

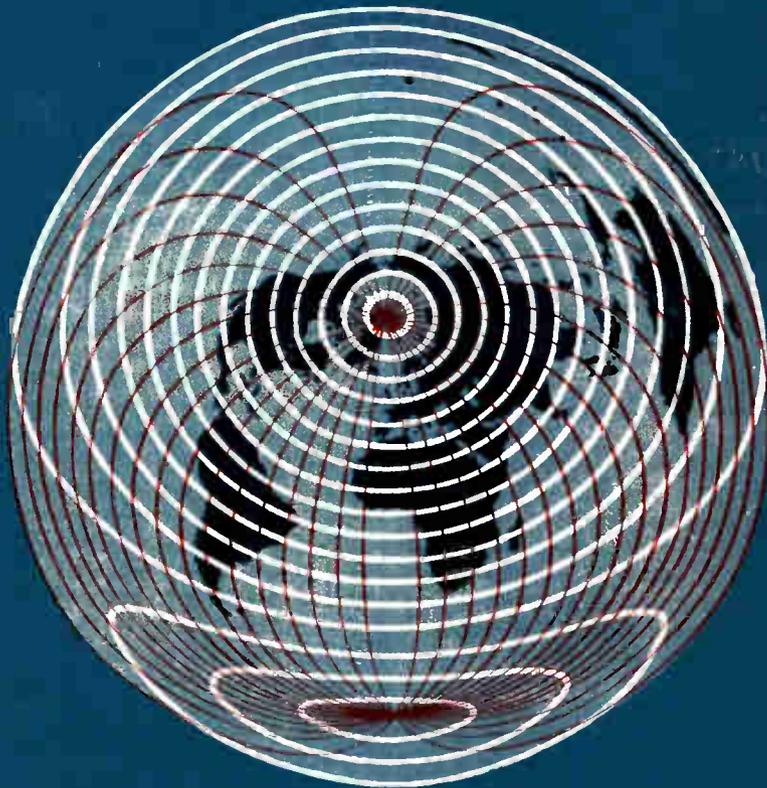
JANUARY 1958

TWO SHILLINGS

Wireless World

ELECTRONICS

Radio · Television



FORTY-SEVENTH YEAR OF PUBLICATION

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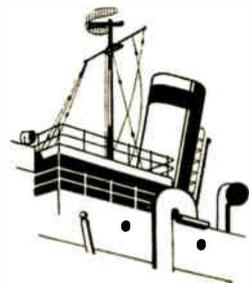
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Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.

Editor: F. L. DEVEREUX, B.Sc.

JANUARY 1958

In This Issue

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Transistor



R.C. Coupled Amplifier Stages

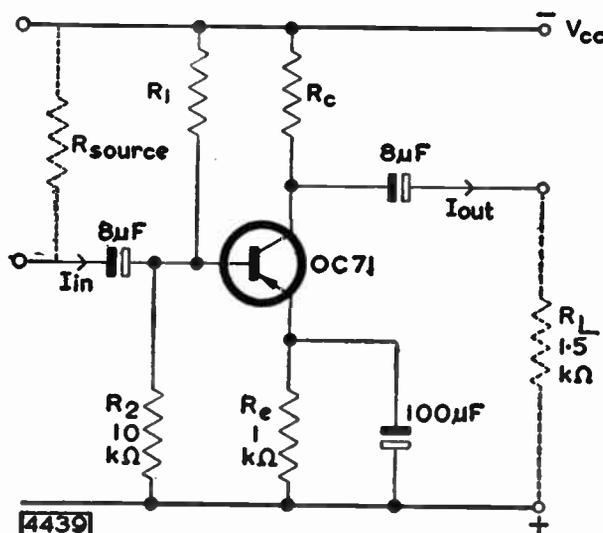
Although it is desirable to design a universal standard transistor amplifier stage, this is not possible because signal level, supply voltage and maximum working ambient temperature each introduce problems which must be overcome in different ways. It is possible however to design and publish typical amplifier stages for several supply voltages, assuming a maximum working ambient temperature, making a compromise between gain and output.

The first stage in an amplifier must be designed to provide as high a ratio of signal to noise as possible, because the accumulated input and circuit noise will give a very impure output over a number of stages. In all other stages the requirement is maximum gain for minimum distortion at the required output level.

The recommended circuit using a Mullard OC71 transistor, with capacitive coupling produces a good gain for a relatively distortion free output. The circuit is suitable for use with supply voltages of 6V, 9V and 12V, stabilised up to 45°C ambient working temperature. Some modifications are indicated below for the user's guidance. It is important when modifications are made to ensure that the collector current should not go below 0.3mA, otherwise the input resistance and collector-emitter gain α' become very non-linear. The distortion and gain data shown in the accompanying table are typical for one OC71 stage from a series of

identical ones in cascade. The source impedance R_{source} is assumed equal to the collector resistance R_C . A resistance of 1.5k Ω is used to shunt R_C , this value is equivalent to the input impedance $R_{i'}$ of the following stage. The current flowing in this 1.5k Ω is the output current considered in the distortion and gain measurements tabulated below. The gain figures apply to a transistor with average collector-emitter gain α' . These component values have been carefully chosen such that in each case the transistor operates satisfactorily up to an ambient temperature of 45°C. It will be seen from the table that the useful output current, for 5% total distortion, and stage gain increase with supply voltage. This distortion is predominantly second harmonic.

The performance obtained with $I_C = 1\text{mA}$ should be adequate in most cases, however the stage gain can be increased by reducing (not below 0.3mA) the collector current, this is only worthwhile at the lower supply voltages. For instance $I_C = 0.5\text{mA}$, $R_e = 2.2\text{k}\Omega$, $R_C = 3.9\text{k}\Omega$ gives 20% increased gain. Increased output can be obtained for a given distortion by increasing the collector current to, say, 1.5mA, altering circuit values accordingly. For minimum distortion it is preferable to keep the collector current in the range 1-2mA, in any case it should not be reduced below 0.3mA, and to keep the source impedance as high as possible.



CIRCUIT VALUES AND GAIN FOR SOME TYPICAL OC71 TRANSISTOR STAGES

V_{CC} (V)	I_C (mA)	R_1 (k Ω)	R_2 (k Ω)	R_e (k Ω)	R_C (k Ω)	$\frac{I_{out}}{I_{in}}$	I_{out}^*
6	1.0	39	10	1	2.2	23	200
9	1.0	62	10	1	3.9	28	260
12	1.0	82	10	1	5.6	31	270

* For 5% total distortion



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Training Technologists

"In the absence of natural resources commensurate with the size of its population, this country lives by trade and by the skill and efficiency of its industry, which must be sustained and expanded by the infusion of the best brains that can be found, trained and stimulated to work with enthusiasm."

THE truth of this typical aphorism is by now universally acknowledged; it is also axiomatic that existing channels of supply do not provide scientists and technologists in sufficient numbers for present, let alone future, requirements. For the sheer spade-work of detail design and development the number of vacancies has long exceeded the supply; and at the top there will always be more than enough room for the Faradays and Blumleins of this world.

Where do the "star" men come from? According to Lord Hives, who spoke recently on the occasion of the introduction of the first report* of the National Council for Technological Awards, there is no evidence to show that any one educational channel is more likely than another to throw up the man of exceptional ability. The important thing is to open up as many channels as possible, so that no one who has the will to apply himself may be debarred by force of circumstance from proving his ability by the acquisition of a universally recognized qualification.

One of the reasons why the technical colleges of this country have been less well supported than the universities is the absence of a generally accepted degree or diploma (other than an external degree from London University) to set the seal on a sustained course of study. This has now been remedied by the Diploma of Technology (Dip. Tech.) which has been established by the National Council for Technological Awards, set up by the Ministry of Education.

Will Dip. Tech. be as good as a degree? For the purpose of qualifying for a post in industry it may well be better. An essential feature of the scheme is the freedom of colleges to develop their Diploma courses *in consultation with industry*, so that students will be well fitted for the industries they serve. In most cases work will be integrated in sandwich courses with industrial training. Teachers are to be encouraged to return periodically to industry, and it is proposed that senior members of industrial staffs should be given a special status in colleges which will enable them to take part in the academic activities. By these means it seems likely that a Dip. Tech. man will be more quickly useful than a man with an academic degree who may take some time to shake down in an industrial environment.

*See "World of Wireless," this issue.

Although the composition of the Dip. Tech. courses will show wide variations, there is little doubt that the standard required will be uniformly high. We are impressed by the stiffness of the requirements laid down by the Council and the fact that more than half of the courses originally submitted for approval have been rejected. The governing body is not lacking in academic attainment, but is drawn mainly from industry and has acted and spoken with a sense of realism which is often absent from the pronouncements of professional "educationists."

It is not the business of the Council to initiate courses—these are prepared by individual colleges—so it cannot be made responsible for what appears to us to be an insufficient emphasis on the importance of electronics. Only one course (at the Northern Polytechnic) on the "Physics and Technology of Electronics" appears in the list of recognized courses in Appendix III of the report, though there are eight courses labelled "electrical engineering" and three "applied physics." No doubt these general subjects include some electronics, but they are now so wide and complex that any attempt to cover them completely in three or four years must surely run counter to the aims and objects of Dip. Tech. Essentially, this new qualification is a matter of expediency and has been created by the need for efficiency. There must be the broadest possible fundamental training at the beginning of the course, but specialization in the final years is inevitable and must tend to become even more narrow as the range of a subject increases with expanding knowledge.

The growing importance of electronics in the national economy is sufficient justification for the strongest possible representation on the Boards of Studies appointed by the Council. The collective experience of the Brit.I.R.E. should be added to that already available from the I.E.E., and many associations of specialists would have useful contributions to make. A separate Subject Panel in electronics should then be appointed, and this in itself would encourage the submission of more courses in electronics. We would also urge the larger electronics firms to use their influence with local colleges to submit more courses of a type appropriate to the needs of their industry.

Fears have been expressed that the advantages of a liberal education will be lost to those who elect to study for Dip. Tech. This need not be so, for the development of the critical faculty and a capacity for concentrated effort, resulting from the mastery of any one subject, are the best preparation for the continuous process of learning by which a liberal education is acquired.

WORLD OF WIRELESS

Technological Education

ON the recommendation of the National Advisory Council on Education for Industry and Commerce the Minister of Education set up in 1955 the National Council for Technological Awards as an independent self-governing body "to create and administer technological awards . . . available to students in technical colleges who successfully complete courses approved by the council." The council's first report (covering the period from December 1955 to July 1957) was presented by Lord Hives, the chairman, at a meeting early in December.

The first award to be introduced by the council is the Diploma in Technology (Dip. Tech). The first of the 965 students now taking approved courses in a variety of technologies at eleven colleges will be taking their "finals" next June. There is some flexibility in the standards required of students for admission to a course but in general it is either five subjects in the General Certificate of Education or a good Ordinary National Certificate.

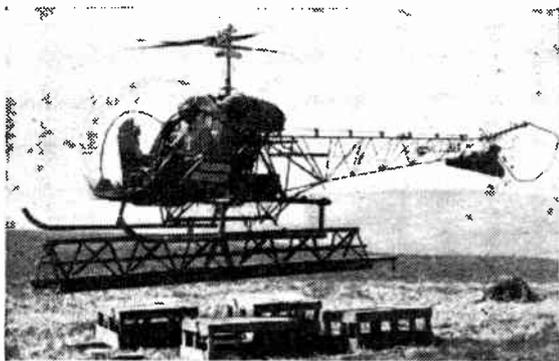
It is pointed out that approval of a course is not granted solely on its academic content but also on the general facilities available at the college. Moreover, the majority of the 50 approved courses are of the sandwich type with integrated college and works training.

The Dip. Tech., which is equivalent to a university honours degree, is the first award to be instituted by the council, which is now considering what post-graduate awards it should introduce.

The council, which has offices in 9 Cavendish Square, London, W.1, has two Boards of Studies, one covering engineering and the other technologies other than engineering.

Helicopter Aids S.H.F. Tests

THE Post Office Engineering Department has recently been carrying out propagation tests from a remote site five miles from Langholm, Dumfriesshire. It took six days to transport the mast, aerials, transmitting and receiving equipment, test hut and engine generator to the site over a mile of peat bog using a caterpillar tractor towing a sledge.



Air-lift for a section of the mast used for the Post Office s.h.f. tests referred to above.

In the light of this experience a helicopter was used for the return journey, the total time taken being only seven hours, spread over two days. Mast sections, paraboloid, and other heavy or bulky equipment was suspended from the machine.

Subscription Television

WE have heard a good deal about proposals for "subscription-TV" from the U.S.A. but not until October did the Federal Communications Commission lay down rules under which applications for operating such a service would be considered. Trial installations are to be limited to cities which already have four "grade A" television services.

Although these rules do not cover closed-circuit systems—the F.C.C. has no jurisdiction over wire transmission—it is of considerable interest to learn from Rediffusion, Ltd., that they have signed a 21-year agreement with the Skiatron International Corp., for the "survey, installation, supervision and maintenance of closed-circuit television systems in the Western Hemisphere."

At the recent luncheon of the Relay Services Association of Great Britain, Mr. Ness Edwards, a former P.M.G., said, "I hope that subscription television is going to be developed by this association." This, however, would need a major change in the P.M.G.'s licence under which relay companies operate.

Student Exchange

SINCE its formation in 1948 the International Association for the Exchange of Students for Technical Experience has arranged for nearly 5,000 students from 36 British universities and colleges to gain experience in industry abroad during their summer vacations. The annual report of the Association records that 34,602 students from 23 countries have participated in the scheme during the past 10 years.

By far the largest number of students among the 5,934 "exchanged" during 1957 came from Germany (1,219). The next highest being Austria (763) with Great Britain third (731). Of the 21 countries receiving students Germany accepted most (1,195) with Sweden second (1,160) and Great Britain third (784).

In the summaries of industrial and academic "spheres of influence" no mention is made of electronics, but it is obvious from the names appearing in the lists of participating companies and organizations, both in this country and abroad, that many of the students were in this field. The number of industrial and other organizations which received students in 1957 totalled 2,761 compared with 413 in 1948.

The secretary for the U.K. is J. Newby, Imperial College, Prince Consort Road, London, S.W.7.

Whilst on the subject of student exchange mention should be made of the Imperial College Vacation Work Scheme. A booklet "Vacation Training" has been issued by the College giving details of the scheme and a list of companies offering to accept students for vacation work.

Television trade tests to assist the industry and dealers are now radiated by the B.B.C. each weekday from 10 a.m. to 1 p.m.. Also all stations now use full power for these tests. Should it be necessary to operate a station on reduced power during the tests the words "reduced power" will be shown on Test Card C or a horizontal bar pattern accompanied by a 250-c/s tone will be transmitted for one minute in every five.

Popularizing V.H.F. Broadcasting.—The next in the series of demonstrations being conducted jointly by the B.B.C., B.R.E.M.A. and R.T.R.A. to foster v.h.f. broadcasting will be in East Anglia. Staged in the Samson & Hercules Hall, Norwich, on January 15th and 16th, it will include in addition to demonstrations an exhibition of v.h.f. receivers.

Wenvoe is to radiate the Third Programme and Network Three on v.h.f. in addition to its existing transmissions of the Light Programme and Welsh and West of England Home Services. The fourth service, which will be radiated on 96.8 Mc/s with a e.r.p. of 120 kW, is hoped to be introduced before the end of 1958. The temporary low-power v.h.f. transmitter at Bristol, which has carried the Third Programme since October, will then close down.

V.H.F. in Scotland.—With the opening of the v.h.f. station at Kirk o' Shotts on November 30th the B.B.C. f.m. service is extended to over 80 per cent of the population of Scotland. Kirk o' Shotts radiates on 89.9, 92.1 and 94.3 Mc/s, with an e.r.p. of 120 kW. The first Scottish v.h.f. station is at Meldrum, Aberdeen. A third station, at Rosemarkie, near Inverness, is planned to be opened in the spring.

B.B.C. Television.—Two new permanent television transmitters have been brought into service by the B.B.C. during December—Douglas, Isle of Man, and Sandale, Cumberland. Both replace temporary low-power transmitters. Douglas operates in Channel 5 with vertical polarization (e.r.p. 2.8kW), and Sandale in Channel 4 with horizontal polarization (e.r.p. 16kW).

Receiving Licences.—During October the number of combined television and sound receiving licences increased by 125,886, bringing the total to 7,524,071. Sound-only licences (including 326,161 for car radio) totalled 7,153,541, making an overall total of 14,677,612 at the end of October. The figures for October, 1956, were, television and sound 6,291,072, sound only 8,128,669 (including 310,301 for car radio), making a total of 14,419,741.

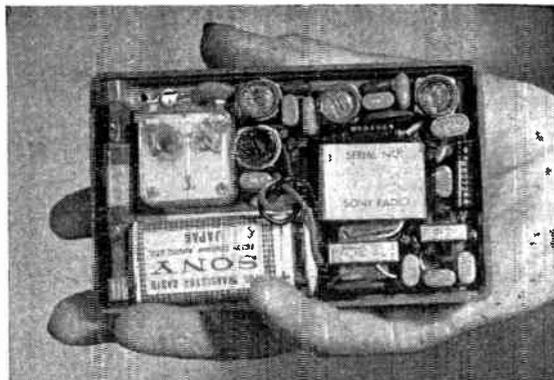
R.S.G.B. Membership.—Last year for the first time since 1948 the membership of the Radio Society of Great Britain increased. The number of members at June 30th was 8,495 compared with 8,102 the previous year. Nearly two-thirds of the members (5,490) hold transmitting licences.

Patents Digest.—A weekly summary of patents in the fields of electrical, electronic and nuclear power engineering is now published by Hunter Digests, Ltd., of 41, Whitehall (T.L.O.), London, S.W.1. "British Electrical Patents Digest," as it is called, costs 10 guineas for six months.

C.I.R.M.—The London office of the International Maritime Radio Committee, of which Col. J. D. Parker is secretary-general, has been transferred from Ludgate House, Fleet Street, to Shipping Federation House, Minories, E.C.3. (Tel.: Royal 1419.)

"Nearest Approach Calculator" (October issue, p. 175).—We have been asked to point out that this device is the subject of Patent Application 27407/56 by R. V. Brass and T. P. McLelland, who were mainly responsible for the development work.

"Sensitive D.C. Null Detector." (December issue, p. 597).—The full-scale deflection of this instrument, as stated in the text, is 50 milli-microamperes and not 50μA as shown in the sub-title.



Transistorized personal portable, SONY TR63, which is made in Japan, is now being sold on the Continent. It measures $4\frac{1}{2} \times 2\frac{1}{2} \times 1\frac{1}{2}$ in., weighs 10½ oz and costs about £17 (in Germany 198 DM). It covers the medium-wave band using a ferrite rod aerial and selectivity is claimed to be -15 dB at 10 kc.s off resonance.

"E.B.U. Review" is the new title under which the *Bulletin of the European Broadcasting Union* is being issued from January. It will be published from the Technical Centre, 4 rue de la Vallée, Brussels, in two parts (a) technical and (b) general and legal, the parts being issued in alternate months. The annual subscription for part (a) is 150 Belgian francs or 300 Belgian francs for both parts.

The "sunspot number," which is a measure of the number and size of disturbed areas on the sun, for October was the highest since records have been kept (about two centuries). The figure was 263. September also produced a high figure, 244. The Royal Society states that the previous highest record was 239 in May, 1778. September also provided a record in terrestrial magnetic activity; there were six great magnetic storms.

International Standardization.—Plans for the first plenary session of the International Organization for Standardization to be held in this country are in the hands of the British Standards Institution. The headquarters of the two weeks' conference (opening on June 9th) will be at the Royal Hotel, Harrogate.

Analogue computation methods (differential analyzers, rheo-electrical analogies, network analyzers, simulators, special calculators, etc., and their applications to science and industry) will be covered at the second International Analogy Computation meeting which is being organized by the Association Internationale pour le Calcul Analogique. Originally planned for June it will now be held from September 1st to 9th in Strasbourg, France. Further information is obtainable from F. H. Raymond, 138, Boulevard de Verdun, Courbevoie (Seine), France. The representative of the Association in this country is Professor S. C. Redshaw, Department of Civil Engineering, the University, Edgbaston, Birmingham, 15.

A Data Processing Section was recently formed by the Society of Instrument Technology (20 Queen Anne Street, London, W.1) and a series of meetings is being held in London. The next meeting is on January 28th when M. P. Atkinson, of the National Physical Laboratory, will speak on digital codes and coding. The secretary of the Section is W. T. Bane, 137 Kenilworth Court, London, S.W.15.

Information Engineering.—A graduate course in information engineering will again be held at the University of Birmingham in the 1958-59 session.

Applicants wishing to be considered for a D.S.I.R. grant, covering the fee of £81 and a maintenance allowance, should apply to the electrical engineering department of the University before February 3rd. Copies of the syllabus of the course are obtainable from the Supervisor of Graduate Courses, the Electrical Engineering Dept., The University, Birmingham, 15.

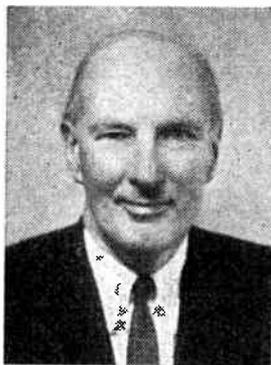
Service and maintenance of sound and television receiving equipment is covered by the course opening at the Wesley Road Evening Institute, Stonebridge, London, N.W.10, on January 6th. The fee for the course, which will be held on Mondays and Wednesdays until July 2nd, is 25s.

Communication Networks.—A course of lectures on modern electric network theory and design will be given by Dr. W. Saraga on six consecutive Wednesday evenings from January 22nd at the South East London Technical College, Lewisham Way, London, S.E.4 (fee 10s).

Southall Technical College introduces three new series of evening lectures in January. They are, "Sound Recording and Reproduction" (12 lectures), "Colour Television" (9 lectures), and "Design and Usage of C.R. Tubes" (12 lectures). The fee for each course is £1. The first course begins on 13th and the other two on 15th.

Personalities

B. St. J. Sadler, managing director of Redifon, Ltd., has retired after 13 years with the company. He was commercial manager of Marconi's Wireless Telegraph Co. before he joined Redifon. He is succeeded by F. Youle, B.Sc., A.C.G.I., A.M.I.E.E., who joined the company as sales manager in 1942 and became a director four years later. Since last July he has been general manager responsible for the factories and laboratories at Wandsworth and Crawley. Following his training in electrical engineering at the City & Guilds of London Institute, his industrial career began in 1921 with Marconi's where he spent some time in the development laboratories. He later became television sales manager of Marconiphone. From 1940 to 1942 he was in the Ministry of Aircraft Production.



F. YOULE



H. C. PRITCHARD

W. H. Apthorpe has retired from the managing directorship of Cambridge Instrument Company with which he started his career in 1900. After a few years he left to continue his technical education and returned in 1914 to take charge of the company's testing department. He is continuing with the company as deputy chairman. His successor is H. C. Pritchard, B.A., who, after graduating at Oxford, joined the Air Ministry and in 1939 was appointed head of the Navy section of the Royal Aircraft Establishment. After the war he became head of the Blind Landing Experimental Establishment at Martlesham and in 1949 was seconded to the Australian Government as chief superintendent of the Woomera rocket range where he stayed for three years. He subsequently left Government service and has been for the past four years with Elliott Brothers, latterly as group manager at Rochester. He is a Fellow of the Royal Aeronautical Society.

Sir Robert Watson-Watt has been awarded the Elliott Cresson medal of the Franklin Institute of America "for his contribution to the conception of pulsed radar and his leadership in its development." Sir Robert, now living in Canada where he runs the consultancy organization Adalia, Ltd., has recently completed his autobiography which is inevitably a virtual history of radar. It is entitled "Three Steps to Victory" and is being published by Odhams in February. Sir Robert is soon revisiting this country and will be addressing the Radar Association on February 12th on "The Early Days of Radar."

Dr. J. C. West has been appointed to succeed Prof. P. L. Burns, who is retiring from the chair of electrical engineering in Queen's University, Belfast. Dr. West graduated at Manchester University in 1943 and after service in the Royal Navy returned in 1946 to join the staff of the University's department of electrical engineering and was appointed senior lecturer in 1953. His early researches were in the field of electron optics but he has subsequently specialized in non-linear servomechanisms, and as a result of this work he has received the degrees of Ph.D. (1952) and D.Sc. (1957). Prof. Burns has been at Belfast since 1924, having entered the teaching profession at Hull in 1918. During the first world war he was at Manchester University where he was associated with Lord Rutherford on submarine detection.

Dr. T. G. Pickavance, at present deputy head of the general physics division of the Atomic Energy Research Establishment at Harwell, has been appointed by the National Institute for Research in Nuclear Science as director of its Rutherford High Energy Laboratory (Harwell). Dr. Pickavance, who is 42, is at present officer in charge of the group responsible for the design and supervision of the construction of the new large accelerator for the Institute. He has been at Harwell since 1946 and in his present position since 1955.

Major C. Collaro, O.B.E., who, as announced last month, resigned his position as chairman and managing director of Collaro, Ltd., has joined Camp Bird Industries, Ltd., as chairman. He succeeds John Dalgleish, who will continue as chairman and managing director of Camp Bird, Ltd., the parent company. Camp Bird Industries controls the electrical, electronics and communications group of the parent company. This group includes Ambassador, Hartley Baird and E-V (Sapphire Bearings).

C. E. Payne, B.Sc.(Eng.), M.I.E.E., chief engineer and a director of Ferguson Radio Corporation Ltd., has been co-opted to the governing body of Enfield Technical College. He has been closely associated with the college for some time on the educational and training schemes operated by the parent company Thorn Electrical Industries.

Clive Barwell, general publicity manager of Mullard, has completed 25 years service with the company. He was at one time production manager of one of the company's valve factories, but has been mainly concerned with publicity and public relations.

G. R. Scott-Farnie, M.Brit.I.R.E., has been appointed managing director of International Aeradio, Ltd., in succession to Air Commodore C. S. Cadell, C.B.E., M.A., M.Brit.I.R.E., who has resigned to join *The Times*. Both of them were members of I.A.L. on its formation in 1947. Mr. Scott-Farnie, who for the major part of the war was on special signals duties in the R.A.F. and from 1944 to 1945 was signals intelligence officer on General Eisenhower's staff, joined the company as operations manager. He operates amateur station G5FI.



G. R. SCOTT-FARNIE



R. E. ROBINSON

Three assistant managing directors have been appointed by the G.E.C. They are T. W. Heather, M.C., Comp.I.E.E., who will be responsible for the general products group, A. L. G. Lindley, the engineering group, and R. E. Robinson, M.I.E.E., the telecommunications group. The company has also appointed two new directors, D. G. W. Acworth, M.A., M.I.E.E., and W. J. Bird. Mr. Heather, who has been with the company 44 years, was elected to the board in 1938 and is also on the board of a number of other companies, including M.O. Valve Co. and Salford Electrical Instruments. Since 1944 he has been chairman of the G.E.C. education and training committee. Mr. Lindley, a mechanical engineer, joined G.E.C. as an apprentice in 1918. Mr. Robinson has concentrated on telecommunications throughout his industrial career which began in 1903 when he joined the Western Electric Company in London. In 1905 he went to the Bell Telephone Company in Antwerp and in 1908 became chief engineer of the Peel-Conner Telephone Works, then a G.E.C. subsidiary. Mr. Robinson, who was appointed director in charge of telephone and radio works in 1945, is a past chairman of the Tele-communication Engineering and Manufacturing Association.

John Dyer has resigned from the position of public relations officer for E.M.I. Electronics, Ltd., to which he was appointed in 1954, and has joined the staff of the British Electrical & Allied Manufacturers' Association as technical editor of *BEAMA Journal*. He was with the Philco organization for some time before the war and again from 1950-54. Mr. Dyer was at one time editor of *Wireless & Electrical Trader*.

Sergeant Edward J. Gane has been seconded by the R.A.F. to be senior wireless operator at the Royal Society Antarctic base at Halley Bay for 1958. He has sailed in M.V. *Tottan* which, after visiting the Norwegian base and Halley Bay, will be bringing home some members of the advanced party. Among them will be chief technician Ronald Evans, R.A.F., who has been senior wireless operator during the past year.

B. V. Baliga, chief engineer of All India Radio, is the new president of the Indian Institution of Telecommunication Engineers. He has been vice-president of the Institution since its formation in 1953.

Dr. James R. Killian, president of the Massachusetts Institute of Technology since 1948, has been appointed by President Eisenhower to the new post of Special Assistant to the President for Science and Technology. Dr. Killian, who is 53, has been closely associated with government research in the U.S. and was a member of President Truman's communications policy board.

Dr. A. W. Hull, consultant to the General Electric Research Laboratory, Schenectady, U.S.A., is to receive the Medal of Honour, the premier technical award of the American Institute of Radio Engineers. Dr. Hull, who is credited with creating a greater number of new types of valve than any other man, receives the award "for outstanding scientific achievement and pioneering inventions and development in the field of electron tubes."

OUR AUTHORS

J. C. Beckley, B.Sc.(Eng.), author of the article on the design of car radio receivers, graduated at London University in 1954 and since then has been on the staff of the Applications Research Laboratory of the Mullard Radio Valve Company. His work there is concerned with the design and development of valves and circuit techniques at radio frequencies.

T. G. Clarke, A.M.Brit.I.R.E., contributor of the article on the cathode-coupled flip-flop, is senior development engineer with Decca Radar where he has been responsible for the electronic design of several types of marine and windfinding radar. He is at present engaged on investigations into the use of storage tube systems in radar. During his military service he was a warrant officer in the R.E.M.E. and served as an instructor at various training establishments both in the United Kingdom and overseas.

Dr. D. H. Martin, the first part of whose article on magnetism in materials appears in this issue, is a lecturer in physics at Queen Mary College, University of London, where he is engaged in research into superconductivity and spectroscopy in the very far infra-red. He graduated with first-class honours in physics at the University of Nottingham in 1950 where for four years he undertook post-graduate research into the domain structure of ferromagnetic metals, concentrating on domain nuclear processes.

P. R. Stutz, B.Sc.(Eng.), A.C.G.I., Grad.I.E.E., author of the article on turret tuners for Band V, has been with Kolster-Brandes, Ltd. for the past nine years. He is a senior engineer in charge of a section engaged on television research and development, and represents the firm on the U.H.F. Working Party of the British Radio Equipment Manufacturers' Association. He graduated at the Imperial College of Science and Technology with an honours degree in electrical engineering in 1948.

OBITUARY

A. Cecil Barker died on December 10th, aged 58, at his home, The Close, Hurst Wickham, Hassocks, Sussex. He was trained as a singer and broadcast in the 1930s, and his interest in sound reproduction took the practical form of designing the "Duode" loud-speaker. This was patented in 1936 and manufactured during the pre-war period by Magnavox (Benjamin Electric). During the war Mr. Barker served in the Admiralty (A.S.R.E.) and in 1947 started the business of Duode, Ltd.

Frank S. Allen, works director of E. K. Cole, Ltd., and a director of Egen Electric and Ekco Electronics, died on November 20th aged 56. He joined the Ekco organization in 1941 as assistant works manager and four years later became general works manager of the radio division.

TELEPHONE AUTOMATION

AN electronic switching system taking the place of trunk-call telephone operators is to be installed by the Post Office at Bristol as part of their national scheme for "automation" of the telephone service. Known as GRACE (from Group Routing And Charging Equipment), it will enable subscribers to dial trunk calls just as they do local calls on the automatic system. The equipment, which is based on cold-cathode tubes, has been designed and developed in co-operation with the General Electric Company. It will register a dialled number, select a route to the distant exchange, ring the wanted number, and, when the distant subscriber answers, record the appropriate charge on the caller's local exchange meter. The word "Group," incidentally, derives from the new system of grouping exchanges which comes into force on 1st January.

To make an automatic trunk call the caller dials the national number of the distant subscriber. The first digit of all national numbers is "0," and receipt of this causes the call to be connected to a "call charger" equipment. The remaining digits of the number are received and stored in a register. Of these, the first 1, 2 or 3 digits identify the distant "Group." A "translator" equipment then inspects these digits and deduces from them the route and charge rate for the call. The translator incorporates a permanent store giving details of the routes and charge rates for calls from the originating exchange to all other "Groups" in the country.

The information passed back from the translator to the register is in the form of a charging rate digit and several routing digits. To avoid having to provide storage capacity for all these digits at once, they are passed to the register one at a time as required. The register uses a digit supplied by the translator to further the setting up of the call and then makes a fresh demand for another digit. The time taken by a register to use a digit is far greater than that required by the translator to supply it. The translator is therefore freed between demands for use by any other register, and it may serve up to 40 registers altogether.

The first digit returned to the register from the translator is used to select the appropriate charging rate in the call charger. Subsequent digits are used by the register to operate switches in the originating and distant exchanges to complete the connection. When the connection has been completed the register is released and made available for use with other call chargers in setting up further calls. The call charger remains connected throughout the call and, when the distant subscriber answers, levies the charge by operating the caller's exchange meter periodically, at intervals depending on the distance between the two "Groups" concerned.

Another equipment, developed by the Automatic Telephone and Electric Company and somewhat similar in function, was put into operation recently at the Lee Green (London) automatic exchange. This, however, is not dealing with trunk calls but replaces some of the electromechanical equipment in the automatic system. Moreover, it is based on a magnetic drum storage system, which provides the registers for the dialled numbers on some of its tracks and the information for translation into routing directions on a "library" of other tracks.

The associated electronic equipment here makes use of thermionic valves. One important part of it is a



The magnetic drum director at the Lee Green exchange showing the actual drum in the right-hand cabinet.

"scanner," driven by synchronizing tracks on the magnetic drum. This scans the subscribers' lines and, where dialling pulses are present, causes the dialled numbers to be put in the appropriate register on the drum. This scanning provides a means of keeping a running record of the state of each of the subscribers' lines, and the record is kept up to date merely by putting the most recent state in place of the old one. In this way the electronic equipment and the drum can be time-shared over any 114 subscribers' lines in as little as 17 milliseconds each. Moreover each of the 114 lines can be rescanned every 17 milliseconds, so that changes of state of up to 60 changes per second are recognized. This permits considerable economies in apparatus and is one of the reasons for developing the trial equipment.

MSF TRANSMISSIONS

A NEW edition of the pamphlet* describing the U.K. standard frequency service has been issued by the National Physical Laboratory. These transmissions are radiated almost continuously from the Post Office station MSF at Rugby on behalf of the N.P.L. Both the carriers (2.5, 5, and 10 Mc/s) and the modulation frequencies are maintained to ± 5 parts in 10^7 . The MSF frequencies are now based on the resonant frequency of the caesium atom (9, 192, 631, 830 c/s).

The transmitted power on each of the carriers is 0.5 kW. A bottom-fed mast radiator is used for the lower frequency and quadrant dipoles for the other two.

The accuracy obtainable from MSF is, however, limited by propagation conditions which can cause changes in the received frequency amounting to ± 2 parts in 10^7 . An additional transmission is therefore radiated daily for one hour (1429 to 1530) on 60 kc/s with a power of 10 kW.

The results of daily measurements made by the N.P.L. at Teddington on the MSF transmissions are given in our sister journal *Electronic & Radio Engineer* each month.

* "MSF-Standard Frequency Transmissions from the United Kingdom."

Reception on Band V

An Introduction to Circuit Techniques for the Ultra High Frequencies

THE announcement in last month's *Wireless World* that the B.B.C. has started transmitting on an experimental basis sound and vision signals in Band V must give rise to speculation on the kind of problems likely to be encountered in designing receivers for 650Mc/s.

The Band-V receiving problems are certain to be a little more difficult to solve than those encountered when Band III was first opened to television, but they are not likely to be exceptionally troublesome. Band V has been in use for television in the U.S.A. for a few years now and we are in the fortunate position of being able to study the circuit techniques adopted on that side of the Atlantic.

Some new valves had to be developed and while British prototypes have been made in this country it may be some time before they become generally available. However, the Band-V transmissions are only experimental, and who can say when a regular service will be inaugurated? Suitable valves are bound to be available to all when the time arrives.

R.F. amplification on 650Mc/s is not ruled out by any means, but if the current practice in the U.S.A. can be taken as a guide the r.f. amplifier is a luxury rather than a necessity on this band. Where it is used it takes the form of an earthed-grid amplifier usually with line-type circuits and one such arrangement is shown in Fig. 1. It would be justifiable to draw the inductors L_1 , L_2 , L_3 , L_4 and L_5 in the familiar helical form, but it is desired at this stage to emphasize one of the main differences that will often be encountered in tuned circuits on u.h.f. On these frequencies coils, as we know them, are in most cases replaced by straight pieces of thick wire, by a hairpin, or even a strip of metal, while

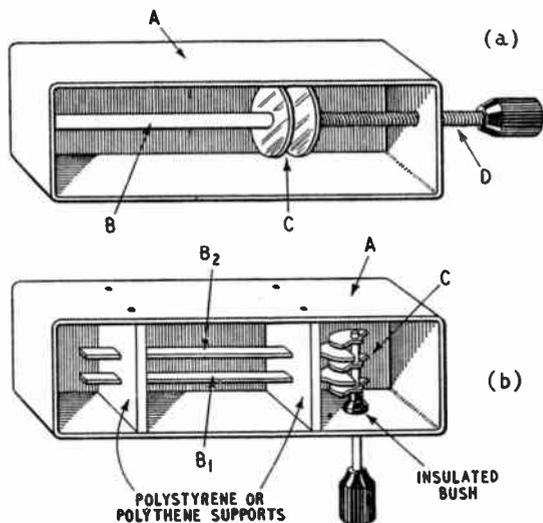


Fig. 2. Coaxial line (a) and balanced line (b) tuning elements for use on u.h.f.

an alternative would be sections of coaxial or twin wire transmission line as shown in Fig. 1(a) and (b) respectively. These lines are tuned by small capacitors, C in Fig. 2 and C_1 , C_3 and C_4 in Fig. 1. In the case of Fig. 2(b) the open ends of the two metal strips can be joined together to form a hairpin, with the capacitor in its centre, or joined to the grid and anode of a valve.

Fig. 1(a) is sometimes called a trough-line circuit.

The case A is usually "earthed" to the chassis but true earths are difficult to locate in u.h.f. equipments. The way out is to avoid as far as possible including any parts of containers or chassis in the tuned circuits. For this reason Fig. 1(b) is to be preferred for u.h.f. oscillators as the container is merely a screen.

The rod D in Fig. 2(a) is screw threaded and serves for adjusting the capacitor C. These troughs or boxes are invariably closed by a lid or cover-plate. The best material for these circuit elements, where the highest attainable Q is required, is silver, but as this is impracticable

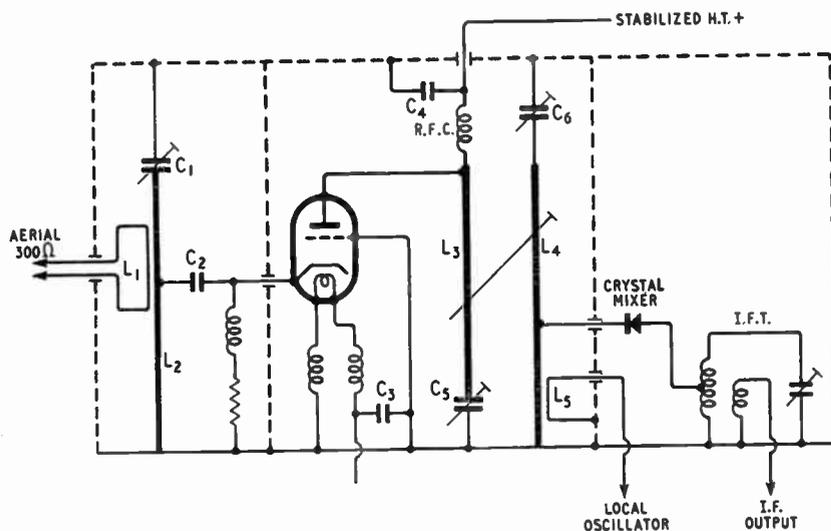


Fig. 1. Basic circuit of a u.h.f. earthed-grid r.f. amplifier.

silver-plated copper, or silver-plated brass is generally employed. Plain copper is the next best.

Fig. 1 has some shortcomings as a practical arrangement as it may need neutralizing. However, this does not invalidate it as an example of the basic principles involved. The component marked "crystal mixer" will be dealt with later.

A special type of valve is required for the r.f. stage in Fig. 1. R.F. pentodes are unsuitable at u.h.f. (at least existing types are) and triodes are invariably used at the higher frequencies. The Band-III cascode r.f. amplifier is a case in point. Cascode stages do not seem to be satisfactory at Band-V frequencies and the only alternative seems to be the earthed-grid triode. Ordinary triodes are not suitable, the requirements being very small spacing of electrodes to reduce transit time, unusual rigid construction to give frequency stability and multiple connections to some electrodes, but particularly the "earthed" electrode, as it is essential to eliminate as far as possible impedance common to two or more circuits.

Special valves have been available for some time

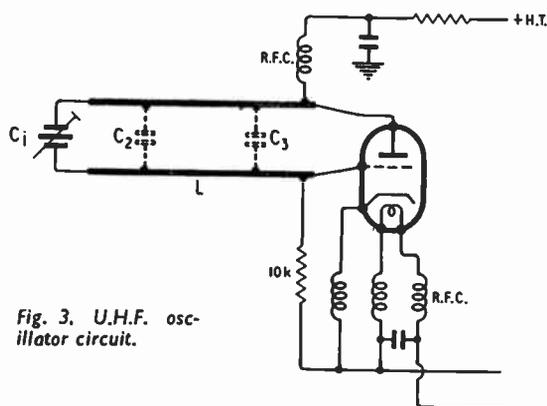


Fig. 3. U.H.F. oscillator circuit.

for use as earthed-grid amplifiers, but the form of construction has been too costly for use in domestic equipments. A cheaper form of assembly has recently been evolved and is typified by the G.E.C. A2521 which was described in "Technical Notebook" in the January, 1957, *Wireless World*. There are other makes in existence but the supply position is at the moment a little vague.

When an r.f. stage is not used the signals received on the aerial are fed *via* an r.f. pre-selector, consisting of a pair of coupled tuned circuits, to a crystal mixer. A crystal is generally used, one might say invariably, in u.h.f. "front ends," since crystals are more efficient for this function than a valve, unless it be a special type, and in general the noise level is lower. The crystal used in this position is a point-contact silicon type similar to those developed for radar receivers and exemplified by the B.T.H. CS2A and similar models, or the American 1N82. There are probably other types that would be equally suitable, but it is essential (and this cannot be over-emphasized) that a low-noise type be employed.

The u.h.f. oscillator is possibly one of the most difficult problems in the design of Band-V equipment. Assuming the output from the Band-V mixer is to be fed into a standard television i.f. amplifier, with the sound on about 38Mc/s and the vision on

about 34Mc/s, then the local u.h.f. oscillator must be about 36Mc/s higher in frequency than the signal; say between 686 and 690Mc/s. It will be realized that a very special valve is required for generating oscillations on this high frequency. However, the ability to oscillate in the region of 700Mc/s is only part of the problem involved; of equal or possibly more importance is the frequency stability of the oscillator.

Many factors are involved in the frequency stability of a u.h.f. oscillator. There are the inter-electrode capacitances of the valve and the effect of temperature on their capacitance values, also the capacitance of the valveholder and the effect of temperature on the inductor rod or rods. The variable tuning capacitor also has a temperature coefficient. Most of these will be positive, a rise in temperature bringing about a decrease in frequency since their individual values, whether of inductance or capacitance, increase. The customary way of compensating for this is to include one or more capacitors in the circuit having a negative coefficient of temperature and to connect it, or them, in the position which as near as possible gives an overall zero coefficient of temperature. Another factor influencing frequency stability is the steadiness of the h.t. voltage, any fluctuation being reflected in the stability of the oscillator. Thus a stabilized, or closely-stabilized, h.t. supply for the oscillator is essential.

A typical u.h.f. oscillator circuit is shown in Fig. 3. This circuit is based on the use of an all-glass type valve such as the EC93 with a B7G-arrangement of base pins. This is a special u.h.f. triode and should be generally available in the near future. The valve is also made on the Continent and there are some equivalents with different type numbers in America. In Fig. 3, L is a parallel-line tuning inductor of the kind shown in Fig. 2(b), the open ends being connected direct to the valveholder pins, or if this is thought to be a little too drastic, by very short lengths of flexible copper braid. Direct connection is quite feasible but it demands careful assembly. C₁ is the tuning capacitor and since it is a split-stator type each half will need twice the capacitance of the single capacitor C in Fig. 1(a) to give the same capacitance coverage. The capacitance change of the disc-type capacitors is very small indeed until the two plates get very close. There are some very tiny commercial variable capacitors in existence which would be ideal for this purpose but they are difficult to acquire outside manufacturers' channels of supply.

Capacitors C₂ and C₃ are alternative positions for a negative-temperature coefficient capacitor for frequency stability control. Sometimes one at either end of the line is desirable and sometimes one only connected somewhere across the line will suffice. It is a matter for experiment. Bi-metal strip has been used as a compensating capacitor with one end soldered to one rod and the other end close to, but not touching, the adjacent rod.

Whilst it is not the purpose of this article to explain how to find one's way around the u.h.f. bands, it must be fairly obvious that a yard-stick of frequency is essential. Those who contemplate experimenting on Band V would be well advised to lose no time in providing themselves with a wave-meter covering say 500 to 1,000Mc/s. It is ex-

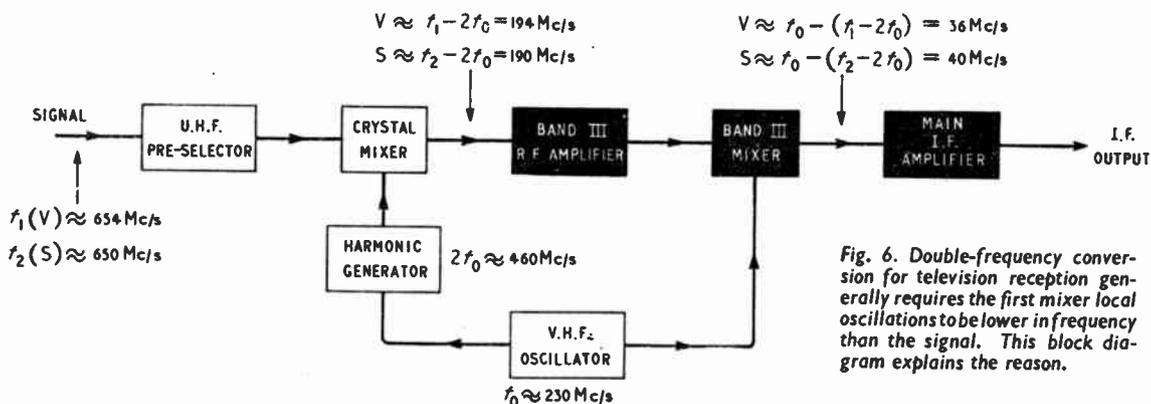


Fig. 6. Double-frequency conversion for television reception generally requires the first mixer local oscillations to be lower in frequency than the signal. This block diagram explains the reason.

plifier for use as a 34-38Mc/s i.f. stage. The Band-III oscillator can be switched off. With a turret tuner this is quite easily arranged.

Another scheme is to employ double frequency conversion and obtain the local oscillations for the first frequency changer from an harmonic of the Band-III oscillator. There are objections to double conversion as although only one oscillator need be employed interference can be produced by it and its family of harmonics.

Unless the oscillator stage is exceedingly rich in harmonics, which in a well-designed set it should not be, a harmonic generator has to be employed. One of the simplest is a crystal with a resistance-capacitance network in series and this is used quite extensively in the U.S.A. The circuit is very simple and is shown in Fig. 5, the circuit L, C being tuned to the desired harmonic. The Band-III cascode r.f. stage continues to function as such, but it might have to be tuned to a frequency different from the usual and possibly outside Band III in order to avoid interference from harmonics and fundamental of the oscillator.

It should be remembered that any system involving two frequency conversions for receiving television necessitates the correct choice of oscillator frequency for the first mixer; in the cases under discussion the crystal mixer. In most superheterodyne receivers conversion to i.f. can be effected with the local oscillations either higher or lower in frequency than the signal, since when extracting the difference, or beat, frequency of the two it matters not which is the higher. However, when two signals, such as sound and vision, are involved the i.f.'s that emerge will be transposed when the local oscillator is shifted over to the alternative beat.

It has been recommended by B.R.E.M.A. that the sound and vision i.f.'s should be about 38Mc/s and 34.5Mc/s respectively which requires that the local oscillator be *higher* in frequency than the signal.

When double-frequency changing is employed the first conversion must be made with the local oscillator on the *low* frequency side of the signal. The reason for this is best explained by means of a block schematic diagram such as Fig. 6. The frequencies marked against each stage are not necessarily those which would be employed in a practical case since the likelihood of interference from oscillator harmonics has not been taken into consideration. The example given here is to illustrate the basic principles involved.

We are indebted to Kolster Brandes, Ltd., and to Mullard, Ltd., for information on some of the principles and problems likely to be encountered in reception on Band V.

VALVE LIFE

IF asked the question "how long do the valves last in your radio or television receiver" few listeners, or viewers, would venture an answer. It is also doubtful if many users of commercial radio equipment would commit themselves. Would 30,000hrs. be too long?

A trial system of multi-channel radio equipment was installed in 1949 between the Marconi works at Chelmsford and a site at Woolwich for the purpose of compiling data on the reliability of equipment, which means primarily the reliability of the valves employed. The system operated continuously for 24 hours each day.

The original valves were removed in 1953, a log having been kept of any replacements required in the interim period. Many of the valves employed are ordinary receiving types found in domestic sets and the data relevant to their performances are given in the table here. This data was originally published in the October, 1957, issue of the Marconi journal, *Point to Point Telecommunications*.

Valve Type	Total Number Used	Failures		Average Working Time of all Valves (hrs.)
		Total Number	Average Life (hrs.)	
EF91	138	3	28,000	31,900
EB91	4	—	—	32,600
EAC91	2	—	—	32,600
ECC91	6	4	9,250	19,560
ECC32	8	1	26,500	29,000
KT66	12	—	—	32,600
SU4G*	16	9	4,600	5,000
U52*	16	32	6,060	8,090

*Alternative types were used during the trial.

