in. High Q dust cored coils. SHORT, MED., LONG, GRAM switching. Only 27/6 each with connection diagram and circuit.

F.M. TUNER COIL KIT 27/6. H.F. coil, Aerial Coil Oscillator Coil, two I.F. Transformers 10.7 Mc/s. Detector transformer and heater choke. With circuit and component list for popular F.M. Tuner using four 6AM6 valves and standard components.

COILS. Wearite. "P" type 2/6 each. Osmor Midget "Q" type adj. dust core 3/6 each. All ranges in stock. REACTION COND. .0001, .0003, .0005 mfd., 3/6 each.

I. F. TRANSFORMERS

WEARITE TYPE 500. 465 Kc/s., adjustable 450-470 Kc/s., size 3½ × 1¾ × 1¾in., 10/6 pair.
MIDGET I.F.s, size 1 × 1 × 2in., 8/9 pair.

BAND 3 T.V. CONVERTOR KITS

Suitable all T.V. makes. T.R.F. or Superhet. Ready wound coils, B.V.A. valves, all components, punched chassis, circuit diagram, wiring plans, COMPLETE KIT for mains operation 200-250 v. A.C. £3/10/-.
AS ABOVE less POWER PACK. Requires 200 v. 20 ma H.T., 6.3 v. 1 a. L.T., £2/5/-.
PUNCHED CHASSIS and WOUND COILS, component list, circuit diagram, wiring plans, only 19/6.

T/V PRE-AMP. Channel 1. Midget Chassis 4⅛ × 2¼ × 1½ with EF42 or 6F13 valve, coaxial lead, Belling plug and Octal plug Ready for use. Brand new. Special Price, 21/-.

Volume Controls

Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg.

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EXT. SPKR. TYPE 3/-

80 ohm CABLE Coaxial

Semi-air spaced Polythene insulated. ⅜in. dia. Stranded core. Losses cut 50% 9d. yd.
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COAXIAL PLUGS 1/- DOUBLE SOCKET 1/-
SOCKETS 1/- OUTLET BOXES 3/6
T.V. AERIALS. Band I, all channels in stock. Indoor loft type Inv. T., 13/6.
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BALANCED TWIN FEEDER per yd. 6d. 80Ω or 300Ω
TWIN SCREENED BALANCED FEEDER 9d. yd. 80 ohms.
50 OHM COAXIAL CABLE 8d. per yd. ¼in. dia.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf. 1/3; 250 pf., 1/6; 600 pf., 750 pf., 1/9.
P.V.C. CONN. WIRE, 10 colours, single or stranded 2d. yd.
5in. RADIO SCREWDRIVERS. 4½d. each.
NEON MAINS TESTER SCREWDRIVER, 5/6.

VCR97 TESTED FULL PICTURE £2

MULTICORE SOLDER, 60/40, 18 s.w.g. 3d., 16 s.w.g. 4d. yard, ½ lb. 2/6.
ALL BERNARDS BOOKS IN STOCK.
CONDENSERS. New stock. .001 mfd. 7 kV. T.C.C., 5/6. Ditto, 12.5 kV., 9/6; 2 pf. to 500 pf. Micas, 6d.; Tubular 500 v. .001 to .01 mfd., 9d.; .05 .1, 1/-; .25 1/6; .5 1/9; .1/350 v. 9d.; .1/600 v. 1/3; .1/1,500 v. 3/6.
CERAMIC CONDENSERS, 500 v. .3 pf. to .01 mfd., 1/-.
SILVER MICA CONDENSERS. 10%, 500 v. 5 pf. to 500 pf., 1/-. 600 pf. to 3,000 pf., 1/3.
DITTO 1%, 500 v. 1.5 pf. to 500 pf., 1/9. 515 pf. to 5,000 pf., 2/-.

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A SMALL SELECTION FROM OUR STOCKS
All Boxed — New & Guaranteed

6/6	1/6	3/6	2/6	5/6
6AL5	EA50	3D6	2X2	6AG5
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6K7G	OZ4	7/6	12BE6	EF50
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8/6	1S5	6K6	EF39	6AM6
6AC7	1T4	6K8	EF92	6J6
6AT6	1S4	6SA7	EL32	ECL80
6C9	3S4	6SL7	HVR2A	EF55
6SN7	3V4	6V6G	U22	EF80
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12/6		12AX7		12K8
EY51				25Z4

Send Stamp for Full Valve List. All B.V.A. Types at 1951 Low Tax Prices.

ELECTROLYTICS ALL TYPES NEW STOCK

TUBULAR		CAN TYPES		CAN TYPES	
2/450 v.	2/3	16/500 v.	4/-	8+16/450 v.	5/-
8/450 v.	2/3	500/12 v.	3/-	32+32/350 v.	4/6
16/500 v.	4/-	SCREW BASE		32+32/450 v.	6/6
25/25 v.	1/9	TYPE 512		60+100/350v.	11/6
50/50 v.	2/-	8/500 v.	3/-	1000+1,000/6v.	6/6
100/25 v.	2/-	16/500 v.	4/-	1,500/6 v.	4/6

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

SENTERCEL RECTIFIERS. E.H.T. TYPE FLY-BACK VOLTAGES. K3/25 2 kV., 4/3; K3/40 3.2 kV., 6/-; K3/45, 3.6 kV., 6/6; K3/50 4 kV., 7/3; K3/100 8 kV., 12/6.
MAINS TYPE. RM1, 125 v., 60 mA., 4/-; RM2, 100 mA., 4/9; RM3, 120 mA., 5/9; RM4 250 v. 275 mA., 16/-.
FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp. 8/9; 2 a. 11/3; 4 a. 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ amp., 13/6, 4 amp. 21/-.
ACID HYDROMETER. New Ex-Govt. Unbreakable. Packed in metal case 7 × 1½in. dia. 4/6.
H.F. MIDGET CHOKES. 14 M.H. 2/6 each.
WAVECHANGE SWITCHES.

5 p. 4-way 2 wafer	6/6
2 p. 2-way, 3 p. 2-way	2/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way	3/6
3 p. 4-way, 1 p. 12-way	3/6

KNOBS, GOLD ENGRAVED. Walnut or Ivory, 1½in. diam., 1/6 each. "Focus," "Contrast," "Brilliance," "Brilliance—On-Off," "On-Off," "Volume," "Vol.-On-Off," "Tone," "Tuning," "Treble," "Bass," "Wavechange," "Radio Gram," "S.M.L. Gram.," "Record-Play," "Brightness," Ditto, not engraved, 1/- each.

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WE PURCHASE ALL TYPES OF RECEIVERS AND TEST GEAR

DEAF-AID UNITS

An exceptional offer of new deaf-aid units made by famous manufacturer. Complete with three sub-miniature valves, crystal mike, volume and tone controls etc., less only outside bakelite case, 19/6. Ditto less mike, 12/6d. Miniature ear-pieces to match, 3/6d. or with lead and plug, 4/6. **DEAF-AID VALVES.** Brand new CK505AX equivalent to DF70, 2/6, holders 6d. each. Deaf-Aid Pots, 1 megohm with switch, 1/- each.

12 VOLT ROTARY TRANSFORMER. Input 12 volts D.C., output 190 volts 65 m/a., ideal for running electric razor or radio from car battery. Completely enclosed in small grey case, 19/6 each.

BRAND NEW ELECTROLYTICS
8 mfd. 450 v., 1/9; 8-8 mfd. 500 v., 4/3; 8 mfd. 500 v., 2/-; 8-16 mfd. 450 v., 4/3; 16 mfd. 450 v., 2/9; 16-16 mfd. 500 v., 4/3; 16 mfd. 500 v., 3/3; 32-32 mfd. 350 v., 4/3; 32 mfd. 500 v., 3/9; 32-32 mfd. 450 v., 4/6; 25 mfd. 25 v., 1/6; 16-16-8 mfd. 350 v., 3/3; 30 mfd. 25 v., 1/-; 12-12-12 mfd. 275 v., 1/9; 50 mfd. 50 v., 1/9; 100 mfd. 12 v., 1/6; 50 mfd. 25 v., 1/-; 100 mfd. 25 v., 1/6.

HEAVY DUTY VOLTAGE REGULATOR TRANSFORMERS. These transformers will regulate 50 cycle A.C. mains between 185 and 250 volts at 24 amps. Price £12/10/- each.

HEAVY DUTY L.T. TRANSFORMERS. Input 230 volts 50 cycles. Output 17.75 volts 35/50 amps. Brand new and boxed, 72/6 each. 75/80 ohm.

COAX CABLE. 80 ohms, 7½d. per yard; 12 yds. 6/6. Twin feeder 80 ohms 9d. yard.

VARIAC TRANSFORMER. Few only of these superb transformers. Specification: 0-270 volts, 20 amps. Size 14½in. dia. × 10in. Price £35 each.

100 MICROAMP METERS. 2½in. flush mounting meter, scaled 0-1500 yards, first-grade instruments, brand new and boxed, 39/6. 250 microamp, 3½in., brand new, 49/6.

AVO ELIMINATOR POWER PACKS. Input 230 volt A.C. Output 90 volts, stabilised VS70, and 1.4 volts. Supplied brand new in bakelite case, fully fused, 39/6 each.

MIDGET REVERSIBLE MOTORS. For operation on 6, 12 or 24 volts D.C. Size 2in. × 1½in. Ideal for model makers, 10/6.

AVO CASES. Brand new leather cases for universal AVO minor, 7/6 each.

AUTO TRANSFORMER. 0-110-200-220-240 volt, 150 watt, brand new, 21/- each.

TELETRON BAND III CONVERTOR. Complete kit of parts, £2.8.0

TRANSFORMER BARGAINS.
No. 1. Primary 230 volts 50 cycle. Secondary 620/0/620 volts, 250 m/a., tapped 550/0/550 and 375/0/375 volts. Two 5 volt 3 amp. windings. Ample space for 6.3 volt windings, 42/6.
No. 2 Primary 230 volts 50 cycle. Secondary 5/0/5 volts, 5/0/5 volts and 5/0/5 volts at 5 amps. Brand new 39/6.
No. 3. Primary 200/250 volts 50 cycle. Secondary 350/0/350 volt 180 m/a., 6.3 volt 4 amp and 5 volt 3 amp. Only 29/6 each.
No. 4. Primary 200/250 volts 50 cycle. Secondary 4 volt 14 amps., and 6.3 volts C.T. 1½ amp., only 10/6 each.
No. 5. Primary 230 volt 50 cycle. Secondary 2,000 volts 5 m/a. Ideal for scope, 14/6 each.
No. 6. Primary 230 volts 50 cycle. Secondary 500/0/500 volts, 250 m/a., 4 volt 4 amps. C.T., 3,000 volt insulation, 22/6 each.
No. 7. Primary 250 volts 50 cycle. Secondary 250/0/250 volts 80 m/a., 6.3 volt 4 amp., 5 volt 2 amp. tapped 4 volt, 16/6. Ditto wound 350 volt, 16/6

CAMBRIDGE UNIPIVOT GALVANOMETERS. A few only of these instruments at a fraction of original cost. Specifications: Moving coil movement, F.S.D. 50-0-50 microamps, res. 50 ohms, 3in. mirror scale with knife edge pointer. Dia. 4in., depth 2in. Supplied brand new and tested in leather carrying case, £3/19/6 each.

CRYSTAL MICROPHONE INSERTS. A sensitive high impedance crystal mike, ideal for tape recorders, amplifiers, etc., 4/6 each.

WESTERN ELECTRIC HANDSETS. Standard P.O. type, 12/6 each.

DON MK. V FIELD TELEPHONES. A pair of these telephones will give communication between any two points. Supplied in new condition, complete with handset, buzzer, bell, key and headset and instructions, 39/6 each.

INSTRUMENT POTENTIOMETERS. Brand new American type. 10,000 ohms., 5½in. dia. Built in correction plate, 22/6 each. Brand new Colvern type 3½in. dia. 50,000 or 100,000 ohms., 10/6 each.

VALVE VOLTMETERS. A bargain test instrument measuring 15/200/500 volts D.C. on three ranges. Meter is a 2½in. 1 m/a. movement. Operation from 230 volt 50 cycle mains. Housed in wooden instrument case, size 14in. × 8½in. × 9in. Complete with all valves and supplied as new, 79/6 each.

WANTED

All types communications receivers, test equipment, components, and valves. Large or small quantities, highest prices paid.

COMMUNICATION RECEIVERS. MARCONI CR100 RECEIVERS. Frequency coverage 60 Kc/s-30 Mc/s on six bands Gap 420-500 Kc/s. Two R.F. and three I.F. stages. Variable selectivity, crystal filter, 6,000, 3,000, 1,200, 300 and 100 Kc/s. Self-contained power supply for operation on 200/250 volts A.C. Supplied in absolutely mint condition, calibration and sensitivity checked, £30 each.

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HALLICRAFTER S27 RECEIVERS. 27/143 Mc/s., A.M./F.M., 110/230 volt A.C. operation. Perfect condition, £35 each.

VALVE VOLTMETERS No. 2. Few left as previously advertised, £17/10/- each.

METER SWITCHES. Standard "Yaxley" type 8 bank, single pole, 9, 11 or 12 way, 7/6 each.

SMOOTHING CHOKES. American potted type, "Collins," 8 henry 100 m/a., res. 160 ohms 8/6. Ex-Admiralty 10 henry 275 m/a., 10/6. 10 henry 60 m/a., 4/6.

B.S.R. MONARCH RECORD CHANGERS. Latest model, three speed, brand new and boxed, £7.15.0 each.

COLLINS TCS TRANSMITTERS. Frequency range on three bands 1.5-12 Mc/s. 2 1625 P.A. stage, 1625 buffer, 1625 modulator stage, 3 12A6 oscillator stage. Radio telephone or radio telegraph. Plate and aerial current meters. Calibrated V.F.O. and 4 Xtal positions. Supplied in brand new condition, £25 each.

HALLICRAFTER POWER UNITS. Brand new and boxed. 12 volt D.C. input. Output 250 volts 70 m/a. (supplied by vibrator unit) and 350 volts 165 m/a. (supplied by rotary transformer.) Complete with smoothing and send/receive relays. Ideal for portable or marine transmitter/receiver, 62/6.

METERS. All brand new and boxed. 0-50 m/a., 2in. square, F/M., M/coil, 7/6; 0-100 m/a., 2½in. found, F/M., M/coil, 9/6; 0-150 m/a., 2in. square, F/M., M/coil, 7/6; 0-200 m/a., 2in. square, F/M., M/coil, 7/6; 0-200 m/a., 2½in. round, F/M., M/coil, 9/6; 0-300 volts D.C., 2in. square, F/M., M/coil, 10/6; 0-5 amp., 2½in. round, F/M., R.F., 7/6; 0-10 amp., 2½in. round, F/M., M/coil, 12/6.

A.C. VOLTMETERS 50 CYCLE. 0-15 volts, 2½in. round, F/M., M/I., 8/6; 0-20 volts, 2½in. round, F/M., M/I., 9/6; 0-300 volts 2½in. round F/M., M.I. 25/-.

MARCONI BAND III CRYSTAL CALIBRATORS. Frequency coverage 170/240 Mc/s. Complete with 5 m/cs. crystal, accuracy .001%. Supplied brand new in original transit case with spare set of five valves, £5/19/6 each.

MARCONI SIGNAL GENERATORS TYPE TF390G. Brand new with spares, instruction manual and charts, £25. TFG517, ditto £35.

R.1132 RECEIVERS. Few left in good condition 65/- each

ROTARY CONVERTORS. Input 24 volt D.C. Output 230 volts 50 cycle 100/150 watts. Supplied in perfect condition, £4/12/6 each.

I.F. TRANSFORMERS. 465 Kc/s., Standard size, 7/6 pair. 2.1 Mc/s I.F.T s. Miniature type, 2/- each.

AMERICAN POWER RHEOSTATS. Brand new and boxed. 8 ohm. 3.3 amp., 7/6; 8 ohm. 2.5 amp., 7/6; 60 ohm. 1.3 amp., 7/6; 90 ohm. .74 amp., 7/6; 200 ohm. .35 amp , 5/6.

H.R.O. 6 VOLT VIBRATOR SUPPLY UNITS. Output 165 volts 80 m/a., 6.3 volt 3 amp. 6×5 rectifier, choke and condenser smoothed, 29/6 each.

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VALVE BARGAINS. 6H6 1/9; SP61 2/-; 6V6 6/6; VU111 1/9; 6U7 4/6; 5Z4 7/6; EA50 1/9; EF36 4/6; 5U4 7/6; 6AG5 4/-; EBC33 6/6; PEN46 4/6.

INDICATOR UNIT TYPE 96. These indicator units contain a VCR97 CRT, 6 SP61, 3 VR54, 1 EA50 and thousands of components. Supplied brand new, 39/6.

RECORD AMPLIFIERS. A push-pull amplifier giving 8 watts output. For operation on 200/250 volts A.C. Standard gram input, output matched to 3 or 15 ohms. Tone and volume controls. Complete valve line-up; 6SN7, 6V6, 6V6, 5Z4. Supplied in an attractive desk type cabinet, brand new, £6/10/-.

HOURS OF BUSINESS:—9 a.m.—6 p.m. Thursday 1 p.m. Open all day Saturday.
PLEASE PRINT NAME AND ADDRESS CLEARLY, ALSO INCLUDE POSTAGE OR CARRIAGE ON ALL ITEMS.

PROOPS BROS. LTD. *The Walk-around Shop*

2-METRES!

RECEIVER TYPE R1392

FREQUENCY 95-150 Mc/s (2-3 METRES)
AIR TESTED 15 VALVE SUPERHET

Valve line up: 1st and 2nd R.F. Amp VR.136 (EF.54); 1st local oscillator VR.65 (SP.61); 2 Oscillator Multipliers VR.136 (EF.54); 3 I.F. Amp V.R.53 (EF.39); A.G.C. 6Q7; Output 6J5; Muting VR.92; (EA50); Noise Limiter VR.92 (EA.50); B.F.O. 6J7; Mixer VR.136 (EF.54); De Mod. 6Q7.