"F.M. Discriminator Bandwidth." We regret that a sentence, which should have referred to co-channel interference, beginning "Fortunately, this has been anticipated . . ." on line 17, right-hand column of p. 572, December 1957 issue, was transposed. It should have followed the words ". . . to the same programme," five lines before the bottom of the preceding column.

Television Aerials For Bands IV and V

ADVANTAGES OF THE CORNER
REFLECTOR DESIGN FOR U.H.F.

SINCE November last, and for several months to come, the B.B.C. is radiating still and motion video transmissions on a frequency of 654.25Mc/s in Band V with a view to assessing all the technical factors involved should it be decided, at some future date, to provide a regular service in this band or in Band IV. During the spring the definition will be increased from 405 lines to 625 lines. It is uncertain whether the improvement noticed on a closed circuit between transmitter and receiver will be maintained under conditions of space propagation and one of the objects of the tests is, presumably, to check this doubt.

In order that a television picture shall maintain the original quality delivered from the camera it is essential to retain, throughout the entire transmitting and receiving system, the correct amplitude and phase relation of each picture element in relation to the next. The manner in which this is achieved is within the control of the circuit designer, but he cannot control the vagaries of propagation. True, a line-of-sight experiment over an open space, free from any sources of reflection, will closely simulate closed-circuit conditions but would take no account of the practical conditions of terrain variations, built-up areas, and isolated structures involved in providing a public service.

In considering the radiation of electromagnetic energy from an aerial it is desirable to regard the aerial as a point source. The energy will spread out into space and flow through a hemispherical boundary of ever-increasing radius. At a radius of a few hundred wavelengths a small area of this hemispherical boundary can be regarded as being perfectly flat so that all the energy flowing through any selected small aperture in space is in equiphase and plane-wave propagation prevails. Departure from plane-wave conditions is caused by adverse effects which worsen as the frequency of the wave energy is increased. At low frequencies, say 100kc/s, the earth appears as a mirror-like surface. If the wave were endowed with human faculties it would be unable to recognize anything smaller than the high mountains. Trees, buildings and hills would be invisible and so, apart from a slight tilt imparted to the wavefront by virtue of energy absorption by the resistance of the earth, plane-wave propagation is preserved over considerable distances in daytime. At night-time the effect of reflections from the ionosphere vitiates the conditions.

As the frequency is increased the earth no longer retains its mirror-like properties and at, say, 1Mc/s hills and large structures are becoming visible in varying degrees. At frequencies of the order of 100Mc/s small structures and trees become visible

until, at several hundred megacycles per second, the fine detail of structures and the foliage of trees are clearly outlined.

This "visibility," increasing as it does with frequency, is responsible for such effects as absorption, reflection and diffraction, and their combined effects tend to diffuse the wavefront of the energy and so disturb the equiphased front originally radiated from the transmitting aerial. Thus the relative phase and amplitude of the picture elements transmitted in the sidebands will be disturbed and loss of definition will result. Multi-path propagation produces displaced images (ghosts) and it is now well known that these tend to be worse on Band III than on Band I and may be expected to deteriorate further with a threefold increase in frequency.

At first thought it might seem that little can be done to correct for these effects but a directive receiving aerial will reject most of the multi-path reflections since it is known that the more serious reflections emanate from objects at the side and rear of the aerial.

The effects of departure from plane-wave conditions can be minimized by using as

small an area as possible for the aerial consistent with providing useful gain. For example, a pair of half-wave dipoles spaced several wavelengths apart and fed in phase to the receiver might show loss of both gain and definition as compared with the same arrangement spaced at one half wavelength. As a somewhat crude analogy, if one wishes to view a distant object through a small gap in the foliage of a tree a wider spacing of the eyes could result in only one eye being able to see the object with consequent impairment of brightness and detail. Because an aerial will possess different characteristics when operating under diffused-wavefront conditions it is customary to refer to the plane-wave characteristics as being under the ideal conditions.

If a radiating oscillator is set up some fifty wavelengths from a receiving aerial on flat ground quite clear of buildings and obstructions the gain and directivity of any experimental aerial may be compared with that of a simple half-wave dipole. If the oscillator is replaced by a powerful transmitter beyond the horizon, and the tests are repeated in a built-up area, lower gain and a change in the directional characteristics of the experimental model invariably result. The change in gain is due to departure from plane-wave propagation, and the change in directivity to reflections from buildings and other reflecting objects.

This accounts for the fact that certain types of aerial do not appear to live up to their plane-wave performance in some fringe areas while others, with

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BY
F. R. W. STRAFFORD*
M.I.E.E.

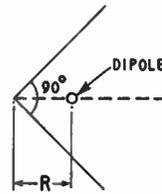
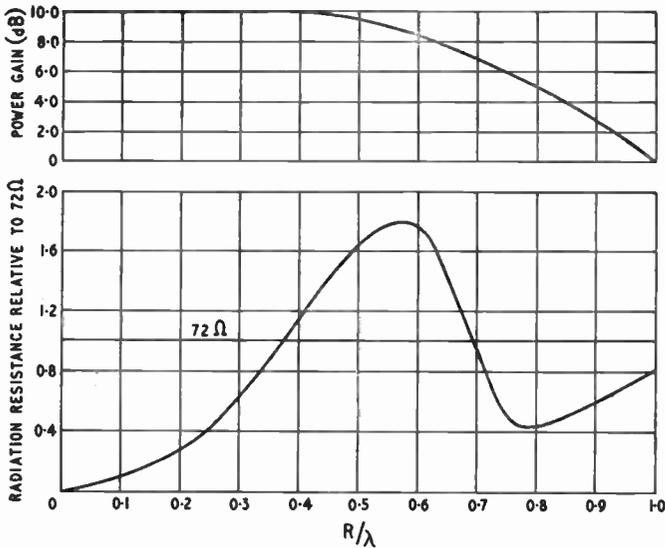


Fig. 1. Variation with spacing (R) of radiation resistance and gain for a corner reflector aerial.

inferior plane-wave characteristics, are the better performers!

A further requirement of a suitable aerial is that it will maintain its gain and directivity, not only over the sideband frequency range, but throughout the whole band allocated to the service. Finally, there should be no serious mismatch of impedance between the aerial and its feeder. A reasonable standard would be a mismatch of not greater than two to one.

Before reviewing aerials in terms of satisfying the foregoing requirements for Bands IV and V an examination of the table will be helpful.

Band	Coverage (Mc/s)	Mid-frequency (Mc/s)	±% deviation
I	41—68	54.5	25
III	174—216	195	10
IV	470—585	527.5	11
V	610—960	785	22

The widest deviation occurs on Band I where experience has proved that H and Yagi type aerials employing parasitic elements must be optimized dimensionally for each channel.

On Band III it is just possible to maintain good characteristics over two neighbouring channels. With some compromise three channels may be covered, but, ideally, the Yagi type of aerial is really only suitable for a single channel if full use is to be made of its properties. Such an aerial, if optimized on a single channel, might reverse its directivity in some part of the band.

These arguments apply equally to Bands IV and V, but there is a further fact which tends to make the Yagi type of aerial unsuitable for these elevated frequencies, and that is the dependence on plane-wave conditions for obtaining useful gain and directivity. Since the present tests are radiated with horizontal polarization there is good reason to assume that any future service will be based thereon so that consideration of possible aerials will be based on this assumption.

As a general consideration u.h.f. aerials with a gain of less than 3dB and front-to-back ratio of less than 6dB should be discarded except for exception-

ally favourable sites close to the transmitter. Aerials unsuitable for the above reason, together with their inability to function correctly under diffused-wave conditions, will include H and Yagi types, and the small loop. Rhombic and other long wire aerials, are omitted on account of their length relative to the plane-wave gain achieved, and the need for resistive termination at the remote end for one-way directivity. The slot aerial, plus a sheet or mesh reflector, might be considered if it were not for the fact that its terminal impedance—of the order of 300 ohms—did not

need transforming to the 75-ohm coaxial feeder which has now become the general standard. The frequency selectivity introduced by the impedance transformer restricts its original broadband characteristics. The helical aerial¹ has excellent gain and directivity for its compactness but it is equally responsive to both vertical and horizontal polarization and a pair, oppositely wound, must be used to receive one plane of polarization only. Such an aerial would present packaging problems if mass-produced, but there is no real technical argument against its use as it has all the desirable characteristics including that of broadband.

This leaves the corner reflector aerial^{2,3} in which is located a half-wave dipole at a point R from the apex. (Fig. 1.) If the angle of the reflecting sheets is 90° the interesting characteristics of Fig. 1 are

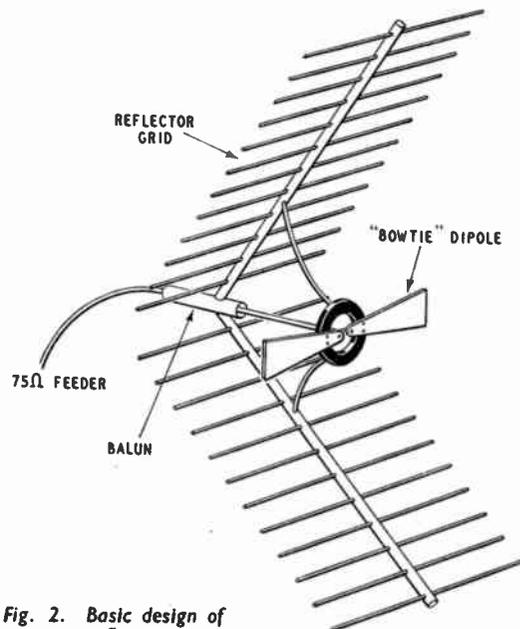


Fig. 2. Basic design of a corner reflector aerial.

obtained. These are for infinite sheets but it has been shown that sheets¹ one wavelength wide and two wavelengths long give results surprisingly close to the ideal. In fact, the dimensions may be reduced further without serious loss of performance. It will be observed that, up to $R=\lambda/2$, the radiation resistance rises from zero through 72 ohms up to 120 ohms. From $R=\lambda/4$ to $R=\lambda/2$ the mismatch to a 75-ohm feeder will not exceed 1.6 to 1, so that if the dipole is located at $R=3\lambda/8$ good matching will be maintained over a frequency deviation of plus or minus 33%. Also Fig. 1 shows that the gain will be closely maintained over this range of deviation from the design frequency. These characteristics are ideally suited to Bands IV and V because relatively compact and simple mechanical structures, without dependence on close-limit manufacturing tolerances, can be readily achieved. It is a pity that the corner reflector becomes rather unmanageable, on account of size, on Band III, and quite impossible, for both size and economy, on Band I, for it possesses all the desirable properties of a first-class general-purpose aerial.

The practical construction of the corner-reflector aerial permits of considerable latitude in the hands of the designer. The reflector may be of sheet, continuous, or perforated to reduce windage, or wire mesh may be used provided that the size of the mesh does not exceed about 0.1λ . According to Moullin² the screening or reflecting properties of a conductive mesh are at least 90% as good as a continuous sheet of the same material. Kraus³ has shown that a row of rods may be used to make a corner reflector grid, and if these are spaced not much greater than 0.1λ a very convenient and attractive aerial results. Such an aerial was constructed about a design frequency of 654.25Mc/s as shown in the sketch of Fig. 2. The overall dimensions of each reflector grid are 10in wide by 18in long.

A "bow-tie" type of dipole is used as it has the required broadband characteristics. Fat cylinders could be used instead but they do not give a smooth impedance transfer at the feeder connections. Measured data of this type of aerial, taken under carefully controlled plane-wave conditions, gave the following results:—

1. Power gain relative to half-wave dipole, 8.7dB.
2. Half-power beam width, 64°.
3. Front-to-back ratio, 15dB.
4. Minima in excess of 40dB, at 90°, 140°, 220°, and 270°.
5. Mismatch ratio to 75-ohm feeder, 1.4.

These characteristics varied very slightly over a range of ± 30 Mc/s. It was not possible to extend the measurements over the whole of Band V, but the results indicate that the performance is most likely to be maintained, and this is a matter for further experiment. A simple quarter-wave balun was included in the design but its removal during the course of tests did not appear to have much

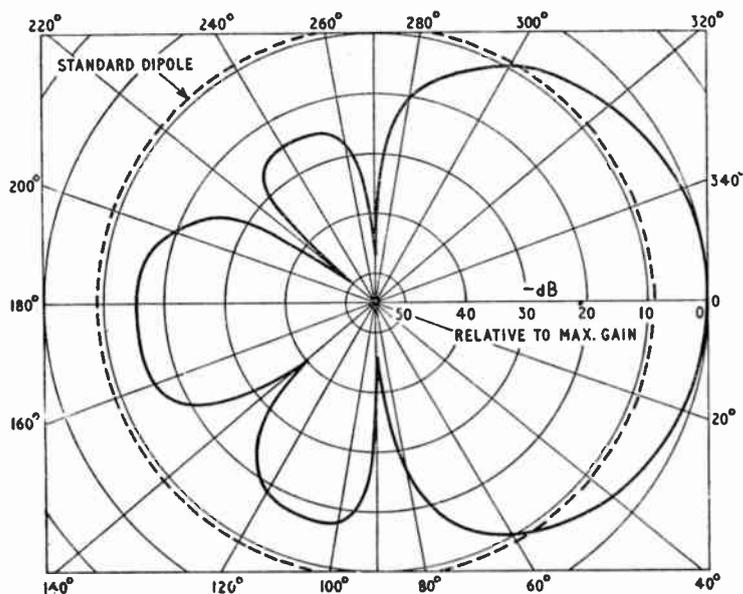


Fig. 3. Polar diagram of the corner reflector aerial.

effect. If much larger reflectors had been used, with a consequent increase in front-to-back ratio, the balun would probably prove an advantage, since it reduces the effects of pickup on the feeder which shows up as a reduction in the overall front-to-back ratio.

The directional response in the azimuthal (E) plane is shown in the polar plot of Fig. 3. Plotted in decibels it gives the *false impression* of poor directivity because of the size of the side and rear lobes. Had this diagram been plotted in voltage ratios, or better still, in voltage squared (power) ratios, the amplitude of the rear lobes, relative to the main lobe, would *appear* to show improved directivity. An examination of the diagram will reveal that, over the rear 180° of the aerial, the response is never less than 15dB below that of the main beam. As an integrated effect it probably averages 25dB below the main lobe.

It might be a good idea to standardize the amplitude scale of a polar co-ordinate graph say, in five steps of 10dB with 50dB coinciding with the centre of the chart and 0dB on the circumference. The *appearance* of the curve would then line up with the degree of directivity found between samples.

A pair of these aerials may be mounted side by side a little over a half-wavelength between centres. Provided that the respective outputs are connected in phase the gain will be increased by 3dB and the half-power beam width reduced to about 55°.

It is hoped to publish the results of practical tests with this aerial on the B.B.C.'s transmissions after both standards of definition have been used.

Acknowledgement. This article is based on work done on behalf of Kimber-Allen, Ltd., to whom thanks are due.

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BAND V ON A TURRET TUNER

ADAPTING AN EXISTING BAND I — BAND III FRONT END FOR U.H.F. TELEVISION

BY P. R. STUTZ*, B.Sc. (Eng.) Hons., A.C.G.I., Grad. I.E.E.

WHEN the decision was taken to begin television test transmissions in Band V at a vision carrier frequency of 654.25 Mc/s, the problem arose of providing television sets capable of receiving these signals.

The type of receiver which has been adapted for u.h.f. reception uses the well-known turret tuner for channels in Bands I and III. The r.f. stage of this tuner is a double triode connected as a cascode amplifier which is followed by a triode-pentode frequency changer. A separate set of coils is used for each channel, mounted in a twelve-position turret.

In order to receive the u.h.f. transmissions, special coil strips or inserts are mounted in the turret†. To obtain satisfactory results these inserts use the double superhet principle. This necessitates a rather more complex insert than the type used on the lower frequencies of existing television channels in this country. A schematic arrangement of the u.h.f. inserts is shown in Fig. 1.

The incoming u.h.f. signal is first frequency con-

verted to an intermediate frequency lying in the 135-Mc/s region using a u.h.f. germanium diode mixer. This signal is amplified by the cascode valve in the tuner. The signal is then frequency converted again, using the pentode mixer, to the normal 34.65-Mc/s vision intermediate frequency of the receiver. A harmonic of the triode local oscillator is used for the first frequency-changing operation and the fundamental for the second frequency conversion. For this particular channel, the third harmonic of the local oscillator is used: this harmonic is generated by a germanium diode from the fundamental and is selected by a resonant circuit.

As a result of using a harmonic selector circuit, the mixing diode obtains a local oscillator voltage with the unwanted harmonics and the fundamental reduced to a minimum. This ensures that a good noise factor is obtained and reduces unwanted responses.

The circuit diagram of the inserts is given in Fig. 2. The aerial input is for a 75-ohm unbalanced feeder, the same as is used on Bands I and III. The feeder is matched into the primary of a mutually coupled band-pass circuit tuned to the u.h.f. channel fre-

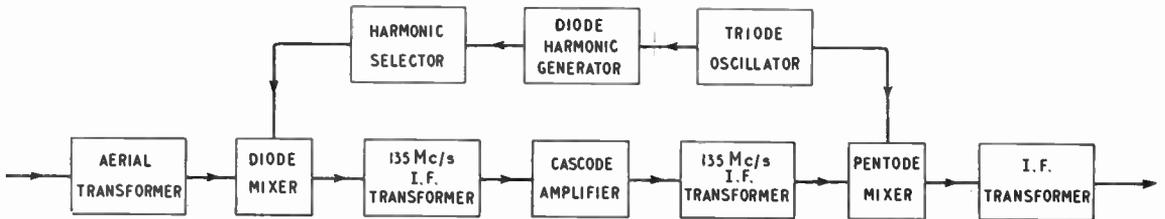


Fig. 1. Block schematic of the u.h.f. inserts for the tuner.

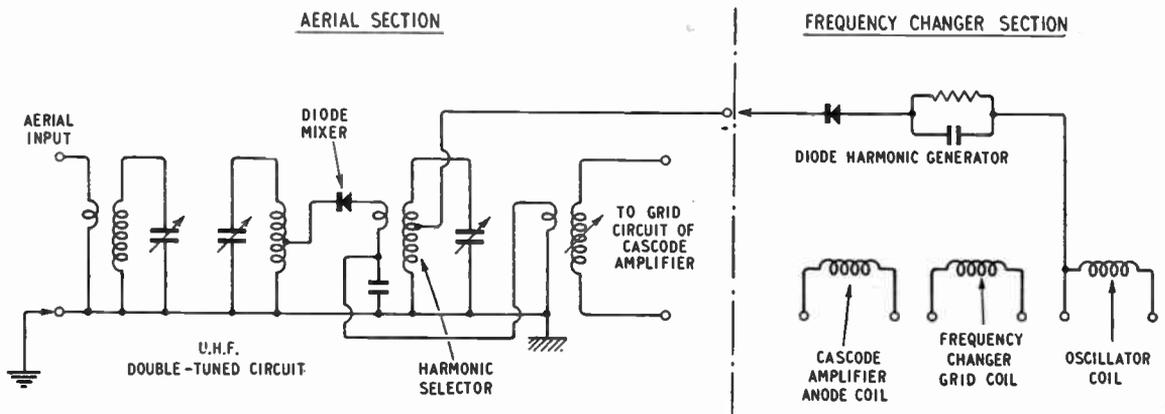
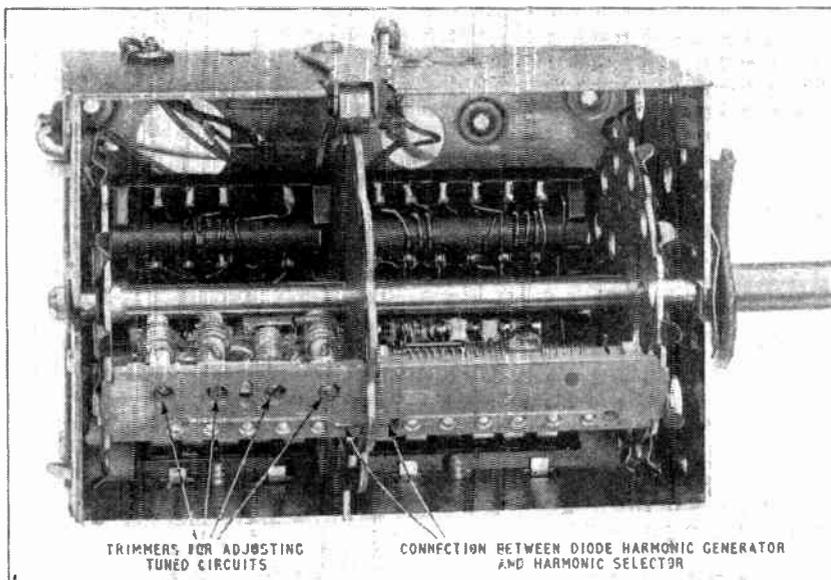


Fig. 2. Circuit diagrams of the two u.h.f. inserts.

*Kolster-Brandes.

†The units are of American design and have been modified to 75-ohm aerial input and to suit the frequency of the test transmission.

quency. The output is matched into the diode mixer by means of a tap on the secondary tuned circuit. The i.f. output from the diode mixer is coupled into the grid circuit of the cascode amplifier using an impedance-matching transformer tuned to 135 Mc/s. The diode used for obtaining the third harmonic of the triode oscillator is connected to one side of the local oscillator winding via a biasing network. As this diode is mounted on the frequency-changer section and its output has to be fed to the harmonic selector on the aerial section, a special link is required between the two sections of the u.h.f. inserts. This link between the two sections can be seen on the photograph of the inserts in position in the turret tuner. On the frequency-changer section, there is the coil connected in the anode circuit of the cascode amplifier which, together with the other coil connected to the grid of the pentode mixer, forms a band-pass coupled circuit tuned to a centre frequency of about 135 Mc/s. The local oscillator coil on this frequency-changer



An existing tuner with the u.h.f. inserts in position on the turret.

probably the noise factor. This type of unit was found capable of a noise factor of about 17dB; this figure compares quite well with other types of tuner which do not use a stage of u.h.f. amplification before the mixer diode.

The overall selectivity of the arrangement is quite adequate, as can be seen from the curve of

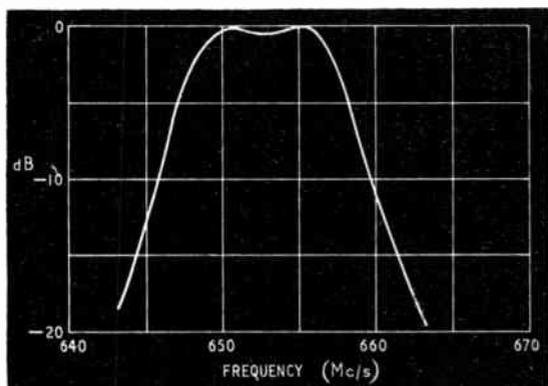


Fig. 3. Frequency response of the u.h.f. tuner, measured from the aerial input to the pentode mixer stage.

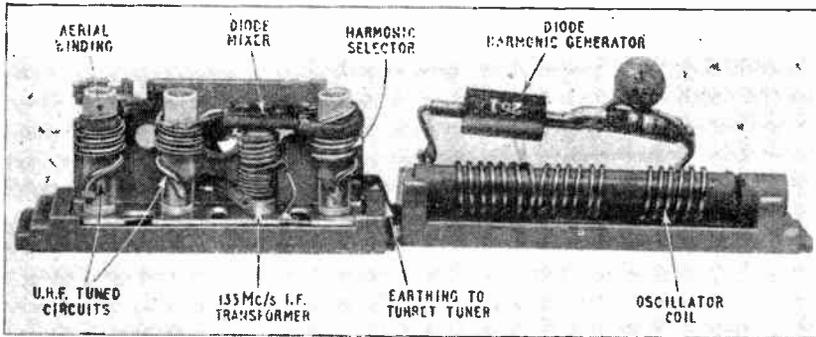
section is designed for a fundamental frequency of 172.225 Mc/s.

The circuits on the aerial section are tuned by means of the trimmers shown in the photograph. The coils on the frequency-changer section are tuned by adjustment of the end turns, except for the local oscillator coil which has a brass core accessible from the front of the tuner, in the same manner as with the coil strips for the existing television channels. Constructional details of the inserts can be seen in another photograph on the next page.

In assessing the performance of these u.h.f. inserts, one of the more important considerations is

Responses from an insert tuned to 654.25 Mc/s vision.

Oscillator Harmonic (Mc/s)	Vision Frequency (Mc/s)	Sound Frequency (Mc/s)	Measured Amount Down on Required Response (dB)	Comments
	137.575	134.075	28	1st i.f.
Fundamental 172.225	34.65 309.8	38.15 306.3	65 53	Final i.f.
2nd harmonic 344.450	206.875 482.025	210.375 478.525	63 35	
3rd harmonic 516.675	379.100 654.250	382.60 650.750	40 0	Required channel.
4th harmonic 688.90	551.325 826.475	554.825 822.975	38 46	
5th harmonic 861.125	723.550 998.700	727.050 995.200	49 55	
6th harmonic 1033.350	895.775 1170.925	899.275 1167.425	45 Not measured.	



Showing the construction of the two u.h.f. inserts and how they are linked together when on the turret.

Fig. 3. Unwanted responses due to oscillator harmonics are sufficiently down on the main response to be considered negligible, as can be seen from the measurements given in the table. Rejection at the 135-Mc/s i.f. is sufficient for all normal purposes. The value of the rejection seems to be controlled by stray coupling from the aerial input to the cascode amplifier grid.

It is thought that with future units it may be possible to improve this figure if necessary, as the layout of the units used was originally intended for a 300-ohm balanced aerial input.

The voltage gain of a tuner using these u.h.f. inserts is somewhat less than that of the same tuner working on Bands I and III, owing to the loss of gain in the aerial section. The difference in gain of the tuner between Band V and Band III will be about 10dB.

The stability of the local oscillator is obviously important for convenience of operation. The drift was found to be about three times greater than that experienced on Band III, but was found in practice to be tolerable.

The range of the fine tuner control is about three times greater than that on Band III channels but, despite this, it was found perfectly simple to tune in the picture on a receiver.

The considerations leading up to the choice of 135 Mc/s as the first i.f. have not yet been men-

tioned. Owing to the fact that the triode local oscillator is used for both frequency - changing operations, there is a relationship between the oscillator harmonic chosen and the first i.f. Also, to avoid reversing the relative positions of the sound and vision carriers, the first frequency conversion must be done with the local oscillator low. This leads to:

$$f_o = f_{if(1)} + f_{if(2)}$$

$$f_o = \frac{f_{uhf} + f_{if(2)}}{N + 1}$$

where f_{uhf} = frequency of Band-V channel

f_o = oscillator fundamental frequency

N = harmonic of the oscillator used

$f_{if(1)}$ = the first i.f.

$f_{if(2)}$ = the second i.f. (34.65 Mc/s vision)

It was considered desirable that the frequency of the local oscillator fundamental and the first i.f. should be chosen so that they were located between Bands I and III and cleared the band allocated to v.h.f. radio transmissions. This led automatically to the choice of the third harmonic of the local oscillator for this particular channel and a value of 135 Mc/s for the first i.f.

A small practical point worth mentioning is the care that had to be exercised in the choice of mains isolating components for the aerial feeder. If this is not done and unsuitable values and layouts are chosen, the noise factor and sensitivity of the receiver will be impaired.

The performance of the u.h.f. inserts on the test transmissions came fully up to expectations, the pictures obtained being free from any unwanted beats or patterning. In practice these inserts were fitted to an unused channel position in the turret, thus leaving the receiver free to receive the normal transmissions in Bands I and III as well as the u.h.f. transmissions.

Books Received

The B.B.C. Riverside Television Studios: The Architectural Aspects, by E. A. Fowler. B.B.C. Engineering Monograph No. 13 includes an appendix on the sound proofing, and the acoustic treatment used to secure the optimum reverberation time. Pp. 25; Figs. 10.

The B.B.C. Riverside Television Studios: Some Aspects of Technical Planning and Equipment, by H. C. Nickels and D. M. B. Grubb. B.B.C. Engineering Monograph No. 14 includes description of television and sound studio and distribution apparatus and also telecine equipment. Pp. 32, Figs. 18. The above B.B.C. Engineering Monographs are each priced 5s and may be obtained from B.B.C. Publications, 35, Marylebone High Street, London, W.1.

Glossary of Abbreviations, compiled by S. T. Cope, covers names of technical, scientific, industrial and professional organizations, with particular reference to the

telecommunications industry. Pp. 38. Price 2s 6d. Marconi's Wireless Telegraph Co., Ltd., Baddow Research Laboratories, West Hanningfield Road, Great Baddow, Essex.

Electronic Voltage Stabilizers for Laboratories, Computers and Control Systems, by J. Miedzinski, B.Sc., and S. J. Zgorski, describes series valve stabilizer with twin-triode amplifier and gas discharge voltage reference tube to give up to 50 mA at 320 or 400V. Pp. 19; Figs. 8. Price 12s 6d. Electrical Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

The "Mercury" Switched F.M. Tuner, by G. Blundell, gives description and constructional details for a new Jason circuit incorporating a.f.c. and a Foster-Seeley discriminator. Pp. 20, Figs. 9. Price 2s. Data Publications, Ltd., 57, Maida Vale, London, W.9.

Some Special Magnetrons

—AND HOW THEY ILLUSTRATE BASIC IDEAS

THE magnetron consists essentially of an anode and cathode which are concentric cylinders. The anode has a number of subdivisions, usually referred to as segments, in which high-frequency oscillations can be produced. These segments generally take the form of resonant cavities so that oscillations are essentially only possible at a number of discreet frequencies. Power from the oscillations is generally coupled out from a single segment, a wide variety of methods being used.

The cathode is at a high negative d.c. potential relative to the anode. A powerful magnetic field in the direction of the anode and cathode axis prevents more than a small proportion of the electrons emitted from the cathode from reaching the anode under static conditions, most of them being returned to the cathode.

Under dynamic conditions, the r.f. field produced by the oscillations gives energy to electrons whose

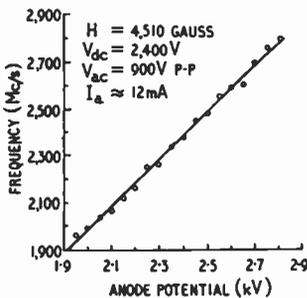


Fig. 1. Linearity of tuning in voltage tunable magnetron.

phase with respect to this field is favourable. This enables them to reach the anode where they give up their potential energy to sustain the oscillations. The field also produces a "bunching" effect¹, or in other words tends to concentrate electrons as they proceed to the anode into groups with a favourable phase. Those electrons for which

this does not occur soon return to the cathode, and bombarding it, increase its temperature.

The anode segments generally have a constant phase difference between individuals. This phase difference may be thought of as being produced by r.f. waves travelling round the anode, when the phase change in distance round the anode will be related to the phase change in time of the travelling r.f. wave.

We can thus draw a useful analogy with the travelling wave tube¹. The magnetic field (by the left-hand rule) imparts an angular motion to the electrons about the anode and cathode axis. This motion will not be essentially modified by the r.f. fields, and the electrons will stream past the anode segments either individually or in bunches as they approach. By analogy with the travelling wave tube we will expect maximum interaction to occur when the electron bunches and r.f. waves have the same velocity.

Relationships between Operating Parameters.—The need for this equality between the velocities of the electron bunches and r.f. waves gives a relationship between the operating voltage, magnetic field, and

frequency. The frequency is also usually largely fixed by the resonant properties of the anode segments.

By adopting certain simplifying assumptions it is possible to obtain this relationship in a quantitative form which is close to that obtained by more sophisticated methods.

The electrons can be assumed to leave the cathode with zero velocity and to proceed towards the anode under the influence of the static electric and magnetic fields only, until the r.f. field becomes significant. Here, for optimum interaction, the angular velocity round the anode of the electrons and the r.f. field must be the same. We then assume that from here outwards the electrons become "locked" to the r.f. wave, so that their angular velocity remains constant until they reach the anode².

When the r.f. field is negligible, the electric field will be entirely in a radial direction. The angular equation of motion for an electron of mass m and charge e may then be written

$$\frac{m}{r} \frac{d}{dt} \left(r^2 \frac{d\theta}{dt} \right) = eH \frac{dr}{dt} \dots \dots \dots (1)$$

Integrating this equation we obtain

$$r^2 \frac{d\theta}{dt} = \frac{eH}{2m} (r^2 - r_c^2) \dots \dots \dots (2)$$

where r_c is the cathode radius, and the constant of integration is obtained by putting $d\theta/dt=0$ at $r=r_c$. If r_1 is the radius at which the electrons become locked to the r.f. wave, equation (2) gives the corresponding angular velocity ω , as

$$\omega = \frac{eH}{2m} (1 - r_c^2/r_1^2) \dots \dots \dots (3)$$

It is reasonable to assume that when oscillations are only just sustained the energy fed into the electrons is as small as possible. If this is the case nearly all of the energy will be used to keep the electrons in a circular orbit locked to the r.f. wave, and there will be only a small amount left to provide radial motion. Thus we can neglect the rate of change of the radial component of velocity. The radial equation of motion can then be written as

$$-mr \left(\frac{d\theta}{dt} \right)^2 = eE_r - Her \frac{d\theta}{dt} \dots \dots \dots (4)$$

where E_r is the radial field. Integrating this equation from $r=r_1$ to $r=r_a$ (where r_a is the anode radius), and remembering our assumptions that $d\theta/dt=\omega$, and that radial r.f. fields are negligible we obtain

$$e(V - V_1) = (He\omega - m\omega^2) \left(\frac{r_a^2 - r_1^2}{2} \right) \dots \dots \dots (5)$$

where V_1 is the voltage at r_1 . V_1 can be obtained very simply from the conservation of energy since we are assuming that r.f. fields are negligible inside r_1 .

¹ This type of approach is developed in greater detail in H. W. Welch, Jr., and W. G. Dow, "Analysis of Synchronous Conditions in Cylindrical Magnetron Space Charge," *Jour. Appl. Phys.*, vol. 22, April 1951, p. 433

² "Cathode Ray," "Valves for Microwaves," *Wireless World* vol. 43, September 1953, p. 417, and October 1953, p. 482

Thus, equating the potential energy lost to the kinetic energy gained, we obtain

$$eV_1 = \frac{1}{2} m r_1^2 \omega_1^2 \quad \dots \quad (6)$$

Substituting equation (6) in equation (5) to eliminate V_1 , and then using equation (3) to eliminate r_1 , we obtain

$$2V = H \omega_1 (r_a^2 - r_c^2) - \omega_1^2 r_a^2 m / e \quad \dots \quad (7)$$

Finally, we must obtain a relation between ω_1 and f the oscillation frequency. In the idealised case where the r.f. field has a simple sine wave variation both in angle and time, the r.f. potential at a point between anode and cathode can be written

$$V_{r,f} = V_{r,f}(r) \cos 2\pi n \theta \cos 2\pi f t \quad \dots \quad (8)$$

where $V_{r,f}(r)$ is a function of r only, and n the number of repeats of the field pattern round the anode. Since the magnetron anode is closed upon itself (unlike the newer backward wave oscillators³) n must be a whole number. (This restriction on n is one of the reasons why the magnetron can only oscillate at certain frequencies.) Equation (8) can then be rewritten as

$$V_{r,f} = \frac{V_{r,f}(r)}{2} [\cos 2\pi(n\theta + ft) + \cos 2\pi(n\theta - ft)] \quad (9)$$

which represents two progressive waves travelling round the anode in opposite directions with angular velocity $2\pi f/n$. Actually the angular variation of the r.f. field is more nearly a set of square pulses whose steps occur at the discontinuities in the anode produced by the segments (see for example Fig. 6). This was discussed in detail by Hartree⁴, who showed that there were a number of other possible angular velocities for the r.f. waves. These are of the form $2\pi f/(kN \pm n)$ where k is a positive integer and N the number of segments. Substituting this set of values for ω_1 in equation (7) we obtain finally

$$V = \frac{\pi f H}{kN \pm n} (r_a^2 - r_c^2) - \frac{2\pi^2 f^2 r_a^2 m}{(kN \pm n)^2 e} \quad \dots \quad (10)$$

This is, in fact, the well-known Hartree threshold relationship⁴, and is generally confirmed in practice to within a few per cent.

Voltage Tunable Magnetrons.—It has been mentioned that anode structure resonances usually restrict oscillation to a number of discreet frequencies. Other types of microwave oscillator, such as the backward wave oscillator³, have been developed to avoid this restriction. It is not however a fundamental limitation of the magnetron, and non-resonant anode structures have also been used to obtain wide-band operation.

If we refer to equation (10) it can be seen that, when there are no other restrictions, for a given mode of oscillation (i.e. a given k, n), the frequency is determined only by the voltage and the magnetic field. The field cannot be varied conveniently, so that in such magnetrons the frequency is varied by varying the voltage. For a sufficiently large magnetic field H , equation (10) moreover shows us that the frequency will be proportional to the voltage, and

a fuller analysis⁵ confirms this. This is a very useful characteristic, for example, in obtaining undistorted frequency modulation. In practice a "sufficiently large" field in this context is not particularly high compared with usual magnetron fields.

To avoid resonances a structure consisting of two sets of interlocking fingers (interdigital) has generally been used. In this case all major frequency sensitive elements except the capacity between the two sets of fingers are removed from the interior of the valve; and the exterior cavity can more easily be made non-resonant. For example, this type of structure lends itself to direct mounting in waveguide, the fingers lying across the narrow dimension. In this arrangement ideally the guide only imposes its cut-off property in the valve.

A description of such a magnetron is given in a paper by J. A. Boyd⁶, of Michigan University. Fig. 1, taken from this paper, shows the linearity of the voltage-frequency relationship.

The power output of such magnetrons is very dependent on the total shunt impedance of the r.f. circuit, and this should be as high as possible. Here a limiting factor is the capacity between the two sets of fingers. Boyd used rounded digits in order to reduce this capacity as much as possible. Another model of similar structure, but with this capacity doubled, showed a greatly inferior performance.

As regards the external circuit, it is difficult to give this a high shunt impedance over a wide band. Thus a compromise must be made between power output and band-width. Boyd was able to obtain powers of the order of half a watt over 2,000 Mc/s, or four watts over 200 Mc/s.

Boyd also found that in order to produce coherent oscillations it was necessary to limit the anode current by keeping the cathode temperature low. This disagrees with some other observations of voltage tuning using a different structure discussed later. Such temperature limitation is, however, certainly useful in keeping the anode current, and thus the output power, approximately constant. The extent to which this can be achieved in Boyd's valve is shown in Fig. 2 (also taken from reference (6)). Boyd found that in c.w. operation, owing to variations in the electron bombardment of the cathode, temperature limitation could not be obtained unless a directly heated cathode was used. The total cathode heating power required is greater for such a cathode so that the bombardment is a smaller fraction of this power.

When there are no powerful frequency determining elements noisy operation is likely. However

⁶ J. A. Boyd, "The Mitron—An Interdigital Voltage Tunable Magnetron," *Proc. I.R.E.*, vol. 43, March 1955, p. 332.

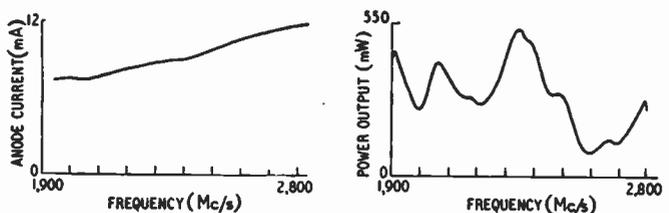


Fig. 2. Constancy of anode current and output power with temperature limited emission.

³ See for example, R. Warnecke and P. Guenard, "Some recent Work in France on New Types of Valves for the Highest Radio Frequencies," *Proc. I.E.E.*, vol. 100, Part III, Nov. 1953, p. 351.

⁴ D. R. Hartree, "Mode Selection in a Magnetron by a Modified Resonance Criterion," *C.V.D. Report*, Mag. 17.

⁵ H. W. Welch, Jr., "Prediction of Travelling Wave Magnetron Frequency Characteristics: Frequency Pushing and Voltage Tuning," *Proc. I.R.E.*, vol. 41, Nov 1953, p. 1631.

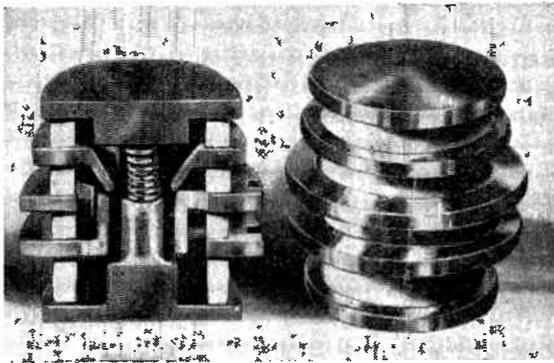


Fig. 3. G.E. Company of America voltage tunable magnetron.

when used as a local oscillator Boyd's valve had a noise figure only ≈ 3 dB worse than a klystron.

In normal magnetrons the r.f. field is at right-angles to the cathode axis, from one cavity to the next. In interdigital valves, however, this field is parallel to the cathode axis from one set of fingers to the other. Because of this asymmetry of the cathode with respect to the r.f. field resonance and electronic interaction effects due to the cathode structure are more serious and difficult to avoid in interdigital valves.

A version of this type of magnetron only about half an inch long has been developed by the G.E. Company of America⁷, and is shown in Fig. 3 reproduced from page 244 of *Electronics* for October 1956. The spiral cathode is offset from the interaction space. This is possibly to reduce the effects due to the cathode discussed above. This offsetting would also decrease the electron bombardment which was troublesome in the Michigan valve. The extra, shaped, electrode may help to focus the emitted electrons into the interaction space.

Scaling.—The remaining two types of magnetron we shall discuss were developed to produce the highest frequencies.

In considering these magnetrons it is necessary to elaborate the Hartree threshold relationship a little. We have not introduced the fact that there will be a minimum voltage at which a magnetron can oscillate. This is that voltage for which electrons at the anode have just given up all their potential energy in order to attain the angular velocity of the r.f. field with which they are interacting, so that no energy is left to build up oscillations. The minimum voltage is also that voltage at which, under static conditions, the electron orbits just graze the anode, so that the r.f. field necessary for them to reach the anode can be vanishingly small. From the first definition, the minimum voltage V_o is given immediately by

$$eV_o = \frac{1}{2}mr_a^2\omega_1^2 \quad \dots \quad (11)$$

$$\text{i.e. } eV_o = \frac{2\pi^2mr_a^2f^2}{(kN \pm n)^2} \quad \dots \quad (12)$$

The first definition of V_o also gives an immediate upper limit for the efficiency. To give output, only the potential energy from the d.c. field is useful, the kinetic energy being wasted. Thus, considering a single electron, the efficiency will be at most

one minus the minimum possible kinetic energy at the anode divided by the potential energy obtained from the d.c. field,

$$\text{i.e. } \eta \leq 1 - V_o/V \quad \dots \quad (13)$$

Remembering that there will be further losses in the output circuit, it is thus usual to operate at several times the minimum voltage.

Another useful concept which follows rapidly from the definition of V_o is that of "scaling." If we substitute V_o for V in the Hartree threshold relationship (equation (10)) we can obtain a corresponding value H_o for H . Equation (10) then reduces to the simple form

$$V/V_o = 2H/H_o - 1 \quad \dots \quad (14)$$

Of the most fundamental conditions of operation only the anode current requires a corresponding I_o to be defined. Several such definitions have, in fact, been proposed. The simplest is that current which would be drawn at zero magnetic field when the magnetron is acting simply as a diode, although this is much greater than any operating current so that it does not correspond to any minimum. I_o is then given by the relation

$$I_o = \frac{8\sqrt{2}}{9} \pi \sqrt{e/m} \frac{V_o^{3/2}l}{r_a} \quad \dots \quad (15)^8$$

where l is the anode length,

$$\beta = u - \frac{2u^2}{5} + \frac{11u^3}{120} - \frac{47u^4}{3300} + \dots,$$

$$\text{and } u = \log_e \left(\frac{r_a}{r_c} \right).$$

Since the early days of magnetron development much use has been made of the fact that if, using I_o , V_o , H_o as units, we operate under the same conditions, then the efficiency and stability are similar for *different* designs of magnetron, provided that the anode segments remain of similar shape. In this way by altering the size of a successful design it can be "scaled" to work at a different wavelength.

Minimum Voltage Magnetrons.—Returning to our immediate problem, from equation (12) we can see that if we wish to obtain higher frequencies we must either reduce r_a , increase V_o , or increase $(kN \pm n)$. We will consider the third possibility later. As regards the other two possibilities, it is clear that there will be practical limits to decreasing r_a or increasing V . A less obvious consideration which arises in c.w. operation is that the anode power, and hence current, at which oscillations begin must be sufficiently low. This will also in practice limit the maximum voltage and minimum size. Reducing the size of the anode also reduces the possible power dissipation.

Another possibility is to operate nearer the minimum voltage. Looking at this the other way round we can then increase V_o (for a fixed V), and thus increase f . It is however clear from equation (13) that the efficiency will fall.

In the sense that operation remains based on the equalization of velocities we have described, no essential change is produced by working near the minimum voltage. However, the bunching influence of the r.f. field which we have also discussed will

⁷ T. R. Bristol and G. J. Griffin, Jr., "Voltage-Tuned Magnetron for F-M Applications," *Electronics*, May 1957, p. 162.

⁸ I. Langmuir and K. B. Blodgett, "The Effect of Space Charge and Residual Gases on Thermionic Currents in a High Vacuum" *Phys. Rev.* vol. 2, December, 1913, p. 450.

largely disappear, and this leads to considerable practical differences.

It will be necessary to provide the required equality of the electron and r.f. wave velocities as far as possible even in the static case in order to do without the help of the r.f. field. If we return to equation (2) we can see that if r_c the cathode radius is small, then the angular velocity varies only slightly with changing r . In this case we have a stream of electrons at various radii but with the same angular velocity which can interact with an r.f. wave with this velocity.

We can develop this point more exactly when we realise that in such a valve there will be an optimum value for the radius at which velocity equalization occurs. If this is too small, the r.f. fields will be too weak, and little interaction will occur. On the other hand, if this is too large, insufficient interaction can occur before the electrons reach the anode.

Substituting equation (3) in equation (7) to eliminate H , and then using equation (11) to eliminate ω_1 , we obtain the relation

$$\frac{V}{V_0} + 1 = 2 \left[\frac{1 - r_c^2/r_a^2}{1 - r_c^2/r_1^2} \right] \dots \dots (16)$$

We can see that if r_1 is fixed, as V approaches V_0 , r_c must approach zero. This agrees with our earlier general reasoning. When V becomes large r_c tends to r_1 . Thus r_1/r_a can be obtained from a knowledge of the optimum r_c/r_a for normal operation of the magnetron when scaled to operate at some lower frequency. If we wish to operate somewhat above V_0 , equation (16) can then give us the optimum r_c/r_a . Conversely, equation (16) suggests that, for a given r_c/r_a , there will be an optimum operating voltage V to establish velocity equalization at r_1 . Thus we can expect operation of this type to occur over a fairly limited range of voltage and thus also of magnetic field.

This limited range of operation was observed in the original G.E.C. work on the subject⁹. When the voltage was varied more than about 10%, operation occurred in a number of "modes" (different n

numbers in equation (10)). This was clearly seen by changes in the oscillation frequency. The different modes will of course have different minimum voltages. They may also have different values for the optimum radius r_1 for velocity equalization, due to the different r.f. field patterns.

These properties of limited range of operation and wide degree of mode selection are quite different from those of normal magnetrons. Here operation is generally in the $n=N/2$ mode (π mode), over a wide range of voltages.

Results obtained at Columbia University Radiation Laboratory, New York¹⁰, using cathodes of different sizes support the general result of equation (16) that the operating voltage approaches the minimum as the cathode size is decreased. These results also suggest that the proportional range of voltage in which operation is possible also decreases as the cathode size is decreased.

In later G.E.C. work¹¹ only the π mode was observed. This could have been due to the use of narrow-band output coupling arrangements: wide-band coaxial coupling was used in the original experiments. At higher anode currents considerable increases in efficiency were obtained, for example, up to $\approx 30\%$ overall in valves operating around $V_0/V = 0.6$. In view of output coupling losses, this must represent nearly the theoretical limit of 40%. There was no sign of any falling off in efficiency for currents up to $0.08 I_0$. A practical feature of this type of operation is that the cathode has to be very accurately centred; any slight off-centring produces a marked fall in efficiency and increase in back-bombardment of the cathode.

Spatial Harmonic Magnetrons.—In our search for higher frequencies we must now return to the other possibility shown by equation (12) we have already mentioned, that of increasing $(kN \pm n)$. Magnetrons are generally designed to operate in the π mode where the phase difference between adjacent resonators is π , and which correspond to $n=N/2$, $k=0$. Modes corresponding to smaller n numbers are well known, but modes with $n > N/2$ (corresponding to harmonics of the individual resonators) have only rarely been observed, and seem unimportant in magnetron operation.¹²

We are thus left with the possibilities of increasing N , the number of resonators, or operating with non-zero values of k . However, if the number of resonators is increased, the relative wavelength separation for the various modes is decreased. Interference between such modes is then more likely. The limit in this direction has already practically been reached in conventional designs.

We must now consider operation with non-zero values of k , that is spatial harmonics of the r.f. pattern round the anode. Early attempts to observe this operation, using values of $(k + \frac{1}{2})N$ of 12 or more and anode diameters greater than 0.1λ were unsuccessful. This is probably because the r.f. field fell off too rapidly from the anode to produce any interaction. An analysis shows that, at least in the absence of space charge, this field is proportional to

(Continued on page 21)

⁹ W. E. Willshaw and R. G. Robertshaw, "The Behaviour of Multiple Circuit Magnetrons in the Neighbourhood of the Critical Anode Voltage," *Proc. Phys. Soc.*, vol. 63, Part B 1950, p. 41.