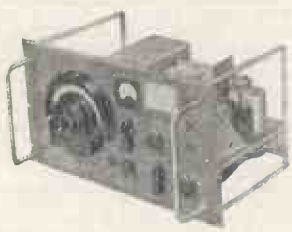
Slow motion Tuning over 95-150 Mc/s or can be Crystal controlled.

Power supply required: 240-250 volts at 80 mA 6.3 volts at 4 amps. Size 19" × 10" × 10" Standard Rack Mounting. PRICE **£6. 19. 6.** Complete with valves and circuit diagram. Packing and postage 17/6. 10/- returnable on packing case.

MAINS POWER UNIT TYPE 234 USED WITH R1392 and R1192

With change-over link. Double smoothed. Input 200-250 volts 50 cycles. Output 240 volts at 200 mA. 6.3 volts at 6 amps. with volt-meter 0-300v Reading Input and Output voltages. Size 19" × 10" × 6½" Standard Rack Mounting.

PRICE **£3. 10. 0.** Packing Postage 7/6 (limited quantities).



RECEIVER TYPE R1132

FREQUENCY 100-126 Mc/s. 11 VALVE SUPERHET

Valve Line Up: R.F. Amplifier VR.65 (SP.61); Frequency changer VR.65 (SP.61): Local Oscillator VR.66 (P.61); Stabilizer VS.70 (7455); 3 × I.F. Amplifiers VR.53 (EF.39); B.F.O. VR.53 (EF.39); Detector VR.54 (EB.34); A.F. Amplifier VR.57 (EK.32); Output VR.67 (6J5).

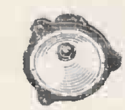
Switchable A.G.C. and A.V.C. Variable B.F.O.

Circuit diagrams with units. Easily converted to cover Wrotham Band. No alterations to wiring required. Conversion Slugs and instructions. 5/- Extra. Size 19" × 10" × 10". Standard Rack Mounting.

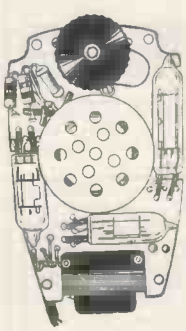
PRICE **£3. 7. 6.** Packing and carriage 15/-. 10/- returnable on Packing Case.

FL 8 RADIO FILTERS with PL 55 and JK26, plug and socket. Size 2¾in. × 3in. × 2½in.
10/6 each. 1/6 Post and packing

REFLECTOR in bakelite case fitted with small bayonet cap holder. Size 5in. in diameter by 3in. deep.
2/6 post paid



Make a miniature POCKET RADIO



Incorporating high "Q" technique using the New Ferrite rod. Made possible by simple conversion of an ex-Govt. Hearing Aid.

Technical Details. A Germanium Diode Detector circuit followed by the existing 3 valve Amplifier, giving adequate amplification throughout the medium wave band.

This conversion can be carried out in approximately 30 minutes.

SEE and HEAR this Miniature POCKET RADIO demonstrated.

THE COMPLETE KIT OF PARTS includes a Type OL10 Hearing Aid (with Crystal microphone) in perfect working order with miniature ear phone and moulded ear insert attached: ferrite rod, germanium diode, components, circuit diagram and full instructions. Price **£2 6s. 0d.** post paid

ALL COMPONENTS SOLD SEPARATELY

Deaf Aid Unit with earpiece	£1. 15. 0.
Plastic Ear Mould	2. 0.
Ferrite Rod	5. 0.
Conversion Components	4. 0.
Batteries 1.5v. L.T. (Type D.18)	8.
30v. H.T. (Type B.119)	4. 3.

NOTE: As the crystal microphone is not used in the Pocket Radio, it can, if desired, be used as a general microphone and it does not require a matching transformer.

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ABSORPTION WAVEMETER

Easily converted to 2 metres or 70 cm. In Copper-plated metal case 3½″×4½″×5½″ with dial calibrated 0-100 and 80V Neon Tube. Coverage approx. 190-210 Mc/s. New.

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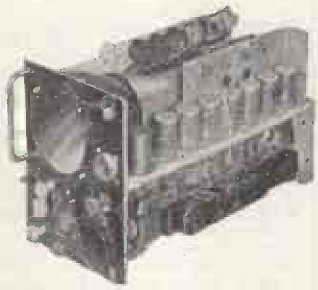
TYPE 62 INDICATORS



Ideal for conversion to oscilloscopes, T.V. units, etc. Containing V.C.R.97, 12 VR.91 (EF.50), 2 VR.54 (EB.34), 3 VR.92 (EA.50), 4 CV.118. Slow-motion dial, 13 Pots and scores of useful components. Size: 8½″×11½″×18″. New in wooden packing case.

£3. 10. 0. carriage 7/6.

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R.F. 25 40-50 Mc/s Switched Tuning Valved **9/6** ea.

R.F. 26 50-65 Mc/s Variable Tuning Valved (Dials Damaged) **15/-**

Packing and postage 2/- ea.

RECEIVER UNIT Ex-TR1143A.

Suitable for conversion to 2 metres and F.M. Wrotham. Circuit diagram free.

Price—less valves, 9/- post paid.

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High fidelity Electrostatic Tweeters 3,000 to 20,000 cycles. This loudspeaker is essential when receiving F.M. transmissions or reproducing high quality recordings and TV sound. 20,000 cycles response+10db.

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AMPLIFIER UNIT Ex-TR1143A.—A 3-stage transformer coupled amplifier. Push pull VT52s output to modulate push pull VT501s. Circuit diagram free. Price, less valves, **4/6** post paid.

TRANSMITTER UNIT Ex-TR1143A.—Suitable for conversion to 2 metres. Circuit diagram and coil conversion details supplied free. Price, less valves, **5/-** post paid.

A SELECTION OF EX-GOVERNMENT SURPLUS VALVES

1A3	4/6 ea.	6F7	6/6 ea.	6SN7	6/6 ea.	FW4/800	9/- ea.	VT52 (EL32)	5/- ea.
1A5	4/6 „	6G6	5/6 „	6SQ7	7/6 „	PEN46	7/- „	VT501 (TT11)	5/- „
3B24	2/6 „	6H6	2/6 „	6V6G	6/6 „	VR53 (EF39)	5/- „	VU111	2/- „
5U4G	7/6 „	6H6 Metal	3/- „	6V6 Metal	8/6 „	VR55 (EBC33)	7/- „	446A	25/- „
6AC7	5/- „	6K6.GTG	5/6 „	6X5	7/- „	VR56 (EF36)	5/- „	713A	8/6 „
6AG5	6/6 „	6L6	7/6 „	12J5	5/- „	VR65 (SP61)	3/6 „	807 U.S.A.	6/6 „
6B7	5/- „	6L7	6/- „	12SJ7 Metal	5/- „	VR65A (SP41)	2/6 „	866A	10/- „
6C4	4/- „	6SA7	7/- „	12SH7 Metal	5/- „	VR91 (EF50)	5/- „	954	2/6 „
6C5	5/- „	6SJ7	7/- „	12U5	5/- „	VR135	5/- „	9004	3/6 „
6F6.GTG	7/- „	6SK7	5/6 „						

All above prices post paid.

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R.1132A RECEIVERS. In perfect condition, £3/17/6, carr. 7/6.

R.1155 RECEIVERS. Condition as new. Limited quantity only. Fully tested before despatch. £8/10/-, carr. 10/-.

R.1155 AND R.1132A POWER PACK AND OUTPUT STAGE. Complete with speaker, built in attractive, polished 8in. extension speaker cabinet. Ready to use for A.C. mains. This unit can be used for either receiver without alteration. £5/10/-, carr. 7/6.

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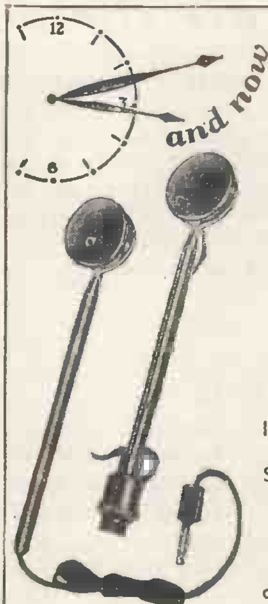

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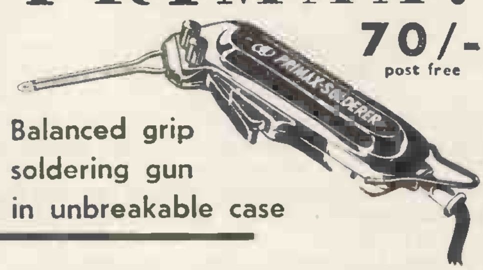

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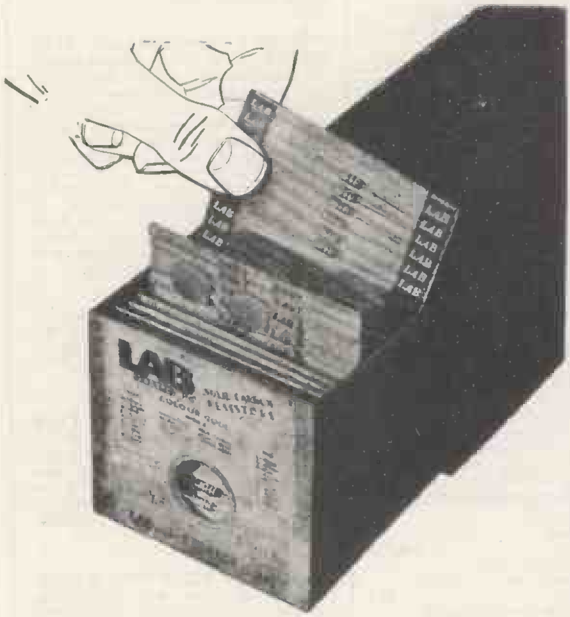

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45 Mc/s **PYE STRIPS.** Vision unit for London frequency. Complete with 6 EF60 and EA50. Circuit provided. Brand new. 59/6 each.

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The instrument itself has a basic movement of 1 mA and incorporates a full-wave instrument rectifier. There are two ranges 0-500 milliwatts and 0-5 watts and also a decibel scale. The input impedance is 5,000 ohms. These are all BRAND NEW AND UNUSED in sealed individual Manufacturer's cartons, complete with instructions and are offered at about a third of list price. Only 35/- each plus 1/6 post.

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MODEL MI—11220

★ Manufactured by Radio Corporation of America.
★ Brand new and unused.
★ Power output 12 watts at 5-7.5-15-600Ω.
★ Valve line up, 2 of 6L6, 4 of 6J7, 1 of 5U4.
★ Tapped transformer for use on 190-250 volts A.C.
★ Grey crackled case, size 17×11×9in.

CIRCUIT SUPPLIED. **ONLY £9. 19. 6 Plus 10/6 carriage**
(LESS VALVES, AS SHIPPED BY MAKERS)
SET OF VALVES, NEW, BOXED, 59/6 POST FREE.

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RANGE	TYPE	SIZE		PRICE
50 Microamp.	D.C. M/C	2½in.	flush circular	59/6
100 Microamp.	D.C. M/C	2½in.	flush circular	39/6
500 Microamp.	D.C. M/C	2in.	proj. (scaled 10 V.)	12/6
500-0-500 MicroA.	D.C. M/C	2½in.	fl. circ. (scaled 100-0-100 V)	25/0
1 Milliamp.	D.C. M/C	2½in.	flush circular	22/6
1 Milliamp.	D.C. M/C	2½in.	desk type	25/-
5 Milliamp.	D.C. M/C	2in.	flush square	7/6
10 Milliamp.	D.C. M/C	2½in.	fl. circ. (blank scale)	10/6
100 Milliamp.	D.C. M/C	2½in.	flush circular	10/6
150 Milliamp.	D.C. M/C	2in.	flush square	7/6
1 Amp.	Thermo.	2½in.	projection	6/9
3 Amp.	Thermo.	2in.	flush square	5/0
20 Amp.	D.C. M/C	2in.	circular proj.	7/6
30-0-30 Amp.	D.C. M/I	Metal cased.	Car type	5/0
50-0-50 Amp.	D.C. M/C	2in.	flush square	12/6
15 Volt	A.C. M/I	2½in.	flush circular	8/6
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HEAVY DUTY L.T. TRANSFORMERS. Standard tapped primary. Type A.30 v. 36 amp. or Type B, 50 v. 16 amp. Size 6in. × 5½in. × 8in. high. Weight 24lb. BRAND NEW, not ex-Govt. suitable for soil heating, rectifiers, chargers. etc., special offer, 55/- each, plus 5/- carriage.

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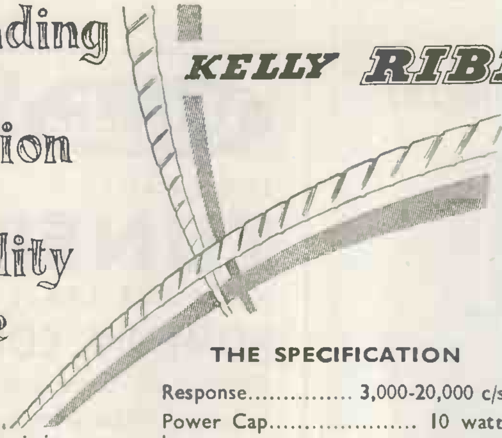

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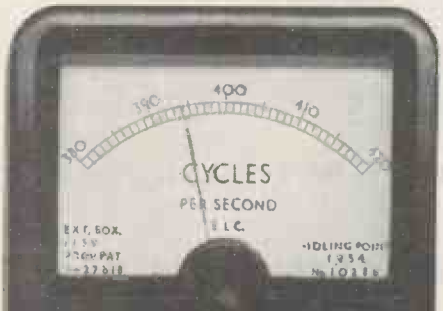

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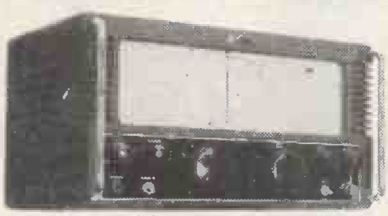

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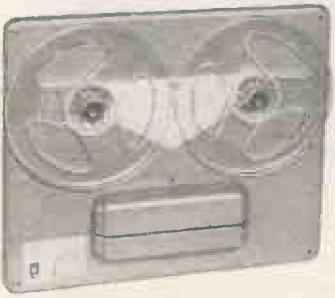

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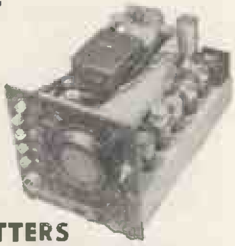

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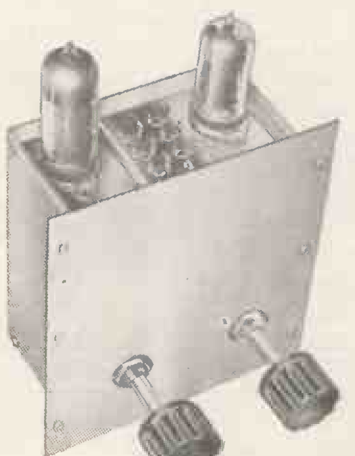

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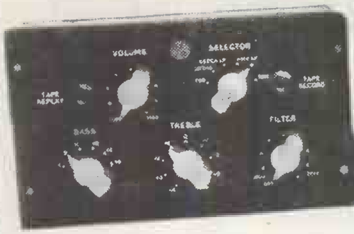

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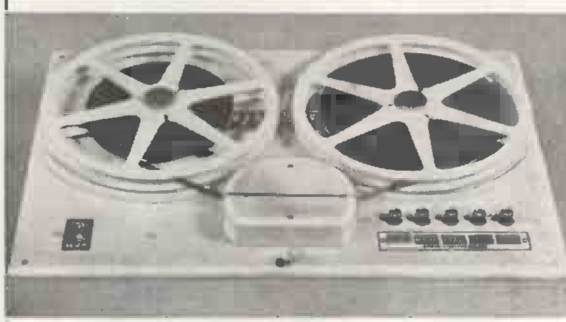

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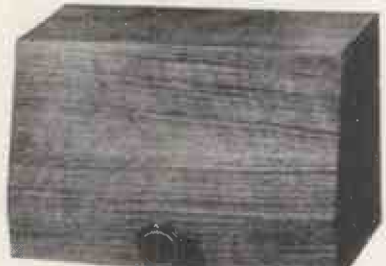

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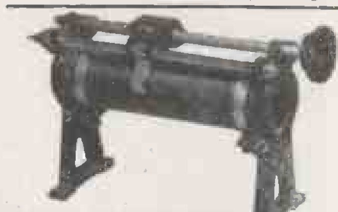

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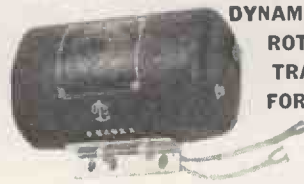

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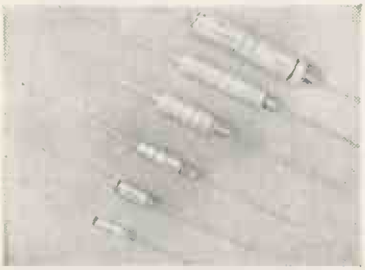

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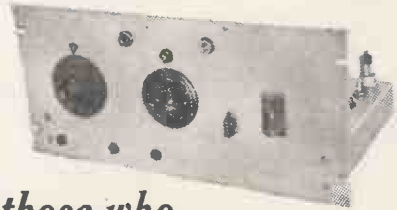

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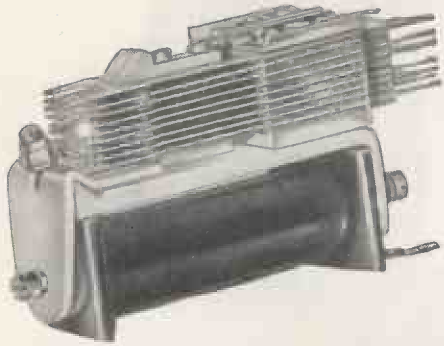

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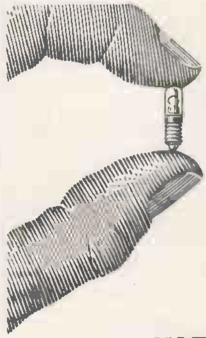