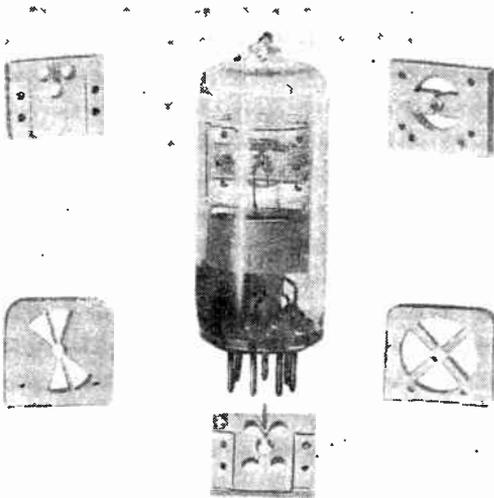


Fig. 4. G.E.C. (British) spatial harmonic magnetron and anodes.

¹⁰ Z. Fraenkel, "The Development of a Tunable CW Magnetron in the K-Band Region", *I. R. E. Trans. E. D.*, Vol. ED-4 No. 3, July 1957, p. 271.

¹¹ T. M. Goss, R. G. Robertshaw, J. R. Tew and W. E. Willshaw, "A Review of the Performance of Magnetrons Operating at Low Magnetic Field", *L'Onde Electrique*, Vol. 37, Oct. 1957, p. 804.

¹² G. B. Collins, "Microwave Magnetrons", McGraw-Hill, p. 17.

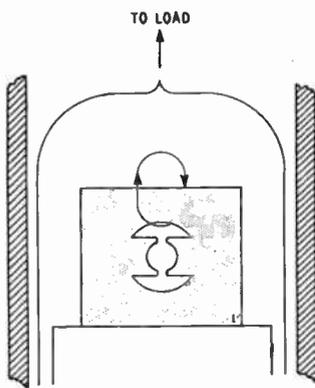


Fig. 5. Magnetic coupling to load in a spatial harmonic magnetron.

$(r/r_a)^{M-1}[1-(r_c/r_a)^{2M}]$ where M is the value of $(kN \pm n)$. Thus the successful G.E.C. workers¹³ were led to the use of anodes of 4 or 2 segments only, with operation with M values around 6.

Although this approach thus does not give an increase in $(kN \pm n)$, it does result in a considerable simplification in the mechanical and electrical structures of the anodes used. Considering, for example, the case where $k = 1$ and $M = 3N/2$,

the form of the spatial harmonic of the r.f. field concerned is the same as that of the r.f. fundamental in a valve with $3N$ segments. In some ways we can consider that we are using a valve with $3N$ segments, but in which $2N$ of them are "missing." In this case the problem of distributing the segments round the anode is considerably eased. Some of the asymmetrical anode structures used very forcibly suggest this idea of missing segments, an example being shown at the top left of Fig. 4. In this case, in fact, there would not be room for the full number of segments (12) round the valve.

Fig. 4 also shows a complete valve for operation at about 9,000 Mc/s, and illustrates the neat construction possible using an ordinary B7G valve base and glass envelope.

The first experiments were made with asymmetrical anode structures. Another example is shown at the

bottom of Fig. 4. (This is not to the same scale as the other anodes in Fig. 4.) Unfortunately the results obtained were not very repeatable owing to difficulties in accurately machining the long narrow slots used in the design. Consequently a change was made to symmetrical anode structures of two and four segments as at the right of Fig. 4.

The use of a symmetrical anode structure permits a very simple magnetic coupling to the load by means of the current circulating round one of the cavities as shown in Fig. 5 (taken from reference (12)). In the case of the original asymmetrical anodes this simple coupling is not so easy to obtain. Oscillations in the two adjacent cavities are out of phase so that the couplings for the two cavities tend to cancel out. This may be avoided by slightly rotating the segments as in the anode at the bottom left of Fig. 4, for in this case coupling occurs mainly to one segment. In the original anodes a radiating probe between the cavities parallel to the cathode was used, as can be seen at the bottom of Fig. 4.

We assume, as before for simplicity, that the r.f. wave round the anode can be represented by a set of square pulses whose steps occur at the discontinuities at the anode gaps. An example is shown in Fig. 6 (taken from reference (12)) for one case in a 4 segment asymmetrical anode. In this case the r.f. wave can be Fourier analysed into a set of component sine waves of different amplitudes. These sine waves correspond to different values of $(kN \pm n)$. In this way it is possible to predict the types of interaction that can occur. Modes have been observed which are not predicted by this analysis, but this is attributed to slight constructional asymmetries. Conversely it is possible to design anode structures suitable for working in particular modes. This is done essentially by altering the angular position of the gaps. In the case of symmetrical anode structures this involves altering the thickness of the vanes between the segments.

A performance chart of one of the asymmetrical anode valves is shown in Fig. 7 (taken from reference

¹³ R. G. Robertshaw and W. E. Willshaw, "Some Properties of Magnetrons Using Spatial Harmonic Operation." I.E.E. Monograph No. 168R. To be published in Part C of *Proc. I.E.E.*

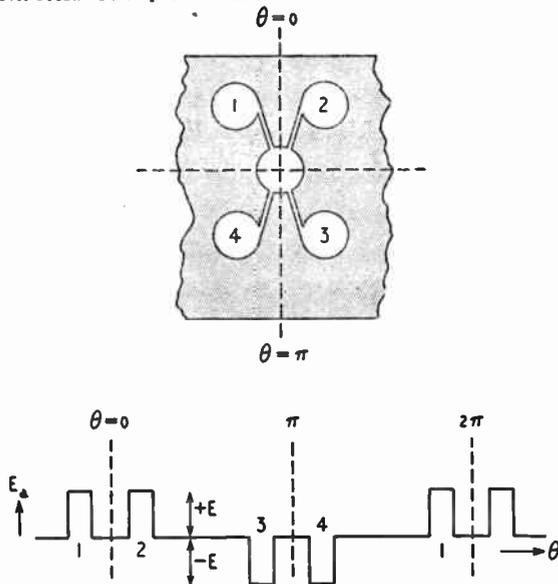


Fig. 6. Typical anode and associated r.f. wave in spatial harmonic magnetron.

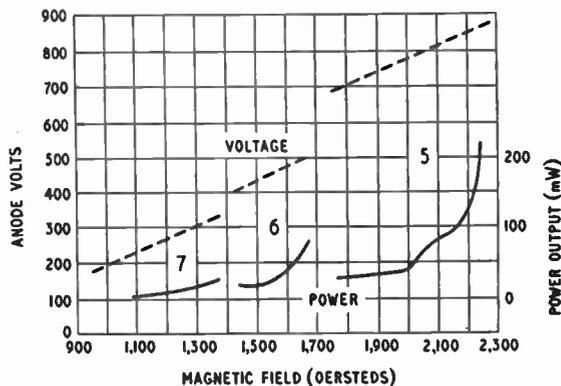


Fig. 7. Performance chart of spatial harmonic magnetron.

(12)), the numbers showing the relevant values of $(kN \pm n)$. Owing to the simpler anode resonance structure of such valves with few segments it is possible to achieve a useful tuning range by coupling the valve to a simple external-cavity tuner. The simple anode structure also permits pulse operation with very short oscillation build up times. Preliminary measurements suggest that the limit in this

direction is less than 0.1 μ sec. The limit is set so far by the shape of current pulses that can be generated with existing apparatus.

Reference to Fig. 7 shows that, in a given mode, if the voltage is increased the power is increased up to a certain point, where it suddenly drops to zero. This is because at high anode currents the space charge forces in the electron bunches defocus these bunches. Interaction is then no longer possible. Spatial harmonic operation of valves is much more prone to this type of "drop out" than normal operation.

If the coupling of the valve to the load is made very heavy the normal resonances are suppressed and voltage tuning becomes possible. Again in these valves the simple anode structure permits this to be more readily carried out, and 2 to 1 frequency ranges have been achieved. The power available is however very much less than in normal operation. Although temperature-limited emission was not used operation was not noisy. This contradicts previously mentioned results on such voltage tuning obtained by Boyd⁶, of Michigan University. M.G.L.

LETTERS TO THE EDITOR

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

"Do it Yourself" Interference

I SHOULD like to allay the fearsome forebodings of your correspondent Douglas Walters regarding the subject matter of my recent "Build your own Radio Set" programmes.

Early on in the series I told viewers that I was receiving letters from dealers, and from boys who had been told by their dealers, pointing out that the set would not oscillate. It was suggested that I had wrongly specified a reaction capacitor of 0.0001 μ F whereas that specified by the makers of the coil was 0.0003 μ F. My reply to viewers was that this was done deliberately as the smaller size just gave enough feedback to increase the volume, but no oscillation over the band was possible. It was pointed out that a reacting receiver could cause interference in other sets and to obviate this dealers were asked to keep to the specification and the lower value.

I have made up three models of the receiver concerned and can only obtain a "squeal" with a new battery at the lower end of the medium waveband. I find the DAF 96 valve difficult to persuade to oscillate and cannot believe that its 69 volts and couple-of-hundred *micro*-amps is going to make it a very powerful transmitter even if some enterprising lad gets it going well. In the indoor aerial conditions under which most of these builders are using it, I find the radiation from the receiver difficult to detect in the next room.

From many letters I have received since the series ended, it is apparent that most builders of the set are getting good reception and I hope that I have added over 25,000 youthful enthusiasts to those of us who love the hobby. Perhaps I may use this opportunity to thank the B.B.C. Engineering Staff, various manufacturers and thousands of dealers for their interest and help both to myself and to many novice set-builders (of both sexes!).

Kenton, Middlesex.

GILBERT DAVEY.

ALTHOUGH I agree with your correspondent Douglas Walters that the type of receiver to which he refers is very likely to lead to a lot of curious noises on medium wavelengths, I cannot see why he is so worried about it.

Having been chased off the long and medium wavebands by the scream of a hundred line timebase oscillators which made reception unenjoyable when not actually impossible, I am now using v.h.f., and, so to speak, "fireproof."

So far as oscillations on these wavelengths are concerned, those who watched the programme were, for the most part, "doing it themselves" with a vengeance! Surely any interest in the well-being of the medium waveband is somewhat belated. I doubt whether the youngsters will be noticed among the noises already there.

Workshop.

H. S. CHADWICK
(G8ON).

Interference Suppression

WHILE one must approve of the laws regulating ignition systems, the question is "Why only motor vehicles?" What is being done about electric shavers, hair driers, trolley buses, and, in the country, electric fences?

While I suffer to some extent from motor interference, it is only a very small part of the sum total of interference from which one suffers.

I am contemplating the purchase of an electric cooker with a simmerstat. I understand the simmerstat is quite unsuppressed, and is apparently quite legal.

Although I am a very considerable user of short waves, being an amateur radio transmitter, and suffer considerably from interference of all kinds, I do feel that too much attention is being paid to car ignition and too little to the multitude of other causes of interference which now plague us. Let us start a propaganda drive to suppress all these other sources.

London, N.W.3.

E. M. WAGNER.

TV Whistle

YOUR Editorial in the October issue on the subject of the "ideal" receiver has prompted me to make a general complaint about one aspect of television receiver design—the noisy line output transformer.

I think I can truthfully say that I have not yet come across a receiver with a line output transformer which was inaudible at normal viewing distance.

I may be unusual in that at 35 I still have good sensitivity at about 10 kc/s, but what about the hordes of children who view television? Does the whistle not annoy them? My last visit to the Radio Show two years ago was spoiled by the whistle pervading (so it seemed) the whole building.

It has taken 35 years to get rid of the whistle from sound broadcasting (FM be praised) and I wonder if it will take as long to produce a whistle-free TV receiver, for I will have no other in my home.

Cardiff.

D. A. THOMS.

Optical "Noise" Filter

THE reference to the above in "Technical Notebook" (October issue) reminded the writer of an effect noted in school at the age of 12/13 years. It was observed that if the blackboard were viewed through a small aperture (actually a curled up forefinger) the writing became much clearer. Possibly the effect is similar to that of a pin-hole camera, although it is recalled that the physics master thought that the reason in this case was rather more obscure.

At this time the writer was in need of spectacles although, through lack of a comparative standard, un-

aware of the fact. It was the above-mentioned observation that provided the comparative standard and, subsequently, the spectacles.

It would seem that an effect similar to the triangular frequency response utilized in, for example, a camera head-amplifier occurs. Perhaps a reader having knowledge of optical effect would be able to comment further on this subject.

East Molesey.

T. G. CLARK.

IS not this effect due to the physical nature of the iris of the eye which automatically opens wider when it is shielded from extraneous light by the tube held over it?

Norwich.

E. R. SLAUGHTER.

Genesis of Sound Reproduction

THE British Sound Recording Association has offered to try to help supplement the national collection of sound recording and reproducing apparatus and other acoustic and electro-acoustic equipment in the Science Museum, South Kensington.

Our main appeal is to and through members of the Association, but if any non-members have equipment which they would like to give to the B.S.R.A. Historic Collection, I should be very pleased to have details from them at the address below.

I should make it clear that we are not collecting recordings of historical interest, the proper repository for which is the British Institute of Recorded Sound, 38 Russell Square, W.C.1.

Disley House,
Carlton Road,
Reigate, Surrey.

PETER FORD,
Hon. Historian, B.S.R.A.

How Little Distortion Can We Hear?

IT is a pity that Mr. Lazenby (September, 1957, issue, p. 435) gave little attention to more practical conditions for distortion detection. The results quoted showed that the simplest (single frequency sine wave) signals were not the most suitable for the detection of distortion, as slightly more complex signals (containing two or more frequen-

cies) allow the formation and detection of intermodulation products. Although I realize that not everyone will agree with this, some of the results using speech and music suggest that for still more complex signals one's sensitivity to distortion is decreased again. There is an example of this on the Vox record "This is High Fidelity," where the same amount of distortion sounds much less objectionable in a complex orchestral passage (mainly strings) than in a simple piano or horn solo. Another point is that significant distortion in the reproduction of music is only likely to occur at peaks of sound, and in such peaks the signal wave form is almost always very complex.

Edgware.

D. J. KIDD.

Help for the Blind

NO doubt many of your readers know of the existence of a library of "talking books" for the blind. These have been recorded on long-playing records and are reproduced by portable battery- or mains-operated gramophones specially designed for the purpose. Such is the demand for these reproducers that there is at present a normal waiting period of about one year for new readers.

There are a number of problems in operating and maintaining these sets. Most of the readers are old and many have never seen or previously handled a set of this nature. In one distressing case a reader had been listening to the needle scratch for days, not realizing that the equipment had to be switched on. In another, the set which had ceased to function was returned to London, and smashed in transit, all because of a faulty flex lead, which had in any case been left behind, unseen, in the house.

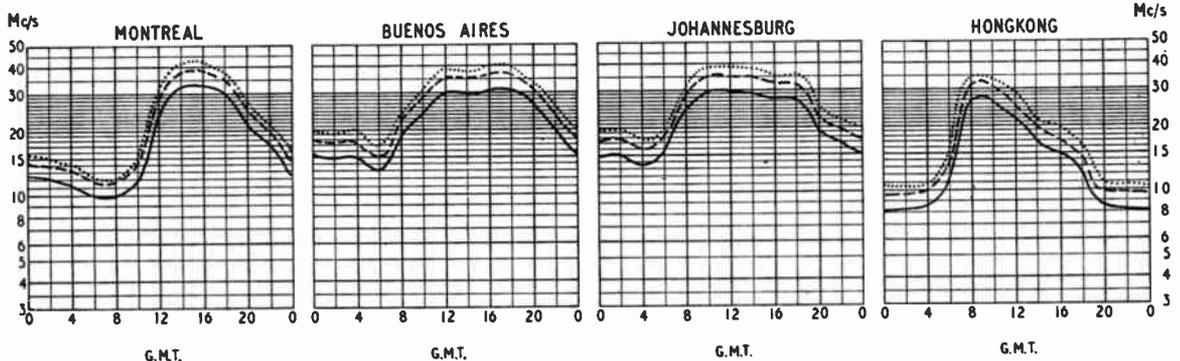
Helpers with a knowledge of audio amplifiers are urgently needed in London and in many other areas in England to instruct new readers in the use of their sets and to investigate cases of faulty performance.

If you would like to assist or would like further information, please write to me at J. Gladstone & Co. Ltd., Galashiels.

D. FINLAY-MAXWELL.

Honorary Organizer of
Voluntary Helpers, Nuffield
Talking Book Library for the Blind.

SHORT-WAVE CONDITIONS Prediction for January



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

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

Cathode-Coupled Flip-Flop

A Reliable Design Procedure

By T. G. CLARK,* A.M.Brft.I.R.E.

THE science of electronics is too frequently practised as an art, even by quite senior engineers, and, with a minimum of "know how," circuits are "bodged" to meet design requirements. In general, however, it is possible to produce a paper design that, when assembled practically, will produce a result within 5 to 20% of that predicted. Furthermore, less time is wasted by proper design methods. The introduction of feedback techniques into the design will render the operation stable and predictable. Having designed a circuit to within reasonable limits final adjustment may be effected by means of pre-set controls.

The cathode-coupled mono-stable multi-vibrator (shown in Fig. 1) is used extensively as a generator of pulses having durations ranging from microseconds to minutes. It is the object of this article to show that, using 5% tolerance components and the published valve characteristics, it is possible to design such a flip-flop to an accuracy of the order of 10%. Moreover, provided that a standard configuration is accepted, further design reduces to the simple equation

$$t_o = KCR$$

It is not proposed to discuss the effect of tolerance variations upon the end result, for, as previously indicated, a pre-set control will take full account of such variations.

The information required to initiate the design is as follows:—

- (1) Pulse duration, or durations.
- (2) Pulse amplitude.
- (3) Pulse polarity.
- (4) Available h.t. supplies.

Circuit Operation.—Referring to Fig. 1, the grid resistor R of V2 is returned to a positive potential, Eg, whilst the grid of V1 is returned to a lower positive potential. The design is such that the anode current of V2 flowing in R₃ creates a potential that, in conjunction with the potential upon V1 grid, causes V1 to be cut off. The initial stable condition then, is that V2 is conducting heavily whilst V1 is cut off.

Trigger pulses of suitable polarity, as indicated in Fig. 1, upset the stable state as follows:—Positive pulses at V1 grid cause negative pulses at the anode and these are communicated through C to the grid of V2, thus causing the common cathode to drop. This switches on V1 thereby enhancing the original negative fall at the anode. The action is cumulative and results in V2 being switched off and in V1 being switched on for a period determined by the recovery time of V2 grid circuit. When the grid of V2 has recovered to a point within the grid base of the valve, essentially the same cumulative action resets the circuit to the stable state.

Since R₃ is common to V1 and V2 it will be seen that R₃ must be greater than R₄ in order to produce a drop at the common cathode during the operative period.

Typical waveforms and voltage levels are shown in Fig. 2. These waveforms are self-explanatory and of a type given in many text-books. For present purposes it is sufficient to note that, in terms of the total potential grid excursion, i.e. from -50 V to +Eg, the grid base of the valve is negligible. In addition, the difference between the quiescent potentials of V2 grid and the common cathode is

also negligible. "Cut on" then occurs at the common cathode potential obtaining during the pulse. This potential may be varied by means of the potential at V1 grid, thus providing control of the pulse duration. Outputs of opposite phase may be taken from anode and cathode, the cathode output being at a relatively low impedance. It is not desirable that outputs should be taken from the anode of V1 or the grid of V2, since the loading of the external circuit will affect the predicted performance. However, if a negative going pulse of approximately 150 V is required, then an output may be taken from V2 grid, provided that the external circuit is of high impedance.

The simple description given earlier may be modified by a number of effects. For example, the trigger pulse should be of

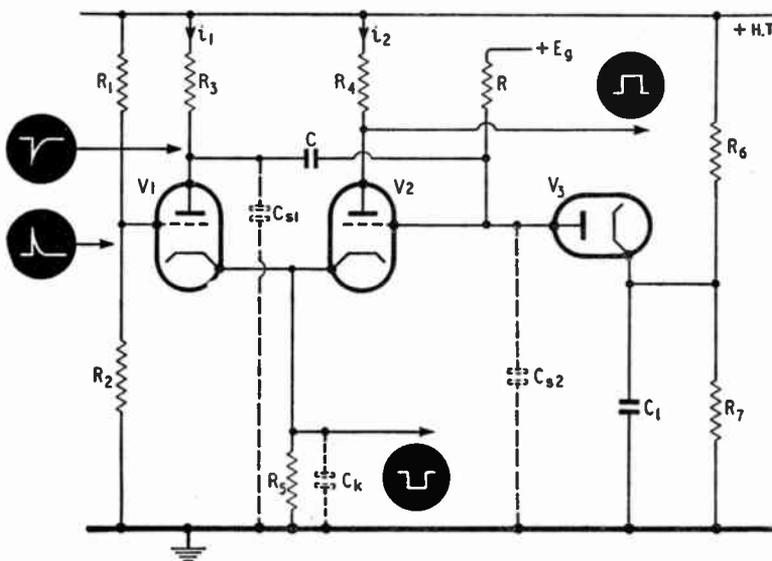


Fig. 1. Cathode coupled flip-flop circuit.

* Decca Radar Ltd.

adequate amplitude and duration having regard to the rise time of R_3 and the total stray capacity, $C_{s1} + C_{s2}$. Previously, it has been stated that an essential to the operation is that the common cathode must fall at the moment of initiation. If, in fact, the cathode does not drop adequately during the duration of the trigger pulse due to the effect of C_k , then regeneration will not occur and the circuit will behave simply as a cascaded amplifier. When using a trigger amplifier d.c. coupled into the anode of V1 the pulse duration will tend to be longer than that calculated, since V1 anode will fall by an amount dependent upon the anode current of V1 with the addition of an increment from the trigger amplifier.

The circuit operation depends upon the anode currents flowing during the respective "on" periods, so that design stability will be improved if these are subjected to negative current feedback. This may be accomplished by ensuring that the valves are operated during the respective "on" periods within the valve grid base, i.e. at a grid bias of about -1 V, and also by choosing an adequately large value for R_5 . Valve V1 may be readily operated in the specified conditions by choosing a suitable value for its grid potential. For most purposes this is sufficient, but for more precise applications it is necessary to ensure that the quiescent grid potential of V2 is also within the grid base. (Normally, V2 grid is operated at zero bias due to grid current flowing in the grid resistor R.) The clamping diode, V3, in conjunction with the potentiometer R_6 and R_7 , can be used to ensure that the grid cannot move more positive than the potential at the junction of R_6 and R_7 , this potential being chosen to give the desired conditions. In order to ensure satisfactory clamping the parallel impedance of R_6 and R_7 must be very much lower than that of R. In addition, the capacitor C_1 should have a value very much greater than C in order to supply a re-charging pulse to C at the moment of clamping. In the absence of this capacitor a spike would occur on the lagging edge of the output pulse as the grid overshoots the clamp potential and then returns at a rate dependent upon C, R_6 and R_7 .

In general, it is required that the rise and fall times of the output pulse should be as short as possible and, for this reason, the resistors across which outputs are taken are made as small as possible consistent with the limitation of valve anode dissipation. For a 12AT7 working at an h.t. potential of $+250$ V this means that, from Fig. 3, the sum of R_4 and R_5 should not be less than $6.8k\Omega$. Thus, if it is decided that the cathode resistor R_5 should have a value of $3.3k\Omega$, then the value of R_4 should not be less than $3.6k\Omega$. However, if the design requirement does not require fast edges to the output pulse, then $R_4 + R_5$ may be made larger than this minimum value, thus achieving economy in the operating current.

Introduction to Design.—The principles underlying the design may be summarized as follows:—

(1) The conditions in the two valves are considered separately during the respective operative periods.

(2) The valve V1 is operated within the grid base, i.e. at a bias of -0.5 V to -1 V, in order to obtain current stabilization.

(3) Grid current onset in V2 is assumed to occur at $V_g = 0$, and the anode current at this

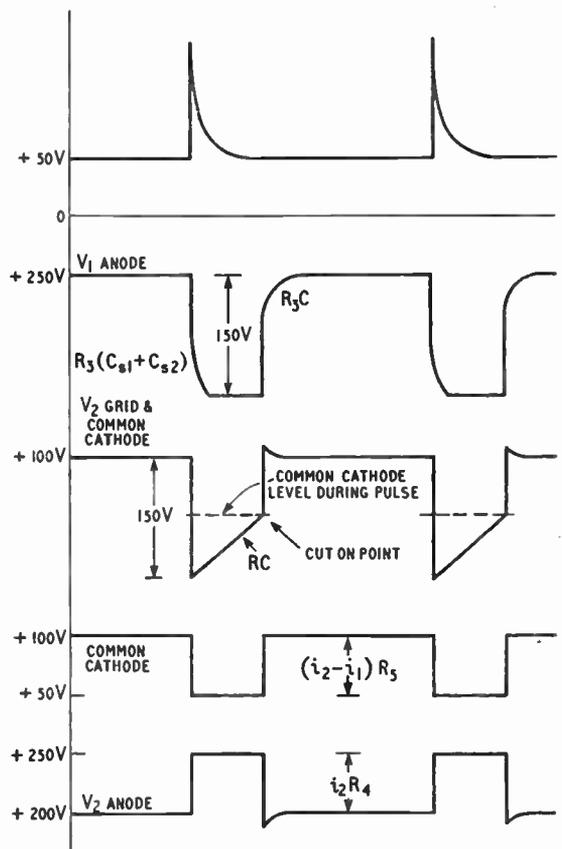


Fig. 2. Cathode coupled flip-flop waveforms with typical voltage levels.

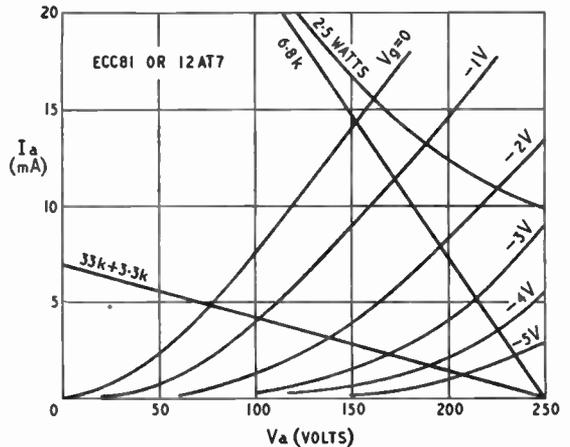


Fig. 3. Characteristic curves of ECC81/12AT7 with loadlines used.

point is assumed to be moderately constant from valve to valve.

(4) The grid base of V2 is assumed to be negligible compared to the potential grid swing.

(5) For more precise applications, a clamping diode V3 is used to maintain V2 within the grid base during the quiescent period, in order to obtain current stabilization.

(6) A clamping diode may also be used when the value of R would cause excessive grid current at $V_g=0$.

(7) A positive-going pulse of amplitude $i_2 R_4$ may be taken from the anode of V2.

(8) A negative-going pulse of amplitude $(i_2 - i_1) R_5$ may be taken from the common cathode.

(9) All components shown in Fig. 1, except C_1 , should be 5% preferred values.

For present purposes R_3 will be $33k\Omega$ and R_5 $3.3k\Omega$. R_4 will be chosen having regard to the required amplitude of the output pulse, the maximum anode dissipation of the "normally on" valve, and the requirement that it should be smaller than R_3 in order that the common cathode may fall adequately during the pulse. It may be observed here that R_4 may be zero if a negative pulse only is required.

Consider, now, the load line for V1, the $36k\Omega$ line of Fig. 3. For a bias of, say, -0.5 V a current i_1 flows, and this is the current in R_6 when V2 is cut off. The potential at the grid of V1 will be given by $(i_1 R_6 - 0.5)$ V, and the ratio $R_3/(R_1 + R_2)$ is established. Actual values may be chosen having regard to a convenient current flow and preferred values of resistors. The effective negative bias on V1 when V2 is conducting will be given by $i_2 R_5 - (i_1 R_6 - 0.5) = R_5(i_2 - i_1) + 0.5$ V. This value is dependent upon the difference between the two operating currents and must be greater than the grid base of V1.

If it is required to operate V2 within the grid base the ratio $R_7/(R_6 + R_7)$ must be chosen to operate V2 at a suitable negative grid bias relative to the cathode. Additionally, as we have already mentioned, the parallel sum of R_6 and R_7 must be very much less than the lowest value of R in order to ensure effective clamping.

Calculation of Pulse Duration.—Now that the operating conditions during the respective operative periods have been established it is possible to calculate the generated pulse width. Consider Fig. 4.

The amplitude of the exponential curve, relative to point A at any time t , is given by:—

$$E(t) = E \left\{ 1 - e^{-\frac{t}{T}} \right\}$$

where $T = CR$

$$\text{Therefore } e^{-\frac{t}{T}} = \frac{E - E(t)}{E}$$

$$\text{and } \frac{t}{T} = \log_e \left\{ \frac{E}{E - E(t)} \right\}$$

$$\text{Giving } T = CR = \frac{t}{\log_e \left\{ \frac{E}{E - E(t)} \right\}} \dots \dots (1)$$

Putting the required time interval as t_0 and the value of $E(t)$ to the "cut on" point as E_0 , we have then, from Fig. 6,

$$E = E_g + i_1 R_3 - i_2 R_5$$

$$E_0 = i_1 R_3 - (i_2 - i_1) R_5$$

Since the grid potential of V2 during the quiescent period is very nearly equal to the common cathode

potential and the grid base of V2 is negligible compared to the total potential grid excursion (to $+E_g$).

$$\text{Thus } CR = \frac{t_0}{\log_e \left\{ \frac{E_g + i_1 R_3 - i_2 R_5}{E_g - i_1 R_5} \right\}} \dots (2)$$

$$\text{whence } t_0 = KCR \dots \dots (3)$$

$$\text{where } K = \log_e \left\{ \frac{E_g + i_1 R_3 - i_2 R_5}{E_g - i_1 R_5} \right\} \dots (4)$$

and this is a constant for a given configuration in which only t_0 and CR are variables.

For convenience equation (4) may be re-written

$$K = \log_e \left\{ \frac{E_g/R_5 + i_1 \frac{R_3}{R_5} - i_2}{E_g/R_5 - i_1} \right\} \dots \dots (5)$$

$$= \log_e \left\{ \frac{i_3 + i_1 \frac{R_3}{R_5} - i_2}{i_3 - i_1} \right\} \dots \dots (6)$$

where $i_3 = E_g/R_5$

It may be shown that the circuit operation is less sensitive to variation of the individual components within the bracket if the bracketed term is made as large as possible consistent with other requirements. In the design to be discussed the value of this term is approximately 1.5. This value is quite suitable, and since the function is logarithmic, an optimum value cannot be given. From equation (6) it may be inferred that R_5 should be small. However, this contradicts the requirement for current stability.

As i_3 will be greater than i_1 it can be seen that, for the bracketed term to be positive, we must

$$\text{have } i_3 > i_2 - i_1 \frac{R_3}{R_5}$$

i_3 should be made large by using a high value for E_g . This is in accordance with the conception of having a large potential grid movement (returning to $+E_g$) in order that, (a) the grid base may be considered negligible and that, (b) the rate of change of the grid movement through the grid base shall be fast, thus minimizing time jitter on the back edge of the pulse.

Apart from the basic design considerations previously discussed there are a number of factors establishing limits to the circuit values. These may be enumerated as follows:—

(1) C should be not less than about 100 pF in order to obviate the modifying effects of the stray capacitance C_{s2} , unless a cathode follower is interposed between V1 and V2.

(2) R should not be less than about $0.5M\Omega$ in order to limit grid current, except when a clamping diode is used. However, a low value of R will reduce the a.c. gain of V1.

(3) R should not exceed $10M\Omega$ from considerations of component stability and circuit leakage.

(4) When operating at high duty ratios C should have adequate time to recover. A time equivalent to at least $5CR_3$ should be allowed, and it may be that this consideration will dictate the choice of C and hence R.

(5) Components must be adequately rated. Cer-

(Continued on page 27)

tain components will have a dissipation dependent upon the duty ratio; this should be considered when designing a flip-flop of variable duration.

(6) Positive trigger pulses capacity coupled to V1 grid should not drive this valve into grid current, otherwise the recovery of the grid coupling capacitor will modify the circuit operation.

Practical Design.—As an example, the following specification will be discussed.

- Pulse width .. 100 μ s
- Output .. + 50 V
- H.T. Supply .. +250 V

Other considerations Variable duration not required. Fastest possible pulse edges consistent with using a standard valve type 12AT7. Extreme precision not required.

The design procedure then runs as follows

$$R_3 = 33k\Omega, E_g = +250 V$$

$$R_5 = 3.3k\Omega, V_s \text{ not required}$$

$$\text{Try } R_4 + R_5 = 6.8k\Omega$$

From the characteristic curves of Fig. 3,

$$i_s = 14 \text{ mA at } V_g = 0$$

$$\therefore R_4 = \frac{50}{14} = 3.6k\Omega,$$

agreeing sufficiently with our values for R_5 and $R_4 + R_5$.

If this trial had been unsuccessful different values for R_4 and R_5 would have been tried. There would be no objection to varying R_5 within reasonable limits.

From the characteristic curves,

$$i_1 = 4.5 \text{ mA at } V_g = -0.5 V$$

Therefore $i_1 R_5 = +14.8 V$

and the voltage at V1 grid is given by

$$i_1 R_5 - 0.5 = 14.3 V$$

Therefore

$$\frac{R_2}{R_1 + R_2} = \frac{14.3}{250}$$

$$\text{i.e. } \frac{R_1}{R_2} = 16.5$$

This ratio is obtained if $R_1 = 240k\Omega$ and $R_2 = 15k\Omega$, both of which are preferred values.

Proceeding, $CR = \frac{100 \times 10^{-6}}{\log_e \left\{ \frac{250 + (33 \times 4.5) - (3.3 \times 14)}{250 - (3.3 \times 4.5)} \right\}}$

$$= 250 \times 10^{-6}$$

Let $C = 250 \text{ pF}$

Then $R = 1 \text{ M}\Omega$

The pulse amplitude and duration of this design were 53 volts and 97 μ s as measured on a Cossor oscilloscope.

Another flip-flop was designed by the same method but to a different specification. The durations measured on the same instrument were as follows:—

Calculated	Measured
406 ms	380 ms
263 ms	270 ms
128 ms	125 ms
73 ms	70 ms
41 ms	38 ms
26 ms	26 ms

All components shown in Fig. 1, except C_1 , have

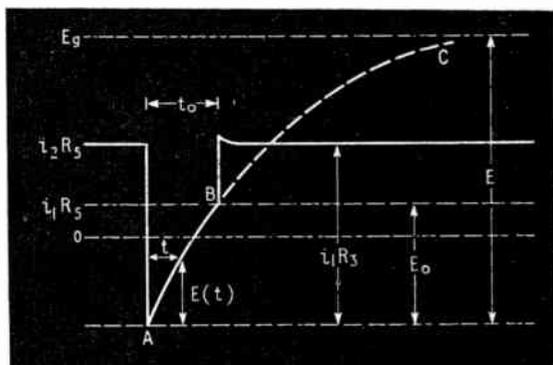


Fig. 4. Detail of V2 grid waveform.

an effect upon the circuit operation. Final trimming may be achieved by varying any such component.

The circuit of Fig. 1 has been used in production equipment as the heart of a decade counter with complete success. Greater precision than the basic circuit offers was obtained by utilizing an amplitude-limited negative pulse stream applied to V1 grid as terminating pulses.

A method of design has been offered which permits the engineer to design a flip-flop without excessive trial and error, and to achieve results within normal experimental error. The design formula for an established configuration has been reduced to $t_0 = KCR$.

Dates for Your "Wireless World" Diary

ANNOUNCEMENTS have already been made of the dates of many of this year's exhibitions and conventions, but for the convenience of readers we give below a list of the principal events in 1958.

Television Society Exhibition	March 4-6
Royal Hotel, Woburn Place, London, W.C.1.	
Physical Society Exhibition	March 24-27
Royal Horticultural Society Halls, London, S.W.1.	
International Instruments Show	March 24-29
Caxton Hall, Westminster, London, S.W.1.	
Electrical Engineers' Exhibition (A.S.E.E.)... ..	March 25-29
Earls Court, London, S.W.5.	
Convention on Radio Aids to Navigation	March 27-28
I.E.E., Savoy Place, London, W.C.2.	
Components Show (R.E.C.M.F.)	April 14-17
Grosvenor House and Park Lane House, Park Lane, London, W.1.	
Instruments, Electronics and Automation Show... ..	April 16-25
Olympia, London, W.14.	
Audio Fair... ..	April 18-22
Waldorf Hotel, London, W.C.2.	
International Convention on Microwave Valves	May 19-23
I.E.E., Savoy Place, London, W.C.2.	
National Radio Show (R.I.C.)	Aug. 27-Sept. 6
Earls Court, London, S.W.5.	
Farnborough Air Show (S.B.A.C.)	Sept. 1-7
Electronic Computer Exhibition	Nov. 28-Dec. 4
Olympia, London, W.14.	

OVERSEAS

Symposium on Reliability and Quality Control	Jan. 6-8
Washington, U.S.A.	
I.R.E. National Convention and Show	March 24-27
New York, U.S.A.	
British Electrical Conference	May 16-17
Brussels, Belgium.	
Solid State Physics in Electronics and Telecommunications (Conference)	June 2-7
Brussels, Belgium.	
International Analogy Computation Meeting	Sept. 1-9
Strasbourg, France.	
International Congress of Cybernetics	Sept. 3-10
Namur, Belgium.	

Magnetism in Materials

I.—The Physical Basis of Dia-, Para-, Ferro- and Ferri-Magnetism

BY D. H. MARTIN, Ph.D.

ALTHOUGH only four of the elements—iron, nickel, cobalt and gadolinium—are ferromagnetic, there is to-day available to the electrical engineer a remarkable range of magnetic alloys and compounds from which he must select the most appropriate for his particular application. In these articles I plan to examine more closely what conditions led to the distinctive and useful phenomenon of ferromagnetism, and then to illustrate how the bewildering variety of magnetic behaviour may be understood in terms of a few basic ideas.

All substances become magnetized when subjected to a magnetic field though sensitive apparatus is needed to detect the induced magnetization except in the case of the ferromagnetics. Most materials are either paramagnetic or diamagnetic. A specimen of the former kind will move, when placed in a non-uniform magnetic field, to the point where the field is most intense. This is because the induced magnetization is in the same direction as the field, as it is in the case of the ferromagnetics. The intensity of magnetization, however, is at least a million times less than that which would be induced in a ferromagnetic sample. Specimens of a diamagnetic material, on the other hand, move to where the applied field is least intense, for example, away from the pole-pieces of a magnet. This is because the induced magnetization is opposite in direction

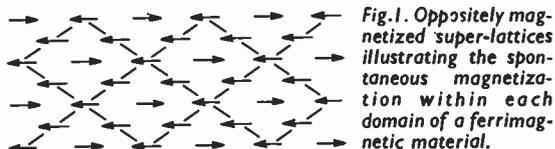


Fig. 1. Oppositely magnetized super-lattices illustrating the spontaneous magnetization within each domain of a ferromagnetic material.

to the applied field; it is of the same order of magnitude as that in a paramagnetic sample. Almost all organic materials are diamagnetic and, among the elements, copper, silver, gold and hydrogen are examples of diamagnetics, and oxygen, aluminium and platinum of paramagnetics.

Materials are magnetic because atoms themselves behave as magnetic dipoles, that is exactly as minute bar magnets or as minute electric current circuits. This, of course, is not surprising since it is well known that electrons circulate within each atom around its nucleus. There is, moreover, experimental evidence of a direct nature for the dipolar properties of individual atoms. In a non-uniform field a dipole experiences a translational force proportional to its dipole moment and in the 1920s Stern and Gerlach directed a beam of atoms, which had been evaporated from a metal in a furnace, through the pole gap of an electromagnetic which produced a non-uniform field. The beam was deflected and the deflection was registered by condensing the atoms on a cold plate where, after a time, they left a visible trace. In this way precise measurements of atomic dipole

moments were made and much was learnt about atomic structures.

A point of particular interest for our present purpose is that atoms of iron, nickel and cobalt do not have dipole moments which are very much larger than those of other atoms. The extreme ease with which a ferromagnetic may be magnetized to a high degree is certainly not due to its atoms possessing peculiarly high magnetic moments. It must, therefore be due to a particular kind of arrangement of the atomic dipoles, and I shall discuss this arrangement in some detail later. First I must describe briefly what happens in paramagnetic and diamagnetic materials.

Diamagnetism.—The several electrons in each diamagnetic atom or molecule move in orbits which are so directed that they give rise to a zero resultant magnetic moment in the absence of an applied field. There is a fundamental reason for electrons in atoms adopting such a balanced distribution and so diamagnetic materials are by no means uncommon. In an applied field, however, the magnetic forces which act on the electronic currents within each atom distort the orbits and thus induce a resultant magnetic moment, which is always opposite in direction to the applied field. This may be looked upon as an example of ordinary electromagnetic induction and the negative direction of the induced dipole corresponds to Lenz's law, which governs the direction of induced e.m.f. This process is diamagnetism.

Paramagnetism.—A paramagnetic atom, on the other hand, has a permanent dipole moment regardless of whether a field is applied or not. The magnetic fields due to the moving electrons in each atom do not cancel one another out. In the absence of an applied field the energetic thermal vibrations of the atoms in a paramagnetic sample cause their dipole moments to be directed in a completely random way, and the direction of each dipole changes rapidly with time. The overall magnetization of a sample is, therefore, zero. The fields attainable in practice are sufficiently intense only slightly to disturb this completely random arrangement. In the presence of an applied field each atomic dipole spends slightly more of its time in directions having components parallel to the applied field, and less time in directions opposed to the field. The sample as a whole, therefore, exhibits a weak magnetization and this is paramagnetism. In a hypothetical field of sufficient intensity the dipoles would approach a saturated condition, each being almost parallel to the field. This stage would be expected only if the magnetic potential energy of an atom became comparable to the energy of its thermal vibration. That is to say if

$$\mu H \approx k T$$

where μ , k and T are respectively the dipole moment of an atom, Boltzmann's constant, and the

absolute temperature. Now μ is of the order 5×10^{-20} e.m.u. and k is 1.38×10^{-16} erg per $^{\circ}\text{K}$, and H cannot in practice exceed about 100,000 oersts. Even with such intense fields, therefore, saturation effects should not be observable except at very low temperatures, a few degrees above absolute zero. Such effects have, in fact, been recorded recently in experiments conducted at about 4°K , that is -269°C . At more normal temperatures the intensity of magnetization, I , is strictly proportional to the strength of the applied field, H , and the ratio I/H , that is the susceptibility, is of the order 10^{-5} e.m.u. for most paramagnetic materials at room temperature. This is in contrast with susceptibilities of more than 10^3 in most ferromagnetic materials.

Ferromagnetism.—The characteristic feature of ferromagnetism is the attainment of a high intensity of magnetization in comparatively small fields, and even the retention of an intense magnetization when the field is switched off. As the field applied to a demagnetized specimen is increased the intensity of magnetization rises rapidly until saturation is attained when no further increase in magnetization is possible, however much the field may be increased. This occurs in fields of less than a few hundred oersts, for some materials in fields of only one oersted or so. The saturation value of magnetization is just about what would be expected if nearly all the atomic dipoles were aligned parallel to one another. This is in fact the situation that exists in a saturated ferromagnetic material and the problem of ferromagnetism is to explain how this comes about in such small fields, in spite of thermal vibrations.

It is known that a sample of ferromagnetic material is made up of small contiguous regions, called domains, within each of which almost all the atomic dipoles are aligned exactly parallel to one another even in the absence of an applied field (see Fig. 3). This alignment is known as spontaneous magnetization and its direction in each domain is different from that in the neighbouring domains. Spontaneous magnetization is the basic characteristic feature of ferromagnetism. It can be destroyed only by heating the specimen above a critical temperature called the Curie point, which for iron is 770°C , for nickel 358°C , for cobalt $1,120^{\circ}\text{C}$ and for gadolinium 16°C .

The arguments of the previous section on paramagnetism therefore indicate, since saturation effects persist at these high temperatures, that whatever force it is that aligns the atomic dipoles to give spontaneous magnetization, it must be equivalent to a large internal magnetic field of some ten million oersts! It was not until 1928 that the nature of these forces was discovered by Heisenberg. They are clearly too large to be ordinary magnetic forces and in fact they are due to an interaction, between neighbouring atoms, which requires the language of modern quantum physics for a full description. An atomic electron spins about its own axis as well as moving in an orbit round the nucleus. The elementary atomic dipole moments in ferromagnetic materials are in fact due entirely to the spin motions of certain of the electrons, the moments associated with the orbital motions cancelling out. Now a full quantum description of a spinning electron shows that between any two electrons there is an interaction, known as exchange interaction, which tends

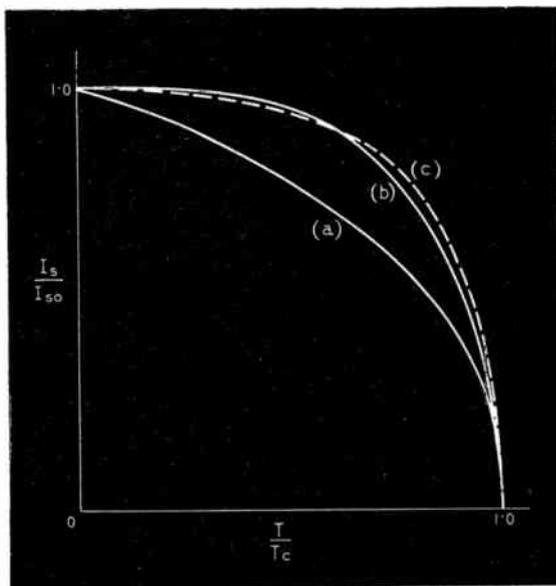


Fig. 2. Variation of the spontaneous magnetization I_s of iron, nickel and cobalt, with temperature T . I_{s0} is the spontaneous magnetization at absolute zero of temperature and T_c is the Curie temperature. Curve (a) is given by the simple Weiss theory, (b) by an improved Weiss theory and (c) records the experimental values of iron, nickel and cobalt.

to set the spin dipole moments either parallel or antiparallel to each other, depending on the details of the situation. The effects of exchange interactions in simple molecules are well established, but a metal consists of many millions of interacting atoms and the theory has not yet been fully worked out in rigorous detail. There is no doubt, however, that spontaneous magnetization is due to an alignment of the spin motions of certain electrons in the material under the action of exchange forces.

It is argued that the alignment will be parallel rather than anti-parallel if the number of interacting atoms is large and if the radius of the electron orbits is relatively small compared with the distance between the atoms. Now the electrons in an atom are arranged in "shells" at different distances from the nucleus. In an atom of an element belonging to the group known as the transition metals the resultant dipole moment is due entirely to the electrons in an inner shell known as the 3d shell. The magnetic effects of the other electrons cancel out. Of these metals, iron, nickel and cobalt have the smallest ratio of 3d radius to atomic separation. That they are ferromagnetic is therefore in accord with the conclusion above. It is of great interest to note that manganese and chromium, both of which are transition metals, but paramagnetic when pure, can be rendered ferromagnetic by alloying them with certain other metals, thus altering the interatomic distances. For example the Heusler alloys are ferromagnetic. They contain manganese, copper and aluminium but no iron, nickel or cobalt. Compounds of manganese with arsenic, with bismuth, with tin, and several other elements are ferromagnetic. Chromium compounds containing antimony, arsenic, platinum, or a number of other elements are ferromagnetic.

Gadolinium is the only pure element other than iron, nickel and cobalt which is known to be ferromagnetic, though it is suspected that dysprosium might be at very low temperatures. As in the transition metals, the atomic dipole moment of gadolinium is due solely to the electrons in an inner shell.

There is a group of non-metallic materials which exhibits properties resembling those of the ferromagnetic metals. They are intimate mixtures of iron oxide and oxides of divalent metals and have recently gained commercial recognition mainly because of their high electrical resistivity, as I shall discuss in more detail in a later section. They are known as ferrites, and the term ferrimagnetic has been coined for the rather different arrangement of atomic dipoles in these materials. They resemble ferromagnetics in that they are spontaneously magnetized and have a domain structure, and they are often included under that title. A ferrimagnetic must be a compound because two kinds of dipole are involved. Nearly all the dipoles of the one kind are aligned parallel to each other, while the others

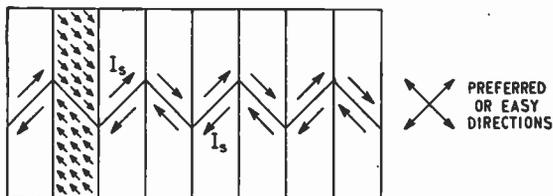


Fig. 3. Example of the arrangement of spontaneous magnetization in a domain structure. The alignment of atomic dipoles is illustrated in two of the domains.

are also aligned but in the opposite direction. The situation is illustrated in Fig. 1. Spontaneous magnetization results from this anti-parallel arrangement since one kind of dipole is more numerous and/or has a larger dipole moment.

The general formula for a ferrite is Fe_2MO_4 , where M is any divalent metal, for example copper, silver, magnesium, manganese, lead, zinc, etc. The crystal structure is of the type known as a spinel, that is the oxygen atoms are arranged on a close-packed cubic lattice and the metallic atoms occupy the interstices between the oxygen atoms. There are two kinds of interstice and they are known as tetrahedral and octahedral sites. A metallic atom in a tetrahedral site is surrounded by four oxygen atoms and in an octahedral site by six.

The elementary dipoles in a ferrite are the metallic atoms, those in one kind of site forming one spontaneously magnetized super-lattice and those in the other forming the oppositely directed super-lattice. There are twice as many octahedral as tetrahedral sites and so an overall spontaneous magnetization results. Exchange forces are again responsible for the spontaneous magnetization, but whereas in a ferromagnetic metal the interaction favours parallel alignment, in a ferrimagnetic the interaction of predominant importance is that between a metallic atom in a tetrahedral site and its neighbours in octahedral sites, and this interaction is negative, favouring anti-parallel alignment, and the two oppositely magnetized super-lattices result. The intensity of spontaneous magnetization in a ferrite is, of course, considerably smaller than that in a ferromagnetic metal.