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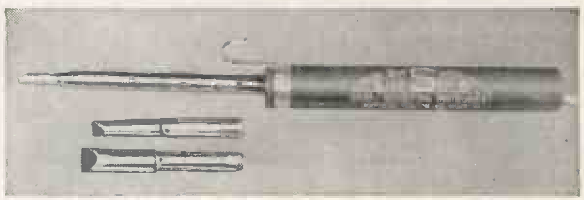

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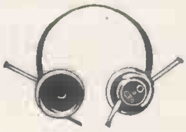

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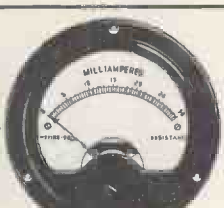

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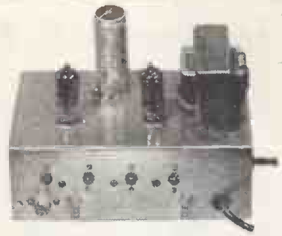

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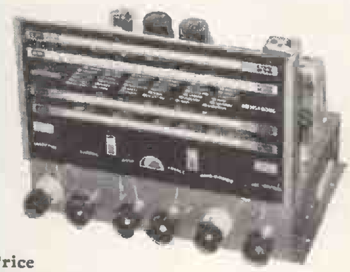

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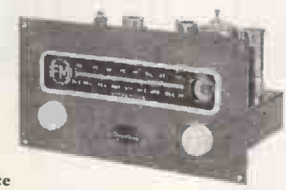

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VARIOUS type relays, induction coils, choke coils, condensers, etc. Price on application with stamped addressed envelope.
"ONILY" COMPONENTS, Ltd., Llanerch-y-Mor, Holywell, Flintshire. [5142

AUTOMATIC dual coil winding machines, range from 22 to 44 S.W.G.—Hawkins, 170, Witton Rd., Aston, Birmingham, 6. [5019

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

YOUR own tape recording transferred to disc.—Write, call, or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio recordings, tape recording service. [5194

BUILD your own TV and learn about its operation, maintenance and servicing; qualified engineer-tutor available whilst you are learning and building.—Free brochure from E.M.I. Institutes, Dept. WW.58, London, W.4. (Associated with H.M.V.) [0180

COPPER wires enamelled, tinned, Litz, cotton, silk covered, all gauges; B.A. screws, nuts, washers, soldering tags, eyelets, ebonite and laminated bakelite panels, tubes, coil formers; Tufnol rod, headphones, flexes, etc.; latest radio publications, full range available; list, s.a.e.; trade supplied.—Post Radio Supplies, 33, Bourne Gdns., London, E.4. [0138

NOTICES

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

SITUATIONS VACANT

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

SUNVIC CONTROLS, Ltd.

ELECTRONIC test engineer required for the test dept. of the above company; applicants must have Higher National Certificate in electrical engineering, with experience in pulse technique and associated equipment; write stating details of previous experience and salary to:
THE Works Manager, Sunvic Controls, Ltd., Harlow, Essex. [5232

DEVELOPMENT engineers

MUIRHEAD & CO., Ltd., Beckenham, Kent, have vacancies in their Servo and Instrument Laboratories for several grades of qualified engineers or physicists to work in the following fields.
1. DEVELOPMENT of magslips and synchros of all types, high precision miniature motors, servo mechanisms and automatic control devices.
2. DEVELOPMENT of electrical and electronic measuring instruments for laboratory and industrial purposes.
QUALIFICATIONS.
SENIOR posts: University degree in engineering or physics, with experience in either of the above fields.
JUNIOR posts: University degree in engineering or physics or H.N.C., some experience advantageous but qualified engineers who have recently completed National Service should apply.
SALARY commensurate with qualifications and experience
A PENSION scheme is in operation and the company has its own sports ground; excellent recreational, social and canteen facilities are available. [5255

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

INSTRUMENTATION engineers.
AN attractive vacancy exists for an electronic instrumentation engineer (one senior and one junior) for the design and development of electronic instruments and instrumentation systems.
APPLICANTS should have a sound engineering background (preferably with a degree) and appropriate experience in the design and development of electronic instruments and systems, or closely allied equipment, is essential; in the case of the senior engineer, experience in the supervision of small development teams is necessary.
THE posts are pensionable and offer excellent opportunities for engineers with an inventive and progressive outlook.
PLEASE send full details of training, qualifications and experience in confidence to Personnel Dept. (ED/253), E.M.I. Engineering Development, Ltd., Hayes, Middx. [5226

SITUATIONS VACANT

CIRCUIT Design Engineers.

ARE required by Decca Radar for positions created by the continued expansion of their Research Laboratories. These cover work in a wide field, embracing high and low power pulse, receiver, A.F.C., radar display, and test equipment design in standard and sub-miniature form. Applicants should preferably be of degree or H.N.C. standard, and have had previous experience in this field. A pension scheme is in operation. British Nationality essential.—Please write to Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey, quoting reference RLA.103. [0167

SIEMENS BROTHERS & Co., Ltd.

DEVELOPMENT & Research Laboratories.
THERE are vacancies for:—
SENIOR Engineers to take charge of long-term development in:—
(a) ELECTRONIC switching and computing.
(b) TRANSISTOR applications.
(c) MULTI-channel carrier current telephone and telegraph equipment.
(d) CARRIER current terminal equipment for radio links, and submarine cable systems employing submerged repeaters.
(e) NEW types of Mercantile Marine radio communication equipment.
(f) DESIGN of new components including miniaturisation.
(g) ELECTRO-acoustics.
ASSISTANT Engineers & Laboratory Technicians to carry out the detailed development for the above.
TECHNICAL Sales Engineers for carrier equipment to undertake preparation of tenders, editing and writing technical publications, and training customers' engineers.
APPLICANTS with any of the following qualifications will be considered:—
(i) DEGREE in Physics or Electrical Engineering with some previous industrial experience.
(ii) RECENT and prospective Science Graduates.
(iii) H.N.C. Electrical or Telecom. Engineering or A.M.I.E.E.
(iv) O.N.C. or equivalent City and Guilds Certificates with practical industrial experience.
ALL are pensionable staff posts with good prospects of advancement.
SALARY according to qualifications and experience.
APPLY in writing to Siemens Brothers & Co., Ltd., London, S.E.18, Ref. 744/29, giving appropriate letter reference, and stating age, educational qualifications, experience and salary required. [5272

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

EXPERIENCED valve engineer.
AN interesting vacancy has arisen at the company's Feltham laboratories for a valve engineer with 4-6 years' experience of both valves and micro-wave generators; applicants who should be qualified, will have some knowledge of testing, both in quantity, and for special purposes, will be able to design suitable test equipment, and have some applications experience; the salary offered for this pensionable post is attractive, and the prospects in this active company are excellent.—Please address your first reply to Personnel Dept. (ED/252), E.M.I. Engineering Development, Ltd., Blyth Rd., Hayes, Middx. [5227

E.M.I. ENGINEERING DEVELOPMENT, Ltd.

A VACANCY exists for an
ELECTRONIC engineer to undertake inter-company liaison duties in connection with the distribution and design of telemetry equipment; a wide experience of electronic engineering including V.H.F. techniques is essential; experience of telemetry equipment and ability as a technical writer would be an advantage.—Please write with full details to
PERSONNEL Dept. (ED/266), E.M.I. Eng. Dev., Ltd., Hayes, Middx. [5228

WIRELESS Station Superintendent required for the
POSTS and Telecommunications Department, Gold Coast Local Civil Service, for two tours of 18 to 24 months in the first instance; consolidated salary scale £990 rising to £1,230 a year; gratuity at the rate of £100/£150 a year, outfit allowance £60; liberal leave on full salary, free passages; candidates should possess C and G Final Certificate in Telecommunications (Radio) or C and G Certificates Radio III and IV equivalent, and have had three years experience in two or more of the following fields: V.H.F. link systems, H.F. communications systems, frequency shift keying and teleprinter maintenance, V.H.F. and H.F. cathode ray direction finding system, aeronautical navigation aids (ground), manufacture of light engineering equipment.—Write to the Crown Agents, 4, Millbank, London, S.W.1, state age, name in block letters, full qualifications and experience and quote M20/29100/WF [5240

MUIRHEAD & Co., Ltd., Beckenham, Kent, have vacancies for:—
TECHNICAL sales engineers (age over 28).
(a) TO travel in S.E. England.
(b) TO travel in E. Midlands.
WITH possibly short period assignments abroad. Applicants should have a sound knowledge of electrical and electronic instruments in the audio frequency range, also the ability to do routine servicing; degree or H.N.C. desirable; full expenses and car provided; pension scheme. —Apply, stating age, salary and experience, to Personnel Manager. [5260

CHIEF radio and T.V. tester for production line, good prospects.—Box 6545. [5252

SITUATIONS VACANT

NORTH-WEST Kent College of Technology, Dartford.
DEPARTMENT of Electrical Engineering.
APPLICATIONS are invited for an appointment as Lecturer in Electrical Engineering, duties to commence on January 1st, 1956.
APPLICANTS should possess an Honours Degree in Electrical Engineering or in Physics (and/or be a Chartered Electrical Engineer), and should have had industrial experience in electronics or telecommunications; teaching experience would be an added qualification.
SALARY in accordance with Burnham Scale, viz., £965×£25 to £1,065 per annum.
FURTHER particulars and form of application may be obtained from the Principal at the College, Miskin Rd., Dartford, Kent. [5278