Only at absolute zero of temperature does the magnitude of the spontaneous magnetization in ferromagnetic materials correspond exactly to complete alignment of the elementary dipoles. Above this temperature thermal vibration of the atoms always causes a few dipoles to be unaligned. At the Curie point the thermal agitation is sufficient to override even the strong exchange forces and full disorder sets in with the complete disappearance of spontaneous magnetization.

The variation of the intensity of spontaneous magnetization, I_s , with temperature is shown for iron, nickel and cobalt in Fig. 2. Long before Heisenberg, in 1928, identified exchange interaction as the force producing spontaneous magnetization, Weiss had shown (1908) how the phenomenon could be understood in terms of a hypothetical molecular field and he derived an expression for the dependence of I_s on temperature which to a first approximation agrees well with the observed variation. He supposed that each elementary dipole behaved as if acted upon by a molecular field, which he assumed to be proportional to the mean magnetization of the specimen. The molecular field is now recognized as an approximate representation of the exchange forces, since the exchange force tending to set an atomic dipole in a particular direction is greater the larger the number of its neighbours already set in that direction, that is the larger the magnetization, I , in the material surrounding the dipole. Weiss used this assumption in elaborating upon the Langevin theory of paramagnetism which showed that the intensity of magnetization of a paramagnetic specimen depended upon H the applied field, and T , the absolute temperature, according to the relation:

$$I = I_0 \tanh(\mu H/kT).$$

μ and k are the atomic dipole moment and Boltzmann's constant respectively, and I_0 is the magnetization which would be observed if all the atomic dipoles were perfectly aligned. The presence of T reflects the effect of thermal vibrations. For H Weiss substituted WI , where W is the molecular field constant, thus

$$I = I_0 \tanh(\mu WI/kT).$$

This relation contains the dependence of I upon T . Since the applied field is zero, I is here the spontaneous magnetization, I_s . The relation above is plotted in Fig. 2 with the experimentally observed variation. The Weiss theory is only an approximation to the real state of affairs, and the fuller theories are complex and not yet fully worked out.

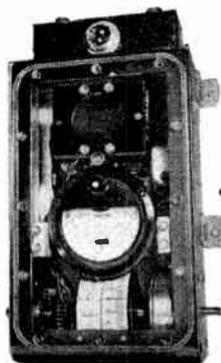
The molecular field representing the exchange forces proves to be of the order 10 million oersteds. It will be clear, therefore, that the fields used in practice, which seldom exceed 10,000 oersteds, are negligible in comparison and cannot change the magnitude of the spontaneous magnetization by a significant amount. The complicated changes in the overall magnetization of a specimen which occur when it is subjected to an applied field must therefore be due to changes in the direction of I_s in the domains of the sample. Recent studies of such changes have contributed enormously to our understanding of ferromagnetic behaviour and I shall describe the main features of domain theory in the following sections.

(To be continued)

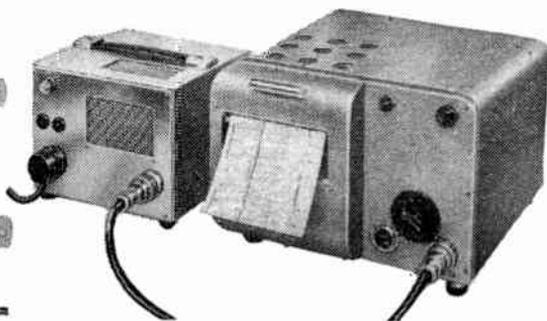
Gold Dip-Plating, using "Atomex" solution developed by the Baker Platinum division of Engelhard Industries, is claimed on a variety of metals, including copper, zinc, nickel, iron, steel and pewter. The plating takes place by ionic displacement so that no electric current is necessary. Thus there is no possibility of electrical shielding and a uniform deposit even in recesses is obtained. Control of temperature and pH is necessary, particularly when depositing on copper and for obtaining consistent colour in decorative work. The solution may be operated between 60°C and boiling point, except for deposition on copper, when the range is from 45° to 75°C. The pH is initially between 7 and 8, and should be kept in this region during deposition by adding small amounts of ammonia. Otherwise the solution becomes slightly acid and the pH drops to 6. All the gold in the bath can be used and the spent solution thrown away. Suitable container materials are polyvinyl plastics or glass.

Gas Electrochemical Cell using hydrogen and oxygen (or air) has been developed by the National Carbon Company of America, and is described in the October 1957 issue of *Electronics*. Each gas is fed at a pressure of about one atmosphere into a hollow porous carbon rod surrounded by potassium hydroxide as the electrolyte. The reaction produces water, which is removed by evaporation. As this is the only by-product the cell theoretically has an infinite life. About one volt is developed, and it is hoped to produce as much as 1 kW per cubic foot of cell volume.

Photocell-Powered Ohmmeter, using a selenium cell as the source of electric current for a resistance bridge, has been developed by the Fairey Aviation Company for testing the firing circuits of guided missiles. The idea is to ensure that the electrical energy applied to the missile remains below the safety margin so that there is no danger of accidental ignition. Hitherto current or voltage limiting devices have been used, but of course these can break down.



Left: Photocell-powered ohmmeter.



Above: Ultra-violet galvo recorder.

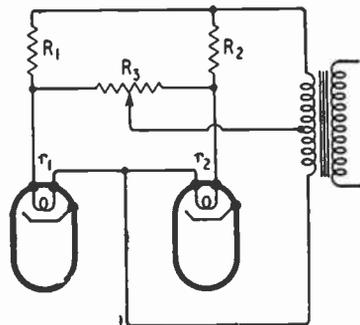
Technical Notebook

With the selenium cell the output under any condition of light saturation or failure cannot exceed a short-circuit current of 10mA or an open-circuit voltage of 0.7V. The bridge itself will measure 0-10kΩ in four ranges with a fundamental accuracy of ±0.3%. The actual accuracy achieved, however, depends on the measurement sensitivity, which in turn depends on the current resulting from the light falling on the photocell. The light intensities required to produce detectable galvanometer currents with different range and scale settings and a ±10% change of the "unknown" element vary between 0.7 and 13 foot candles. These are sufficient to give a measurement accuracy of approximately ±5%.

Ultra-Violet Galvo Recorder seen recently in operation at the Radar Research Establishment combines the sensitivity of galvanometer indication with the ability to give directly written records. This is achieved by using mirror galvanometers to reflect ultra-violet radiation from a mercury vapour lamp on to ultra-violet-sensitive recording paper. The trace is developed simply by exposure to daylight, and becomes visible immediately with low writing speeds and in less than ten seconds with high speeds. Made by New Electronic Products, the instrument provides six recording channels and has paper speeds of 0.2, 0.6, 2 and 6 inches per second. A trace velocity as high as 10,000 inches per second can be obtained, and the galvanometers will operate over a frequency range from d.c. up to 2 kc/s. The records are said to

be permanent unless exposed for a considerable time to strong daylight, and will remain stable for weeks under normal room illumination and hold indefinitely if filed away in the dark. For real permanence they can be fixed by standard photographic methods.

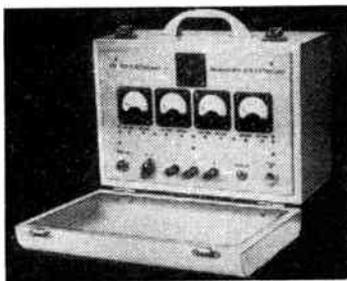
Valve Matching Circuit.—D.C. amplifiers commonly consist of balanced push-pull stages. Drift can take place if variations in heater voltage affect one valve of a pair more than



the other. A new circuit described by D. J. R. Martin in the December issue of *Electronic and Radio Engineer* makes it possible to adjust the sensitivity of a valve to heater-voltage changes. Pairs of valves can then be matched so that balance is maintained even when the heater voltage varies. The matching principle depends on the fact that when heaters are supplied from a high-impedance source, changes in heater current have a much greater effect than do changes in voltage when the valves are supplied from a low-impedance source. Differential adjustment of the source impedance "seen" by pairs of heaters in balanced amplifiers can therefore be used to equalize the sensitivities of the heaters to supply variations. In the circuit diagram, adjustment of R₃ alters the source impedance. For example, with the slider in the extreme right-hand position, r₁ is connected directly across a transformer winding, and therefore "sees" a very low source impedance, while r₂ "sees" an impedance made up of R₁ in parallel with something in excess of R₃. The left-hand valve is then supplied with heater power from a high-impedance source, so that it is affected more by power-supply variations than the

right-hand valve. By adjusting R_v , the sensitivities of the valves can be equalized.

Transistorized Timer recently introduced by Venner Electronics uses 46 transistors but has a consumption of only 1 watt at 12V. It is constructed from nine packaged stages and has a range of time measurement of 0.1msec to 27.8 hours. The basic time reference is a transistorized crystal oscillator operating at a frequency of 10kc/s. Pulses from this are passed via a gate to four decade counters, and thence to a mechanical counter. The division ratio given by the four decades is 10,000, so that the mechanical counter receives 1 pulse per second. The elapsed time can be read in seconds from the mechanical counter, with four decimal places taken from meters, calibrated 0-9, connected to the decades. The gating is arranged so that the open or closed times of contacts can be measured, or the time between one pair of contacts opening or closing and another pair opening or closing. Operation by



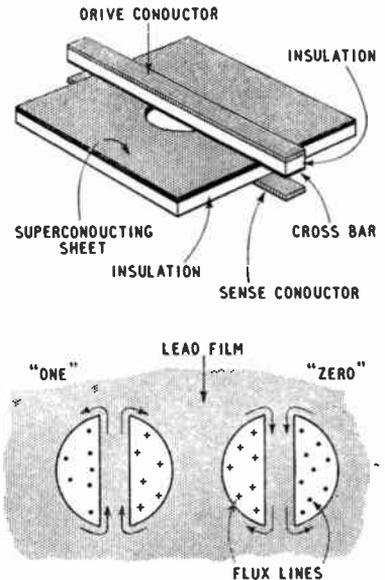
pulses is also catered for. Another timer has been developed by Venner for measuring the speed of road vehicles. This gives the time interval between the operation of two pressure switches which are actuated by the vehicle crossing two rubber tubes laid across the road at a known spacing. The switches open and close a gate which allows cycles of a 2.5-kc/s signal (obtained by frequency division from a 10-kc/s crystal oscillator) to be counted by three decades and displayed on three meters with digital scales. The frequency and rubber tube spacing are chosen so that the vehicle speed can be quickly calculated from the meter indication.

Helical Magnetization Patterns in magnetic wires, produced by the application of coincident circular and longitudinal fields, may provide the basis of a new kind of matrix store which is simpler and cheaper to manufacture than existing ferrite-core and magnetic-cell types. Exploratory work is being done by A. H. Bobeck at Bell Telephone Laboratories. The idea is that the matrix shall consist of arrays of vertical magnetic wires interwoven with horizontal copper

wires. Current passed through the magnetic wires produces the circular fields around them and current through the copper wires the longitudinal fields. The preferred direction of magnetization in the magnetic wires can be shifted from the normal longitudinal path to a helical path by mechanical torsion or perhaps eventually by processing during manufacture. The storing of a binary digit requires two coincident current pulses—one in a magnetic wire and the other in a copper wire. Reading out is accomplished by applying a strong longitudinal field in the reverse direction, and the read-out signal is detected across the magnetic wire. It is thought that at least 10 binary digits per inch could be stored without interaction on a magnetic wire formed by coating a conductor with magnetic material. Transistors could probably be used for the drive circuits.

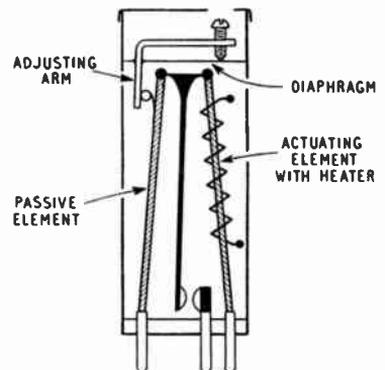
Integrated Tuning Assemblies giving a simultaneous change of capacitance and inductance are being developed by Plessey for u.h.f. tuners. They consist of variable capacitors with stators incorporating inductive loops. When the rotor (which has no connections made to it) is unmeshed from the stator it becomes in effect a short-circuited secondary coupled to the inductors, thereby reducing their inductance at the same time as the capacitance is reduced. This system has been known as a "butterfly" resonator in the past because of the particular shape of the rotor vanes.

Superconductive Storage Element devised by International Business Machines and mentioned in our November, 1957, issue (p. 547) depends on the magnetic flux produced by circulating currents induced in a superconductive lead sheet. (The superconducting condition being obtained by operation at extremely low temperatures below 10°K.) The lead film deposited on an insulator, has a hole cut in it with a lead bar metallized across. When a current pulse is sent through the drive conductor the resultant build-up of magnetic flux links with the superconductor and induces currents in it, as shown in the next column. These circulate indefinitely because of the zero resistance and set up their own magnetic flux. Whether a "1" or a "0" digit is stored is determined by the direction of the induced currents. Actually, the initial build-up of induced current is quite complex because the presence of a magnetic field affects the threshold of superconductivity and the induced magnetic field opposes the driving field. Reading-out is achieved by sending a current in the reverse direction along the drive conductor. This causes the induced currents to collapse, and the resultant change of magnetic flux induces a current pulse of one direction or the other in the sense conductor. An experi-



mental element described in the *IBM Journal of Research and Development* for October, 1957, is said to operate about 100 times faster than ferrite-core stores and to require less than a half of their driving current.

Thermal Delay Relay with greater rigidity and resistance to shock than conventional bi-metal strips has an actuating element which is fixed at both ends and expands longitudinally when its heater is energized. A simple mechanism (shown diagrammatically in the sketch) multiplies the difference in expansion between this element and a similar passive element so as to move the contact arm towards or away from the fixed contact. Ambient temperature changes expand the two elements equally and so do not move the contact arm. The time delay is set by the adjusting screw and arm, which determine the initial contact gap and consequently the time required for operation. Made by G.V. Controls, the relay is available from Mercia Enterprises in various types and ranges, with time delays from 0.5 to 180 seconds.



Starting Tape Driving Mechanisms*

MECHANICAL DESIGN TO AVOID LOOP FORMATION AND SNATCHING

IN magnetic recorders used for analogue signals (including broadcast programme material) the tape mechanism can be divided into three parts, the take-off or feed reel and tension device, the take-up reel and drive, and the drive capstan and pinch wheel.

Such a combination is shown in Fig. 1 in which the tape tension on the feed side of the capstan is provided by means of a reel motor connected to exert an anti-clockwise torque as viewed from above. Ideally, the operation should be that the reeling devices set the desired tape tension and that the reeling device is concerned only with tape motion. Practical considerations, however, set limits to the extent to which

is being run up to full speed, it must be prevented from touching the capstan. It is also possible to engage the pinch wheel before energizing any of the motors, but the time required to reach steady speed conditions will then be unduly long because of the inertia of the capstan flywheel. If the drive motor is of the synchronous type, the settling time will again be increased. Fig. 1 shows a flexible coupling between the drive motor and the capstan flywheel; these form a mechanical low-pass filter. Transient oscillation in this coupling on starting can add further to the delay in reaching the steady state.

The following proposals make use of the second method suggested above, in which the acceleration time is tolerated, first, for the simple case where the desired tape speed has only one value and, secondly, for the more complex case where provision is made for more than one tape speed. In each case, the pinch wheel is actuated by an electromagnet, which is, in turn, energized via a relay. In each case, also, the tape speed is sensed by passing the tape over an auxiliary wheel, called a tape wheel, which has a speed-measuring device fitted to its spindle.

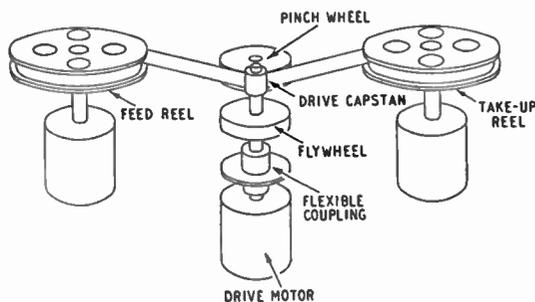


Fig. 1. Typical tape driving mechanism.

this ideal may be achieved, the most important being (a) the inertia of reels, reel motors and tape, and (b) the variation of the outside radius of the tape on the reels throughout the playing time.

Under running conditions the effect of the variation of the radius of the reeled tape may be minimized by using reel motors with suitable torque/speed characteristics, but the effects of inertia and of tape radius during the starting period cannot be modified without considerable elaboration of the mechanism. Consequently, it is difficult to avoid the formation of loops on the take-off side when the pinch wheel engages the tape with the rotating capstan. The formation of loops is generally followed by snatching as the take-up reel regains control. This irregularity of take-up tension can lead to undesirable effects such as uneven reeling, local stretching of the tape and, in bad cases, tearing.

Alternative Solutions.—One way of tackling the difficulty is to pass the tape through low-inertia "reservoirs" (e.g., vacuum boxes) on each side of the capstan and to control the reel motors by servomechanisms responsive to the position of the tape in each of the reservoirs. This method is often adopted if very fast start and stop times are required (e.g., for digital information in data processing equipment).

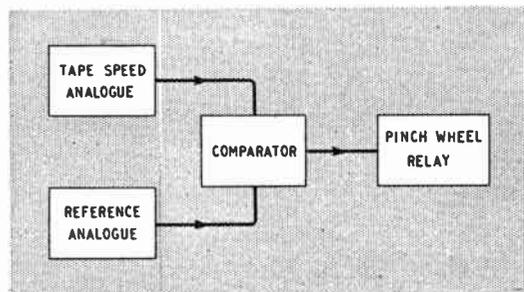
Another method is to tolerate the time required for acceleration of the reels and to engage the pinch wheel when the tape motion has reached its correct speed, i.e., when the tape speed is substantially equal to the peripheral speed of the capstan. While the tape

Single Speed Operation.—In the simple case, as shown in the block diagram of Fig. 2, it will be seen that an analogue of the speed is compared with a fixed reference, and when the difference drops below a threshold level, the relay is energized and the pinch wheel engages the tape with the capstan.

One convenient form of speed-measuring device consists of a magnet and an eddy current disc (or cup) such as are commonly used in indicating tachometers. One can imagine a tachometer, the hair spring of which is so biased that the needle is normally held against the zero stop until the speed reaches the required value. If the needle operates an electrical contact as soon as it moves away from the stop, a relay can be energized and this in turn can operate an electro-magnet which moves the pinch wheel to its operative position (Fig. 3).

Another speed-sensitive device which may be used is a tachogenerator, preferably of the permanent magnet type, arranged to give either a d.c. or an a.c. output. In either case, the output voltage is an analogue of the speed and, in the a.c. case, the frequency of the output is also an analogue of the speed.

Fig. 2. Basic principle of pinch wheel control.



* Communication from Telefunken G.m.b.H. via E.M.I. Ltd.

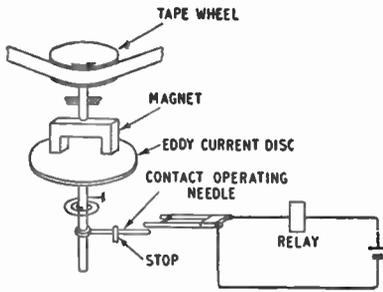
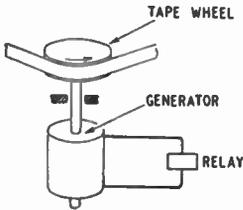


Fig. 3. Eddy current speed indicator.



left: Fig. 4. Tacho-generator for deriving speed analogue.

Right: Fig. 5. Parallel tuned circuit as a frequency sensitive relay shunt.

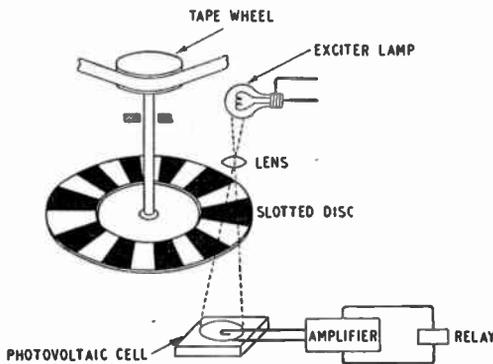
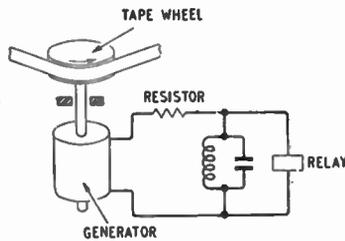


Fig. 6. Optical generation of speed analogue.

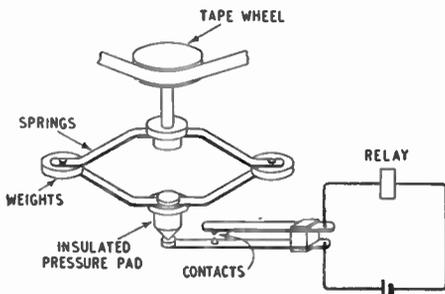


Fig. 7. Centrifugal switch.

A very straightforward embodiment of this principle, in which the speed analogue is the output voltage, uses the minimum value of operating current for the relay as a reference and so avoids the need for the separate reference shown in Fig. 2. Hence, all that is needed is to connect the generator direct to the relay but, in the a.c. case, a rectifier is necessary if the relay is not sensitive to a.c. (Fig. 4).

When the output frequency is used to provide an analogue of the speed, the resonant frequency of a parallel-tuned circuit may be used as a reference as shown in Fig. 5. At low tape speeds, the impedance of this circuit will be low compared with that of the series resistor, and the relay, which must be sensitive to a.c., is virtually short-circuited. However, as the speed approaches the required value, the effective impedance increases and eventually the relay becomes sufficiently energized to operate. A series resonant circuit can be used in much the same way, the internal inductance of the generator being tuned by a series capacitance.

It will be realized that each of the methods so far described involves loss of energy which is obtained from the tape driving motors, via the tape. The tape will experience a drag from this cause, in addition to that due to the inertia of the system. This may be obviated by the use of a more refined transducer which modulates an auxiliary power supply. Fig. 6 shows an example using this principle: power is supplied to the relay by light from an exciter lamp falling on a photovoltaic cell via a chopper, consisting of a low-weight slotted disc carried on the spindle of the tape wheel. The a.c. output from the cell is at a frequency which is an analogue of the speed. The reference may be a tuned circuit, of either the series or parallel type, as already described.

A centrifugal switch requiring a low operating torque and adding only a moderate inertia to the system may also be used. Fig. 7 shows a very useful form of this device in which two spring contacts are held apart by an insulated pad bearing on the lower spring. As the speed increases, centrifugal force acting on a pair of weights distorts the springs which carry the weights and relieves the pressure on the spring contact so that the pinch-wheel relay circuit is closed when the tape speed is correct. The frictional torque is very small because the load on the rotating parts is applied along the axis of rotation.

As the value of the speed analogue approaches that of the reference, the pressure of the operating contacts is at first so light that "chatter" is to be expected with each of the devices so far described. Therefore, the reference value must be so chosen that the pinch-wheel relay operates at a tape speed which is rather less than its final value, but not so much less that engagement of the pinch wheel causes the take-off tension to fall to zero. As the pinch wheel engages the tape, it is rapidly accelerated to full speed and the pressure of the operating contacts is thereby increased to a satisfactory value.

Multiple Speed Operation. Provision is often made for a choice of more than one speed, and accordingly the block diagram of Fig. 2 must be amended as shown in Fig. 8. It will be seen that the fixed reference must be replaced by a correct analogue of the capstan speed, assuming that the diameter of the capstan is not changed. If the capstan spindle speed is kept constant for both values of the tape speed by changing the capstan diameter, the fixed reference system remains suitable.

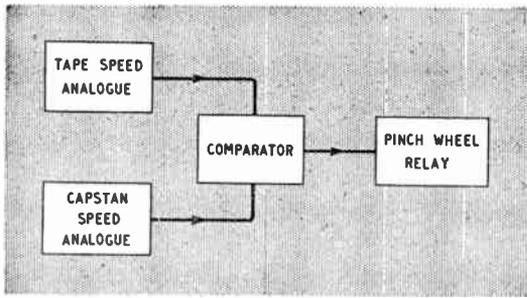


Fig. 8. Modified block diagram for multi-speed operation.

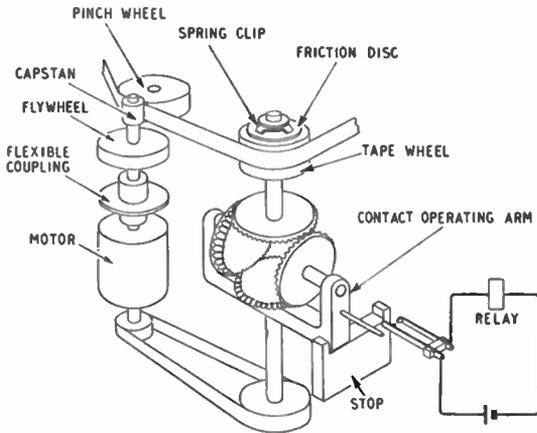


Fig. 9. Differential speed control of pinch wheel.

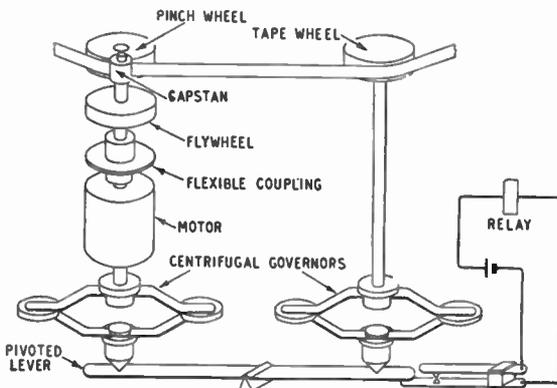


Fig. 10. Mechanical speed comparator.

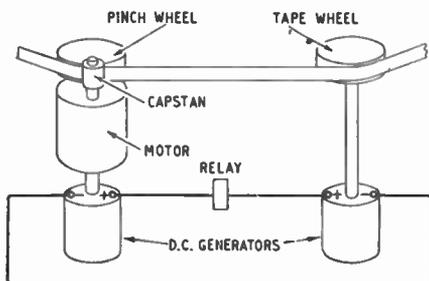


Fig. 11. Electrical speed comparator.

Because the input quantities are both of the same form, i.e. rotating spindles, a differential gear train is a suitable form of comparator, and an example of this is shown in Fig. 9. A simple differential will give an output speed proportional to the difference between its input speeds and an output torque equal to the difference between the input torques. The particular arrangement shown in Fig. 9 makes the speed difference zero and utilizes the torque difference to provide contact pressure. Accordingly, the difference between the capstan speed and the tape wheel speed is absorbed in a friction coupling, and it is the reversal of friction, which occurs when the latter speed overtakes the former, which causes the contact operating arm to move to its alternative position.

Several other mechanical systems designed on lines similar to that of Fig. 9, or closely related thereto, could be used but, since they all involve the use of slipping couplings, they cause drag on the tape wheel. These examples are by no means exhaustive and further devices, based on duplication of the simple schemes already discussed, are possible. For instance, a double version of the system shown in Fig. 7 could take the form shown in Fig. 10. The comparator then takes the form of a pivoted lever with the pressure pads of two centrifugal governors so arranged as to operate, one on each end of the lever.

The comparison may also be obtained electrically by duplicating the system of Fig. 4 as shown in Fig. 11. In this case, two d.c. generators are connected in series opposition to the pinch-wheel relay. When the tape wheel generator output equals that of the capstan generator, the current in the relay falls to zero, releases the armature and completes the circuit to the pinch-wheel magnet. Because the differential voltage becomes small, or vanishes, the drag on the tape under running conditions is low.

CLUB NEWS

Birmingham.—At the annual dinner of the Slade Radio Society the president, C. H. Young (G2AK), announced that 42 members had been enrolled during the year, bringing the membership to 112. The club meets on alternate Fridays at 7.45 at the Church House, High Street, Erdington. At the January 3rd meeting N. R. Nicholl (vice-chairman of the British Interplanetary Society) will speak on the instrumentation of space vehicles. Sec.: C. N. Smart, 110 Woolmore Road, Erdington, Birmingham, 23.

Bury.—The January meeting of the Bury Radio Society will be held at 8.0 on the 14th, when members will hold a debate on "Phone versus C.W." Meetings are held at the George Hotel, Kay Gardens. Sec.: L. Robinson, 56 Avondale Avenue, Bury, Lancs.

Prestatyn.—Meetings of the Flintshire Radio Society are held on the first Monday in each month at 7.30 at the Railway Hotel. Sec.: J. Thornton Lawrence (GW3JGA), Perran Porth, East Avenue, Prestatyn, Flint.

Rochdale.—A new club, to be known as the Roch Valley Radio Club, has been formed in the borough. Meetings are being held each Tuesday at 8.0 in the Windmill Hotel, Sudden. Enquiries to D. J. Power, 2 Clement Street, Rochdale, Lancs.

Wellingborough.—At the January 30th meeting of the Wellingborough and District Radio and Television Society, L. Parker (G5LP) will speak on "This DX Business." The club meets each Thursday at 7.30 at the Silver Street Club Room. Sec.: P. E. B. Butler, 84 Wellingborough Road, Rushden, Northants.

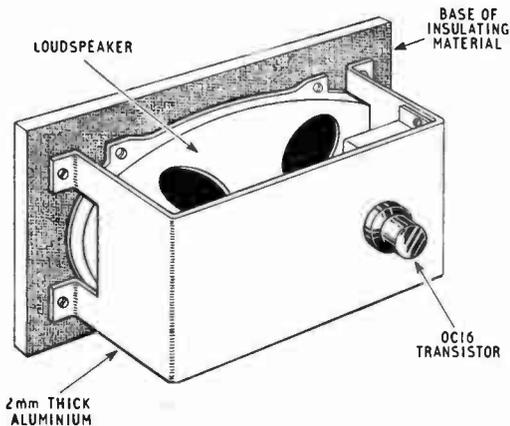


Fig. 1. Heat sink and output stage assembly.

HYBRID CIRCUIT FOR 12-VOLT OPERATION WITH TRANSISTOR OUTPUT

By J. C. BECKLEY,* B.Sc.(Eng.)

Car Radio Receiver Design

IT has been appreciated for many years that it is possible to obtain acceptable performance, in terms of voltage gain, from thermionic valves operated with low anode voltages such as are available from car batteries. However, it is not possible to obtain from a practical valve operating at low anode voltage anything like sufficient audio output power to drive a loudspeaker. Consequently, until quite recently, all car radio receivers and similar mobile equipment have incorporated standard mains valves and a vibrator, or d.c. convertor, to provide a high line-voltage.

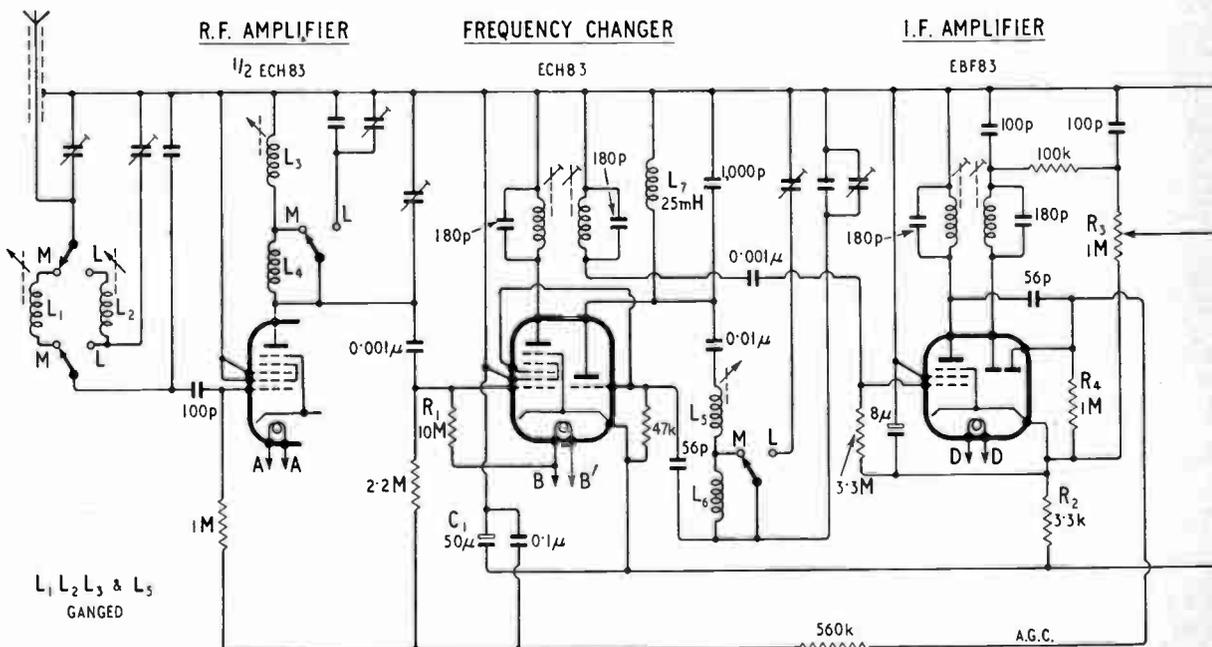
The recently introduced power transistor is an excellent solution to the output power problem,

because a suitable transistor with a 12-V supply can provide several watts output. Many of the present types of mains valve give a useful performance with an h.t. of only 12V, but a new range of valves specially designed for this application is now available.

A hybrid design for a car radio has a number of distinct advantages over all-valve and all-transistor receivers. The present cost of transistors makes an all-transistor receiver for this particular application expensive, but a relatively inexpensive hybrid receiver may be designed employing four valves plus one power transistor. The great superiority of the

*Mullard Ltd.

Fig. 2. Theoretical circuit of the hybrid car radio receiver with an OC16 power transistor in the output stage.



hybrid receiver is that the vibrator h.t. supply is dispensed with. Speaking generally, both the transistor and the valve have much longer working lives than the vibrator, and the potential reliability afforded by the hybrid design is therefore very much greater. Vibrator supplies usually involve an expensive transformer and, also, careful filtering of the d.c. output is necessary to avoid introducing interference from the vibrator. The characteristics of the new valves permit the design of receivers having the same performance as those equipped with normal h.t. operated types, so that nothing is sacrificed by omitting the vibrator pack. Moreover, the current drain of the hybrid receiver is about two or three times less than that of a conventional car radio.

A 12-V car radio receiver is described here for medium- and long-wave operation and it is designed around a normal production car radio tuning unit incorporating permeability tuned aerial, r.f., and oscillator circuits. The output stage is constructed as a separate unit mounted with the loudspeaker.

The new range of valves for application in hybrid receivers are the Mullard ECH83, EBF83, and EF98. The ECH83 is a frequency converter of the well-known triode-heptode type. The ECH83 heptode section is also applied as r.f. amplifier and the triode section as a.f. voltage amplifier. The EBF83 is a double-diode pentode and combines the functions of i.f. amplification, detection and a.g.c. The EF98 is a straight pentode which has been designed to provide sufficient power output (a few milliwatts) to drive the transistorized output stage.

The output transistor is the Mullard OC16 power transistor, which can be operated at a high value of collector dissipation providing an output of about 2.5W.

Receiver Design.—The audio output obtainable with a single OC16 is considered to be sufficient for normal purposes. Push-pull operation has not

been considered here because this design is intended to apply to an inexpensive receiver.

The quality of a car radio depends to a large extent upon the effectiveness of the a.g.c. since rapid and intensive variations of field strength may occur when the car is moving. In the hybrid car radio with a low anode supply voltage the control voltage is obviously small. In order to obtain effective control, therefore, the grid base of the controlled valves is kept small. In this receiver a.g.c. is applied to the r.f. and mixer valves only. No a.g.c. is applied to the i.f. valve as this would reduce the available control voltage.

The r.f., mixer and i.f. stages are operated with grid current bias. The values of grid leak chosen are a compromise between circuit damping and valve operating slope. The valves in the above stages have a high internal impedance ($>500k\Omega$) so that normal r.f. coils and i.f. transformers are employed. The oscillator drive voltage required by the ECH83 mixer is much less than the value required for this type of mixer operating at high anode voltage. Thus, normal, medium- and long-wave permeability tuned oscillator coils may be used in the hybrid receiver, although the effective slope of the ECH83 oscillator section is not as high as ordinary types.

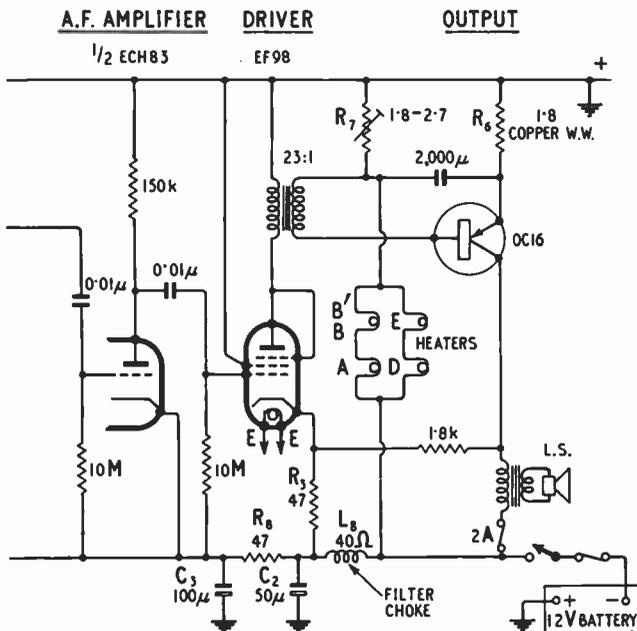
The Output Stage.—In order to obtain sufficient power output from the single OC16 (about 2.5W), it is necessary to operate the transistor at a high collector dissipation. The junction temperature must be limited by the use of an efficient heat sink. Fig. 1 shows the arrangement employed; the OC16 is mounted directly on 2-mm thick aluminium bracket approximately 300 sq cms in area. The transformers associated with the output stage are also mounted on the heat sink. The case of the OC16 is connected to the collector, the heat sink is therefore at collector potential and must be insulated from the main chassis.

The terminal voltage of a car battery varies considerably due to variations of load and charge conditions. A battery of nominal 12V is reckoned to have an average voltage of 14V and a possible maximum of 15V. Hence, the output stage is designed for a normal voltage of 14V and safe operation at 15V.

The circuit is designed for continuous operation at ambient temperatures up to 45°C. At 45°C the junction temperature does not exceed 75°C, the normal limit mentioned in published data. Operation at junction temperatures up to 90°C is possible for short periods (life expectancy at junction temperature of 90°C is greater than 200 hours) without serious effect upon the transistor. This allows occasional operation at ambient temperatures up to 60°C. The circuit is safe from thermal runaway at a battery voltage of 15 and junction temperature of 90°C.

Circuit Description.—The circuit of the receiver, which is shown in Fig. 2, is designed to permit direct connection to a car chassis; the positive line is therefore earthed.

The tuning unit provides separately tuned aerial circuits, L_1 and L_2 , for medium and long waves and a single tuned r.f. coil, L_3 , with an additional loading coil, L_4 , for long waves. The input circuits are designed to match a low-capacitance aerial. The r.f. amplifier is the heptode section of an ECH83 and is operated with grids 2, 3, and 4 at h.t. potential. The valve has a grid leak of about $1.5M\Omega$ taken to



a point 1.5V positive with respect to the cathode.

The ECH83 is operated as a multipliative mixer with a Colpitts oscillator. The oscillator circuit incorporates a single tuned coil, L_6 , for medium-wave operation, an additional loading coil, L_6 , being switched into circuit for long waves. The triode anode is connected to h.t. positive *via* a choke, L_7 , which involves negligible d.c. voltage drop, but provides sufficient inductance to avoid restricting the normal frequency swing of the oscillator. An inductance of about 25mH is adequate for this receiver. The mixer section is operated with a grid leak of about 2.5M Ω connected to 1.5V positive. An additional positive bias is applied to the grid *via* a 10-M Ω resistor taken to the plus 6V point on the heater chain.

The EBF83 is grid-current biased by a 3.3-M Ω resistor returned to the cathode. A resistor, R_2 , in the cathode circuit provides the positive voltage which is applied to the grid resistors of the r.f. and mixer stages. No a.g.c. is applied to this stage.

Detector and a.g.c. diode loads, R_3 and R_4 , are returned to the EBF83 cathode. The detector load, R_3 , is used as the volume control. The a.g.c. voltage is derived from the anode of the i.f. valve and is delayed by the positive voltage across the cathode resistor, further delay being applied to the mixer valve by the 10-M Ω resistor, R_4 , taken to plus 6V. In this way the control characteristics of the r.f. and mixer valves are lined up to give optimum signal handling.

Standard medium-impedance 470-kc/s i.f. transformers are used in this receiver.

The detector output is fed into the triode section of the first ECH83. The triode is biased by grid current with $R_{g1}=10M\Omega$. It functions as an a.f. voltage amplifier.

The EF98 a.f. driver stage is operated as a tetrode with g_3 connected to the anode. The output is transformer-coupled to the output stage. A low value resistor, R_5 , is included in the cathode circuit across which negative feedback is applied from the output stage.

Output Stage.—The OC16 transistor is used in the earthed-emitter mode with a series emitter resistance R_6 . Base bias is derived from a resistor R_7 , in series with the heaters of the valves. The non-linear voltage-current characteristic of the heaters, decreases the effect of battery voltage varia-

tions on the bias voltage. A resistor of about 2 Ω is required in the heater circuit in any case to drop the voltage across the heaters to about 12.6V with a nominal battery voltage of 14V. The low value of base bias resistance, and the use of an emitter resistor wound with copper wire (which has a small positive temperature coefficient), give effective stabilization of collector current with temperature. A fuse is included in the collector supply as protection against accidental short circuits between the heat sink, which is at collector potential, and the chassis.

Matching Driver Valve to Transistor.—As the input characteristic of the transistor is non-linear, the reflected load on the driver valve is similar. The performance of valves is generally expressed in relation to resistance loads, therefore it is necessary to determine a resistance load equivalent of the transistor input characteristic. Fig. 3 shows dia-

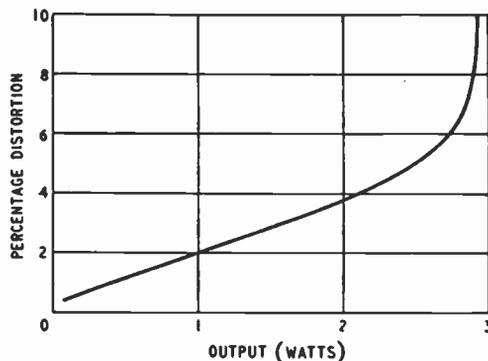


Fig. 4. Relationship between power output and distortion for OC16 transistor.

grammatically how the load line of a low-limit transistor appears on the EF98 V_a/I_a curves. Low-gain transistors generally have a low input impedance, thus the matching transformer ratio is chosen so that maximum power is available from the valve to drive low-impedance transistors. However, the optimum ratio is a compromise between perfect impedance matching and the primary inductance obtainable in an acceptable size transformer.

It is important that the matching transformer is phased so that increase of collector current corresponds to increase of anode current. This enables maximum power to be obtained from the valve and also helps to minimize second harmonic by partial cancellation of that generated in the valve and transistor.

Negative Feedback.—As previously mentioned negative feedback voltage from the OC16 collector is applied across a resistor, R_5 , in the cathode circuit of the EF98. The feedback does not increase the drive requirements of the transistor. In addition to decreasing the distortion, the gain spread of the output stage, due to the relatively large spread of transistor characteristics, is considerably reduced by the application of feedback.

(Continued on page 39)

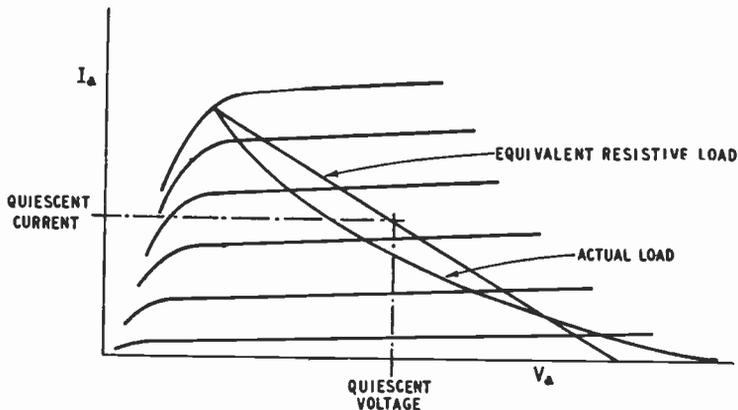


Fig. 3. Reflected load lines of output transistor on V_a/I_a curves of EF98 driver valve.

The negative supply to the valves' cathodes is filtered by an r.f. choke, L_8 , of about $40\ \Omega$ d.c. resistance. The transistor supply is taken directly from the battery.

Decoupling of individual stages was not found necessary in this receiver. The choke L_8 , together with a total capacitance of $100\ \mu\text{F}$, C_1 and C_2 , across the valve supply will generally provide sufficient decoupling, but if it should prove inadequate R_8 and C_3 may be included.

Receiver Performance.—(i). *R.F. Stage (ECH83 heptode section).*—The measured r.f. gain at several frequencies is given in Table 1 together with the r.f. circuit impedance.

(ii). *Mixer Stage (ECH83).*—Measured conversion gain at 1Mc/s = 17 times. I.F. transformer transfer impedance = $87\text{k}\Omega$. Conversion slope of ECH83 $\approx 200\text{mA/volt}$. Measured oscillator grid voltage = 1.0 to 1.5V rms.

(iii). *I.F. Amplifier (EBF83).*—Measured gain at 470kc/s = 52 times. I.F. transformer transfer impedance = $55\text{k}\Omega$. EBF83 operating slope = 0.95mA/volt .

(iv). *A.F. Voltage Amplifier (ECH83 triode section).*—Measured gain at $1,000\text{c/s}$ = 6 times. Output voltage for 5% distortion = 1.8V rms.

(v). *Driver Stage (EF98).*—The optimum load of the EF98 operating with $V_a + g_3 = 12.0\text{V}$ and $V_{g2} = 12.6\text{V}$ is $4.5\text{k}\Omega$. The valve is grid current biased with $R_{g1} = 10\text{M}\Omega$. Under these conditions a maximum power output of 13mW is obtained for 10% distortion.

Table 2 gives the EF98 input voltage required to drive the output transistor to full output and also for 1W output. Sensitivities are quoted for both average and low-limit gain transistors.

(vi). *Output Stage.*—

(a) *Heat Sink.*—The arrangement of Fig. 1 gave a total thermal resistance of 4.5°C/watt when tested in the laboratory. However, as the thermal resistance would vary, depending on the circulation of air and other local conditions, it is important to measure the thermal resistance under actual working conditions. A total thermal resistance of 4.5°C/watt (or less) under working conditions is essential for operation of the OC16 at the conditions mentioned here.

(b) *OC16 Operating Requirements.*—

Supply voltage = 14V.

Collector current = 475mA (Preset by R_7).

Collector dissipation = 6.6W (25°C to 45°C).

Collector load = $25\ \Omega$.

Base Voltage = 1.14V to 1.37V.

Base current = 6mA to 30mA .

Output power = 2.4W at start of clipping. (Into transformer primary) 2.9W at 10% distortion.

(Fig. 4 shows the variation of distortion with transistor output power.)

Overall Receiver Performance.—

Heater Chain $\approx 1.1\text{A}$ at 14V.

Measured Sensitivity.—Sensitivity figures are quoted for an a.f. output of 1 watt with an average transistor and a modulation depth of 30%. (See Table 3).

I.F. Selectivity.—The overall i.f. response is approximately 7kc/s for 6dB down.

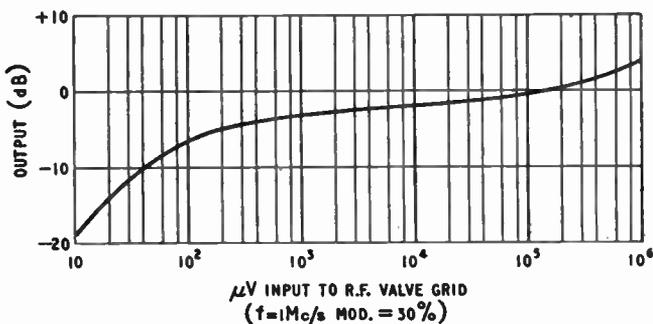


Fig. 5. A.G.C. characteristic of the receiver.

A.G.C. Performance (See Fig. 5).—The a.g.c. curve shows that a delay is maintained up to an input of about $100\ \mu\text{V}$ at the grid of the r.f. valve. The maximum signal handling of the receiver corresponds to an input of approximately one volt at the r.f. valve grid.

The receiver was tried in a modern car and no difficulty was experienced with interference from the dynamo or ignition system. It is possible that as the receiver has valve cathodes floating, interference may be introduced from the heaters. In this case it may be necessary to filter the heater supply by inserting a low resistance choke in series with the resistor R_7 .

TABLE 1

Frequency	Circuit Impedance	Gain*
1,000kc/s	$67\text{k}\Omega$	55 times
1,400kc/s	$48\text{k}\Omega$	40 "
600kc/s	$92\text{k}\Omega$	76 "
200kc/s	$37\text{k}\Omega$	31 "

* Measured from r.f. valve grid to mixer grid. The above values of gain correspond to a valve slope of approximately 0.83mA/V .

TABLE 2

	Low-gain transistor	Average transistor
Input for 10% distortion in transistor output ...	1.0V rms	0.6V rms
Input for 1 watt output from transistor ...	0.6V rms	0.36V rms

TABLE 3

Frequency	Aerial Input*	R.F. Valve Grid Input
1,400kc/s	$1.5\ \mu\text{V}$	$10\ \mu\text{V}$
1,000kc/s	$1.0\ \mu\text{V}$	$7\ \mu\text{V}$
600kc/s	$1.0\ \mu\text{V}$	$4\ \mu\text{V}$
200kc/s	$3.0\ \mu\text{V}$	$12.5\ \mu\text{V}$

* Measurements of the aerial sensitivity were made with a 47-pF capacitor between the signal generator and the aerial input.

The receiver covers the medium and long wavebands only. It has been found that short-wave operation is possible if capacitive tuning is employed.

The results obtained with the hybrid receiver proved highly successful and very promising, not

only for car radios, but also for the future development of other mobile communication equipment fed from a low-voltage supply source.

The author is indebted to L. H. Light for the design of the output stage, and for his advice in the preparation of this article.

A PICKUP TO TRACK AT 2 GRAMS

THE design of barium titanate transducer pickups with tracking weights of two grams or less was described at the 1957 I.R.E. National Convention by W. E. Glenn of the G.E. Company of America.

A sketch of the cartridge is shown in Fig. 1. The 2-mil barium titanate sheet is fastened on one side to a stainless steel wedge. Thus, if this wedge is bent, it will strain the barium titanate and so generate a voltage between its surfaces. The 7-mil diameter 20-mil long diamond or sapphire stylus is force-fitted into a hole in the 0.7-mil stainless steel quill-shaped tip, and further secured with a small drop of Araldite cement.

The cartridge is attached to the arm by butyl rubber to allow it to retract before the cartridge or record can be damaged if the pickup is dropped. The vertical bearing of the arm contains grease which damps the low-frequency resonance between the stylus compliance and arm mass, and also renders the pickup less susceptible to external vibration. The moment of inertia of the arm is reduced by the

same factor as the tracking weight to secure the same stability with warped records as for a standard arm.

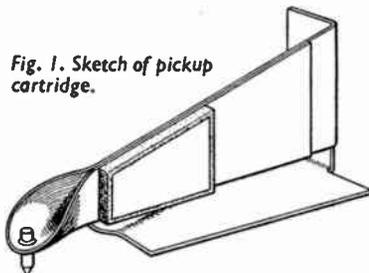


Fig. 1. Sketch of pickup cartridge.

The small section of the vertical wedge between the quill and barium titanate provides the lateral stylus compliance. The thickness of the quill is chosen so that the vertical compliance is about one-fifth of this. Vertical motion of the stylus does not produce any output because of the lateral symmetry of the quill.

The upper frequency of resonance f between the effective mass at the stylus tip and the groove wall and stylus compliance is proportional to t/L^2 , where t is the wedge thickness and L the wedge length. The charge Q developed across the barium titanate is proportional to FL^2/t^2 where F is the flexing force. For a given resonance frequency f and tracking weight (which fixes F), this becomes $Q \propto f/t$. Thus to secure the maximum possible output, t is made as small as possible, and L then chosen to give a suitably high resonance frequency f . To avoid the necessity for an input resistance of more than $1M\Omega$ the capacity of the barium titanate element is made about 1000 pF by choosing a suitable width.

Cartridges with different stylus compliances corresponding to tracking weights from $\frac{1}{2}$ to 2 gm. have been made. The effective mass at the stylus tip for the 2-gm version is 0.1 mgm. The output after

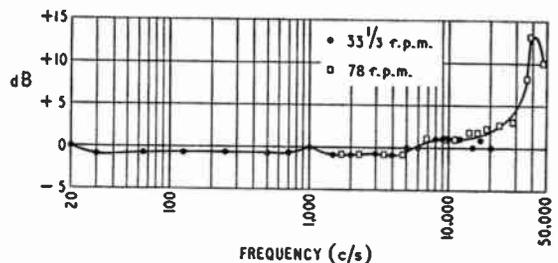
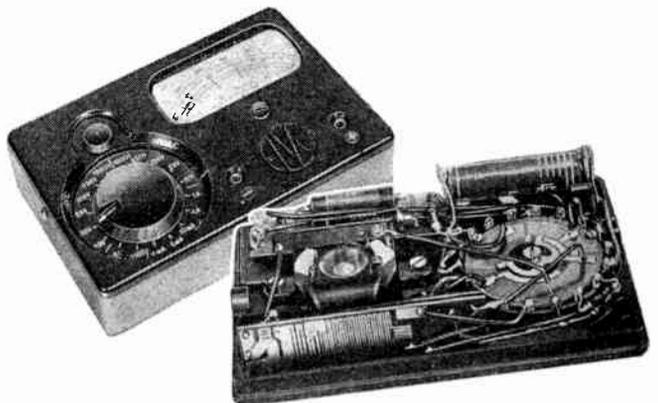


Fig. 2. Frequency response with Cook 10-LP record.

compensation to the R.I.A.A. frequency characteristic is about 40 mV. The frequency response using a Cook 10-LP record run at 33 $\frac{1}{3}$ and 78 r.p.m. is shown in Fig. 2, from which it is seen that the upper resonance frequency is about 40 kc/s.

New Avo Multiminor

THIS new 19-range instrument has a maximum d.c. current sensitivity of $100\mu\text{A}$ f.s.d. The meter series impedances are $10,000\Omega/\text{V}$ and $1,000\Omega/\text{V}$ for the seven d.c. and five a.c. voltage ranges respectively. Potentials up to 1,000 V a.c. or d.c. can be measured. Two resistance ranges (0 to $20\text{ k}\Omega$ or 0 to $2M\Omega$) are provided, using an internal $1\frac{1}{2}\text{-V}$ U12 cell with an adjustment to compensate for ageing. The full-scale error does not exceed 4%. Ranges are selected by a high-quality rotating switch, the 18 fixed silver-plated contacts being wiped by a double contact arm. Some of the resistors are printed; one on a switch-plate forming an integral part of the selector switch mechanism, and another forming the universal meter shunt. Two models at the same price of £9 10s are available, one for use in very humid climates. The address of the manufacturers is 92-96, Vauxhall Bridge Road, London, S.W.1.

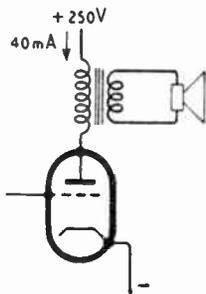


Valves, Transistors and Efficiencies

By "CATHODE RAY"

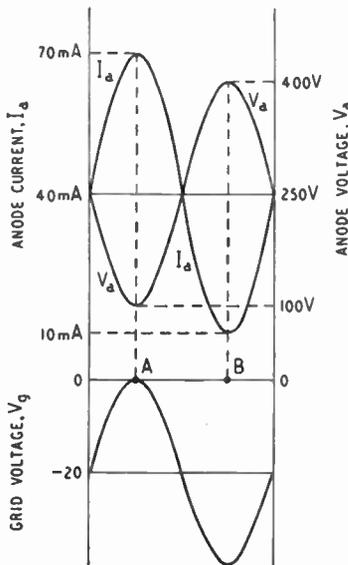
ONE of the little puzzles for the beginner is how it can be that a valve (or transistor) is heated less by a given number of watts put into it when it is working hard than when it isn't working at all. This is so contrary to our own experience, which is that the harder we work (physically) the hotter we get.

Take for example an audio output stage driving a loudspeaker, as in Fig. 1. Suppose it is receiving 40mA at 250V. That, of course, is an input power of $250 \times 40/1000 = 10$ watts. If the grid is receiving no signal, so that the anode current is pure d.c., the whole of this 10W goes into the valve, which is heated accordingly. But if now the grid is made



Above: Fig. 1. If a constant d.c. power is supplied, why does the valve's share become less when the grid is made alternately more negative and positive?

Right: Fig. 2. Variations of current and voltage in a typical example of Fig. 1 during one whole cycle.



alternately more positive and negative at audio frequency (and assuming for simplicity that the valve's characteristic curves are perfectly straight over the parts concerned, so that there is no distortion) the average anode current and voltage are just the same as before, yet some of the 10W of power is going into the loudspeaker. So the power going into the valve is that much less and it doesn't get so hot.

Fig. 2 shows the sort of thing that is happening during one cycle of the a.f. signal. The sine wave at the bottom represents the grid voltage being swung above and below a $-20V$ bias level. The anode current I_a increases and decreases in time with it, with an amplitude (shall we say) of 30mA, that it touches 70mA at maximum (A) and drops to 10mA at minimum (B). Suppose the impedance of the load at the frequency concerned is $5k\Omega$, purely resistive. Then when the anode current rises by 30mA there is a drop of $30 \times 5 = 150V$ across the load, so the voltage at the anode falls by that amount to 100V. Similarly at the current

minimum it rises to 400V, as shown in Fig. 2. As we see, the average current through the valve is the same as when there is no alternation, and this goes too for the voltage across it. Why, then, is there less power being dissipated as heat in the valve?

We can get a clue if we calculate the power at various phases, say for a start the peak points A and B. At A the power going into the valve is $100 \times 70/1000 = 7$ watts, and at B it is $400 \times 10/1000 = 4$ watts. If the signal swing were sufficient to reduce either I_a or V_a to zero, then obviously the power into the valve at those instants would be zero, no matter how large the other factor might be. The aim, then, is to make either factor—current or voltage—as near zero as possible while the other is high.

The average power during each whole cycle can most easily be found by reckoning how much is going into the load and deducting that from the total supplied—10W. The power in a resistance load is of course equal to the product of the r.m.s. values of current through and voltage across it. With a sine wave the r.m.s. value is equal to the peak value divided by $\sqrt{2}$. So in our example the power is $150 \times 30/1000 \div 2 = 2.25W$. The valve dissipation is thus reduced from 10W to 7.75W. And the efficiency (useful power \div power supplied) is 0.225, or 22½%.

This, incidentally, though not an impressively high figure, is pretty good going for a triode, if there is to be only moderate distortion. But why be content with this; why not drive it harder, so that both I_a and V_a touch zero at the peak minima, the load resistance being adjusted to make this possible? The answer is provided by the I_a/V_a characteristic curves (Fig. 3), which are essential for finding out the best working conditions. Even although the triode curves here shown are somewhat idealized (I have never seen such good ones

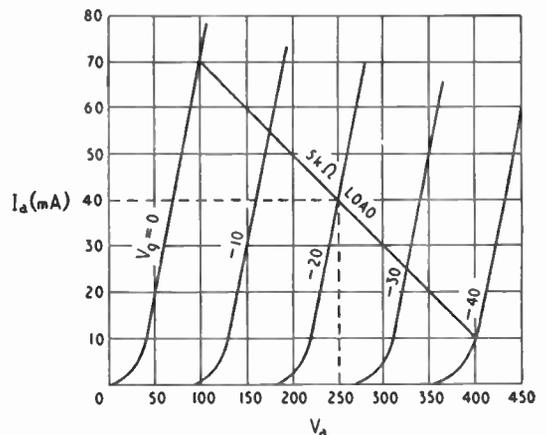


Fig. 3. Rather better than lifelike triode characteristic curves with "load line" corresponding to Fig. 2.

belonging to any real triode) it is clear that the power that can be put into the $5k\Omega$ load—or indeed any load resistance—could not be materially increased without encroaching into the positive grid-voltage region or the bottom bend region, both of which would cause a quick rise in distortion.

The " $V_g=0$ " curve is a particularly irksome restriction, because it prevents us from getting V_a down to anywhere near zero. This is one reason for the popularity of pentodes and kinkless tetrodes, whose curves have shapes that allow wider voltage swings (Fig. 4). Even so, in valves of the 10W order there is usually a useless minimum voltage of at least 50V.

Transistors present a much more attractive picture in this respect. Fig. 5 shows a typical set of I_c/V_c curves, which are spaced beautifully even and have a useless minimum of only about 0.2V! Even allowing for the working V_c being much lower than the corresponding V_a , this is a vast improvement. It is so near perfection that there is more than merely academic interest in enquiring into the efficiency of a perfect output stage—one in which both current and voltage touch zero. Fig. 6

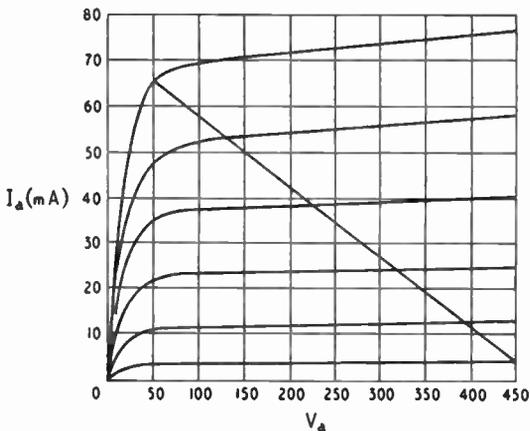


Fig. 4. Typical tetrode or pentode curves for comparison with Fig. 3, showing reason for higher power efficiency.

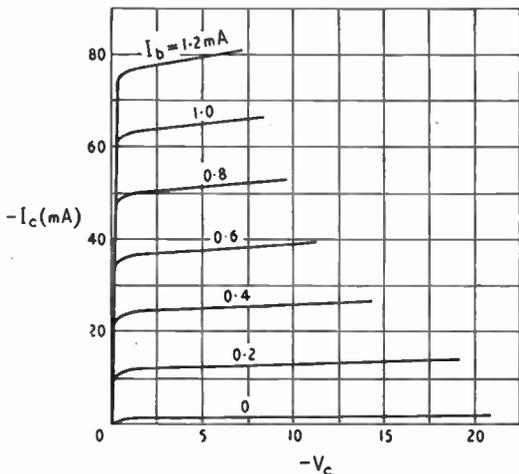


Fig. 5. Typical transistor curves, showing reason for still higher efficiency.

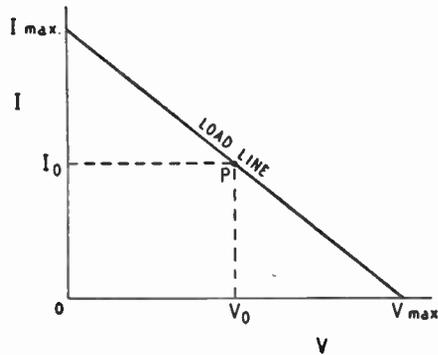


Fig. 6. Load line for an ideal output amplifier, restricted only by inability of current and voltage to be negative.

shows the load line in such a case. Current and voltage swing up and down from the working point P. For equal swings in both directions, obviously $I_{max}=2I_0$ and $V_{max}=2V_0$. The output power, calculated as before, is thus $I_0 V_0/2$; and the input is $I_0 V_0$. So the efficiency is exactly 50%.

That is for "Class A" amplification, in which the power fed in is the same for all amplitudes, because current and voltage swing equally up and down so that their averages are constant. If the efficiency is to be raised any higher, severe distortion is unavoidable, because even in this perfect device the current and voltage are assumed not to be able to go less than zero. That may seem to bar the way to even tolerable a.f. reproduction, let alone "hi fi." But what can be done is to amputate one half of every cycle completely, because that kind of distortion enables the efficiency to be increased very substantially, and although the distortion is drastic it can be put right by simultaneously amplifying the other half of each cycle and bringing the separate halves together into whole cycles. The method of doing this is known as "Class B" push-pull, and as we are at the moment considering only the power efficiency aspect I must assume you know all about the actual method. In essence it consists in adjusting the bias so that instead of the current starting from the half-way mark (I_0 in Fig. 6) it starts from zero. So the voltage starts at maximum and works downwards.

These conditions are shown for the working half-cycle in Fig. 7. The r.m.s. current through the load (as well as through the valve) is $I_{max}/\sqrt{2}$, and the r.m.s. voltage across the load is equal to V_{max} minus the voltage across the valve, so is $V_{max}/\sqrt{2}$. The output power is the product of these, namely, $I_{max} V_{max}/2$. The input power is equal to the product of the supply voltage (assumed constant) and the average current, which for a half sine wave is $2I_{max}/\pi$; result, $2I_{max} V_{max}/\pi$. So the efficiency is $I_{max} V_{max}/2 \div 2I_{max} V_{max}/\pi = \pi/4 = 78\frac{1}{2}\%$. During the second half cycle of this half of the amplifier there is zero current all the time, consequently no power at all; but the other half of the amplifier is doing its 78½%, so that is the theoretical efficiency of the whole output stage.

At the present time, the power that a transistor

(Continued on page 43)

can safely dissipate is its most serious limitation as far as a.f. amplification is concerned, so this matter of efficiency is particularly important. Suppose the maximum rated dissipation for a particular type is 0.25W. Then with Class A amplification the maximum theoretical sine-wave output (the efficiency being 50%) is also 0.25W. But in Class B only $100 - 78\frac{1}{2}\% = 21\frac{1}{2}\%$ of the power put in is dissipated in the transistor, so the output is $0.25 \times 78\frac{1}{2}/21\frac{1}{2} = 0.91W$ —nearly four times as much as in Class A.

So much for sine waves; what about square waves? For them, r.m.s. and average and peak current are all the same and could therefore all be equal to I_{max} . The voltage across the load—the output voltage—could be V_{max} throughout the half-cycle, and consequently the voltage across the valve would be zero all the time. This last fact is enough to establish that the efficiency would be 100%. In practice, of course, such a figure is unobtainable. As Fig. 5 shows, even a transistor has a certain minimum collector current (which increases steeply with temperature) at one end of the load line, and a minimum collector voltage at the other end. And then there is base current. But efficiencies over 90% are possible, so a very small transistor can generate quite a lot of square-wave power.

One aspect of this is that a transistor output stage would not (as one might have thought) be overheated by turning up the volume excessively far. On the contrary it would run cooler, because the sound programme would be distorted into approximate square waves, resulting in exceptional efficiency (regardless of the unprintable thoughts of any hi-fi exponents within earshot!)

Transistor D.C. Converters

Another aspect is the remarkably high performance of transistor d.c. converters. These are d.c. voltage raisers working on the same principle as the vibrator systems used for supplying power to car radio, except that they do the job electronically instead of mechanically. This is not the cue for an exhaustive treatise on these devices, but for the sake of any who are totally unacquainted with them (I did begin this time with beginners) I will explain the general idea.

When current is made to flow through an inductor (which is the thing you call a coil) a certain amount of energy is stored in it. Before the current can be stopped, that energy must somehow be released. This can be demonstrated with apparatus represented by the simple circuit diagram, Fig. 8. It consists of a car battery (or such like) and a coil with a large number of henries—say a winding on a large transformer. When the connection is made, energy is built up and stored in the magnetic field. The current may take several seconds to reach nearly its full value. Then break the circuit. But take care not to hold the wires in your bare hands, for I have no desire to be the defendant in a case of manslaughter. The release of energy much faster than it was built up makes it break out as a high voltage across the newly formed gap, resulting in a spectacular spark, far exceeding what one would get if an equal but non-inductive resistance were substituted for the coil.

In d.c. converters this relatively high voltage (which can be stepped up still further by means of a

secondary winding on the core) is brought under control and rendered useful by adding a rectifier and reservoir capacitor, as in Fig. 9. The rectifier is connected in such a way that it prevents any current passing through it from the battery. But the voltage induced by L at "break" is in the opposite polarity, so finds it easier to send current through the rectifier to charge C than to put on a show of fireworks at the switch contacts.

Obviously, if one is to be able to draw a continuous flow of current from C it is necessary to replenish it at frequent intervals by turning the switch on and off. In vibrator units the switch is a mechanical one, operating on the same principle as an electric bell. The rate of replenishment cannot in practice be much more than about 100 c/s or its hum would be too audible and its rate of wear excessive. Besides acoustic noise to be muffled, its electrical noise has to be suppressed.

A valve oscillator could be used, but a valve is an inefficient switch. Even although in this role the question of distortion does not arise, so that a complete "off" can be obtained by using sufficient negative grid voltage, no amount of positive grid voltage achieves a complete "on"—the valve's resistance is always substantially more than none. And if the grid is driven positive it, too, uses up quite a bit of power.

But a transistor, as we have seen, is at its best when working as a switch. By means of a feedback winding on the transformer it can be made into a blocking oscillator, which in effect turns itself on and off at almost any desired frequency. Because it can replenish C many times faster than a vibrator, it has only a small fraction as much power to handle during each cycle. Even at that rate it is completely silent and hardly wears out at all. I am assured that the overall efficiency—which takes account of losses in the transformer as well as the transistor—can be

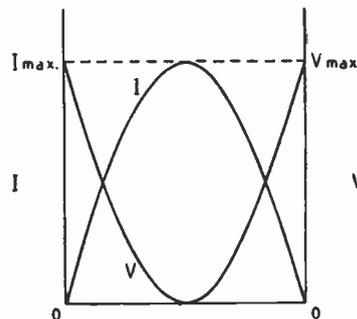


Fig. 7. Current and voltage conditions during the working half-cycle in an ideal Class B amplifier.

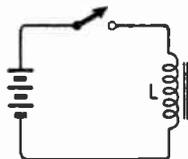
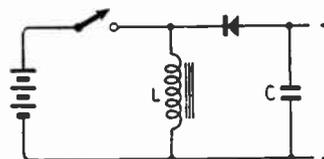


Fig. 8. The basic principle of vibrator and transistor d.c. converters or voltage raisers is the alternate storage and discharge of energy in the form of a magnetic field.

Fig. 9. If the inductive energy in Fig. 8 is transferred periodically to a capacitor it is available for drawing off continuously.



as high as 85%, but even the less efficient specimens seem to be much better than vibrators. So it looks as if the vibrator is doomed to extinction.

The transistor d.c. converter is more adaptable, too. It can be used to generate very small amounts of power, for which a vibrator would be clumsy. I very much doubt whether a vibrator would be satisfactory for running an oscilloscope from a low-voltage battery, but visitors to recent exhibitions have seen an all-transistor oscilloscope demonstrated. I suspect, too, that transistors are or will be in brisk demand for radiation counters, which the way things are going look like becoming standard household equipment!

During this digression in praise of transistor d.c. converters, the beginners I imagined to be puzzling over the problem of the unexpectedly cool valve may by now be puzzling over something else. They may have come fresh from being instructed to the effect that a power generator yields its greatest output when the resistance of the load is equal to that of itself, the efficiency then being 50%. This is a most important law, applying to all generators and loads. Another lesson showed them that valves (and transistors, if the teacher had got around to them) are equivalent to power generators. I have been talking about efficiencies of 80% and 90%, without a word on matching the resistances. So . . .!

Where is the fallacy?

There are really two (at least). One, of course, is jumping to the conclusion that the condition for maximum output is the most efficient condition. And if you say, in a superior way, that even a beginner wouldn't jump to any such thing, I would mention that in the early days of electricity supply the foremost engineers were very confused on this issue.

Numerical Illustration

A simple example ought to make the matter clear. The dotted line in Fig. 10 encloses an equivalent generator, giving an e.m.f. of 100V and having an internal resistance of 50Ω. Let us calculate the output and efficiency for three values of R: 10Ω, 50Ω and 250Ω. The output power is $I^2 R$, and I being $E/(r + R)$ it comes to $E^2 R/(R + r)^2$. The efficiency is this output power divided by the generated power, EI. Working these out we have:

Load resistance, R ..	10Ω	50Ω	250Ω
Output power	27.8W	50W	27.8W
Efficiency	16.7%	50%	83.4%

So the output power is reduced equally from its maximum—50W—by either dividing or multiplying R by 5 (the same applies to any figure), but dividing reduces the efficiency whereas multiplying increases it. If you worked out the algebra from the foregoing you will have arrived at the very simple formula for efficiency— $R/(R + r)$ —which clearly increases continuously as R is increased (or r reduced). To get a high efficiency, then, see that R/r is as large as possible.

The other fallacy is that all this is really irrelevant! (But worth noting on the side.) We had been discussing the efficiency of valves and transistors as converters of d.c. to a.c., and although the "equi-

valent generator" is a very useful idea, having a very general application to things such as valves and transistors, it relates to the "signal" only and does not concern itself with the d.c. "feed" needed to bring the valve etc. to its most suitable working point. It is failure to appreciate this distinction that gets people into a muddle over the direction of current in the valve equivalent generator. They think that because the feed current flows (according to standard convention) from anode to cathode there is some obligation to take that as the reference direction for the signal current in the equivalent generator. But feed current has nothing whatever to do with the equivalent generator.

There is a related misconception that beginners

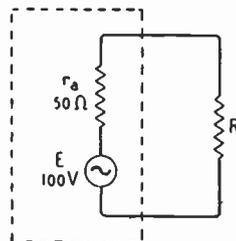


Fig. 10. The dotted line marks the boundaries of an "equivalent generator" supplying a load, R.

should beware of in connection with the maximum-output or matched-load law. An essential part of that law is constancy of the generated voltage, E in Fig. 10. In a valve equivalent generator $E = -\mu v_g$, where v_g is the signal voltage applied between grid and cathode. Generally speaking, with an output stage one is chiefly interested in the greatest output that can be obtained, without putting any fixed restriction on v_g . The really important restriction is the amount of distortion that can be tolerated, and the usual assumption is that v_g is kept adjusted to the point where the maximum tolerable distortion occurs. Where that point lies depends not only on the amount of d.c. power fed in but on the shape of the characteristic curves. We have found the efficiencies for full-sine-wave and half-sine-wave reproduction assuming perfect shapes—50% and 78.5% respectively—so we know the maximum theoretical output power of these waveforms, given the d.c. input. Because valve characteristic curves, and even transistor curves, are not perfect, the actual efficiencies, and therefore outputs for given inputs, are less; in some cases such as thermionic triodes, much less.

V.H.F. Sound Receiver I.F.

WHEN v.h.f. sound broadcasting started in this country, set manufacturers adopted an i.f. of 10.7 Mc/s as this was in use in the U.S.A. and on the Continent. Further consideration has recently been given as to the suitability of this frequency, mainly so far as interference to and from other services is concerned.

Whilst on purely technical grounds certain other frequencies showed a marginal improvement over 10.7 Mc/s, it is considered that those advantages would not justify abandoning this almost universally adopted frequency and the British Radio Equipment Manufacturers' Association has, therefore, endorsed its Technical Committee's recommendation that 10.7 Mc/s should be confirmed as the preferred i.f. for receivers used in the U.K., with the oscillator frequency on the low side of the signal frequency.

Manufacturers' Products

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

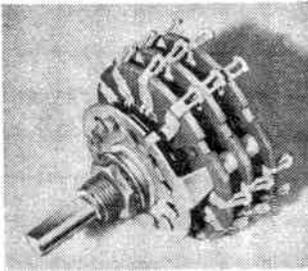
Oak Rotary Switch

A NEW Oak rotary switch known as the Model DQH, and replacing the existing Model QH, has been introduced by N.S.F., Ltd., 31-32 Alfred Place, London, W.C.1.

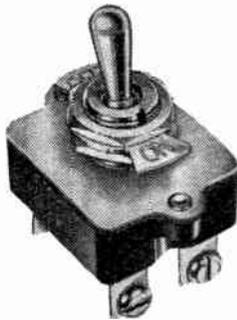
It incorporates an improved form of notched stator plate which is said to completely eliminate trouble due to loosening of the contact clips as a result of overheating during soldering operations.

The Model DQH has a 30° throw making available a maximum of 12 positions on a single wafer and any combination from 1 pole 12 positions to 6 poles 2 positions (on-off) can be provided.

Illustrated is a typical 3-section switch and this can be supplied fitted with an a.c. switch, but the rear two wafers are then omitted.



New N.S.F. Model DQH Oak switch.



Arcoelectric miniature 10-amp switch.

Miniature 10-amp Switch

RECENTLY introduced by Arcoelectric (Switches), Ltd., Central Avenue, West Molesey, Surrey, is an exceptionally compact double-pole on-off switch rated at 10 amps at 250 volts a.c. Known as the Type S254 it is designed on the snap-action, micro-gap principle, has silver contacts and is claimed to have been tested up to 250,000 operations at full rated load. A long pear-shaped "dolly" is fitted and the price is 5s.

Improved P.V.C. Cables

A NEW range of electrical wiring cables suitable for ambient temperatures up to 750°C (167°F) has been introduced by Permanoid Ltd., New Islington, Manchester, 4. They are insulated by p.v.c. compounded with a new long-chain polyester plasticizer known as "Diolpate" with a molecular weight of the order of 7,000. This has virtually no volatility at temperatures below that of decomposition, and as a result there is no migration. The insulation is also less affected by immersion in oils.

Calibration Tape

FREQUENCY response measurements and tape recorder replay head alignment can be performed with the aid of a new "Scotch Boy" twin track test tape. On one track eleven constant frequencies from 40 c/s to 10 kc/s (inclusive) are recorded to within ±1dB of the C.C.I.R. specification. Each of these frequencies

lasts about ten seconds and is preceded by an announcement. On the other track is recorded a continuous 7½-kc/s tone for head alignment purposes. This 150-ft tape costs 49s 6d and is marketed by the Minnesota Mining and Manufacturing Co. Ltd., Wigmore Street, London, W.1.

Expanded Polystyrene

A CELLULAR structure is given to polystyrene in "Polyzote," a product of Expanded Plastics, Ltd., 675, Mitcham Road, Croydon, Surrey. This material is supplied in granular form for moulding with a chemical additive which forms a gas on heating, and fills the mould with a cellular mass, which on cooling has high strength and low density (1½lb/cu ft).

Although used chiefly for heat insulation, the dielectric properties are good (resistivity >10¹¹MΩ, permittivity 1.05, loss factor, tan δ, <0.0005) and it has considerable possibilities in radio and radar. One known application is for the casing of a high-altitude balloon radar sonde transponder where its light weight and transparency to radiation (the aerial system is enclosed) have obvious advantages. Not so obvious perhaps is the fact that the batteries retain their normal temperature and so function longer in the low ambient temperatures of high altitude.

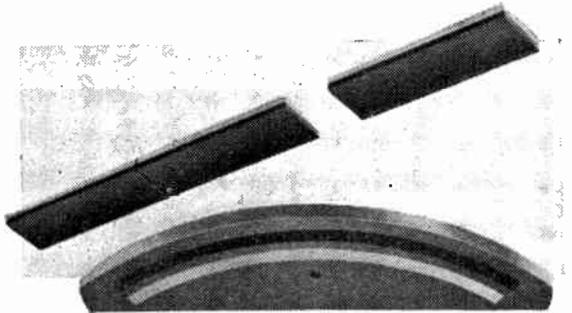
Moulded Resistance Elements

PRECISION resistance elements consisting of tracks of high-grade phenolic of the type used in some of their precision volume controls, can now be obtained from the Plessey Company to meet specific requirements. So far they have found applications mainly in industrial control equipment, but they are equally suitable for use wherever a stable, close-tolerance resistance is required for the variable element in precision equipment.

Elements have been produced in resistance values ranging from 25 Ω to 10 MΩ, at present with a tolerance of ±5% and with a linear or logarithmic resistance law. They are made in a variety of shapes and are said to maintain their stability when operated at temperatures ranging from -40°C to +100°C.

The illustration shows two of the forms they can take; one is a curved element, the other is a series of straight elements, each of 10kΩ, placed end-to-end. A sine/cosine moulded track unit has also been produced for a special type of potentiometer. It is stated that a moulded carbon brush is the most suitable type for the wiper.

The units are supplied to customer's individual requirements by The Plessey Co., Ltd., Swindon Components Division, Kewbrey Street, Swindon, Wilts.



Examples of moulded carbon track elements made by Plessey.

News from the Industry

Anglo-American Agreement.—The Radio Corporation of America has arranged to acquire from Marconi's technical information on the Doppler navigation system which will be used in the design of R.C.A. equipment for civil airlines. Marconi's have been producing Doppler equipment for the R.A.F. for the past three years and introduced a new type (AD2300) for civil use last June (see *W.W.*, August, page 396).

Solartron Expansion.—Work has begun on the first section of a new factory being built for the Solartron group at Tower Hill, Farnborough, Hants. This section of the one-storey building will have an area of 50,000 square feet and is planned to be in use by next August. The whole factory on the 15-acre site, which will include a helicopter landing space, is scheduled to cover 350,000 square feet.

Ekco Electronics, Ltd., designed and installed the complete nuclear instrumentation and control circuitry for PLUTO, the atomic research reactor which recently commenced operation at Harwell. Ekco are now working on similar equipment for the Australian HIFAR reactor at Lucas Heights and the DMTR reactor for Dounreay, Scotland.

Audio Group.—Three companies in the electro-acoustics field—Audio Amplifiers, Ltd., CQ Audio, Ltd. (formerly R.G.A. Sound Services), and Romagna Audio, Ltd.—have formed what is to be known as the Audio Group of Companies. The directors are Stanley Kelly and A. R. Neve. The headquarters are at 2, Sarnesfield Road, Enfield, Middlesex (Tel.: Enfield 8262). Stewart Hillman, formerly with Cosmocord, has joined the group as general sales manager.

Aerialite, Ltd., recently celebrated their silver jubilee and to mark the occasion the staff made presentations to the chairman (L. S. Hargreaves) and his co-directors. The staff, which was two in 1932, is now 2,000.

Peto Scott Electrical Instruments, Ltd., announce that A. T. Black has been appointed to its board. Mr. Black, who was until recently director of electronics production (munitions) in the Ministry of Supply, is also a director of Pena Copper Mines, the parent company, the title of which is being changed to Pena Industries, Ltd.

Decca airfield control radar (Type 424) has been installed by Rolls-Royce at their flight test airfield at Hucknall, near Nottingham.

Wayne Kerr have developed at their Tolworth, Surrey, laboratories an electronic instrument for detecting and measuring the water content in aircraft jet fuel. The equipment is designed to detect, whilst the aircraft is in flight, as little as five parts of water in one million parts of fuel. The icing-up of fuel filters at high altitudes presents a very serious threat to air safety and the Wayne Kerr instrument automatically switches on tank de-icing equipment if moisture is detected.

Modern Acoustics, Ltd., of Manor Way, Boreham Wood, Herts., a subsidiary of the Plessey Co., are to produce a new range of plugs and sockets. They will be manufactured under licence from Tüchel Kontakt of Germany. The world marketing rights outside Europe for the Tüchel design have been assigned by Plessey to their subsidiary.

EXPORTS

Thailand.—A report on the domestic receiver market in Thailand, prepared by the British Embassy in Bangkok, shows that during 1956 only about 4% of the imports were purchased from the United Kingdom. Nearly 50% of the receivers came from the Netherlands, 25% from Germany and about 15% from Japan. The U.K. had a greater share in Thailand's purchase of radio components and accessories—Japan, the Netherlands and Great Britain having 18%, 17% and 16% respectively. The U.S. supplied 24%.

Honduras Agency.—A *gencia* Acorda, Apartado 15, San Pedro Sula, Honduras, are interested in representing U.K. manufacturers of high-fidelity reproducing equipment, receivers and radio-grams.

VENNER ELECTRONICS have developed for the Road Research Laboratories of the D.S.I.R. an electronic vehicle speed measuring instrument which is being tested by the Metropolitan Police. Basically, the device is for measuring small intervals of time and it is started and stopped by the front wheels of the vehicle passing over rubber tubes laid in the road (see page 32). The accuracy is plus or minus $\frac{1}{2}\%$ at 30 m.p.h.



Mobile radio-telephone transmitting and receiving equipment worth approximately £23,000 has been ordered from Marconi's by the Kuwait Oil Co. Five 50-watt base transmitters and associated receivers will be installed at one site (Ahmadi) and two 50-watt transmitters and receivers at two others (Raudhatain and Seismic Camp). The company's fleet of 37 vehicles is being fitted with 10-watt transmitter-receivers.

NEW ADDRESSES

Brighton Laminations, Ltd., makers of Bribond thermosetting and thermoplastic mouldings and printed circuits, have moved their headquarters to Burgess Hill, Sussex, but are retaining their Brighton works. The company has changed its title to Bribond, Ltd.

Farnell Instruments, Ltd., the instrument distributors of Leeds, have moved to Wetherby Industrial Estate, York Road, Wetherby, Yorks. (Tel.: Wetherby 2541). Their service department has been expanded and they are now in a position to undertake the development and manufacture of instruments to customers' requirements. The works manager is Mr. Sidebotham, who until recently was in the aircraft industry as head of an electronics research department.

Allen Components, Ltd., manufacturers of sound and television equipment, have moved from Richmond to 38, Felsham Road, London, S.W.15 (Tel.: Putney 3032).

H. W. Forrest (Transformers), Ltd., of 349, Haslucks Green Road, Shirley, Solihull, Warwickshire, have introduced a range of transformers (from 200mW to 20W) for use with a.f. transistors.

JANUARY MEETINGS

LONDON

9th. Television Society.—“A French portable television camera” by J. Polonsky at 7.0 at 164 Shaftesbury Avenue, W.C.2.

17th. B.S.R.A.—“The electrical production of music” by Alan Douglas at 7.15 at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2.

17th. Institute of Navigation.—“The influence of atmospheric conditions on radar performance” by Dr. J. A. Saxton at 5.15 at 1 Kensington Gore, S.W.7.

22nd. I.E.E.—“Special problems of broadcasting in Sweden” by E. Esping at 5.30 at Savoy Place, W.C.2.

23rd. Television Society.—Fleming Memorial Lecture “Crystal valves” by T. R. Scott (S.T.C.) at 7.0 at the Royal Institution, Albemarle Street, W.1.

24th. R.S.G.B.—Presidential Address followed by “The human machine as a radio operator” by F. J. H. Charman (G6CJ) at 6.30 at the I.E.E., Savoy Place, W.C.2.

27th. I.E.E.—“An enquiry into the specification of transistors” by F. F. Roberts at 5.30 at Savoy Place, W.C.2.

28th. I.E.E.—Symposium on “Long-distance propagation above 30 Mc/s” (a) “Ionospheric forward scatter propagation” (at 2.30), (b) “Tropospheric propagation beyond the horizon” (at 5.30) at Savoy Place, W.C.2.

29th. Brit.I.R.E.—“Ultra-high-speed oscillography” by I. Maddock at 6.30 at the London School of Hygiene, Keppel Street, W.C.1.

ABERDEEN

10th. I.E.E.—“The remote and automatic control of semi-attended broadcasting transmitters” by R. T. B. Wynn and F. A. Peachey at 7.30 at the Robert Gordon's Technical College.

BIRMINGHAM

21st. Institute of Physics.—“The computer and its uses” by C. Robinson (English Electric) at 7.0 at the Birmingham Exchange and Engineering Centre.

27th. I.E.E.—“Transistor circuits and applications” by Dr. A. G. Milnes at 6.0 at the James Watt Memorial Institute, Great Charles Street.

BRIGHTON

15th. I.E.E.—“The B.B.C. sound broadcasting service on very-high frequencies” by E. W. Hayes and H. Page at 6.30 at the Technical College.

BRISTOL

13th. I.E.E.—“The B.B.C. sound broadcasting service on very-high frequencies” by E. W. Hayes and H. Page at 6.0 at Bristol University Engineering Laboratories.

CARDIFF

22nd. Brit.I.R.E.—“Applications of magnetic recording” by J. Cunningham-Sands at 6.30 in the Department of Physics, University College.

22nd. Society of Instrument Technology.—“The use of computers in process control” by W. G. Proctor (Metropolitan-Vickers) at 6.45 in the Physics Lecture Theatre, Cardiff College of Technology.

CHATHAM

23rd. I.E.E. Graduate and Student Section.—“Colour television” by A. Harris at 7.0 at the Medway College of Technology.

DUNDEE

9th. I.E.E.—“The remote and automatic control of semi-attended broadcasting transmitters” by R. T. B. Wynn and F. A. Peachey at 7.0 in the Electrical Engineering Dept., Queen's College.

EDINBURGH

20th. I.E.E.—“Some aspects of half-wave magnetic amplifiers” by G. M. Ettinger and “Some transistor input stages for high-gain d.c. amplifiers” by Dr. G. B. B. Chaplin and A. R. Owens at 7.0 at the Carlton Hotel, North Bridge.

21st. I.E.E.—“The importance of research in hearing and seeing to the future of telecommunication engineering” by Dr. E. C. Cherry at 7.0 at the Carlton Hotel, North Bridge.

FARNBOROUGH

8th. I.E.E.—“Colour television” by C. J. Stubbington at 6.30 at the R.A.E. Technical College.

GLASGOW

9th. Brit.I.R.E.—“Electronic calculator circuitry” by F. Baillie at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

21st. I.E.E.—“Some aspects of half-wave magnetic amplifiers” by G. M. Ettinger and “Some transistor input stages for high-gain d.c. amplifiers” by Dr. G. B. B. Chaplin and A. R. Owens at 7.0 at the Royal College of Science and Technology, George Street, C.1.

LIVERPOOL

3rd. Institute of Physics.—“Radio astronomy” by Dr. H. P. Palmer (Jodrell Bank Experimental Station) at 7.0 in the Department of Electrical Engineering, University of Liverpool.

20th. I.E.E.—“Ferrites” by W. A. Turner at 6.30 at the Royal Institute, Colquitt Street.

MALVERN

31st. Brit.I.R.E.—Annual General Meeting, followed by “Digital computers” by R. Deighton at 7.0 in the Winter Gardens.

NEWCASTLE

8th. Brit.I.R.E.—“The earth satellite project” by P. H. Tanner at 6.0 at the Institution of Mining and Mechanical Engineers, Westgate Road.

15th. Society of Instrument Technology.—“Modern types of electronic recorders” by F. A. Bergen (Cambridge Instruments) at 7.0 at King's College, Stephenson Building.

20th. I.E.E.—“Ferrites” by Dr. F. Brailsford at 6.15 at King's College.

PRESTON

6th. I.E.E.—“The B.B.C. sound broadcasting service on very-high frequencies” by E. W. Hayes and H. Page at 7.15 at the Electricity Board Demonstration Theatre, 19 Friargate.

RUGBY

29th. I.E.E.—“Recent developments in X-ray and electron-microscopy with some applications to radio and electronics” by C. W. Oatley and Dr. V. E. Cosslett at 6.30 at the Rugby College of Technology and Arts.

WOLVERHAMPTON

8th. Brit.I.R.E.—“Instrumentation of space vehicles” by N. R. Nicoll at 7.15 at the Wolverhampton Technical College, Wulfruna Street.

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P277

RANDOM RADIATIONS

By "DIALLIST"

Forward Scatter

IN the B.B.C.'s Annual Report for 1956-57 great concern is expressed about the encroachment by forward scatter transmissions into some sound and TV wavebands. I don't wonder, for forward scatter has been causing horrible interference with television reception in some parts of the country. As the report says, further developments of sound and television services may well be adversely affected, unless action can be taken to resist encroachment into bands allotted to broadcasting by international conferences. It's strange how unlooked-for interference so often arises in both sound and television. With the coming of high-power sound broadcasting stations there arrived the Luxembourg Effect; nobody expected that the Caen TV station would interfere with reception along our south coast, or that there'd be trouble with Liège when Norwich went up to full power. And there's another possible source of worry looming ahead. The Government of Southern Ireland has decided that the Republic must have a television service. It may not be easy to fit its station or stations in on channels where they don't cause despondency and dismay to viewers in some of our westerly districts*.

* There is no provision in the Stockholm Plan for Irish stations in Band I, but five are allowed for in Band III.—Ed.

Light and the Metre

FOR 75 years now the world's standard metre has been "M," the platinum-iridium bar housed at Sèvres, near Paris. But a change has been decided upon and as soon as it has been accepted by the International Committee of Weights and Measures, due to meet next October, it will be officially adopted by all countries. The new measuring rod is to be a wavelength of light, an idea which was first suggested 130 years ago. The light is that of an orange line in the spectrum of the 86 isotope of krypton— ${}_{36}\text{Kr}^{86}$. Multiply its length by 1,650,763.73 times and you have the new standard metre, which is more than 100 times as accurate as that derived from the old metal bar. With such a precise metre to work from it should be possible, one would imagine, to find an exact and

universally accepted value for the velocity of light and wireless waves. A vast amount has been done on this problem by physicists and mathematicians, but no two solutions have ever been exactly the same. Admittedly, the differences are very small; but still they are differences and since the velocity of light is a widely used constant, they shouldn't be there.

Hills and Plains

WRITING from near Colne in Lancashire a reader tells me of the difficulties experienced in that hilly part of the country in receiving Band III television transmissions. Such frequencies, he feels, are quite unsuitable for any but the flatter parts of this country of ours. He has an interesting suggestion to make, though I'm afraid it's hardly a practicable one. Draw a line, he says, through Nottingham from coast to coast: to the south of it there are few hills worth mentioning: to the north it's nothing but hills. He'd like to see all transmission north of this line made in Band I and all those south of it in Band III. Even if his assumptions were correct, what a hullaballoo there'd be should such a change be made! Can't you imagine the tumult and the shouting? Thousands of TV receivers of the Band I only type would become useless in the south unless they were converted. Millions of aeriols would have to be

changed. And neither the B.B.C. nor the I.T.A. would be enthusiastic about altering their transmitters. Even were all this done, would it work out? I don't think so, I'm afraid, for there's quite a lot of hilly country south of this imaginary line. Much of the Welsh mountain country, Exmoor, Dartmoor, the Cotswolds, the Chilterns, the Quantocks and other areas that are far from flat lie there. It's an ingenious idea, but it just wouldn't do.

Canada's TV Problem

CANADA has already a publicly-owned television system which serves about two million owners of receiving sets. "This," wrote George Ferguson, editor of the *Montreal Star*, in a recent Canada Supplement of *The Times*, "extends at the moment from the Prairie Provinces in the West to Halifax, Nova Scotia. There remain the links with Newfoundland and British Columbia, but these will be pressed forward." The main question, I gather, is who is going to pay for the service and how? The service is run by the Canadian Broadcasting Corporation, which, unlike our B.B.C., is not financed from licence fees. The proposal to introduce receiving licences was met by the firmest possible opposition. Instead, the Government put a 15 per cent tax on both sound and television receive-



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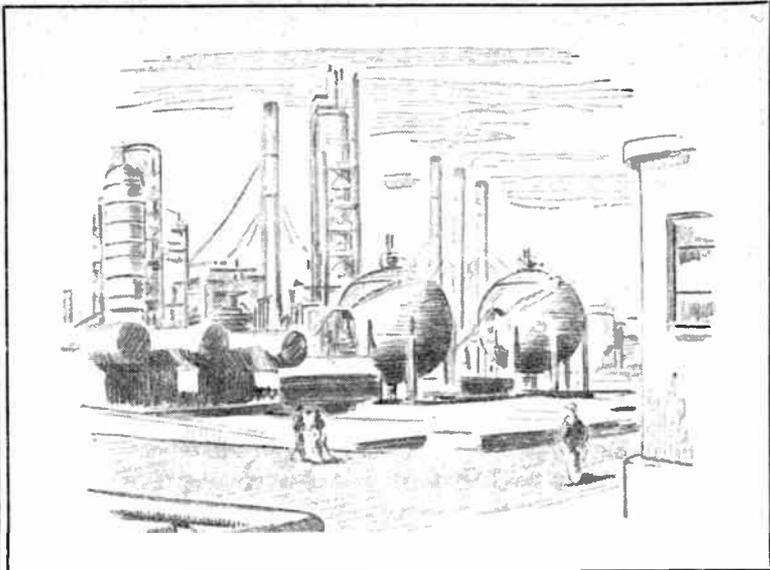
ing sets. This, together with its income from commercial programmes, produces far less than is needed to keep the C.B.C. going and meet the huge capital expenditure envisaged in the next six years. It should be added that Canada has in addition to its growing C.B.C. network a number of privately-owned commercial TV stations.

Making Satellites Work

A NOVEL suggestion for getting further useful work out of artificial satellites was made recently by R. J. Hitchcock, head of a section in the department of the engineer-in-chief of Cable and Wireless, Ltd. Sputnik II is said to be working already by recording a variety of measurements of conditions outside our atmosphere and sending them back to earth; but Hitchcock's idea is something quite different. Briefly, it is that satellites could be used to store communications from one part of the world and later to transmit them to another part. It should, he says, be possible to feed to a satellite in a few minutes all the telegraph traffic normally passing in a whole day between, say, this country and the antipodes. Three-quarters of an hour later the satellite would have reached a point in its orbit from which the messages could be transmitted at high speed to their destination. All this presupposes that some form of power supply, constantly replenished by solar energy, will be developed—and there is nothing unlikely about that. We'd also need satellites which would stay put, once they'd been started in larger orbits, and not come flaming back to earth in a matter of weeks or months.

It Won't be Easy!

There would also be the problem of precession, but that might not matter all that much, for a great number of moonlets would be needed to deal with world-wide communications and the ones in the right sort of orbits at a given moment could be used to deal with particular services. In the light of our present knowledge, the cost of putting such a scheme into practice would be staggering; but we're only at the very beginning of the satellite era and as the years go on cheaper and more effective methods of launching and equipping them will doubtless be discovered. Nevertheless, there are going to be some pretty knotty problems for solution.



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Irritating Irrationalities

WE are all aware that, throughout the world, voltages, whether those of the grid system or those in our homes, are rated in multiples of 11. Thus in the U.S.A. the standard domestic voltage is 110 and over here we had 220. The grid deals in voltages of 11,000, 33,000, 66,000 and so on. All these are multiples of 11, instead of the more obvious ten. There are, of course, odd voltages scattered about, such as 130 and 160 on the Continent and, of course, 230, 240 and others in this country, which don't seem to be based on anything.

"Diallist" once told us that he believed the basing of voltages on 11 instead of ten was due to the fact that originally the e.m.f. of the standard Clark cell, which is 1.1 volts, was taken as a starting point. I believe "Diallist" to be correct in his opinion but if any egghead knows better let him say so.

It would be too difficult to alter



What does 'Stille' mean?"

all this now by changing voltage ratings all over the world. Surely, however, we could get round the difficulty by a similar ingenious dodge to that which we use to make ourselves get out of bed earlier in the summer. All we do is to say it is 7 a.m. when it is really 6 a.m. Could we not therefore abandon the volt and adopt the "Clark" as the unit of e.m.f.?

There is one irritating irrationality or insane illogicality which is of such comparatively recent birth that it can and should be altered. I refer to the irritating speed rating of tape recorders where we have to write clumsy fractional speeds like $1\frac{1}{2}$ in/sec. $3\frac{1}{2}$ in/sec and so on.

Soon, I believe, we are to have a still slower speed for office work, namely $\frac{1}{2}$ in/sec. I suppose these absurdities arose because in the pioneer days of magnetic recording 30 in/sec was used and then this was halved. When it was halved again the trouble started.

There are far too many tape re-

corders in use to alter the speeds to 2, 4, 8, etc., in/sec. It would be perfectly easy, however, to follow the example of the sailor who calls a nautical m.p.h. a "knot" (not a knot per hour!). Let us call $1\frac{1}{2}$ in/sec one "Stille." Better still, to allow for slower and slower speeds in the future, let us call it 100 Stilles (or should I say Stillen?) I hope no W.W. reader is so sunk in ignorance as to wonder what the word "Stille" signifies.