THE GENERAL ELECTRIC Co., Ltd., has vacancies for:
1. TRANSFORMER Designers for a number of development projects including guided missiles. The work involves design of a wide range of types including small power transformers—at mains or audio frequencies—and pulse transformers.
2. ENGINEERS for work on magnetic amplifier transductors.
APPLICANTS should have experience of the design and development of the above types of electronic components and possess H.N.C. C. & G. certificates or equivalent qualifications.
APPLICATIONS will also be considered from ex-Naval R.E.A.s, R.E.s and R.A.F. radar fitters who have reached the required technical standard.
APPLY stating age and experience to the Personnel Manager, The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. Ref. RG. [4994

ULTRA ELECTRIC, Ltd., Western Avenue, Acton, London, W.3
ANNOUNCE the following vacancies for ENGINEERING Staff:—
(1) TELEVISION Development.
(a) SENIOR ENGINEERS required for TV receiver design; applicants should have good academic qualifications and experience of the design of radio frequency amplifiers, preferably up to frequencies of the order of 200 Mc/s.
(b) SENIOR ENGINEERS for time base development; applicants should have good academic qualifications and previous experience in the design of TV scanning circuits.
(c) JUNIOR ENGINEERS with academic qualifications or experience in TV receiver development.
(2) RADIO DEVELOPMENT
(a) SENIOR ENGINEERS required for development of radio receivers embodying the most recent AM/FM techniques, knowledge of FM receiver design desirable.
(b) JUNIOR ENGINEERS required for receiver design; experience desirable but not essential if possessing Hr. N.C. or C. & G. (Telecoms.) Final Cert.
(3) ELECTRONICS.
(a) SENIOR ELECTRONICS ENGINEER with some experience of circuit design for work in one of the following:
(i) Pulse techniques and general waveform circuitry.
(ii) Radar display.
(iii) Feedback techniques at video frequencies.
(iv) Simple servo devices.
SUCCESSFUL applicants will have opportunities of studying recent American techniques and they should be capable of accurate recording of experimental and design data and the preparation of technical servicing information.
(b) ELECTRONIC ENGINEERS for work on one or more of the above subjects.
(4) TEST EQUIPMENT DEVELOPMENT.
(a) TEST EQUIPMENT DEVELOPMENT ENGINEER for design and development of production test equipment for TV, radio or contract work; applicants should have Hr. N.C. or equivalent and good experience.
(b) JUNIOR T.E. ENGINEER with some qualifications or preferably some experience.
(c) MEASUREMENTS SECTION LABORATORY ASSISTANT (m. or f.) with some technical knowledge and experience of calibration and certification of electronic equipment.
APPLICANTS are requested to write to the Personnel Manager, stating which of the post(s) desired and giving full details (in strict confidence) including age, experience and salary expected; Saturday morning interviews can be arranged if desired. [5273

DESIGNER-DRAUGHTSMEN. Vacancies in the Research Department of SHORT BROTHERS & HARLAND, LTD., for work on
INTERESTING military and commercial projects, including automatic controls, navigational systems and guided missiles.
APPLICANTS must have:—
EXPERIENCE of precision, electronic, electro-mechanical, instrument or hydraulic devices, and be able to work on their own initiative.
THESE are permanent positions in an expanding organisation with new and well equipped laboratories; good salaries and prospects, pension scheme, assistance with housing and removal.
PARTICULARS of age, qualifications and experience, with salary required, to—Staff Appointments Officer, P.O. Box 241, Belfast, quoting S.A.89. [5181

EXPERIENCED TV engineers required, must drive; salary from £650 p.a.—Apply, E. Coyne, 120, Ladbroke Grove, W.10. Bay. 1947. [5223

COMMUNICATIONS equipment.—Technical writer required by North London company, an interesting salaried appointment.—Write Box 6664. [5269

TV TUBES £5

6-Month Guarantee

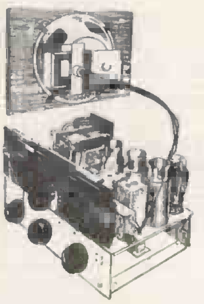
12in. T.V. TUBES. Well known make. Other types 3 months' guarantee. **£5** plus 15/6 ins. carr.

14in. RECTANGULAR TUBES now reduced to £7/10/- plus 15/6 ins. carr.

17in. RECTANGULAR TUBES. £12/10/- plus 15/6 ins. carr. Callers see a picture working. All Tubes C.W.O.

12in. T.V. CHASSIS. 97/6. Drawing **2/6** or free with order. Complete chassis by famous manufacturer (London or Birmingham) R.F. E.H.T. unit included. Owing to this chassis being in separate units (Power, sound and vision-Timebase interconnected) it is easily fitted to table or Console Model. This chassis is less valves and tube but see our catalogue for cheap valves by request. Carr. 5/- London, 10/- Provinces.

TIME BASE. 10/6. Containing scanning coil, focus unit, line trans. 10 controls, etc. Famous mfr. Drawing FREE. Post 2/6.



RADIO-GRAM CHASSIS 29/9

RADIO-GRAM CHASSIS. 29/9. Including 8in. speaker, 5 valve, 3/het, 3 w/band. A.C. Mains, complete less valves, tested guaranteed. Free drawing with order. Post 4/6. Set of 4 knobs 1/6 etc.

"DENCO" RADIO-GRAM CHASSIS 67/6. 4 w/band, 5 valve s/het. Famous turret coil tuning complete with dial and knobs, and 8in. speaker. Carr. 4/6. Set of 5 valves **50/-** extra.

V.H.F. 1124 RECEIVER. 17/6. With 6 valves, ex-W.D., new condition. 6 channel switching. Receives T.V. Sound, police, fire and amateurs. 30/5 Mc/s to 40 Mc/s. I.F. 7 Mc/s. Post 2/6.

V.H.F. 1125 RECEIVER. 7/9. Complete with 2 valves. New X.W.D. Post 2/3.

V.H.F. 24 RECEIVER. 10/6. New X.W.D. Complete with 3 valves. Post 2/3.

SPEAKERS 10/9. 8in. Std. P.M. 2-5 ohms or with matching O.P. Trans. **12/9.** Post 1/9.

MAINS TRANS. 5/9. 6v and 5v heaters 200v-250v primary 350v-0-350v Post 2/-.

MAINS TRANS. 5/9. 12v and 4v heaters 100v-250v primary (ideal auto Trans). Post 2/-.

MAINS TRANS. 3/9. 4v and 4v heaters 200v-250v primary 350v-0-350v. Post 2/-.

MONEY BACK GUARANTEE **DUKE & CO**
621 ROMFORD ROAD, LONDON. E.12
CWO or COD • TEL: GRA 6677

SITUATIONS VACANT

A LEADING electrical and electronic engineering company in London wish to fill the following drawing office vacancies.
(A) COMPONENTS Draughtsman with O.N.C. standard education and experience in radio or light mechanical engineering.
(B) LIGHTING Fittings Draughtsman with experience of sheet metal work, lighting design and electrical wiring. For both positions training will be given and young men with useful but not related experience will be considered. In addition to good starting salaries, the Company offers excellent staff conditions, pension scheme, canteen, etc.—Apply to Personnel Officer, Century House, Shaftesbury Ave., London, W.C.2. Tel. No. Gerrard 7777. [5096

ELECTRONIC Engineers are required on a Guided Weapon Project. Minimum qualifications, either:—
(a) Degree plus two years laboratory experience, or
(b) Five years' laboratory experience.
THESE positions are in an expanding project and offer good prospects for the right men; practical electronic engineering experience and the ability to develop circuits with the minimum of supervision are the main requirements.
PLEASE write to: The Personnel Manager (Technical Employment), De Havilland Propellers, Ltd., Hatfield, Herts, quoting Ref. No. 99. [5178

APPLICATIONS are invited by the Lancashire Constabulary, for personnel for the radio Department, Hutton, as
CIVILIAN Radio Technicians.
APPLICANTS must have a good knowledge of the fundamentals of radio.
RECENT experience of servicing and maintaining V.H.F. equipment an advantage.
SALARY in the scale of £432/10 at 25 years of age, rising to £535 at 32 years of age.
A 44-HOUR week is normal and a superannuation scheme is available for established staff.
Application forms obtainable from the Chief Constable, Lancashire Constabulary, Hutton, Preston. [5281

PROJECT engineers; vacancies exist in an established and progressive company for project engineers aged 25-40, as detailed:—
1. ELECTRONIC component development; experience of electronic or light electrical engineering required, but design experience not essential.
2. TELEVISION and radio aerial development; experience of stress calculations and of light alloy castings and extrusions required.
THE positions are permanent and pensionable; applicants should have Grad. I.E.E. or recognised equivalent qualifications, and should write (in confidence) to the Secretary, Belling & Lee, Ltd., Great Cambridge Road, Enfield, giving details of age and experience and an indication of the salary expected. [5230

INSTALLATION engineer required, preferably with experience of carrying out microwave field surveys and installation.
AS the post will involve a considerable amount of travelling it is essential that applicants be able to drive.
APPLY, giving fullest details of experience, etc., and quoting Ref. IET/1, to the Personnel Manager, Pye Telecommunications, Ltd., Ditton Works, Cambridge. [5203

R. B. PULLIN & Co., Ltd., invite applications for the following vacancies in their recently formed and expanding Electronic Development Division:—
(a) SENIOR Development Engineers: Applicants should possess an Honours Degree or equivalent qualifications, and should have had several years' experience of the development of electronic circuits, preferably including work on electrical servos and magnetic amplifiers.
(b) DEVELOPMENT Engineers: Qualifications to O.N.C. or H.M.C. standard, together with some previous experience of valve circuit design.
THE positions are of a permanent nature; they offer excellent prospects and the opportunity to work in a newly equipped Laboratory on a variety of projects requiring considerable individual technical responsibility and initiative.
A COMMENSURATE salary will be paid. Contributory pension scheme, canteen and recreational facilities.—Applications will be treated as confidential, and should be made to the Superintendent, Electronic Development Division, R. B. Pullin & Co., Ltd., Phoenix Works, Great West Rd., Brentford, Middlesex. [0209

WORK study engineer required for an established department in a light electrical and engineering company; N.W. London area; state experience and salary required.
GOODMANS INDUSTRIES, Ltd., Lancelot Rd., Wembley. Tel. Wembley 1200. [5231

RADIO engineer/mechanic, first class, 12 months overseas; excellent opportunity large firm engineers; write experience, references, age, Box 6338. [5215

CAPACITOR engineer with experience of mica and/or ceramic types required; position is senior and carries a very substantial remuneration: own staff notified.—Box 6372. [5221

RADIO technicians required by International Aeradio, Ltd., for overseas service; permanent and pensionable positions; inclusive salary from £894 per annum to £1,373 per annum, tax free, according to marital status; free accommodation; kit allowance; free air fares; generous U.K. leave.—Qualified candidates, to whom replies only will be sent, please write, quoting RT. to Personnel Officer, 40, Park St., W.1. [0262

GALPIN'S

ELECTRICAL STORES

408 HIGH STREET, LEWISHAM, S.E.13

Tel.: Lee Green 0309. Nr. Lewisham Hospital.

TERMS: CASH WITH ORDER (No C.O.D.)

All Goods sent on 7 days approval against cash

Notice: Owing to increases in Freight and Copper Wire prices we have no alternative but to increase our prices accordingly; all prices quoted are carriage paid unless otherwise stated.

MAINS TRANSFORMERS. Input 200/230 Volts OUTPUT 0/9/18 Volts at 3/4 amps., 25/- each; another output 12½/0/12½ volts 2 amps., 25/- each; another suitable for soil heating, garage lighting, etc., 0/14/17½ volts, 20/25 amps., 52/6 each; another 4 volts 20 amps. twice, 35/- each.
1 only 500 WATT TRANSMITTER complete with Valves, Crystals, etc., 13 meters 3/2kW Variacs Range 6.25 to 12.5 M/cys. 12.5 to 25 M/cys. In very good condition, all fitted into rack approx. weight 5/6 cwt. **£100 to clear, buyer collects.**
EX-GOVT. ROTARY CONVERTORS 24 volts D.C. Input 50 volts 50 cycles, 1 phase at 450 Watts. OUTPUT (complete with Step Up Transformer) from 50 volts to 230 volts, **£13/10/-** each or **CONVERTOR** only **£9/10/-** each.
EX-NAVAL ROTARY CONVERTORS 110 volts D.C. Input, Output 230 volts 50 cycles 1 phase 250 watts capable of 50 per cent. overload, in good condition, guaranteed weight approx. 110 lb. £13/10/- each.
MAINS TRANSFORMERS all 200/250 volts primaries (New) Heavy duty Output combination of 0/6/12/18/24/30/36 volts 4/5 amps., **38/6** each. Ditto 6/8 amps., 51/6 each. Ditto 15 amps. Output 75/- each. Another with combination of 0/6/12/18/24 volts 6/8 amps., 51/6 each. Ditto 10/12 amps., 58/6 each. Ditto 25/30 amps. Output 85/- each.
MEDIUM SPOT WELDER TRANSFORMERS. Input 200/250 volts, OUTPUT combination of 0/2/4/6/8/10/12 volts at 50/70 amps. **£7/7/6** each. Ditto 120/150 amps. Output, **£7/10/-** each.
PRE-PAYMENT 1/- SLOT METERS 200/250 volts A.C. 10 amp. size only, 100 per cent. overload set at 2d. per unit (guaranteed 12 months), **£3/17/6** each. Ditto credit type 10 amps. only, **25/-** each.
RECTIFIERS FOR CHARGERS 6 or 12 volts Output 2 amps., **9/6** each, 4 amps., **22/6** each, 6 amps., **36/-** each. **MAINS TRANSFORMERS** to suit, **25/-, 30/-** and **46/6** each respectively.
EX-CANADIAN EX-GOVT. ROTARY TRANSFORMERS for No. 19 receiver. Input 12 volts D.C. OUTPUTS 275 volts 110 M/amps.; also another output of 500 volts 50 M/amps. completely smoothed, **30/-** each.
AUTO WOUND Voltage changer TRANSFORMERS. Tapped 0/110/200/230/250 volts 200 Watts, **48/6** each; 350 watts, **57/6** each; 500 watts, **76/6** each; 1,000 watts, **£6/5/-** each; 1,500 watts, **£8/5/-** each; 3,000 watts, **£17/10/-**.
EX-R.A.F. ROTARY TRANSFORMERS. Input 24/28 volts D.C. OUTPUT. 1,200 volts 70 M/amps. ½ hour rating, **10/-** each. Ditto 18/24 volts D.C. Input 450 volts 50 M/amps, Output constant, **25/-** each. These latter ones can be used as motors off A.C. mains with a little alteration.
LARGE RECTIFIERS output 50 volts 1 amp. with an input of 70/75 volts A.C., **10/-** each. **Ex-R.A.F. MORSE TAPPING KEYS, 5/-** each.
SINGLE EARPHONE with carbon microphone 40 Ohms, **8/6** each.
ROTARY CONVERTORS. Input 24 volts D.C. Output 50 or 100 volts A.C. 500 cycles 1 phase at 300 Watts, **£8/10/-** each.
DESK-TYPE TELEPHONES for office inter com. with numbered dials, **55/-** each. Moving Coil VOLTMETERS Switchboard type, 6 inch scale 0 to 200 volts, **25/-** each. Ditto 0 to 100 volts, **25/-** each.
EX-R.A.F. 1154 TRANSMITTERS, complete with valves. Complete in TRANSIT CASE. AS NEW. **45/-**.
EX-GOVT. E.H.T. TRANSFORMERS. Large type. Two transformers in one case in Oil input 230 volts OUTPUTS 4 or 5.5 K.V. at 30 M/amps., 6.3 volts 2 amps., 4 volts 3 amps., 2 volts 2 amps. These transformers can be used separately out of the case, size dismantled approx 3¼in. x 3in. x 3in. and 5½in. x 5in. x 4½in., **£4/5/-** each.
Any **TRANSFORMERS** made to order within 7 days from date of order. Please ask for quote. Numerous other Items in stock. Please ask for quotation.
Clients in Eire & Northern Ireland, please ask for quotation as to carriage charges. The above charges only apply to England.

SITUATIONS VACANT

EXPERIENCED fault finders and testers required for work in London on radio and T.V. Good positions for right men with one of the most progressive firms in the industry. APPLY, Works Director, Pye, Ltd., Cambridge. [5012

TECHNICAL authors for a wide range of electronic equipment are required by the Cossor Group of Companies.—Write to: Personnel Manager, A. C. Cossor, Ltd., Cossor House, Highbury Grove, N.5. [5268

RADIO service mechanics required by Smiths (Radiomobile), Ltd., for many parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [0342

RADIO and Television Engineers required for Service Department of Alfred Imhof, Ltd., holders of current driving licence preferred but not essential.—Please telephone Canonbury 1281 for appointment. [5179

SENIOR engineer required by first-class dealer, experienced all leading makes, good salary and permanent position in a respected private business.—E. P. Fox, Ltd., East Molesey, Surrey. Molesey 2721. [5094

ENGINEERS. Physicists. Technicians and Laboratory Assistants, are required by British Telecommunications Research, Ltd. Vacancies exist in departments concerned with:—

(a) Wide-band line communication systems;
(b) Wide-band microwave radio systems;
(c) Measuring and Testing equipment for above;
(d) Magnetic materials and semi-conductors.
(e) Transistor applications to above fields;
(f) Wave filters, transformers and networks;
(g) Electronic switching and computing.

ATTRACTIVE posts are offered to appropriately qualified persons, and the appointments would be permanent.

THE Company operates a superannuation scheme and offers very attractive working conditions with generous holiday and leave arrangements, and good social and recreational facilities.