Callee-Coming Indicator

JUST lately we have heard a lot about the progress of automation in the telephone service but not a single mention has been made of one grave defect in our 'phone system which could be so easily remedied by radio technique.

Like myself, many of you have probably experienced the mortifications of hearing the telephone ring just as you have got into the bath. It always seems to be at a time when there is nobody else in the house.

It may be only a call from your tailor with a polite reminder about his overdue bill. But it may be a call from your favourite blonde, and consequently you spring out of the bath and rush downstairs, wrapping a towel around your midriff as you run, for the

sake of Mrs. Grundy's feelings, even though you know you are alone in the house.

Just as you are a few paces from the 'phone it ceases ringing and, as you squelch your way back to the bathroom, you are left wondering who had rung. It has so often happened to me that I determined to do something about it. As the result of my labours, the distant caller receives a definite indication that his callee is coming so that he hangs on rather than hangs up.

Strictly radio principles are used in my device and the beauty of it is that no breach occurs of the P.M.G.'s regulations which forbids subscribers to fix attachments to the telephone. Over the handset of the desk telephone I have placed a modification of a model grab crane such as is used in those automatic machines on seaside piers in which you are invited to risk a penny trying to get the crane to pick up a trumpery trinket. By the side of the crane I have placed a small tape

machine fitted with a short endless-band tape.

The apparatus is connected to the output of a tiny s.w. receiver of the type used in radio-controlled model planes and boats. On my person I have one of the small transmitters sold for model control. Incidentally, these little transmitters now require a licence from the P.M.G. but the cost is only £1 for five years.

An impulse from the transmitter first sets the crane in motion. It grabs the handset, lifts it and transfers it to the table with its mike near the loudspeaker of the tape machine which is then triggered off and repeatedly bellows out "Hello caller; your callee is coming."

I have designed the tiny transistorized transmitter to fit in an old bowler I always wear when in and around the house, even in the bath.

Tongue Tinglings Explained

IN reply to my request for suggestions for a literally self-contained battery to supply a few volts in my proposed "Torso Two" receiver, I have had an interesting letter from a reader who writes from Orpington.

He points out that when dentists fill a cavity they have to be careful to match the metal filling with any others which already exist in the mouth. The reason is that if dissimilar metals are used, a small e.m.f. is generated and the resultant current causes unpleasant tongue tinglings.

As I have replied to him, I am afraid that many dentists are careless in this respect and probably that is why grandfather usually keeps his denture on the mantelpiece rather than in his mouth. It also accounts for the sharp taste I have with everything I eat and I must try to devise a suitable earthing system.

My correspondent suggests that use might be made of this effect to give me the volts I want. Unfortunately, however, I don't think the voltage would be high enough although the potentialities of such an arrangement are certainly worth the attention of the research worker who is seeking a permanent battery for a hearing aid. There is already a hearing aid combined with a pair of spectacles and so dentists might as well be brought into the syndicate.

So far as women and gum-chewers are concerned it would be only necessary to couple a simple generator to their jaws as the constant movement would keep it going. Actually, I believe this has been suggested before for another purpose. The idea then was that the constant movement of the jaws would steadily build up a high potential in a capacitor which would finally discharge and so give the female tongue wagger a sharp shock to signal the QRT to her.

TO FIT THE POCKET

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 10th Edition of
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 Valve Data Manual
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This splendid new AVO Instrument has been developed to meet a definite demand for a sturdy pocket-size multi-range test meter at a modest price, suitable for use on modern electronic apparatus as well as for radio and television receivers, motor vehicles, and all kinds of domestic appliances and workshop equipment.

Readings are obtainable quickly and easily on a very open scale, and range selection is by means of a robust clearly marked rotary switch of the characteristic Avometer type. Measurements of A.C. and D.C. Voltage, D.C. Current, and Resistance are made by means of only two connection sockets.

19 Ranges

D.C. Voltage	A.C. Voltage
0—100mV.	0—10 V.
0—2.5 V.	0—25 V.
0—10 V.	0—100 V.
0—25 V.	0—250 V.
0—100 V.	0—1000 V.
0—250 V.	
0—1000 V.	
	D.C. Current
	0—100µA
	0—1mA
	0—10mA
	0—100mA
	0—1 A
Resistance	
0—20,000Ω	
0—2 MΩ	

Sensitivity:
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Accuracy:
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List Price: **£9/10s.**
 complete with Test Leads and Clips
 Size: 5½ x 3½ x 1½ inches
 Weight: 1 lb. approx.

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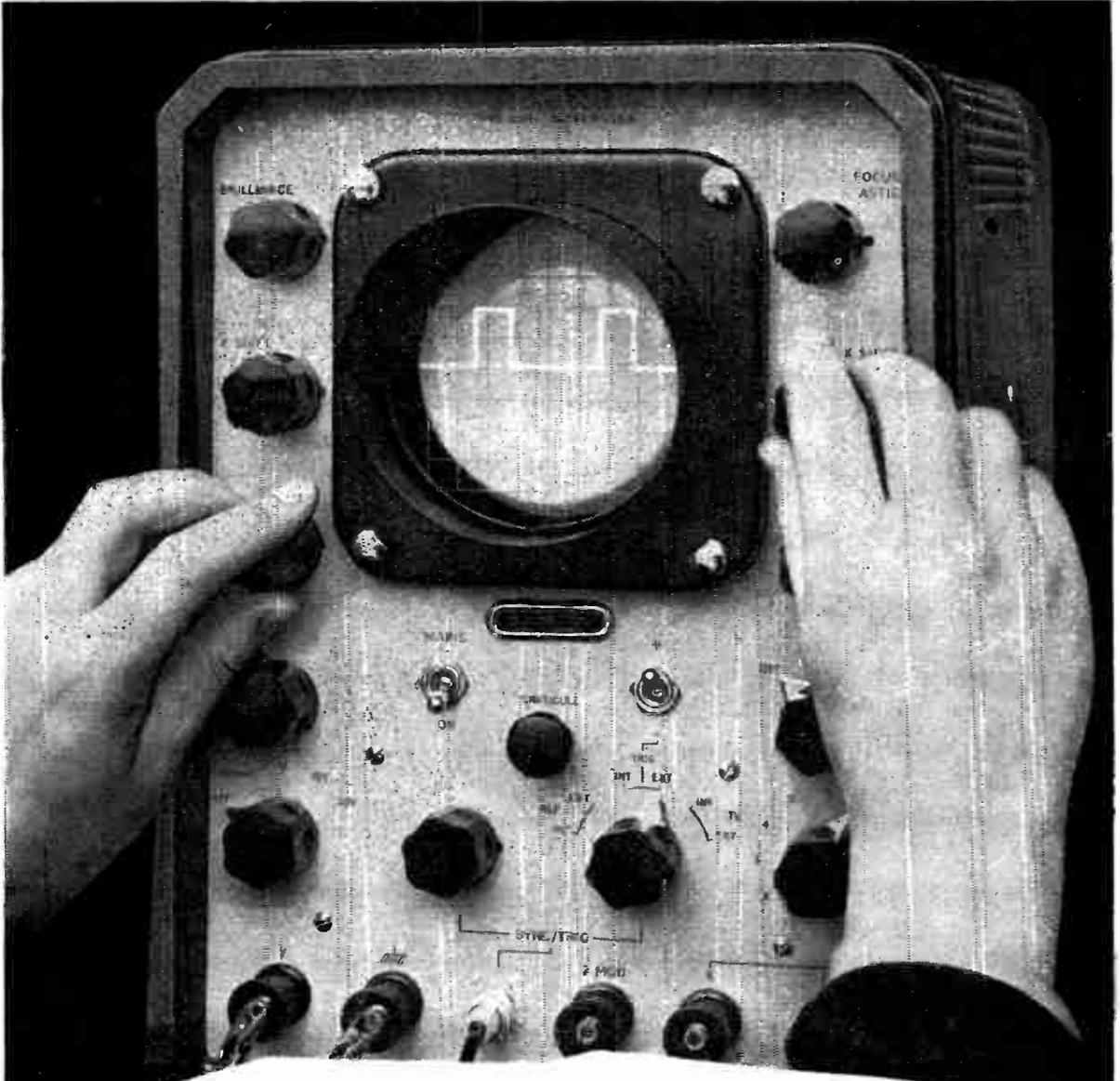


Leather Case
 if required 32/6



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In the Solarscope CD 614 we have included all the valuable features of heavier and more expensive oscilloscopes, while producing a truly portable instrument at an economical price.

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BRIEF SPECIFICATION:

NOMINAL BANDWIDTH
1 c/s—9 Mc/s \pm 1 Mc/s for 3 db down

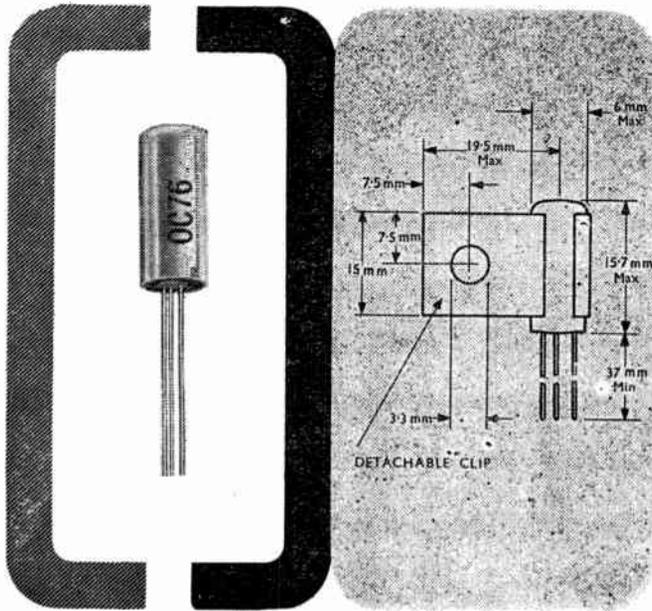
SENSITIVITY CALIBRATION
By a 50 c.p.s. square wave

EXPANSION
10 diameters nominal

CALIBRATION
By 0.1 μ s, 1 μ s, and 10 μ s markers \pm 5%

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10 c.p.s. — 200 Kc/s. Trigger from TV frame block

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A germanium junction P.N.P. transistor available in quantity for industrial and d.c. converter applications in computing, switching and instrumentation.

OC76 industrial and switching TRANSISTOR

The new Mullard transistor OC76 is related to the well-known OC72 but is specially tested for non-sinusoidal industrial and d.c. transformer applications.

The pentode type knee of the OC76 characteristic is carefully controlled to give a low and uniform "bottoming" voltage. Its collector will withstand 30 volts d.c. in grounded base. In grounded emitter 30 volts d.c. may also be applied when the total base-to-ground impedance is less than $1k\Omega$ or the collector current is cut off by a reverse base bias.

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As a power oscillator, efficiencies of over 90% are possible with the OC76, while the high peak current of $\frac{1}{2}$ amp can be used to close large relays and operate small motors.

The OC76 is available in quantity. Full data is available from the address below.

Limiting values (absolute ratings)

Max. collector voltage	...	...	32V peak	32V d.c.
Max. collector current...	...	...	250mA peak	125mA d.c.
Max. junction temp.	...	...	75°C continuous operation. 90°C intermittent operation (total duration 200 hours max.)	



Abridged Characteristics

Max. collector leakage current at $V_c = -10V$	...	...	...	...	10 μ A
Current amplification cut-off frequency	...	...	...	...	350kc/s
Collector knee voltage at $I_c = 125mA$	...	...	...	...	-0.4V
Power dissipation (without heat sink) at 25°C	125mW
Power dissipation (bolted to heat sink) at 45°C	100mW



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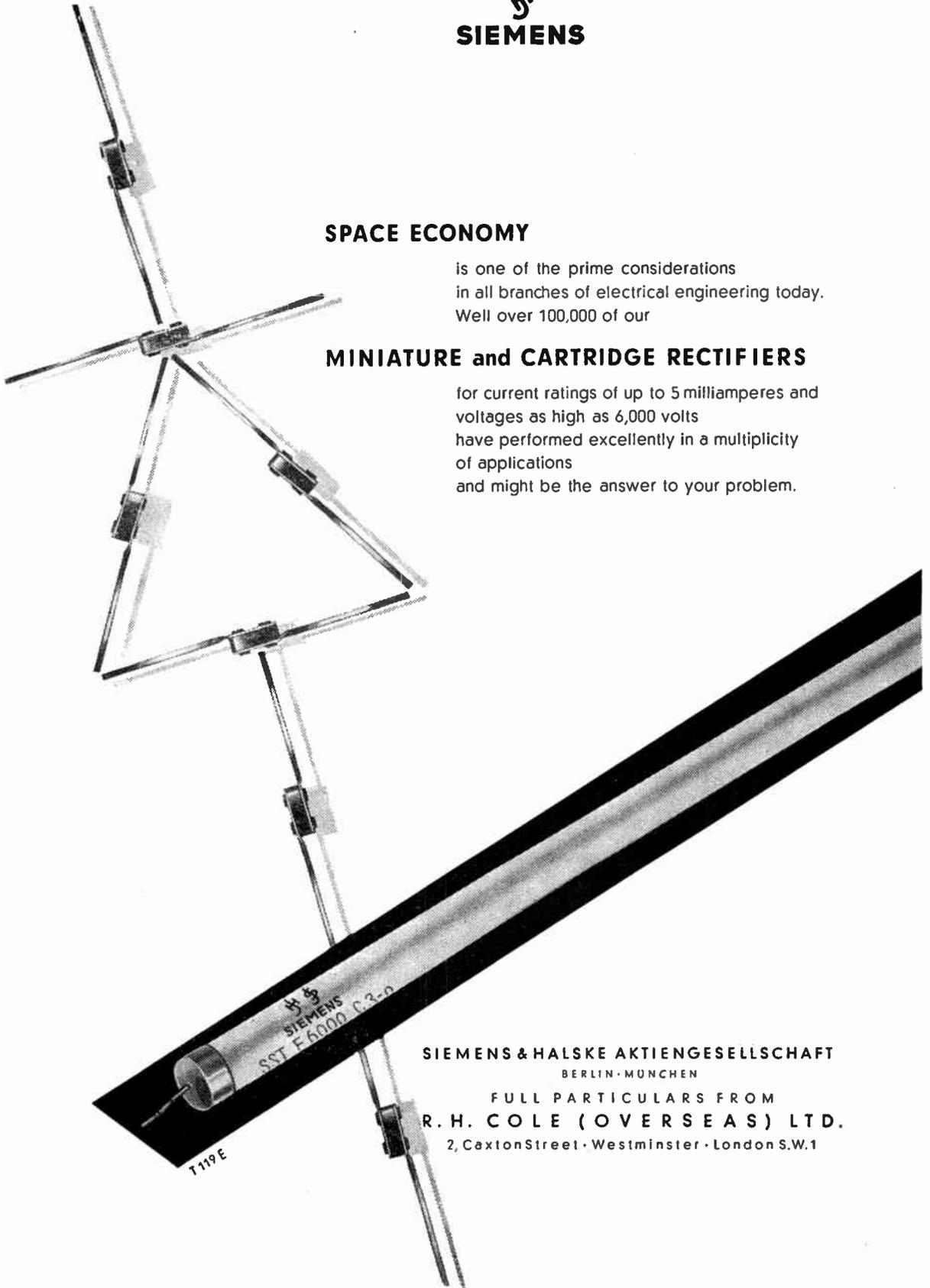


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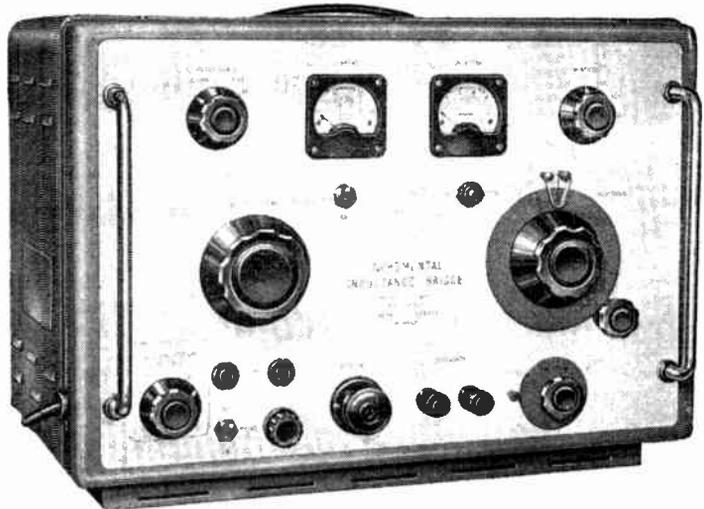
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Provision is made for passing any current up to 1 Amp d.c. through the winding and selectable a.c. excitation voltages of 1, 2, 5, 10 and 20V r.m.s. are provided.

Full technical information is available on request.

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A SELECTIVE MEASURING SET

30 kc/s - 30 Mc/s

H.F. WAVE ANALYSER Type 853

Can be employed

- (a) To measure insertion gain and loss.
- (b) To measure field strength and interference.
- (c) For harmonic analysis.
- (d) As a selective Voltmeter.
- (e) As a Bridge Detector.
- (f) As a Heterodyne Wave Meter.

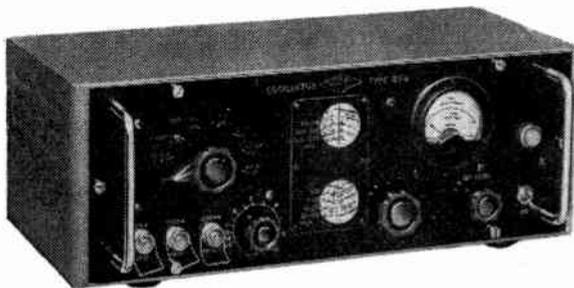
SPECIFICATION

Frequency Range: 30 kc/s-30 Mc/s in 7 ranges.
Amplitude Range: 30 kc/s-20 Mc/s: $1\mu\text{V}$ to 120 db above $1\mu\text{V}$
 20 Mc/s-30 Mc/s: $4\mu\text{V}$ to 120 db above $4\mu\text{V}$.
Harmonic Measurement: 2nd harmonic 70 db and 3rd harmonic 90 db down can be measured.
Selectivity: 3 kc/s bandwidth.
Attenuators: R.F. Attenuator 0-60 db in 20 db steps. L.F. Attenuator 0-60 db in 10 db steps and a 10 db variable attenuator.
Input Impedance: 75 ohms. A high input impedance probe unit is also provided.



OSCILLATOR Type 858

The Oscillator Type 858 is designed primarily for use as a calibrating Oscillator for the Wave Analyser Type 853, and as such provides fixed levels of output for setting up the instrument. It may however, be used separately as a c.w. oscillator of low harmonic distortion and stabilised output level.



SPECIFICATION

Frequency Range: 30 kc/s-30 Mc/s in 7 ranges.
Frequency Stability: Better than 0.05% for a mains change of 25%.
Harmonic Distortion: In general better than 1%.
Output Level: Remains constant within ± 1 db over entire frequency range.
Outputs: 500 mV, 100 mV and 1 mV stabilised. A slidewire attenuator enables a continuous coverage to be obtained from 500 μV to 500 mV.

Full details of these or any other Airmec instrument will be forwarded gladly on request.

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Telephone: High Wycombe 2060

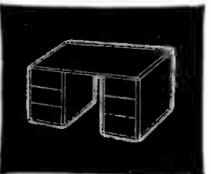
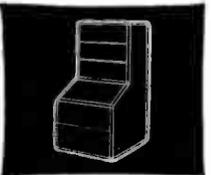
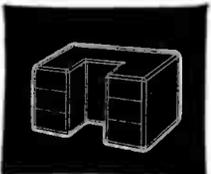
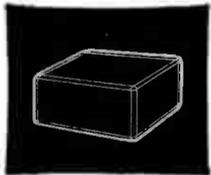
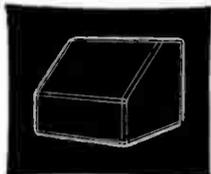
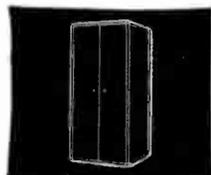
Cables: Airmec High Wycombe

LGB



Extended range of connectors and extrusions means

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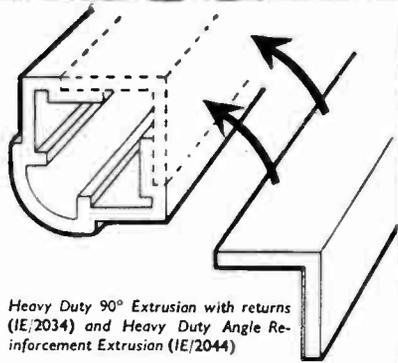
Scope for design unlimited

The Imlok extrusion is now available in five alternative strengths to suit almost every application and the extended range of components means unlimited scope in shapes and sizes. Special jigs for quick, accurate cutting and filing also supplied. May we send more details?

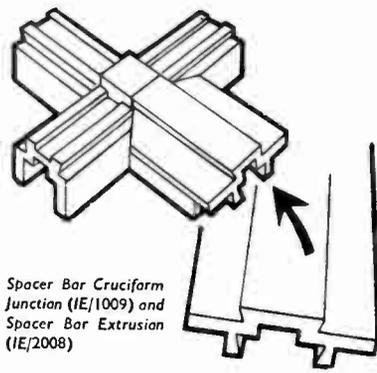
IMLOK

Economical, too!

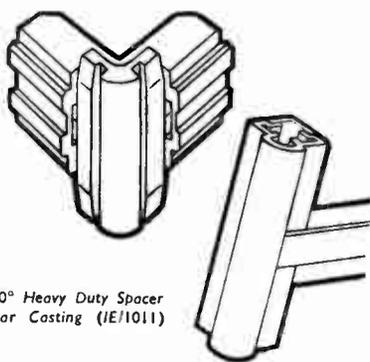
The material's cost of the framework for this Heavy Duty Double Bay Rak, size 6' x 3' 6" x 1' 9", using the Heavy Duty components illustrated, is little over £30. Using general duty components, i.e., IE/1001 90° Casting, IE/2024 90° strengthened Extrusion, IE/1004 Spacer Bar Casting, IE/2008 Spacer Bar Extrusion and IE/1009 Cruciform Junction, the material's cost for the framework only is just under £20.



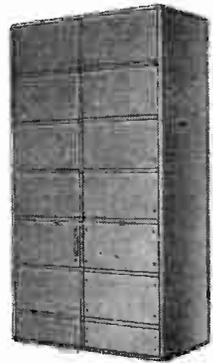
Heavy Duty 90° Extrusion with returns (IE/2034) and Heavy Duty Angle Reinforcement Extrusion (IE/2044)



Spacer Bar Cruciform Junction (IE/1009) and Spacer Bar Extrusion (IE/2008)



90° Heavy Duty Spacer Bar Casting (IE/1011)



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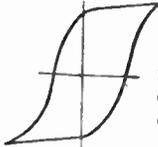
Typical characteristics of Telcon Thermostatic Bimetal

Type	Deflection constant* per °C (d)	Resistivity microhm-cms. at 20°C	Range of maximum sensitivity °C	Useful Range °C
Bimetal 140 ...	14.0×10^{-6}	76	20-230	-70 to 350
Bimetal 400 ...	12.0×10^{-6}	70	70-320	-70 to 400
Bimetal 15 ...	9.5×10^{-6}	16.7	20-160	-70 to 220
Bimetal 75 ...	6.8×10^{-6}	57	150-460	-70 to 550

* The deflection constant (d) is defined as the deflection of a strip of unit length and unit thickness for each °C rise in the temperature over the linear part of the deflection curve.

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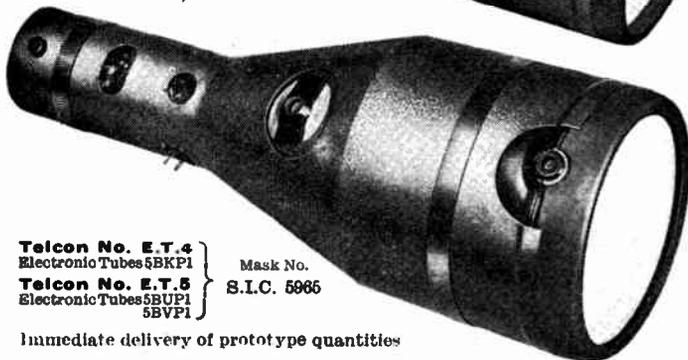
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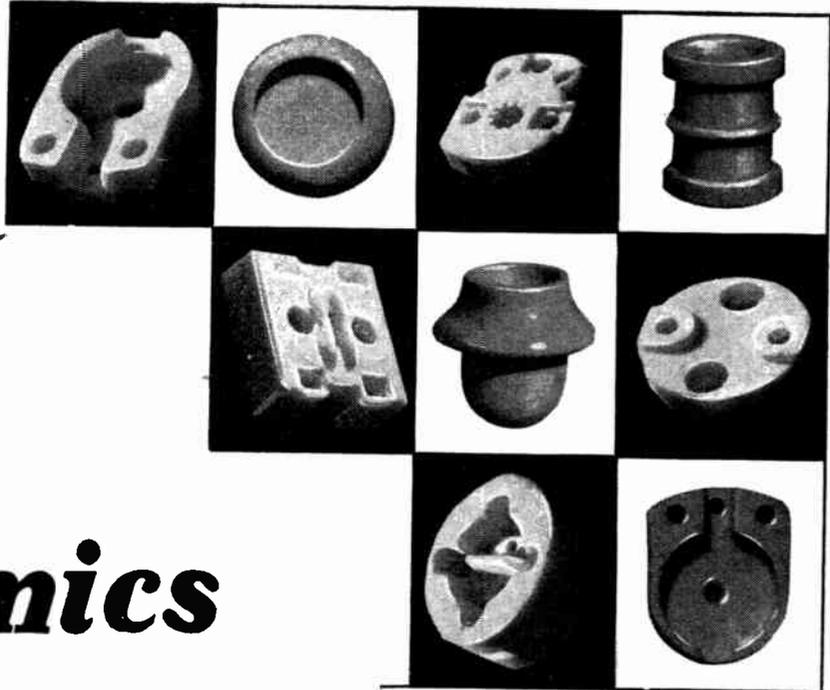
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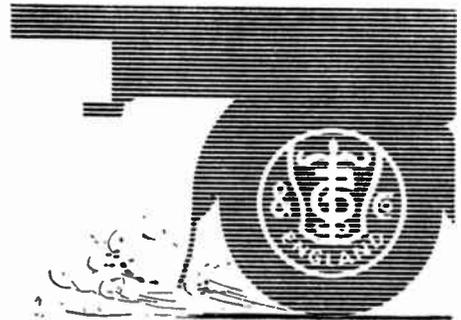


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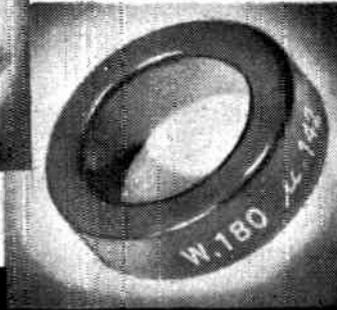
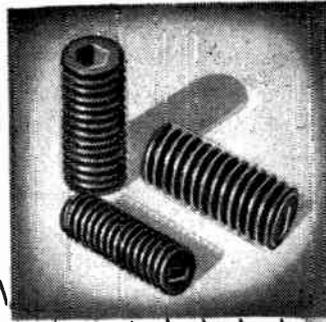
THESE TT INSULATORS PLAY AN
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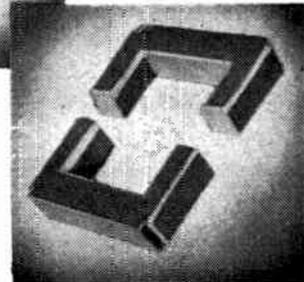
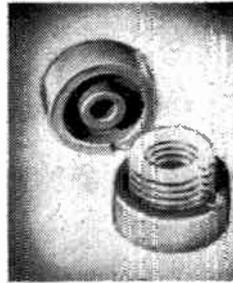
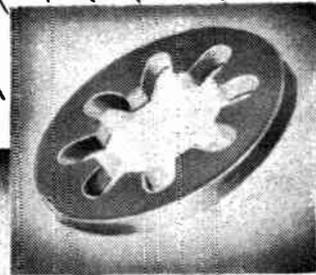
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All frequencies from 25 to 174 Mc/s.

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All powers up to 1 Kilowatt.

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All channel spacings including 20 and 25 kc/s in full production.

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No matter what your V.H.F. requirements are, Pye Telecommunications Ltd., can fulfil them. Your enquiries are invited.

WHAT MAKES A GOOD TAPE RECORDER ?

Winning the treble chance THE HARD WAY

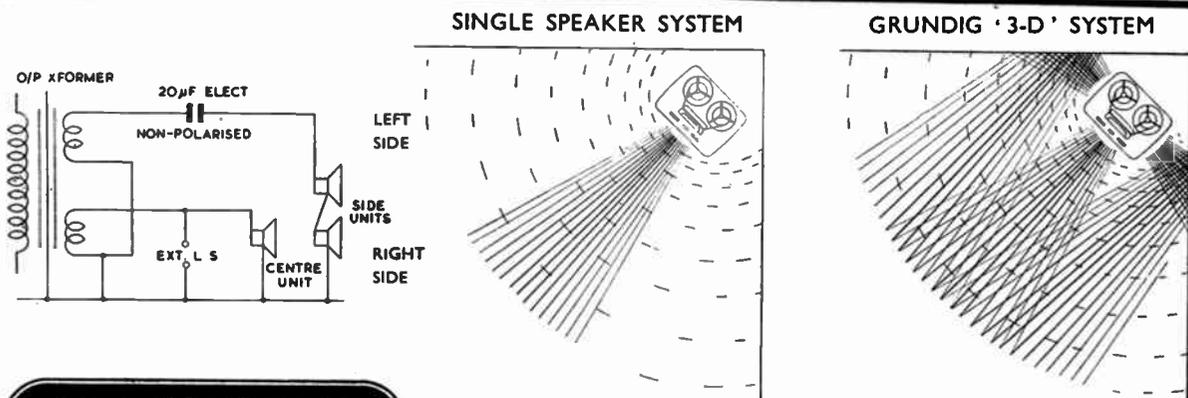
While one tape recorder motor, properly designed for the purpose, can be shown to have advantages over a three-motor system, the same need not apply to loudspeakers. Three speakers can be better than one.

Not that the idea of a multi-loudspeaker system, with a view to maintaining efficiency over the entire frequency range, is new. But the installation of a multi-speaker system in a portable tape recorder is new. It is a recent departure pioneered by Grundig to maintain three-directional distribution of Sound at all frequencies — and has been widely praised.

WHY THREE LOUDSPEAKERS ? THE GRUNDIG LOUDSPEAKERS

Simply, to avoid the effect of "listening to a box". A specially designed, single speaker unit may well be able to reproduce the whole frequency range, but the upper register will be projected in a pronounced beam, (as light from a car headlamp) causing the ear unerringly to locate the source and so destroy the sense of reality. The reproduction of the treble frequencies from three units, however, provides the same distribution that is inherent in the bass notes. If the walls of the room are used to enhance the effect, as shown in the sketch, the apparent source of sound now becomes an area instead of a point.

To a large extent the primary purpose of the portable tape recorder cabinet must be to house the machine and to be compact, stylish and efficient. If, as in a Grundig, the cabinet must also house three loudspeakers, it calls for design and production skill of a high order — and unusually efficient speaker units of a special kind. The method of feeding the audio power to the three units is shown in the accompanying circuit diagram.



Makers of the finest tape recorders in the world

GRUNDIG (Great Britain) LTD. Trade enquiries to: **KIDBROOKE PARK ROAD, LONDON, S.E.3**

Advertising & Showrooms: **39/41 NEW OXFORD ST., LONDON, W.C.1.** (Electronics Division, Gas Purification & Chemical Co. Ltd.)



Four stage amplifier weighing under $\frac{3}{4}$ ounce



The new Multitone Hearing Aid is considered to be the smallest in the world incorporating Automatic Volume Control.

The Orette is a four stage transistor amplifier with built-in microphone and battery (Mallory Type R.M. 625) which powers it for over 100 hours. It can be easily worn in the hair by a woman as it weighs under $\frac{3}{4}$ ounce, and a man can clip it behind his ear. It can be fitted with either air conduction or bone conduction receivers.

Very many deaf people able to use conventional aids without Automatic Volume Control, find a headborne instrument with linear amplification totally unacceptable.

The reasons for this are:—

- * Aids specifically designed to be headborne have a smaller maximum power output than a substantial body aid. Distortion therefore sets in much earlier. Owing to the position of the aid the users' own voice sounds much louder through the aid than through an instrument worn on the person.
- * The effect of high pitched background noises, such as clapping in a theatre, is greatly exaggerated when the aid is worn on the head. These noises can easily become intolerable without Automatic Volume Control, as incorporated in the Orette hearing aid.

The ORETTE is the aid which has been designed to be headborne.

multitone ORETTE

Multitone Electric Co. Ltd. 12/20 Underwood Street, N.1. Telephone: CLerkenwell 8022
(Branches: London, Birmingham, Dublin, Edinburgh, Glasgow, Brighton, Cardiff, Torquay
and Agents throughout Great Britain and the World.)

The
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in the
house . . .

From perhaps just one seat in the concert hall will the sound intensity and tonal relationship of the different instruments suit perfectly your own hearing characteristics. With the new Pye Mozart this one seat is reserved for you indefinitely—in the comfort of your own home. There you can create the music of your choice, free from distortion or audience distraction, and exactly adjusted to your own individual needs . . .



The Pye Mozart is available in a metal openwork case or chassis form, illustrated above — weighs 8½ lbs, measures 3¼" x 10½" x 5" and gives 10 watts output.



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Dialomatic Selector

The Mozart has input facilities for records, tape, and radio. New 'dialomatic' pickup compensation unit gives instant matching for most types of pickup.



On/off Push Button

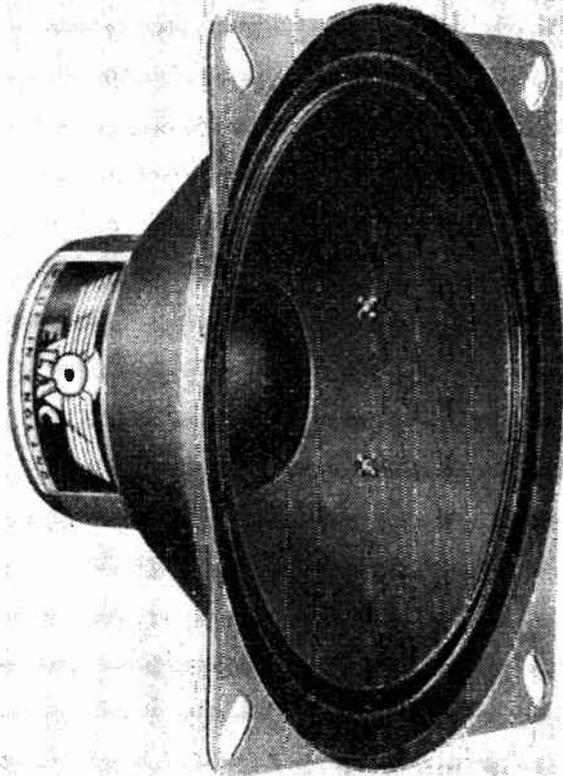
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Concert Grand Cabinet showing layout of deck



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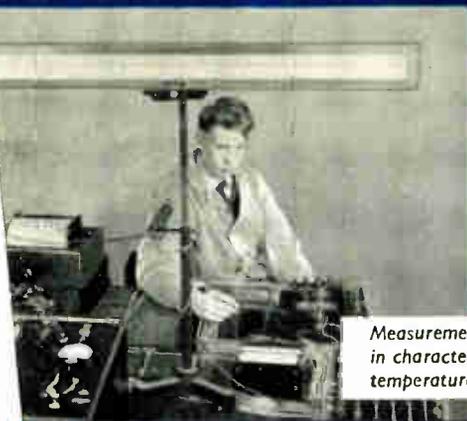
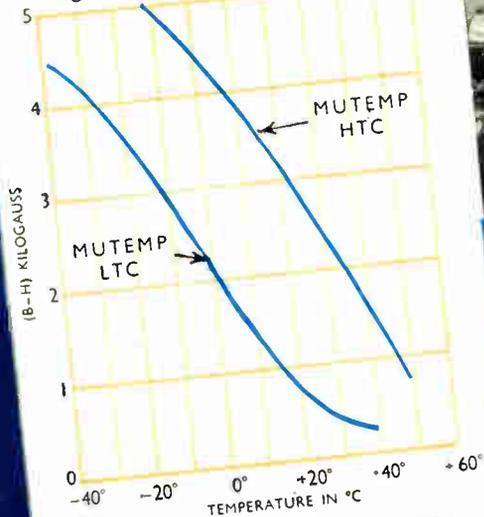
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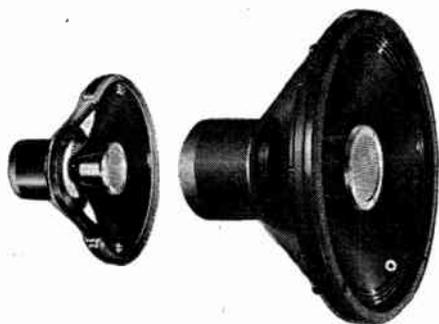
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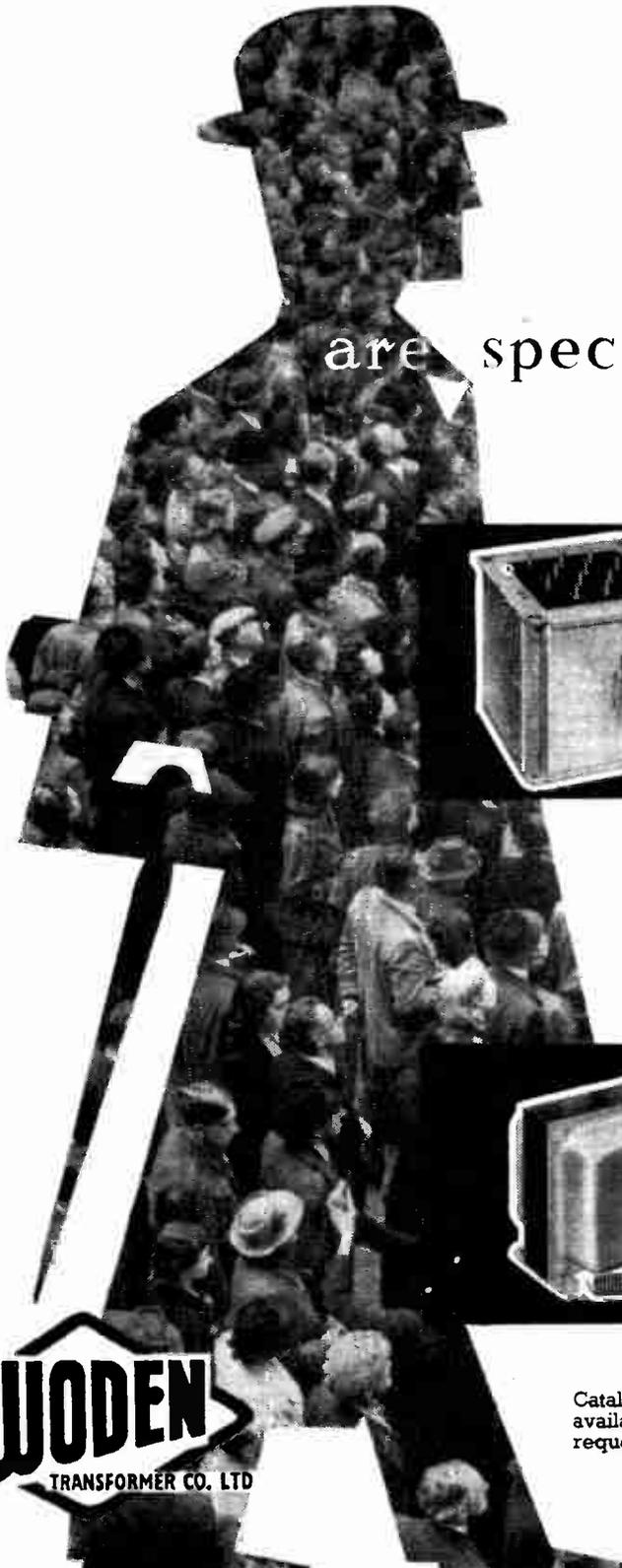
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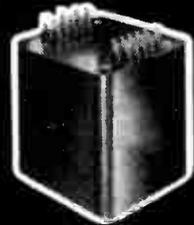
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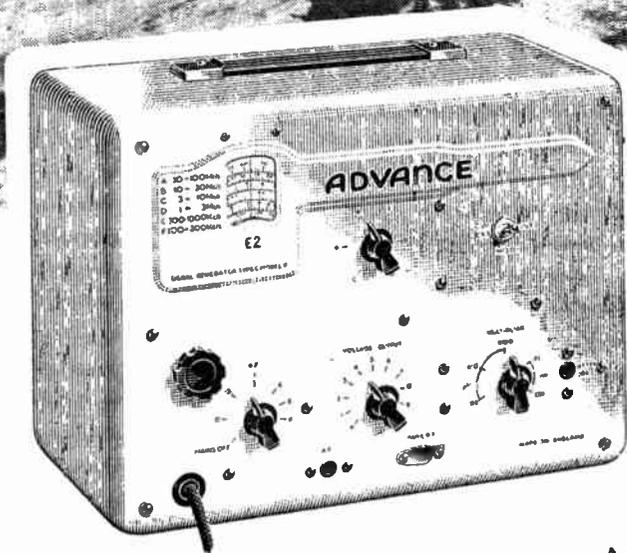
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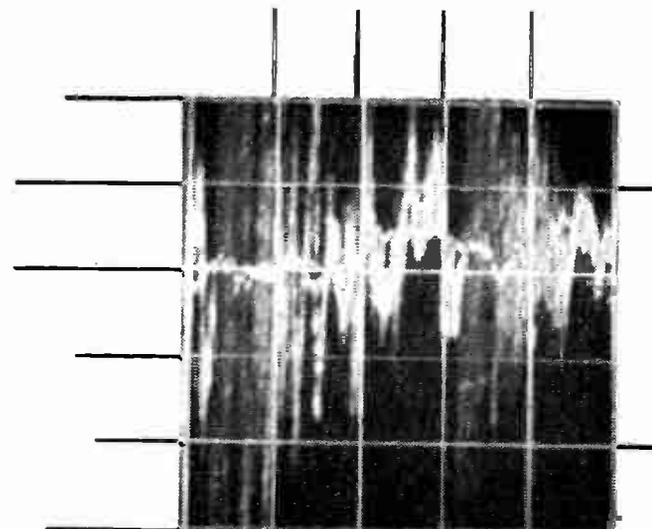
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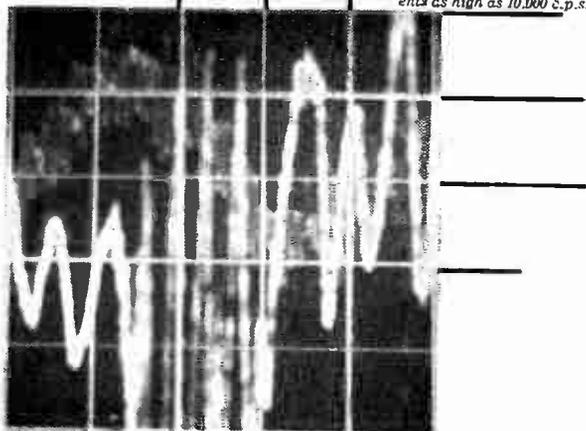
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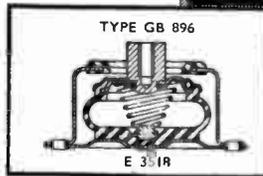
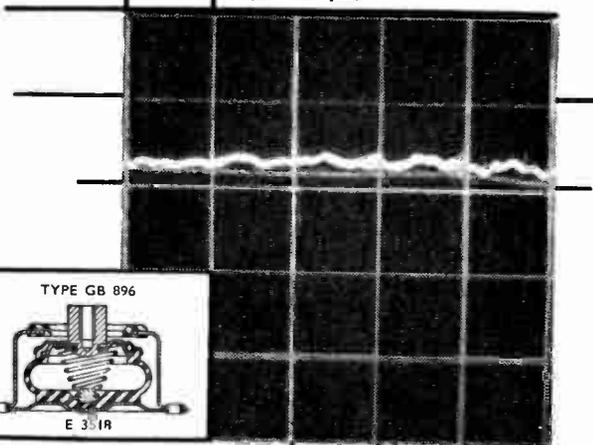
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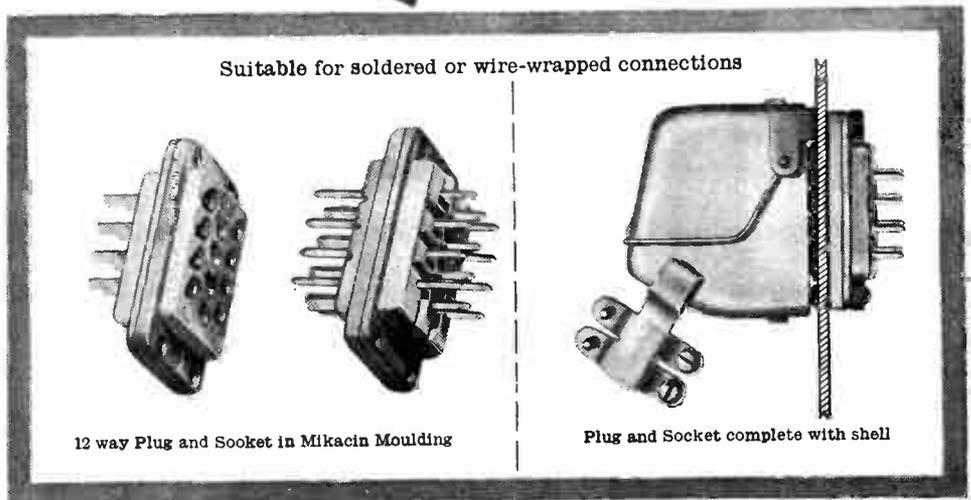


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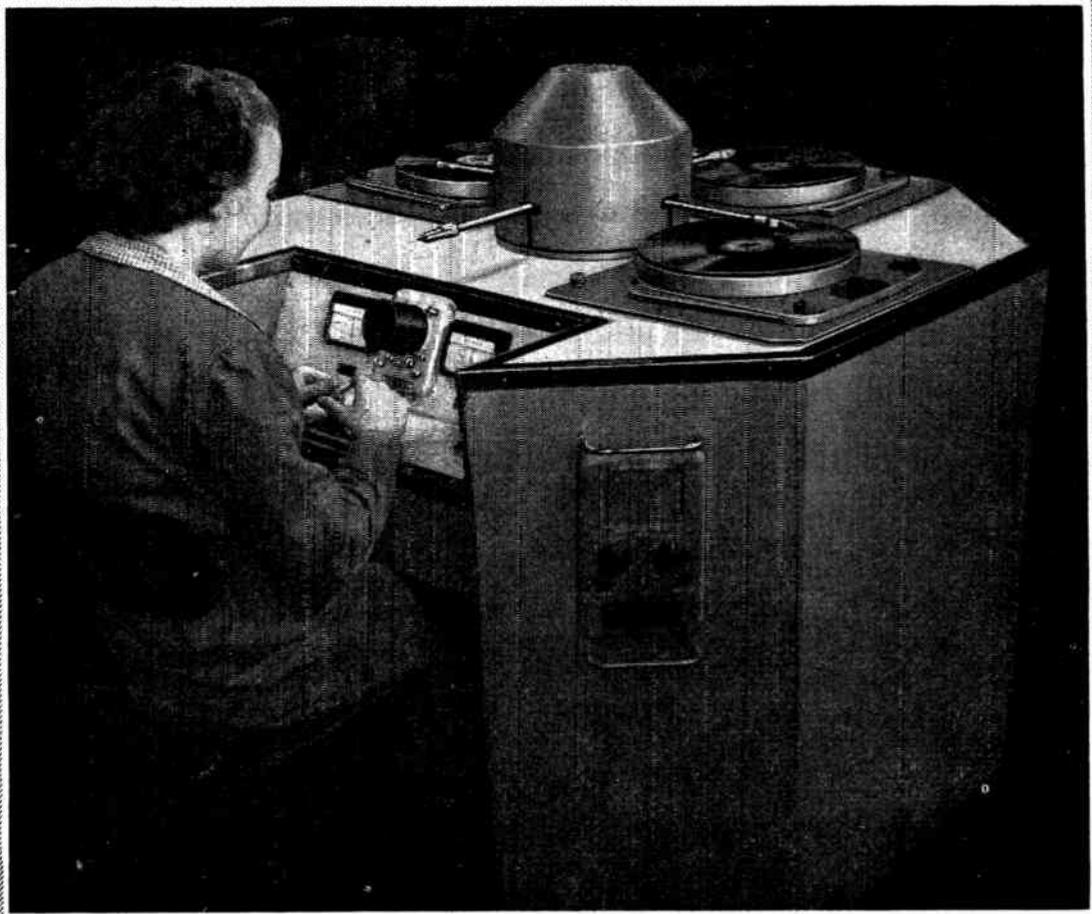
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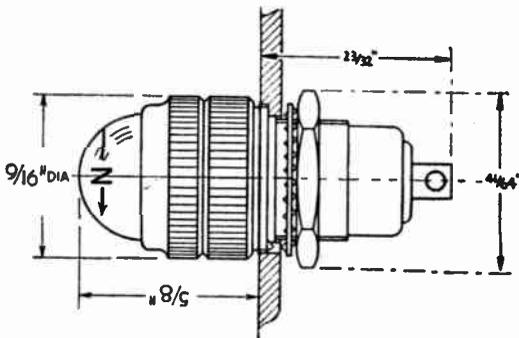
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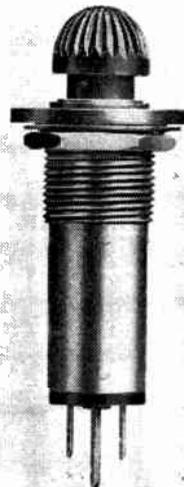
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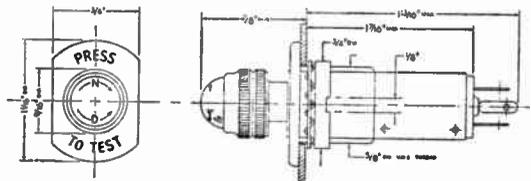


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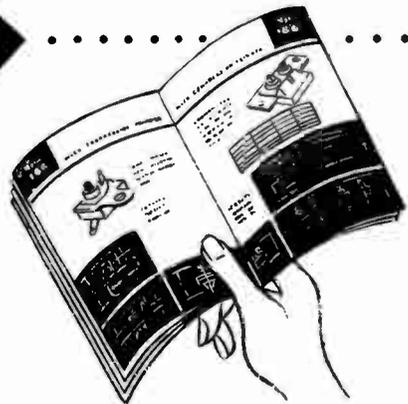
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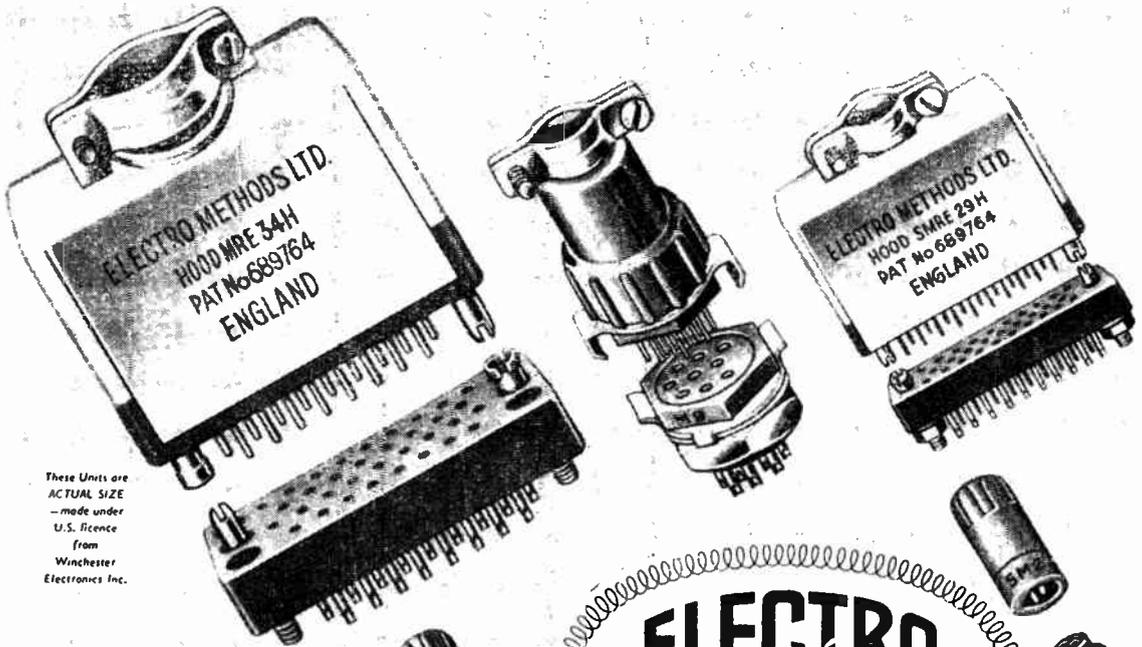


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connectors***

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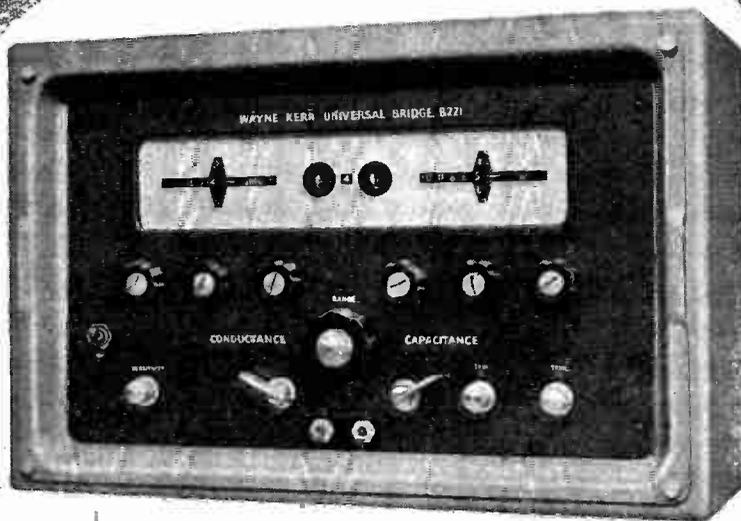
made from spring-tempered phosphor-bronze
provide low contact-resistance,
prevent corrosion and facilitate soldering.