ALL applications will be dealt with in strict confidence and should be addressed to the Director of Research, British Telecommunications Research, Ltd., Taplow Court, Nr. Maidenhead, Berks. [5143

TELEVISION; leading and progressive Murphy dealers need men with good theory background and able to drive, even if little practical experience. Good salary, conditions and prospects.—Singer's, Mal. 5408. [5023

EXPERIENCED radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wirers and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238

RADIO Valve Engineers required for senior positions on development with London company; experience of this type of work essential: starting salary ranging from £750 to £1,000 according to ability.—Apply Box 5648. [5106

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

MURPHY RADIO, Ltd., have vacancies in their electronics division laboratories for engineers and assistants on design and development work, and also on associated electro-mechanical problems; applicants will be considered in the following categories:

1. CANDIDATES with engineering or science degrees or equivalent who have experience in industrial design.
2. GRADUATES who have completed military service but have no experience in design work.
3. CANDIDATES with lesser qualifications but who have considerable experience in industrial design.
4. CANDIDATES under 21 who are at present engaged upon H.N.C. part-time courses.

THE range of work involved is part of an interesting long-term programme in an expanding field and includes:

1. NAVIGATIONAL aids.
2. V.H.F. and U.H.F. transmitters and receivers.
3. PULSE systems.
4. MAGNETIC information recording systems.

THESE posts are permanent and pensionable, and offer good scope to men of ability; applications, giving full details of qualifications, age, experience, should be addressed to Personnel Department (EDL), Murphy Radio, Ltd., Welwyn Garden City, Herts. [5032

RADIO Development Engineer (Senior) required. Fully experienced and able to work on own initiative Excellent prospects with permanency. Pension scheme.—Masteradio, Ltd., Fitzroy Place, London, N.W.1. Tel. Eus. 2628. [5242

CHARGE Hand (25/35) required by well-known firm of radio component manufacturers in Wandsworth. Some electrical knowledge and ability to control female staff essential.—Write, giving full details of age, experience and salary required to Box 6507. [0059

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SENIOR and Junior Electrical and Mechanical Draughtsmen required for the control gear drawing office to the British Thomson-Houston Company, Melton Rd., Leicester.—Please apply in writing to Manager, Drawing Offices, British Thomson-Houston Co., Ltd., Rugby, giving details of age, experience, etc. [5113

SENIOR and junior electrical and mechanical draughtsmen required for the electronics drawing office of the British Thomson-Houston Co., Blackbird Rd., Leicester.—Please apply in writing to Manager, Drawing Offices, British Thomson-Houston, Co., Ltd., Rugby, giving details of age, experience, etc. [5086

SENIOR television development engineer with administrative experience required, capable of carrying out development projects with minimum supervision up to production stage, Kingston area.—Write, giving full personal details, stating salary required, Chief Engineer, Box 5942. [0123

RADIO and Television Engineer, required for North of Scotland area. Selected applicant should be capable of organising and carrying out radio and television repairs and aerial installation. This position offers considerable opportunity.—Write to Box 4123, Robertson & Scott, 42, Charlotte Square, Edinburgh, 2. [5270

SENIOR and Junior Electrical and Mechanical Draughtsmen required for the electronics drawing office of the British Thomson-Houston Company, Blackbird Road, Leicester.—Please apply in writing to Manager, Drawing Offices, British Thomson-Houston Company, Ltd., Rugby, giving details of age, experience, etc. [5180

TEST gear design engineers and maintenance engineers required with practical experience of this class of work, based on sound knowledge of electronic principles; these vacancies are permanent and progressive; a company pension scheme in operation; London area.—Please write, in confidence, giving full details of qualifications, to Box 6370. [5219

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A. H. HUNT (CAPACITORS), Ltd., require draughtsmen for their New Addington factory, preferably with mechanical and electrical experience. for work on special purpose machines.—Write, giving age and previous experience to The Personnel Manager, A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garratt Lane, Wandsworth, S.W.18. [0057

TECHNICAL Writers required for Publicity and/or Instruction manuals in connection with telecommunication equipment. H.N.C. or degree standard an advantage. Applications should be made in writing, stating qualifications and salary required to Personnel Manager, Standard Telephones & Cables, Ltd., North Woolwich, London, E.16. [5280

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ASSISTANTS (Scientific). The Civil Service Commissioners invite applications for pensionable posts. Applications may be accepted up to 31st December, 1955, but early application is advised as an earlier closing date may be announced either for the competition as a whole or in one or more subject. Interview Boards will sit at frequent intervals.

AGE at least 17½ and under 26 years of age on 1st January, 1955, with extension for regular service in H.M. Forces, but candidates over 26 with specialised experience may be admitted.

CANDIDATES must produce evidence of having reached a prescribed standard of education, particularly in a science or mathematical subject. At least two years' experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces essential in one of the following groups of scientific subjects:—

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(iii) BIOLOGICAL Sciences.

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ELECTRONIC installation and service engineers required for work in field and laboratory; duties embrace v.h.f., electronic and nucleonic activities in commercial sphere; applicants must have sound technical knowledge and servicing experience, preferably with electronic instruments.—Write stating age, qualifications and experience, to Personnel Manager, Ekco-Electronics, Ltd., Southend-on-Sea. [5238

REQUIRED for service in Bangkok; Telecommunications Engineer with working knowledge of manual and automatic telephony, H.F. and V.H.F. radio equipment; the position calls for executive and sales ability; applicants preferably single, and between 25 and 30 years old; passages paid; provident fund; accommodation provided; transport assistance and leave at end of contract.—Write Box SE/95, c/o 95, Bishopsgate, E.C.2. [5250

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LIVINGSTON LABORATORIES, Ltd., require a young engineer for administrative duties; candidates should have a degree in engineering or physics and also have or be willing to undertake training in business and accountancy methods; this is an unusual opportunity in a young and expanding firm for an engineer with a definite interest in the administrative side; age 25-30.—Write to The Director, Livingston Laboratories, Ltd., Retcar St., London, N.19. [5254

SINGLE man required for firm in Bogota, Colombia. Must have practical knowledge and be prepared to travel and repair communications equipment. Also required to take charge of other technicians, and should be able to supervise assembly of domestic receivers. Must be good mixer. Opportunity for man to develop into person responsible for the technical and production running of Ekco (Colombia).—Replies to Chief Engineer, E. K. Cole, Ltd., Southend-on-Sea [5245

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THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Allesley, Coventry, requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments, for work on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager, Ref. R.G. [0259

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MINISTRY OF SUPPLY requires engineer in London H.Q. to assist in co-ordinating the use and progressing the development of valves, other electronic components and constructional techniques required in production of guided weapons. Qualifications: British of British parents. Recognized engineering apprenticeship and A.M.I.C.E. or M.E. or E.E. or exempting qualifications. Electronic design experience, preferably including the microwave radar field, and knowledge of valve or component manufacture. Salary: within £705-£1,095. Not established but opportunities to compete for establishment may arise.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D423/5A. Closing date 11 November, 1955. [5251

SITUATIONS VACANT

THE General Post Office has vacancies for Radio Operators at its coast radio stations and applications are invited from men between 21 and 35 years of age who hold the Postmaster General's First Class Certificate of Proficiency in Radiotelegraphy. Selected candidates will be considered later for permanent pensionable posts. Applications should be made to The Inspector of Wireless Telegraphy, Radio and Accommodation Department, Wireless Telegraph Section, Union House, St. Martins le Grand, London, E.C.1. [5078

TESTERS required for type testing in connection with the design and manufacture of a wide range of electrical control equipment and instrumentation for the Test Department of a rapidly expanding company; applicants must have had industrial experience and suitable technical qualifications, preferably Higher National Certificate; housing accommodation can be arranged where necessary.—Write giving particulars of training, experience, etc., to Works Manager, Sunvic Controls, Ltd., Eastern Industrial Estate, Harlow, Essex. [5248

DRAUGHTSMAN required for interesting work on electrical layouts and installations in connection with heavy works plant test schemes; the successful applicant will be required, in the first instance, to devote his efforts to the electrical test equipment of a new large turbo-alternator factory, where a good deal of personal initiative and drive will be expected; National Certificate or equivalent essential; salary in accordance with age and experience.—Apply in writing to Box A58, T. & G., 167, High Holborn, London, W.C.1. [5016

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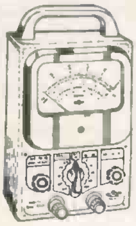

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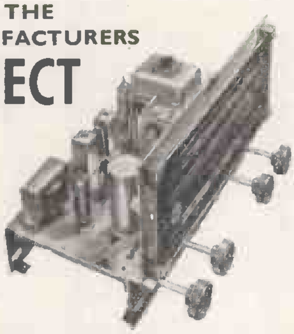

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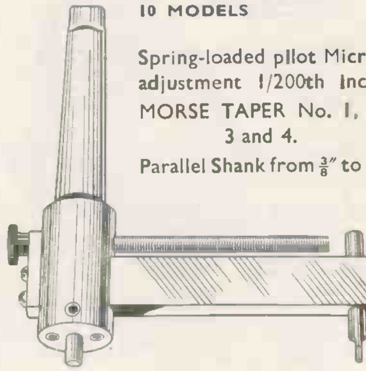

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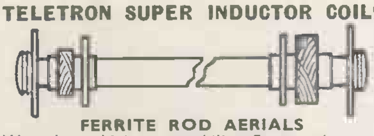

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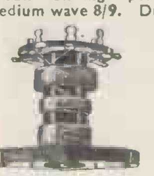

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