MELAMINE MOULDINGS

conforming to B.S.S. 1322
provide high arc-resistance,
high dielectric and mechanical strength.

Full technical data and illustrated
leaflets forwarded on request:
ELECTRO METHODS LTD.
12-36 Caxton Way, Stevenage, Herts.
Telephone: Stevenage 780

WAYNE KERR UNIVERSAL BRIDGE B.221



Specification

BRIDGE ONLY:
 Capacitance: 0.0002 pF to 10 μ F
 in 7 ranges. Accuracy $\pm 1\%$.
 Conductance: 0- \pm 100 mmho
 in 7 ranges. Inductance:
 1mH to infinity in
 7 ranges. Measuring
 Frequency: 10,000 radians/sec.
 (1592 c/s.) Power Supply:
 110/115 and 200 250 V 40/60 c/s.
 Dimensions: 17" x 7" x 11 $\frac{1}{2}$ "
 high. Weight: 25 lbs. approx.

WITH LOW IMPEDANCE ADAPTOR:

Capacitance: 1 μ F—100,000 μ F
 in 4 ranges. Resistance:
 0-100 Ω in 4 ranges: Discrimina-
 tion on lowest range 50 μ Ω .
 Inductance: 0-10 mH in 4
 ranges. Discrimination on
 lowest range 5m μ H.

PRICES:
 Bridge, £175. Low Impedance
 Adaptor £25

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

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

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

Measurement is unaffected by the impedance of the test leads, which can therefore be of any length. Consequently the instrument is ideally suitable for the determination of temperature coefficient of components under test conditions or, in fact, any remote in

situ measurement. A novel mechanism automatically displays the cyphers, decimals and units of measurement. This gives direct reading and avoids any confusion which might be caused by the large multiplying factors involved.

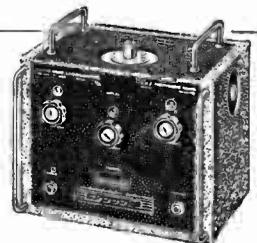
The basic range of the instrument covers impedances from 10,000 megohms to 10 ohms and this is extended to 50 micro-ohms by the use of the Low Impedance Adaptor. Other adaptors have been designed for measurement of conductivity, dielectric constant and loss factor of solids and liquids.

WAYNE KERR



Inductance Meter Type M.149

A small portable instrument designed for the simple and direct measurement of inductance values between 0.05 μ H and 100mH. Price £55.



Admittance Bridge Type B.901

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



5 inch

High Precision Oscillograph Tube 5BKPI

Quantity production of the 5BKPI by ETEL is making it an economic proposition for more designers to incorporate a high precision oscillograph tube in a wider range of applications than has previously been possible.

This five-inch tube employs a two-stage distributed post deflection accelerator. High P.D.A. ratios may be used, and the distortions caused in normal P.D.A. systems largely eliminated, with consequent advantages in brightness and deflection sensitivity. With a P.D.A. ratio of 5½: 1 the maximum pattern distortion is 2% and the maximum deviation from deflection linearity is 2%.

As can be seen from the adjacent data the 5BKPI, with its high sensitivity and low plate input capacitances is specially suitable for wide-bandwidth oscillography. Full data is available on request.

Abridged data

Screen Metal backed P1 green fluorescent medium persistence. Other screens available to order.

Heater $V_h = 6.3V \cdot I_h = 0.55A$

Capacitances x' to x'' 2.3pF · y' to y'' 1.7pF
 One x plate to all other electrodes less other x plate 3.6pF
 One y plate to all other electrodes less other y plate 1.65pF

Typical Operation

V_{a1}	. . . . .	1400	. . . . .	V
V_{a2}	. . . . .	440 to 560	. . . . .	V
V_{a3}	. . . . .	1800	. . . . .	V
V_{a4}	. . . . .	4000	. . . . .	V
V_{a5}	. . . . .	10,000	. . . . .	V
V_g	. . . . .	-45 to -90	. . . . .	V
S_x	. . . . .	26.5	. . . . .	V/cm
S_y	. . . . .	12.5	. . . . .	V/cm

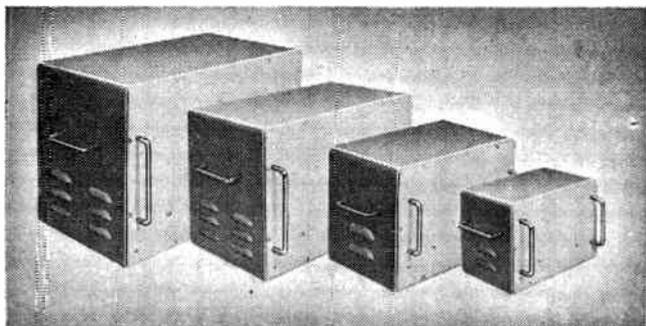


Cathode Ray Tubes

ELECTRONIC TUBES LIMITED

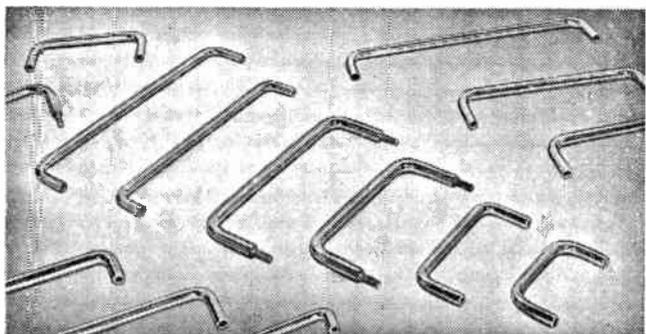
Kingamead Works, High Wycombe, Bucks · Tel: High Wycombe 2020

QUALITY *backed by experience*



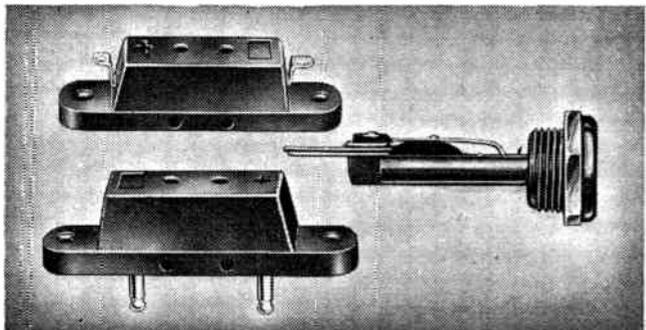
INSTRUMENT CASES

Attractively constructed of seam welded steel, these strong instrument cases are well ventilated and stove enamel finished in various colours. Available in four standard sizes or to your own specification.



HANDLES

Made in standard range (4in., 6in., 8in. and 10in. centres). A wide variety of other sizes can be made to special order.



AMP-CHECKS

Invaluable device designed to facilitate current measurements. Installed in series with an electrical (or electronic) circuit to all points where measurements or checks are required without open circuiting.

Other products include
PULSE GENERATORS
CAPACITY COMPARATORS
TAPE RECORDERS
STABILISED POWER SUPPLIES
PHOTOCELL AMPLIFIERS

Metal components available to customer's specification and small or batch quantities undertaken.

Experienced in research projects and prototype construction. SUB-CONTRACTORS for sheet metal or assembly and wiring. AID and ARB approved.



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TECHNICAL DATA

on the NEW Type 515 Oscilloscope

DC-TO-15 MC PASSBAND

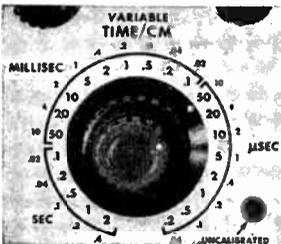
High in performance, but low in size, weight, and cost, the Type 515 fits a relatively new requirement area. Besides its extra capabilities in applications requiring vertical response out to 15 megacycles, it occupies less space and is easier to handle than most other general-purpose laboratory oscilloscopes.

Risetime of the dc-coupled vertical amplifier is less than 23 millimicroseconds. Sensitivity is accurately calibrated, 0.1 v/cm to 50 v/cm in nine steps. A variable control adjusts the sensitivity between calibrated steps and out to 125 v/cm. To help avoid accidental inaccurate readings, a warning light indicates an uncalibrated condition when the variable control is in use. A balanced network delays the signal 0.25 μ sec to permit observation of the leading edge of the waveform that triggers the sweep. Direct input capacitance of approximately 36 μ mf is reduced to approximately 10 μ mf by use of the 10x attenuator probe supplied with the instrument.



SIMPLIFIED SWEEP CONTROL

All 22 of the Type 515's accurately calibrated sweeps are selected by the same control knob. This knob also indicates the sweep time-per-centimeter when the 5x magnifier is in use, making mental calculation of time intervals unnecessary. The normal sweep is expanded to 50 centimeters by the magnifier, and the horizontal-position control has sufficient range to display any 10 centimeters of the magnified sweep. To maintain uniform bias on the control grid of the cathode-ray tube for all sweep speeds and repetition rates, the unblanking waveform is dc-coupled.



Calibrated fixed sweeps extend from 0.2 μ sec/cm to 2 sec/cm. A variable control makes the sweep range continuous from 0.2 μ sec/cm to 6 sec/cm. Here again a warning light indicates an uncalibrated condition when the variable control is in use.

AUTOMATIC TRIGGERING

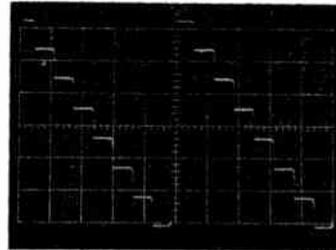
Automatic triggering is a real convenience in a great many oscilloscope applications. This one position, without further adjustment of the triggering controls, permits signals of widely differing frequencies and amplitudes to initiate the sweep, and provides a reference trace on the screen in the absence of an input signal. The automatic circuit operates at a natural rate of about 50 cycles, but synchronizes readily with incoming signals from 60 cycles to 2 megacycles.

Triggering versatility is one of the many highly-useful qualities of the Type 515. You can trigger the sweep from either the positive or negative slope of an internal, external, or line-voltage signal. On any of these signals, you can trigger the sweep at a selected amplitude level. You select

either ac or dc-coupling through the trigger circuitry. You can synchronize the sweep with sine-wave signals up to and beyond 20 megacycles. You can block out the low-frequency component of a composite signal, permitting the high-frequency component to trigger the sweep. These complete triggering facilities make possible a steady display of just about any signal you are likely to encounter.

LARGE DISPLAY AREA

A full 6-centimeter by 10-centimeter linear display can be presented on the screen of the new Tektronix cathode-ray tube, Type T55P, developed especially for this instrument. Characteristics of this new tube help make possible the wide signal-handling range and excellent transient response of the Type 515. Accelerating potential is 4000 volts. A T55P2 is normally supplied, but a P1, P7, or P11 screen is available on request at no extra cost.



PORTABILITY

It's a bit unusual for higher performance to come in an oscilloscope that's smaller and lighter than previous models. But this combination of compactness and performance makes the Type 515 most convenient for those more-exacting field applications. Handling ease and simplified controls are characteristics also desirable in the increasing number of production-line test stations where high performance is a new requirement. The Type 515 weighs only 40 pounds and measures 9 $\frac{3}{4}$ " wide, 13 $\frac{1}{2}$ " high, 21 $\frac{1}{2}$ " deep.

OTHER CHARACTERISTICS

Many of the other features you'd expect to find in any Tektronix Oscilloscope are part of the Type 515. Square-wave amplitude calibrator, sweep sawtooth and gate available at front panel, illuminated graticule, and electronically-regulated power supply are some of the "standard equipment". New style cabinet with removable sides speeds any maintenance that may be necessary.

TYPE 515 . . . \$750 (F.O.B. Portland, Oregon)
£290.0.0 (Delivered in England)

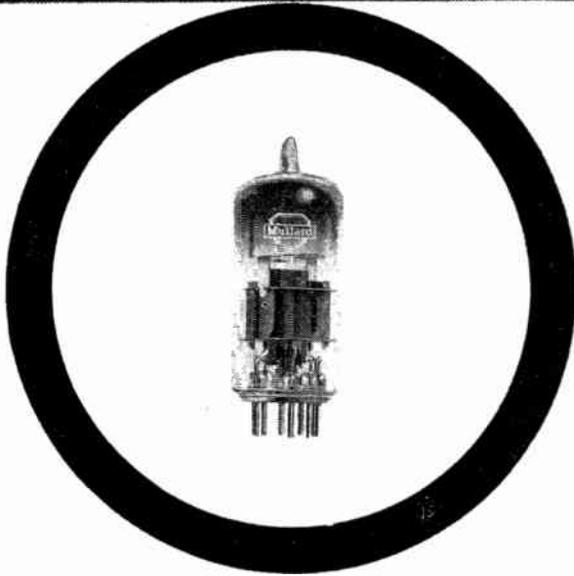
The above prices are exclusive of duty.



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E88CC

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

Close tolerance characteristics

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

Low impedance

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

High slope — controlled cut-off

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

Low cross capacitances

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

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

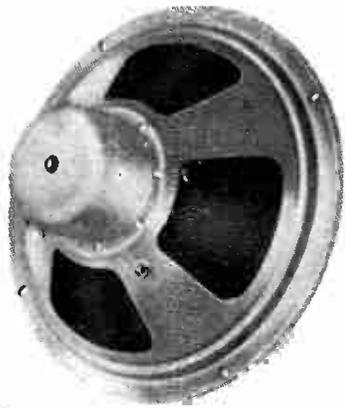
Further technical information concerning the E88CC is available on request.

ABRIDGED DATA

$V_h = 6.3V$	$I_h = 300mA$	
<u>Computer operation</u>		
$V_a(b)$		150V
$V_g (I_a = 100\mu A)$		$-7.0 \pm 1.5V$
$V_g (I_a = 5.0\mu A)$		-15V
V_g difference ($V_{g1} - V_{g2}$ at $I_a = 100\mu A$)		$< -2.0V$
<u>Cascode amplifier</u>		
V_b		100V
$V_g(b)$		+9.0V
R_k		680 ohms.
I_a		$15 \pm 0.8mA$
g_m		10.5 to 15 mA/V
Noise factor ($f = 200Mc/s$)		4.6dB
R_{eq} (r.f.)		300 ohms.
Base		B9A



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



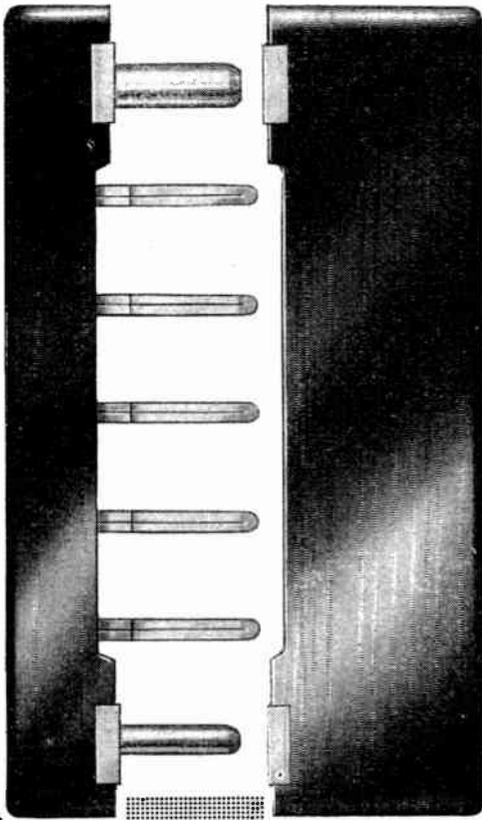
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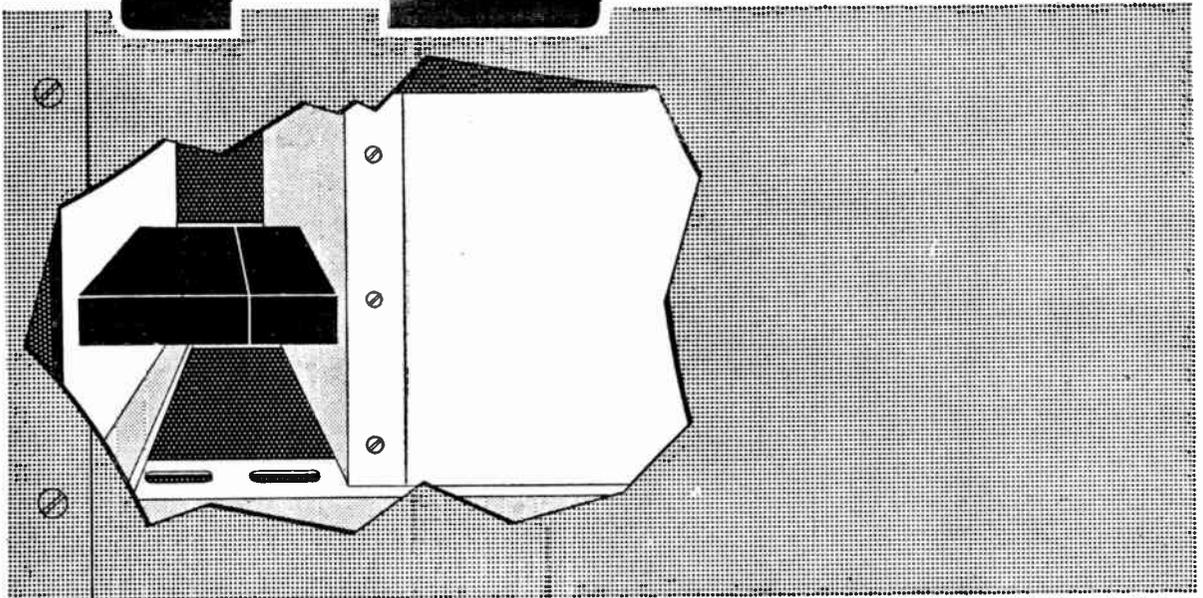
Putting 5 and 5 together

These In-Line Connectors are specially suitable for plug-in unit construction or small rack mounting equipment.

Well proven plug and socket contacts are used and exceptional freedom in dimensional tolerances of fixings etc. has been provided for.

5 and 7-Way versions are available and the Connectors can either be mounted direct to the panel where clearance is provided for contacts or mounted on stand-off pillars.

Location is provided by guide pins which are polarised to prevent incorrect insertion.



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Telephone: Newmarket 3181/2/3.

Telegrams: Powercon Newmarket.

*precision
and
craftsmanship*

Take a look at your wristwatch. The odds are a hundred to one that in small lettering on the dial you will find the words "Swiss Made".

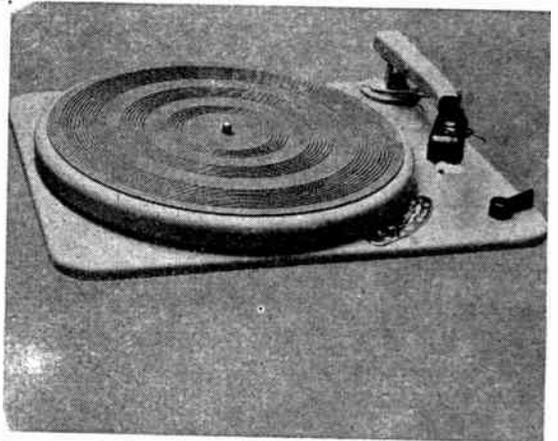
Throughout the world Switzerland is recognised as the centre of craftsmanship in precision mechanisms. When you consider the service your watch gives you day after day—and the price you paid for it—you may well conclude that "Swiss Made" also means sheer value for money.

It was by no accident that Goldring turned to Switzerland for a transcription gramophone motor. Modern record reproduction calls for a craftsman-made mechanism of more than average precision and reliability. And modern strains on purses call for nothing short of real value for money.

The Goldring-Lenco Transcription Motor is designed and made entirely in Switzerland. There are three versions (from £17. 10. 4. to £23. 7. 0. including P.T.) which incorporate the Lenco transcription arm and the Goldring "500". Your dealer will be happy to show them to you—or we will gladly send you a descriptive leaflet on request.

GOLDRING-LENCO

GRAMOPHONE TRANSCRIPTION MOTORS



Goldring Manufacturing Co. (Great Britain) Ltd.

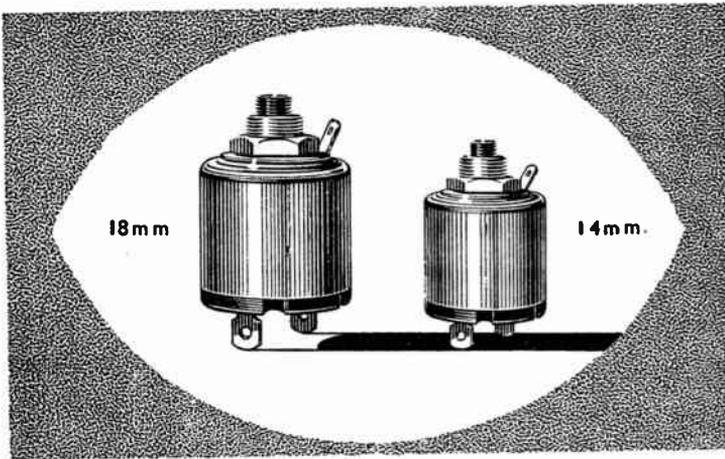
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MULLARD HIGH EFFICIENCY POT CORES

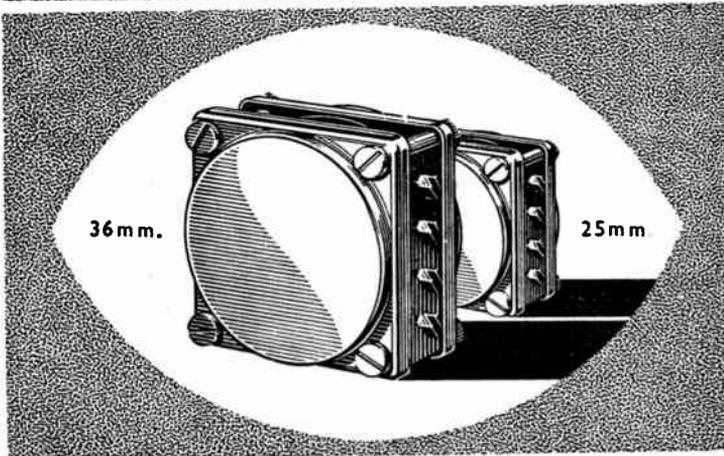
have these outstanding features



- * Pot core design facilitating rapid assembly
- * Small size
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- * Very fine setting accuracies
- * Operative over a wide frequency range
- * Controllable temperature coefficient

Wherever high quality pot cores are required, there will be a Mullard type available to meet the specification, furthermore, they can be supplied wound to customers individual requirements.

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Mullard



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Magnadur ceramic magnets
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MC 255

G.E.C.**CATHODE RAY TUBES****for Oscillography**

*Photograph reproduced by
courtesy of British Communications
and Electronics*

The recently advertised 4GP., 5BHP and 6EP cathode ray tubes are only three of a wide range of instrument tubes marketed by the G.E.C.

The range includes both electromagnetic and electrostatic deflection tubes and all are generally available with any one of six standard screen phosphors. Other screen phosphors can be supplied to special order.

Should you have any cathode ray tube problems—consult the M-O Valve Company. You will most probably find a tube in the range which is ideally suited to your particular application. If not, the Company with its wealth of experience and technical facilities may be able to make a special tube for you.

*Products of the M-O Valve Company Limited, Brook Green, Hammersmith, W.6
a subsidiary of*

THE GENERAL ELECTRIC COMPANY LIMITED, MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

*Some of the many products
of the M-O Valve Co. Ltd.*

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Mercury Rectifiers
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ANTIFERRENCE STANDARD *Coaxial Plug & Socket*

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- ★ **ROBUST CONSTRUCTION**
One-piece Polystyrene interior, no small parts to dismantle, no soldering troubles.
- ★ **FULLY INSULATED**
Neoprene insulating sleeve for safety.
- ★ **EFFICIENT IN OPERATION**
Pressure on copper braid over a large contact area ensures positive and secure contact.
- ★ **SIMPLE TO FIT—FITTED IN SECONDS!**

ANTIFERRENCE LIMITED

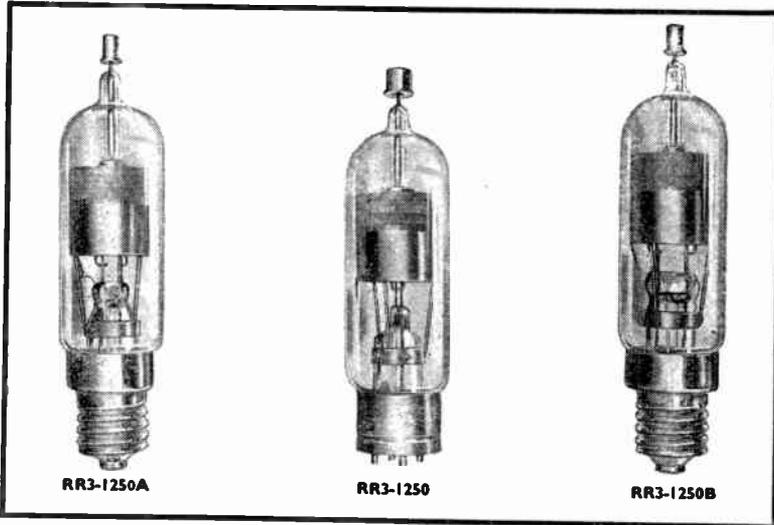
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COAXIAL SOCKET TVS/1

COAXIAL PLUG FOR CAR AERIAL LEADS CRP/200 1/6a.
COAXIAL SOCKET FOR CAR AERIAL LEADS CRS/200 1/6a

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3 new high voltage xenon rectifiers



SHORT HEATING-UP TIME · WIDE AMBIENT TEMPERATURE RANGE · NO "CONDITIONING" ON INSTALLATION

Recent developments in the Mullard 1.25A range of xenon rectifiers have led to improved hold-off characteristics and higher reliability. These improvements, together with the already widely recognised advantages of xenon rectifiers, strongly recommend these valves for power supplies in transmitters, r.f. heaters and similar equipments.

Xenon rectifiers can be operated over a wide ambient temperature range, they are not restricted to vertical mounting, they have a short heating-up time and require no "conditioning" on first being put into service. These features make for great

operational convenience and the valves are suitable for use in both fixed and mobile equipment under all climatic conditions.

Two of the valves can be used as plug-in replacements for mercury types: the RR3-1250-B in place of the RG3-1250; and the RR3-1250A in place of the RG4-1250 (CV5) in applications where the peak inverse voltage does not exceed 13 kV. Write on your company notepaper to the address below for a free booklet "High Voltage Rectifiers" which gives full data on these and other xenon rectifiers together with details of mercury-filled types.

ABRIDGED DATA

Type No.	Base	Vf (V)	If (A)	P.I.V. max. (kV)	Ik (pk) max. (A)	Ik (av) max. (A)	Heating-up Time (secs)
RR3-1250/4B32	B4F	5.0	7.0	10	5.0	1.25	30
RR3-1250A	Goliath Edison Screw	4.0	11.0	13	5.0	1.25	30
RR3-1250B	Goliath Edison Screw	4.0	7.0	13	5.0	1.25	30

Mullard

COMMUNICATIONS AND
INDUSTRIAL VALVE DEPARTMENT

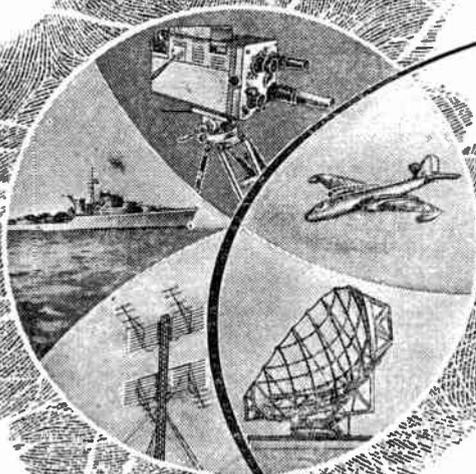


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MVT 330a



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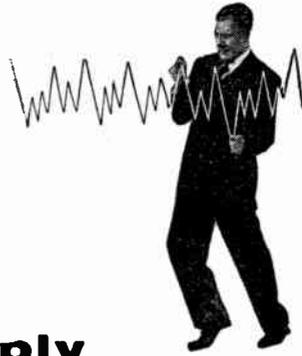
INTRODUCING THE SONOTONE 2T



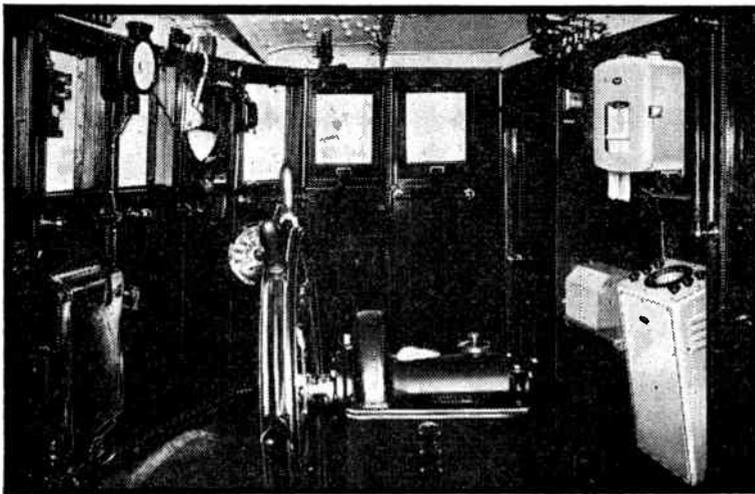
All the recorded sound — that's the way the 'Sonotone' 2T equipped radiogramophone will play it! The revolutionary Sonotone pick-up head — a superior, highly sensitive product — represents another step forward in modern sound head technique by T.C.L. It is completely humidity and temperature proof, produces no magnetic hum and has a great many other technical advantages which are discussed fully in T.C.L. publication No. 1106. Design Engineers are invited to ask for a copy and for any further technical information they may require.

TCL

Technical Ceramics Limited, Wood Burcote Way, Towcester, Northants
Telephone Towcester 312



A problem of Fluctuating Voltage Supply in Echo Sounding



A typical trawler wheel-house showing the Kelvin Hughes Fishing Echo Sounder M.S.29 and KH Kingfisher Scale Expander.

The up-to-date fishing craft carries electronic echo sounders to locate the most promising fishing grounds. This equipment has to cope with supply voltages that fluctuate over a very wide range. In order to obtain reliability, and to *safeguard the life* of electronic components it is essential to stabilise the applied voltage.

How is this achieved?

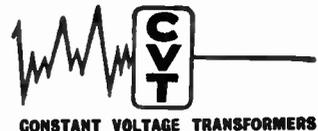
... straightened out by *Advance*



In the Kelvin Hughes Models M.S.28 and M.S.29 Fishing Echo Sounders, 'Advance' Constant Voltage Transformers are incorporated to ensure reliable long-life performance, even where, as on the smaller vessels, the supply may vary between -10% and $+30\%$.

'Advance' Constant Voltage Transformers provide a.c. voltage stabilisation of $\pm 1\%$ for input variations of up to $\pm 15\%$ at maximum load. For power requirements from 4 to 6,000 watts, they are automatic and contain no moving parts.

Technical Details and descriptive Leaflet W28 gladly sent on request.



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The turntable with a 4% variation on all three speeds.

The Connoisseur motor is made for the perfectionist. It is one of the finest turntables in the world.

The speed change is arranged mechanically and gives a 4 per cent variation on all speeds. A synchronous motor, which is virtually vibrationless with low noise level and hum indication, maintains a constant speed at all settings. There is no braking action to obtain speed change.

The 12in. turntable is lathe turned in non-ferrous metal. The main spindle, which is precision ground and lapped to mirror finish, runs in phosphor bronze bearings.

A sound, precision engineering job, the Connoisseur motor provides the foundation for perfect reproduction.

Price £20, plus P. Tax £8/11/-.



Matching Connoisseur Pick-up Mark II with a frequency range from 20-20,000 cycles:

Pick-up complete with 1 head fitted with Diamond armature £8/19/- plus P. Tax £3/16/6.

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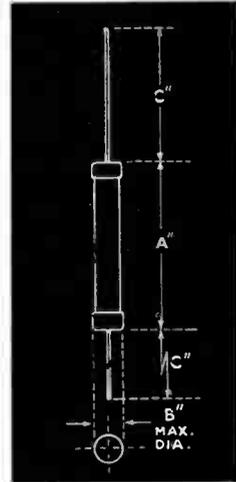
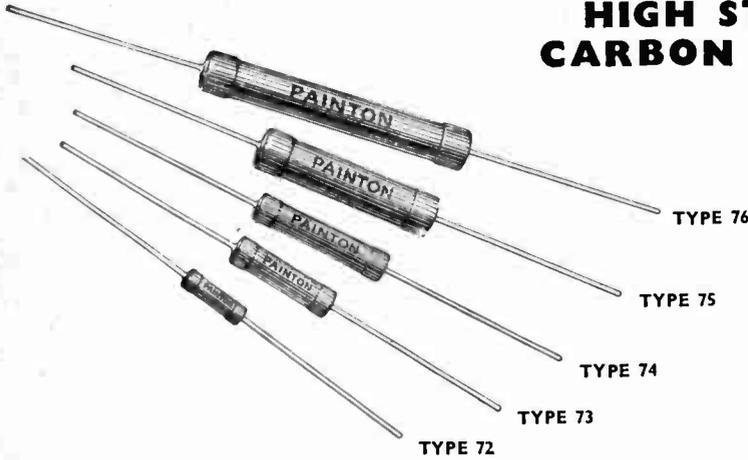
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By Appointment to the Professional Engineer

HIGH STABILITY CARBON RESISTORS



ELECTRICAL CHARACTERISTICS

The electrical characteristic of a High Stability Carbon Resistor depends upon the physical size of the units and upon the ohmic value. All the data given below relates to the Type 73 Resistor. To obtain the equivalent ohmic values to which the information is applicable in the other four sizes of Resistor the following factors should be applied:

- Type 72 x 1/4
- Type 74 x 2
- Type 75 x 4
- Type 76 x 8

FULL LOAD STABILITY

Up to 100 K.ohms the resistance change at full load with an ambient temperature of 70°C. is less than 0.75% (average 0.25%) after 1,000 hours operation. At 1 Megohm the change is less than 1% (average 0.75%).

N.B. On D.C. loading the maximum voltages stated in RCL 112 should be observed.

AGEING AND SHELF DRIFT.

Up to 100 K.ohms the average change is 0.25% in 12 months (never greater than 0.75%). For 1 Megohm resistors the average change is 0.6% in 12 months (never greater than 1.25%).

CLIMATIC

Exposure to the two cycles of H.I. humidity as laid down in RCL 112 shows a change of less than 0.7% (average 0.4%) up to 100 K.ohms. At 1 Megohm the change is less than 1% (average 0.7%).

TROPICAL EXPOSURE

Eighty-four days exposure to the standard 25°C./35°C. 100% humidity cycling shows a change of less than 1% (average 0.5%) up to 100 K.ohms. At 1 Megohm the change is less than 2% (average 1.6%).

TEMPERATURE COEFFICIENT

The temperature coefficient is less than 0.04%/°C. up to 100 K.ohms. At 1 Megohm the coefficient is approximately 0.055%/°C.

NOISE

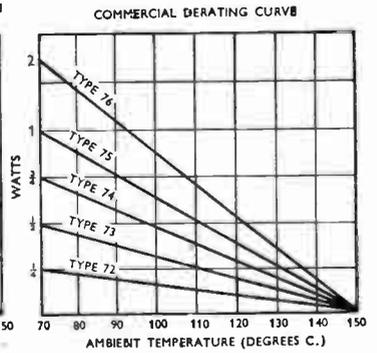
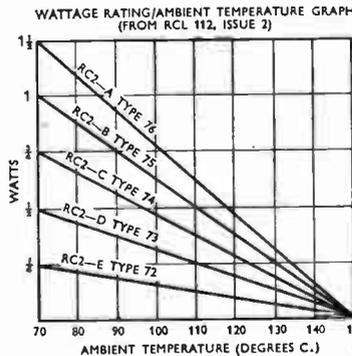
Noise which is generated in a resistor, as the result of a direct voltage applied across it, varies according to the ohmic value of the resistor, the noise decreasing as the ohmic value increases. The noise is also influenced by factors such as the size of the resistor.

For noise which falls within frequency range of 0 to 10 Kc./sec., the Painton high stability resistors have noise levels which are between 0.05 and 0.4 microvolts of noise per applied direct volt, when the resistor is dissipating power at its maximum wattage rating.

VOLTAGE COEFFICIENT

Not exceeding 0.002% per volt D.C.

DERATING FOR AMBIENT TEMPERATURES EXCEEDING 70°C.



TYPE	RESISTANCE RANGE (ohms)		VALUES OUTSIDE THIS RANGE MAY BE QUOTED FOR SEPARATELY.				
	±1%	±2%	±2%	±5%	±5%	±5%	±5%
72	4 — 700K	4 — 1.0M	4 — 1.0M	4 — 2.5M	4 — 5.0M	20 — 10.0M	20 — 50.0M
73	4 — 1.0M	20 — 2.0M	4 — 2.0M	20 — 10.0M	20 — 10.0M	20 — 10.0M	20 — 10.0M
74	±1% 20 — 2.0M	±2% 20 — 4.0M	±2% 20 — 5.0M	±5% 20 — 10.0M	±5% 20 — 10.0M	±5% 20 — 10.0M	±5% 20 — 10.0M
75	±1% 20 — 3.0M	±2% 20 — 5.0M	±2% 20 — 9.0M	±5% 20 — 10.0M	±5% 20 — 10.0M	±5% 20 — 10.0M	±5% 20 — 10.0M
76	±1% 20 — 5.5M	±2% 20 — 9.0M	±2% 20 — 9.0M	±5% 20 — 10.0M	±5% 20 — 10.0M	±5% 20 — 10.0M	±5% 20 — 10.0M
TYPE		72	73	74	75	76	
Normal Commercial Rating 70°C—watts		1/2	1/2	1/2	1	2	
R.C.S.C. style		RC2-E	RC2-D	RC2-C	RC2-B	RC2-A	
R.C.S.C. Rating at 70°C—watts		1/2	1/2	1/2	1	1 1/2	
R.C.S.C. Rating at 100°C—watts		1/2	1/2	1/2	1/2	1/2	
DIMENSIONS IN INCHES	A	1/2	1 1/2	1 1/2	1 1/2	2 1/2	
	B	1/4	3/8	3/8	3/8	3/8	
	C	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	

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Northampton England

... a new battery-operated constant speed miniature motor

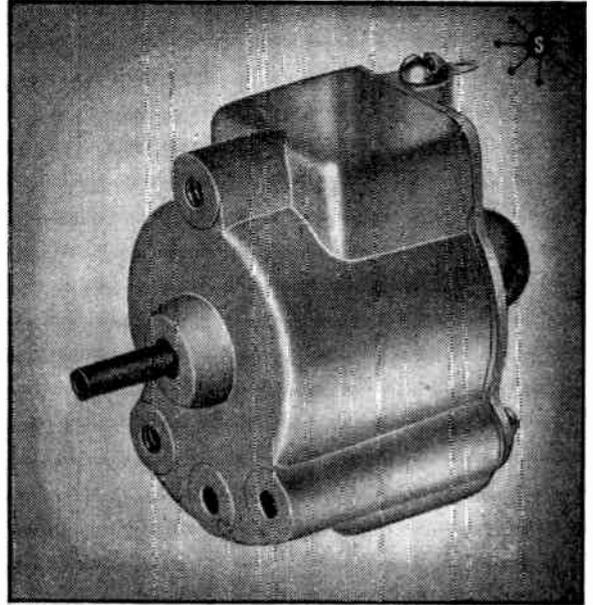
The

Staar-Kinder

Manufacturers are invited to write or telephone for full information on this governor controlled constant speed motor. Only slightly larger than a match-box, the Staar-Kinder Motor presents a noiseless power unit of extremely low current consumption.

The standard unit is for 6v. operation, but the motor can be supplied for usage at other voltages up to 12v.

The Staar-Kinder Motor available only to manufacturers.



Staar Electronics Ltd.,

Ormond House, 26/27 Boswell Street, London, W.C.1

Telephone: CHAncery 8953-4-5-6.

Telegrams: Asterisk, London

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... battery operated player
for single 45 r.p.m. records

★Size of unit base-board only 7½" x 6".

★Weight only 15½ozs.

★Powered by Staar-Kinder motor. Operating voltage 6v., current consumption as low as 27 mA while playing.

★Ideal as the nucleus of a midget player, and amplifier of extreme portability.

The pickup of the Little Staar is fitted with a robust ceramic element transducer with two 1 mm. radius sapphire styli suitable for use in all climatic conditions. The cartridge can be withdrawn and replaced in a matter of seconds. The Staar-Kinder Motor incorporates a centrifugal governor to ensure constant turntable speed within 2% whatever the applied voltage between 7.5v. and 4.5v.



A dual purpose turntable centre is available which allows for playing small or large centre-hole records



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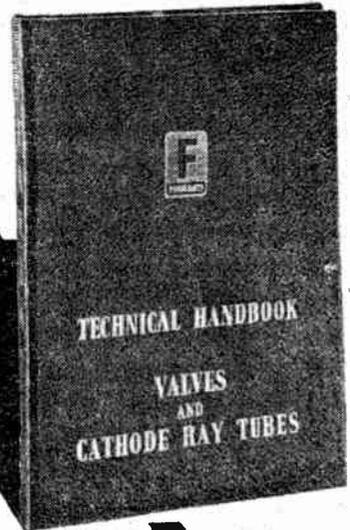


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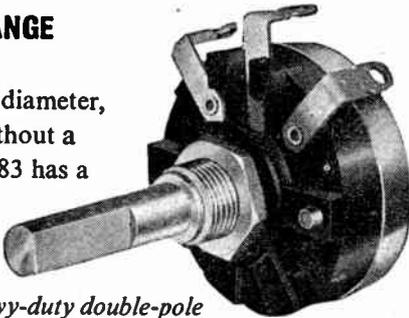
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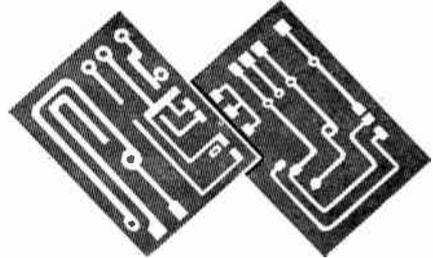
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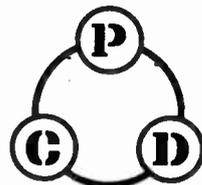
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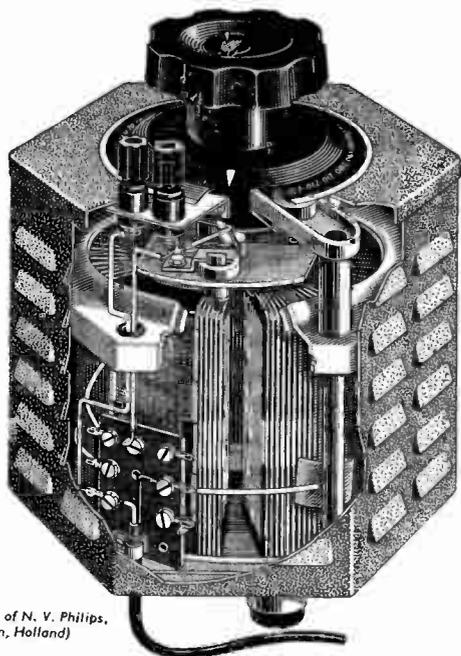
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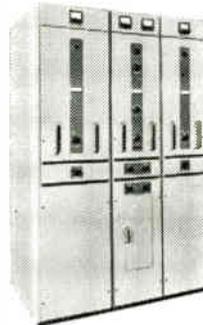
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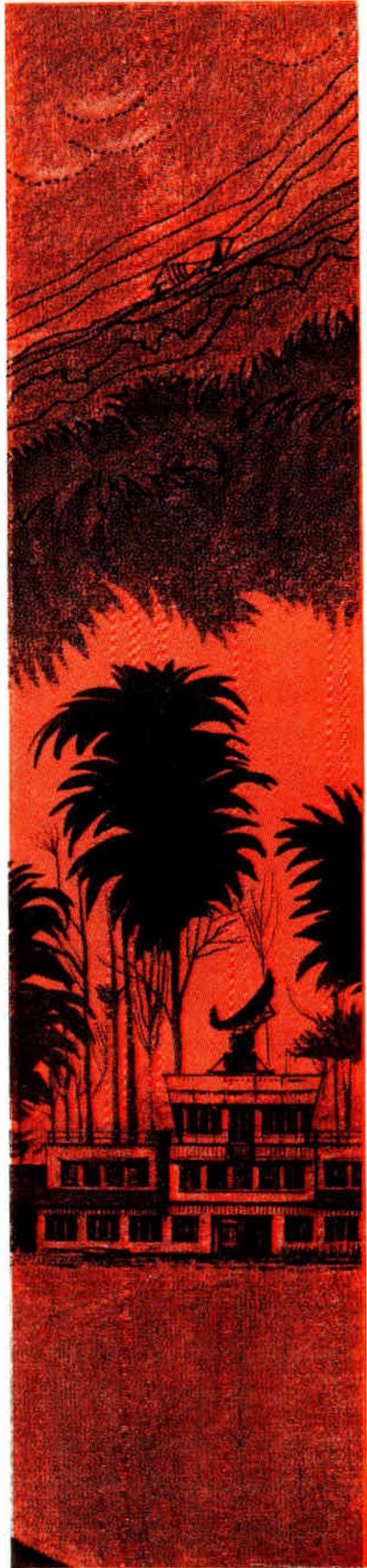
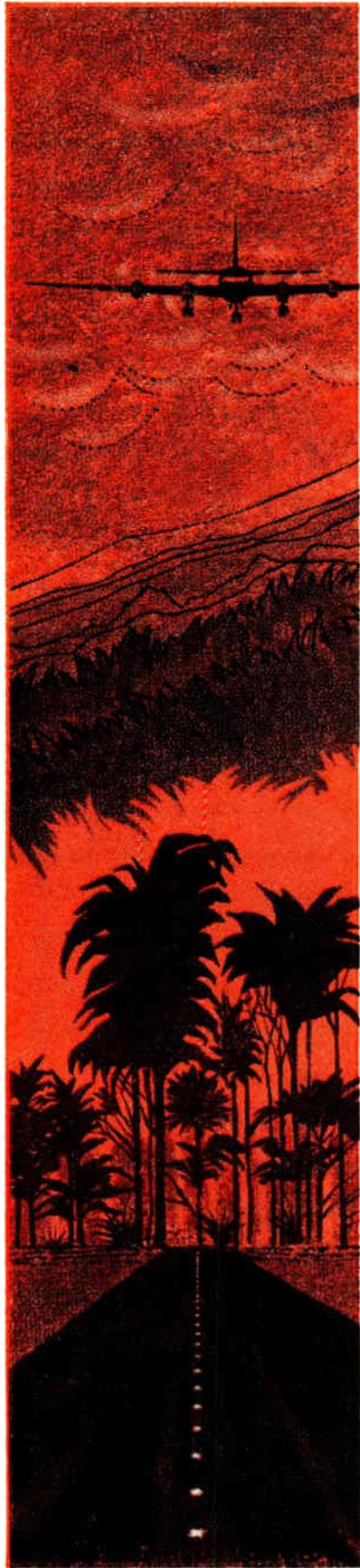
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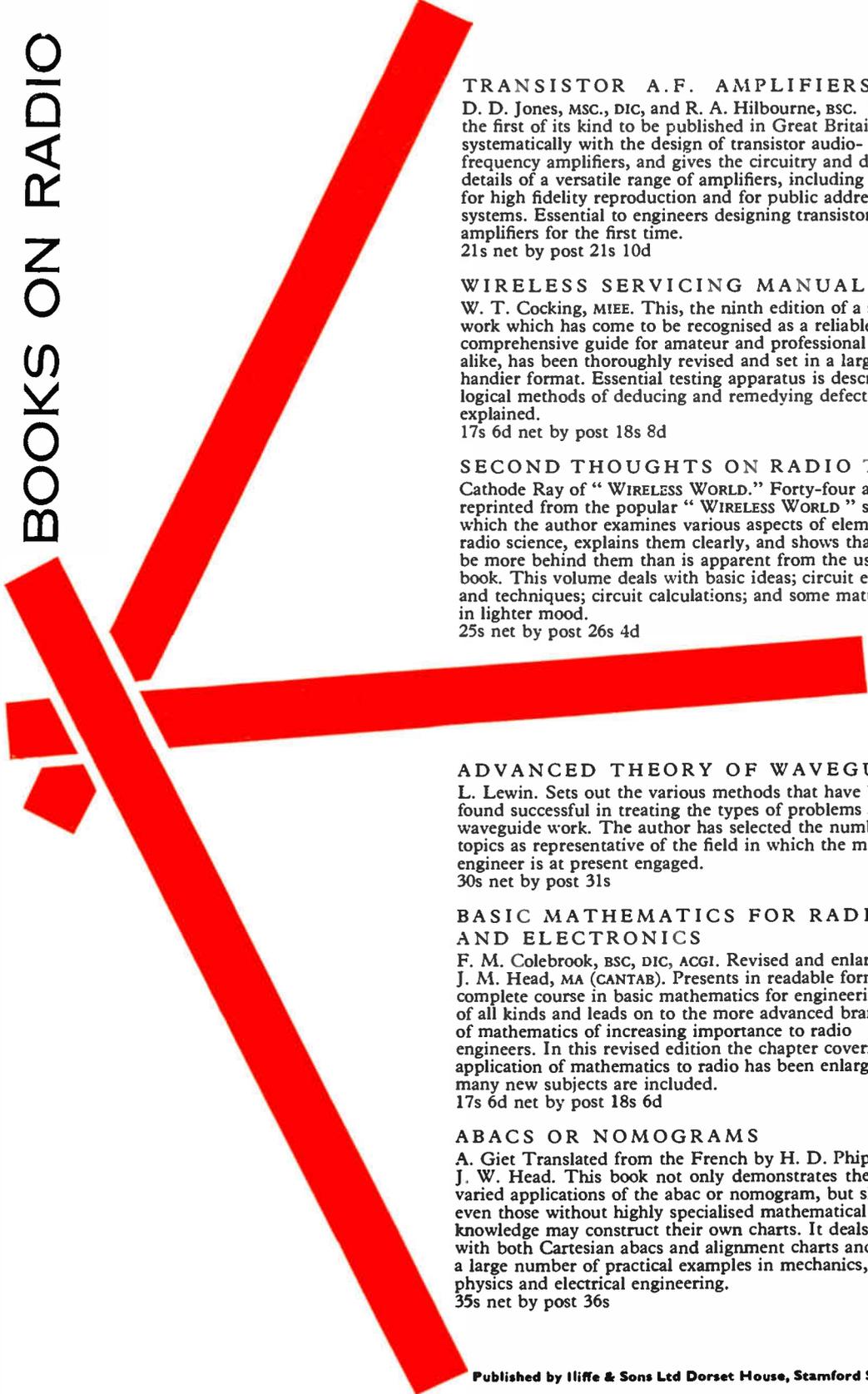
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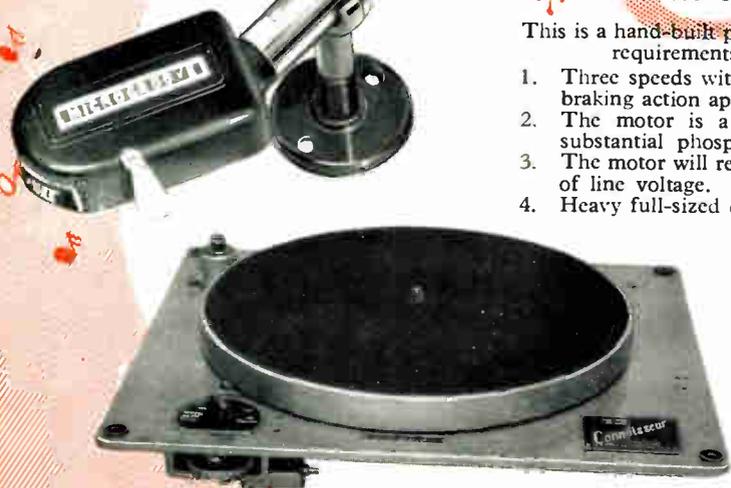


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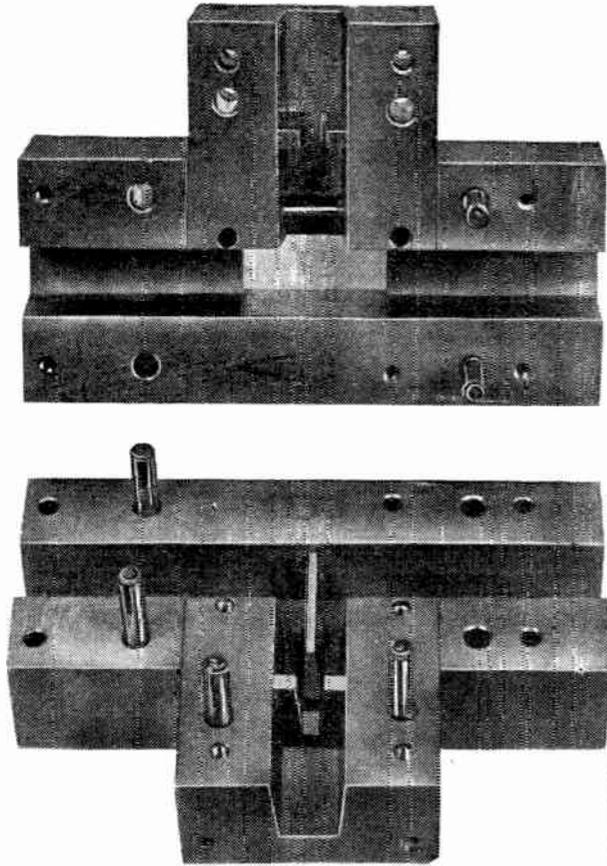
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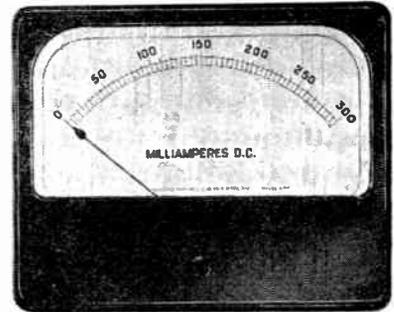
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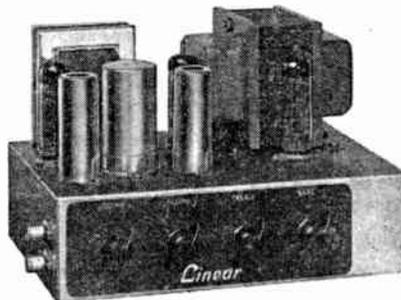
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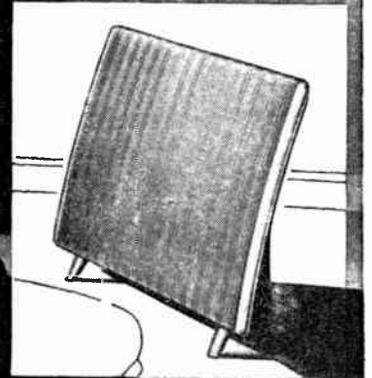
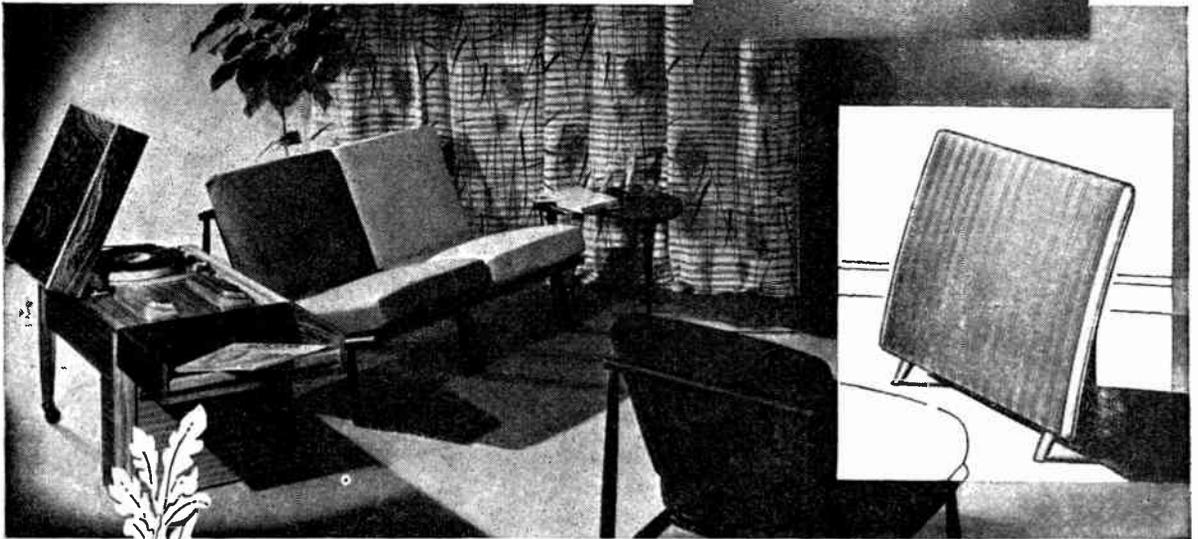
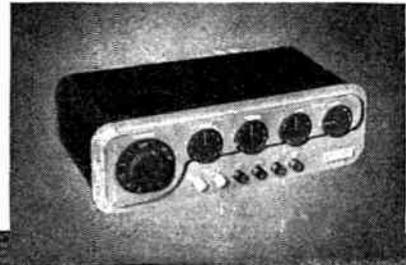
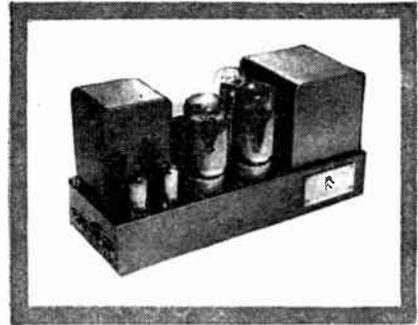
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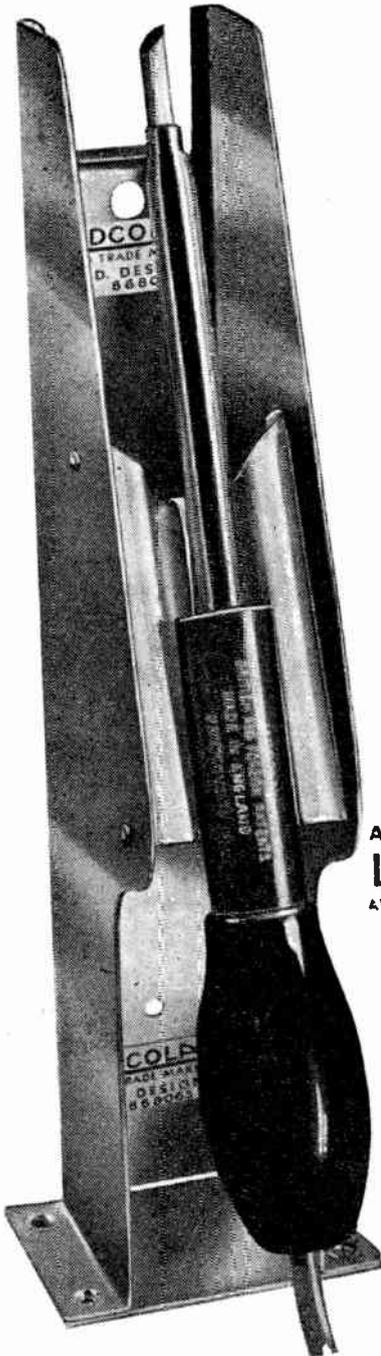
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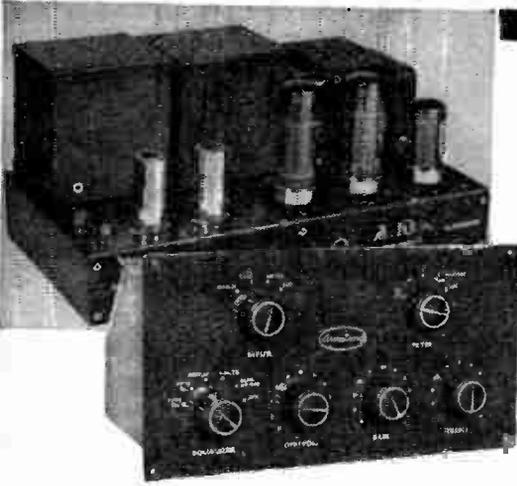


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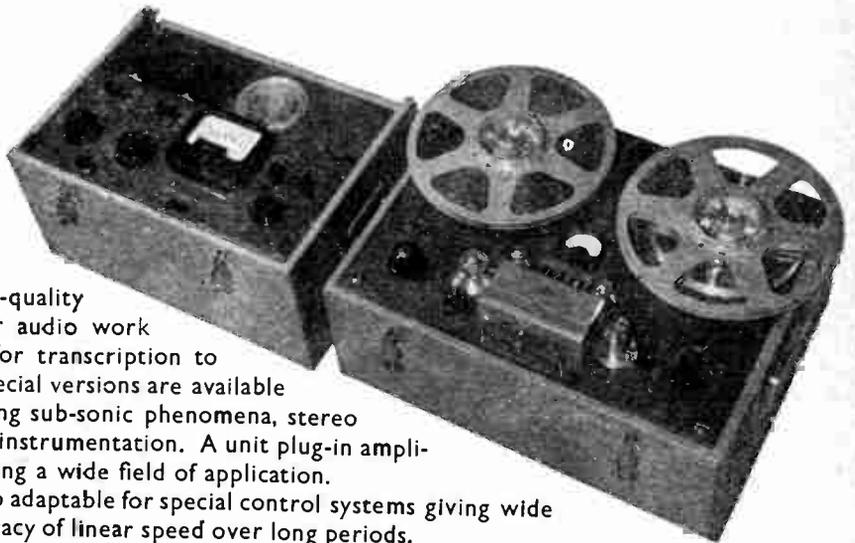
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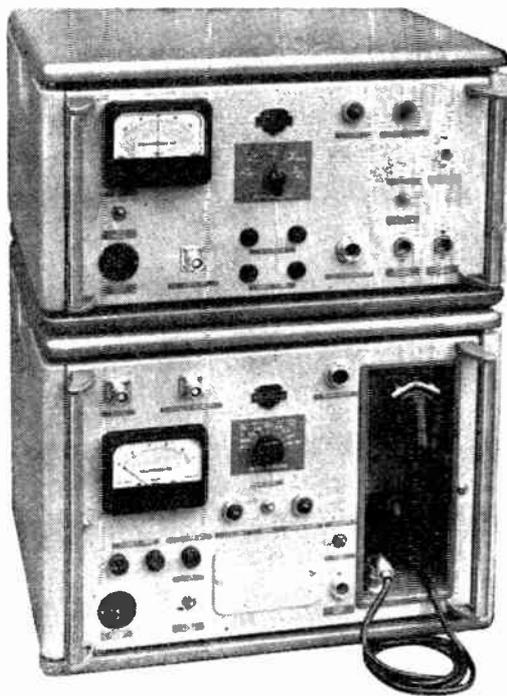
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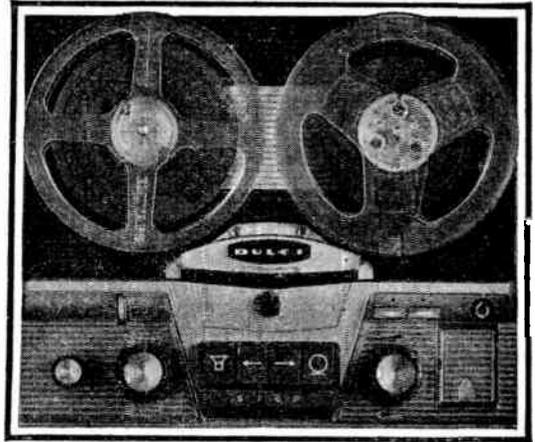


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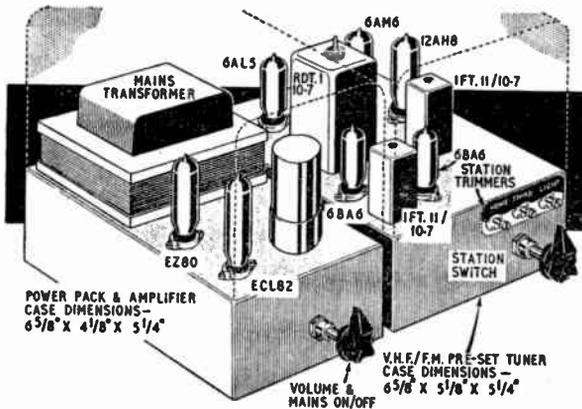
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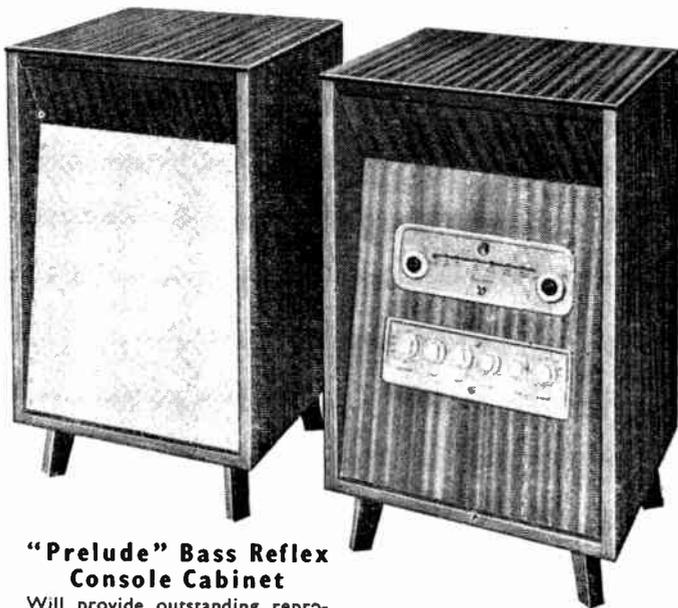
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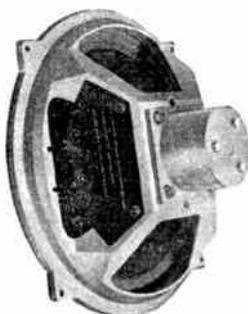
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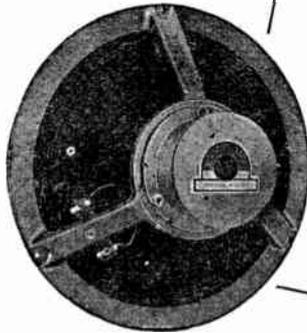
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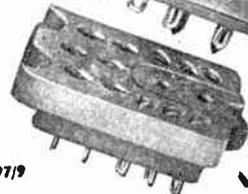
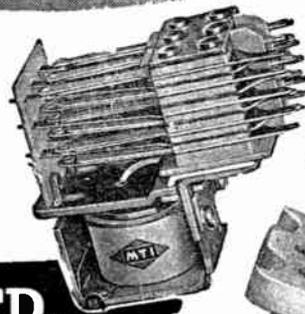
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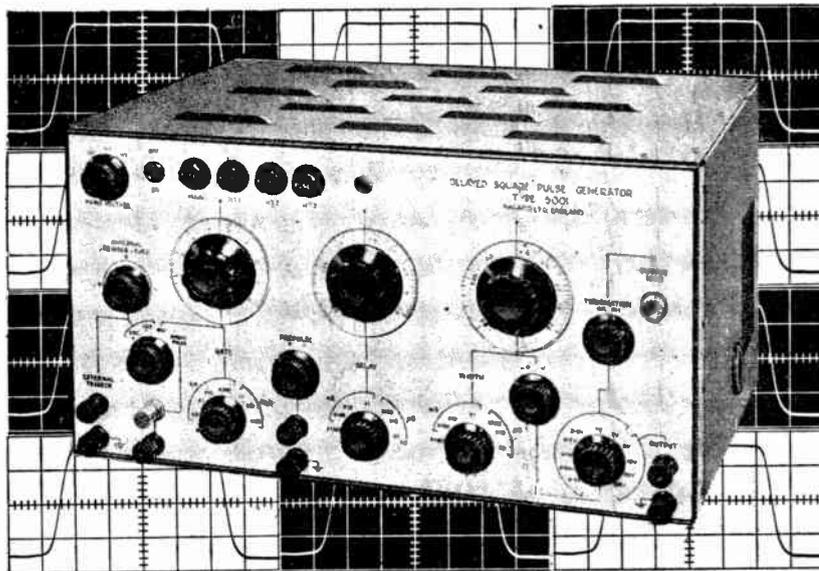
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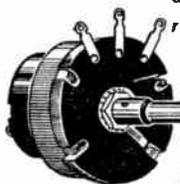
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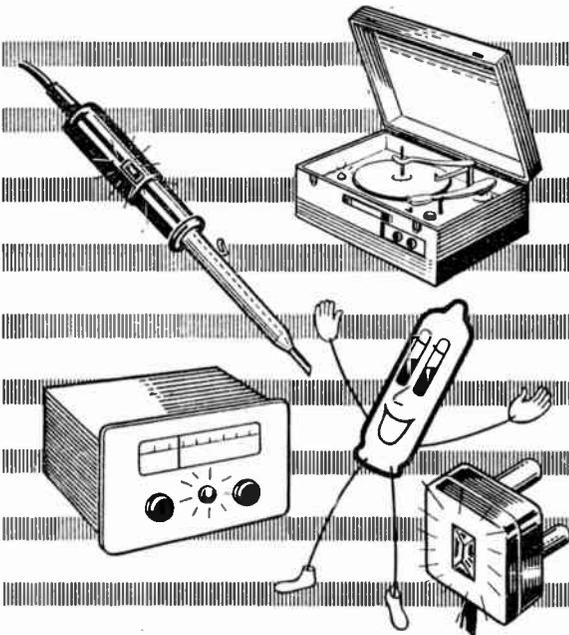
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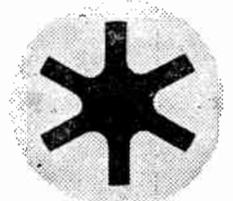
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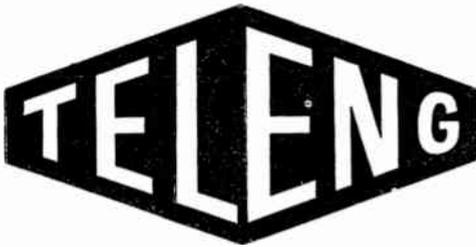


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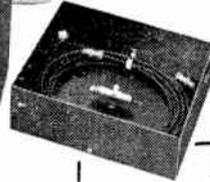
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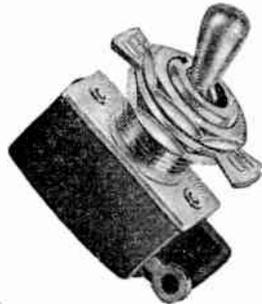
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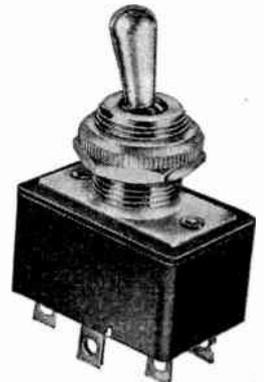
S.936: Normally off
S.938: Normally on



T.603
3-amp., 250v.



S.L.81
Neon Signal Lamp
 $\frac{1}{4}$ " hole fixing



T.622, Foggy Switch
D.P.C.O. 3-amp., 250v



K.75: Small Pointer Knob

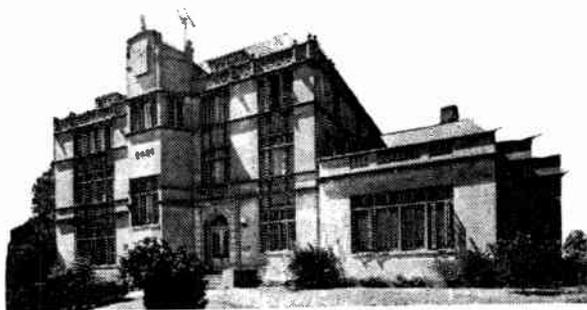


S.L.90/SB
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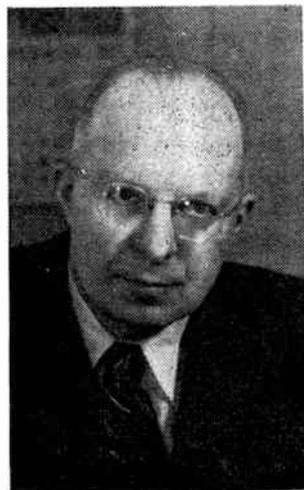
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Average Current Consumption: 120 mA.

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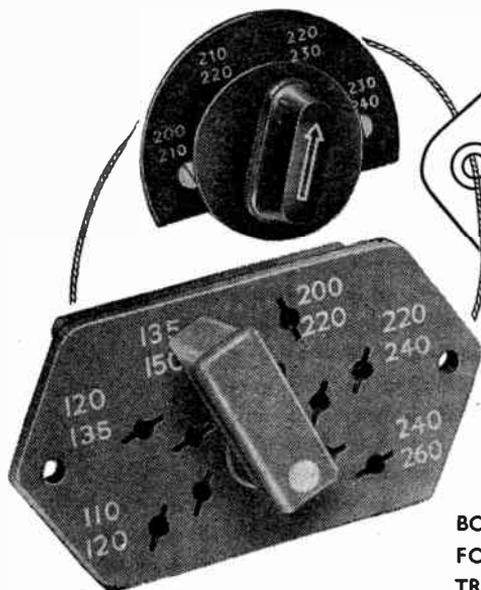
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Weight: 5 lbs. (incl. batteries)

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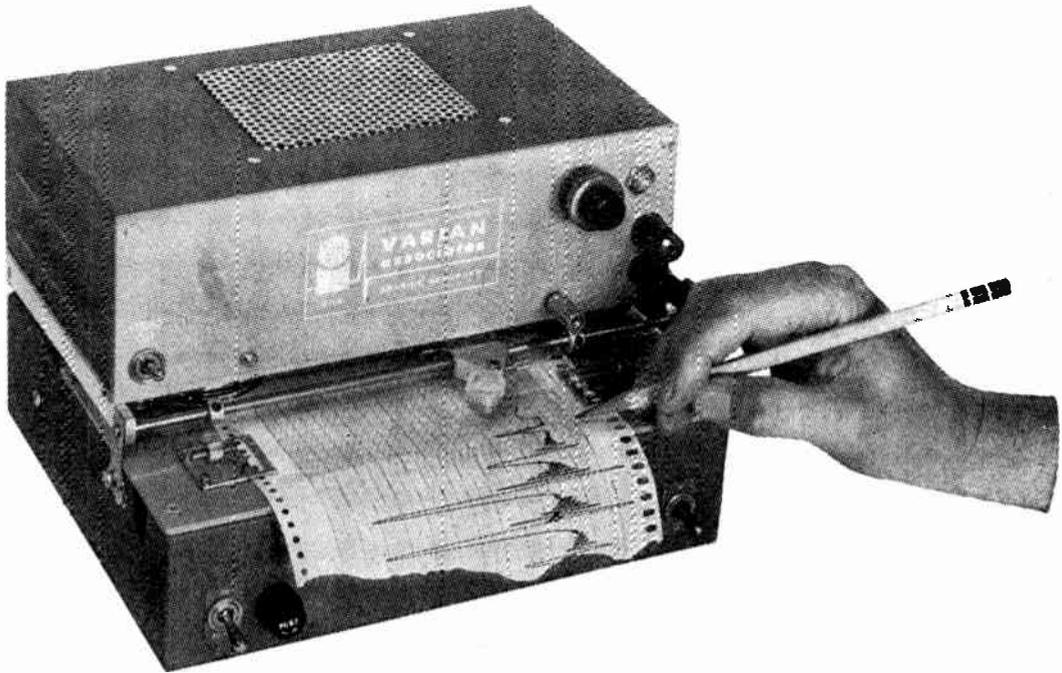
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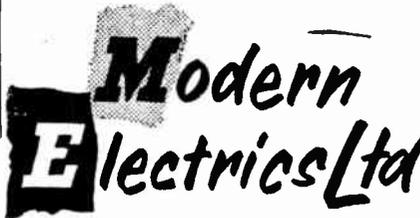
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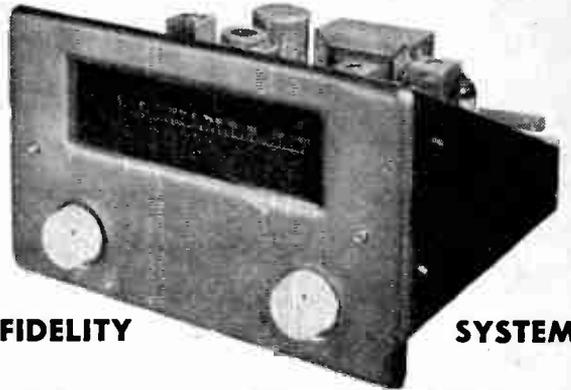
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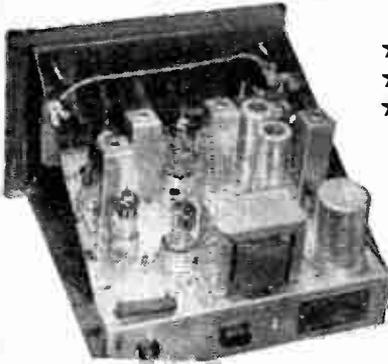
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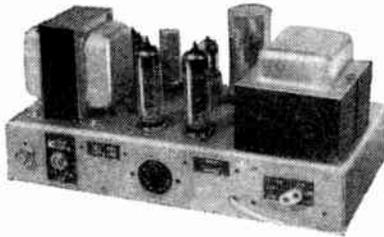
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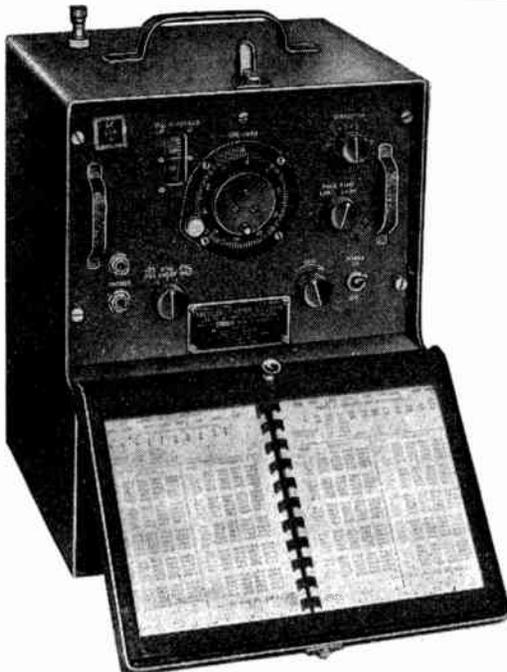
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ALSO AVAILABLE V.H.F. VERSIONS OF ABOVE

TS174

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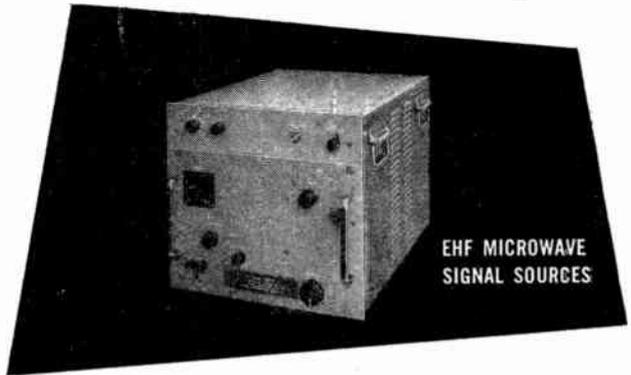
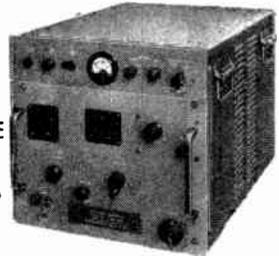
18,000 to 50,000 mc/s
WITH

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SIGNAL
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- 9 plug-in r-f tuning units cover the frequency range from 18,000 to 50,000 mc/s.
- Internal 1000 cps square-wave modulation.
- Capable of external modulation, both pulse and fm.
- Equipped with integral electronically regulated power supplies.
- Frequency calibration accomplished by a $\pm 0.1\%$ direct-reading wavemeter.

SIGNAL GENERATORS Basic Unit Model HU-2

Plug-in Tuning Unit Model No.	Power Output Calibrated
G1822	-10 to -90 dbm
G2225	
G2427	
G2730	
G3033	
G3336	
G3540	

FREQUENCY RANGE
18,000—22,000 mc/s
22,000—25,000 mc/s
24,700—27,500 mc/s
27,270—30,000 mc/s
29,700—33,520 mc/s
33,520—36,250 mc/s
35,100—39,700 mc/s
37,100—42,600 mc/s
41,700—50,000 mc/s

SIGNAL SOURCES Basic Unit Model HU-1

Plug-In Tuning Unit Model No.	Power Output Average
S1822	10 mw
S2225	10 mw
S2427	10 mw
S2730	10 mw
S3033	10 mw
S3336	9 mw
S3540	5 mw
S3742	Approx. 3 mw
S4150	Approx. 3 mw

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 Requirements for external pulse modulation:
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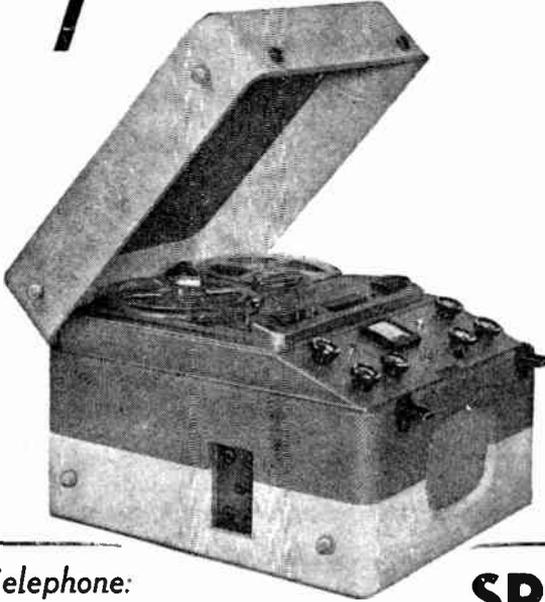
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Electrin Works, Winchester Street, Acton, W.3.

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*Delete whichever Series number not required.

Name.....

Address.....

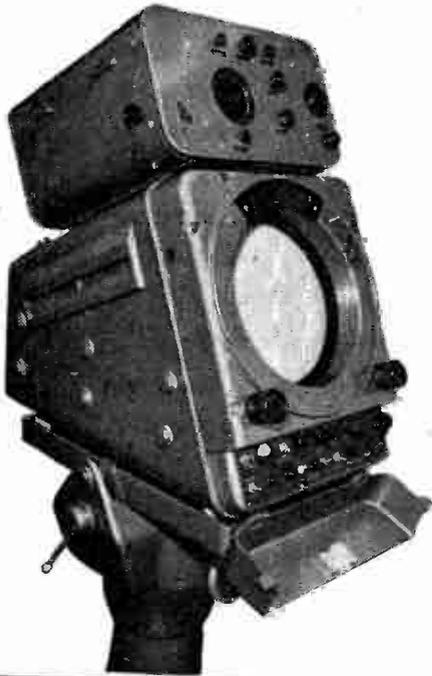
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Series 90
19 self-contained ranges
a.c./d.c. 200 microamps — 1,000 volts 5,000 ohms per volt

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21 ranges
a.c./d.c.
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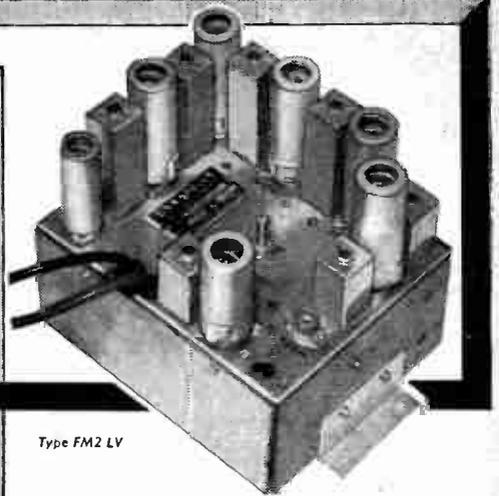
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- Automatic frequency corrector
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43 GNS. (plus £1.15.0 optional legs tax paid.)

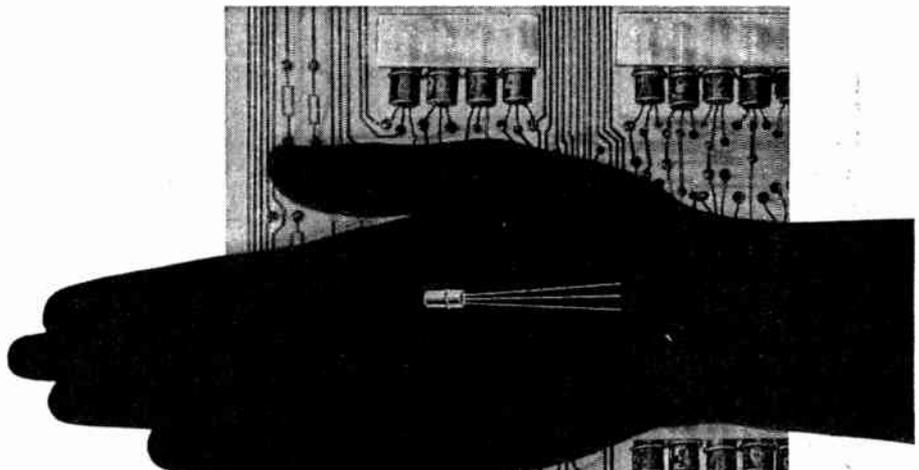


68 GNS.

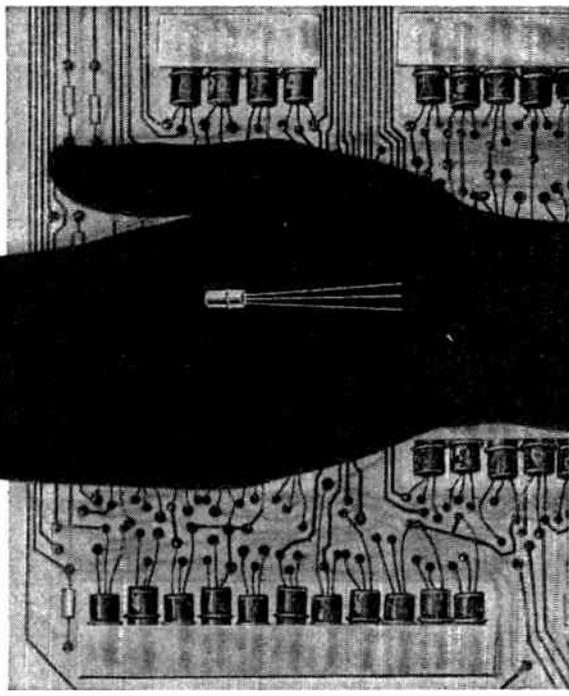
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(An Associate Company of Radio Corporation of America) Telephone: Sunbury-on-Thames 3101.



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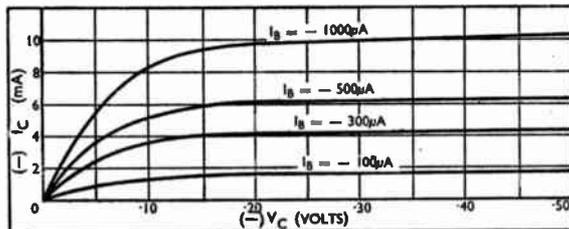
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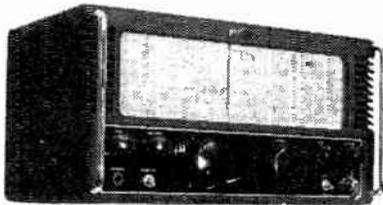
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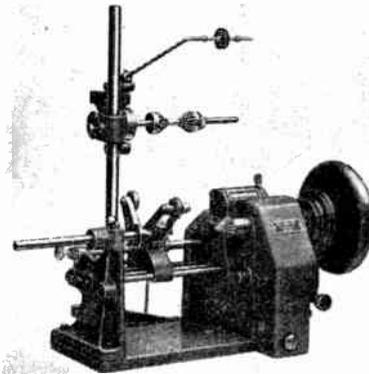
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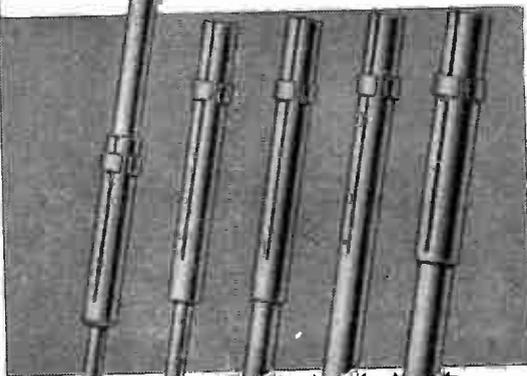
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A. 24	22-26	8	1	"
A. 28	26-30	8	1	"
B. 6	6	12	4	2 or 3
B. 12	12-13	12	4	2 or 3
B. 24	22-26	12	4	2 or 3
B. 28	26-30	12	4	2 or 3
C. 115	110-120	15	4	2, 3 or 5
C. 125	120-130	15	4	2, 3 or 5
C. 220	220-230	15	4	2, 3 or 5



3/32" 2.4 mm 3/32" 2.4 mm 5/32" 4.0 mm 3/16" 4.8 mm 3/16" Heavy Duty 4.8 mm

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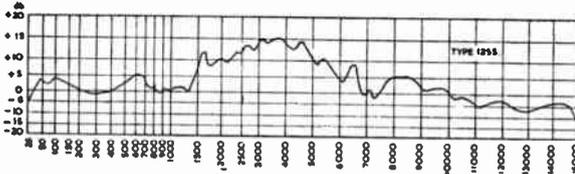
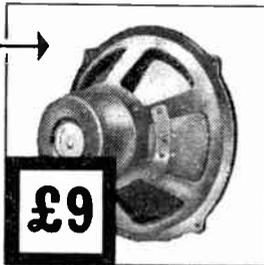


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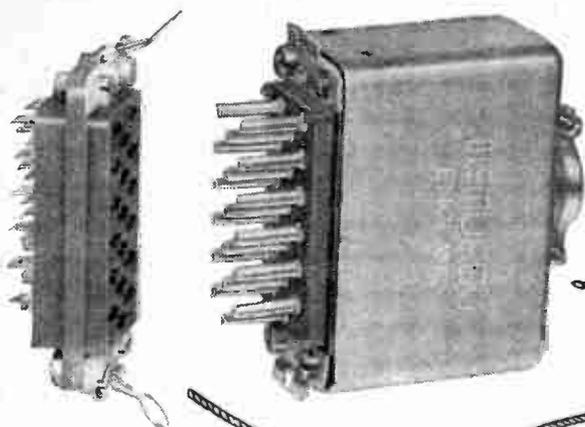
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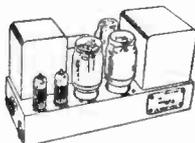
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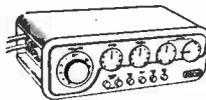
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RADIO EXPORT

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ON LOOKING BACK, WE CAN ONLY HOPE THAT 1958 WILL PROVE LESS DIFFICULT THAN THE SITUATION WHICH AROSE WITH RADIO TUBES DURING 1957. GREAT SHORTAGES APPEARED IN ALL COUNTRIES, WITH THE RESULT THAT PRICES WERE CONTINUALLY ON THE INCREASE.

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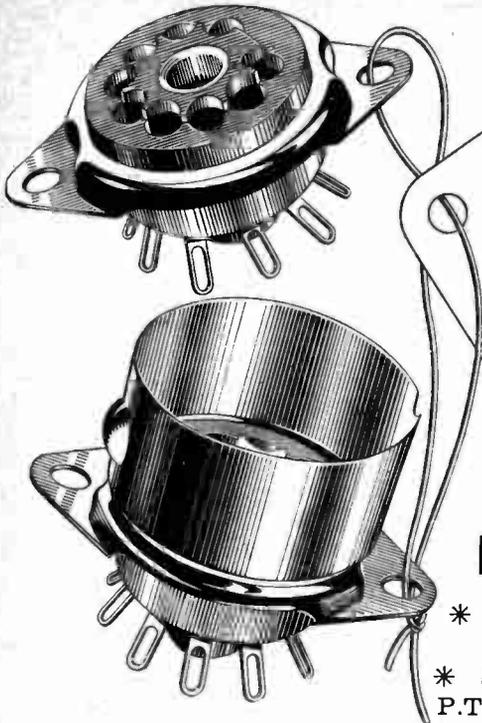
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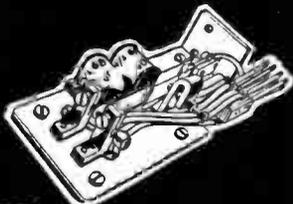
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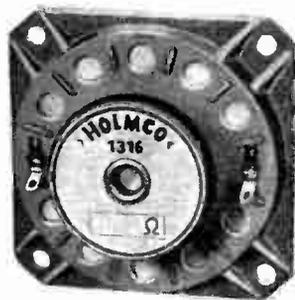
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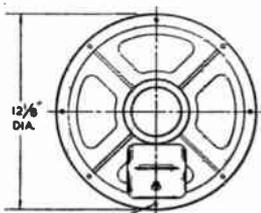
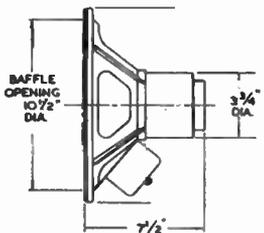
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Now!

a full range
dual concentric
loudspeaker
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8 FIXING HOLES 7/32" DIA.
45° APART ON A PITCH CIRCLE 11 5/8" DIA.

The Altobass 2000 loudspeaker consists of a horn-loaded high-frequency unit mounted concentrically with a conventional low-frequency radiator to form one integral unit. A dividing network is built in to feed high and low frequencies to their respective voice coils. The HF pressure unit is loaded by a truly exponential horn commencing through the centre pole of the LF magnet and terminating in a multicellular assembly within the bass cone. This unique feature disseminates the full range over a wide area, thus eliminating any beam effect.

- * *dual concentric assembly*
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17 GUINEAS

CABINETS & HI-FI EQUIPMENT



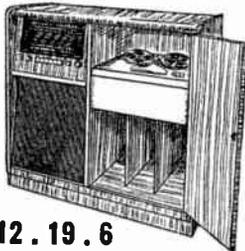
THE CONTEMPORARY. This beautifully made cabinet is oak veneered with mahogany interior and is waxed finished. Available in any shade to order at slightly extra cost.
This cabinet can be fitted with any of the latest Hi-Fi Units.

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THE SERENADE. Veneered with finest selected walnut, beautifully polished to a medium shade; this attractive cabinet has generous storage space, with board sliding out smoothly on metal rollers.
This cabinet can be fitted with any of the latest Hi-Fi Units.



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THE BUREAU. This popular bureau cabinet is veneered with the finest selected Walnut and beautifully polished in a medium shade. Designed to accommodate almost any of the many units we have available and to give generous storage compartments.

HI-FI CHASSIS

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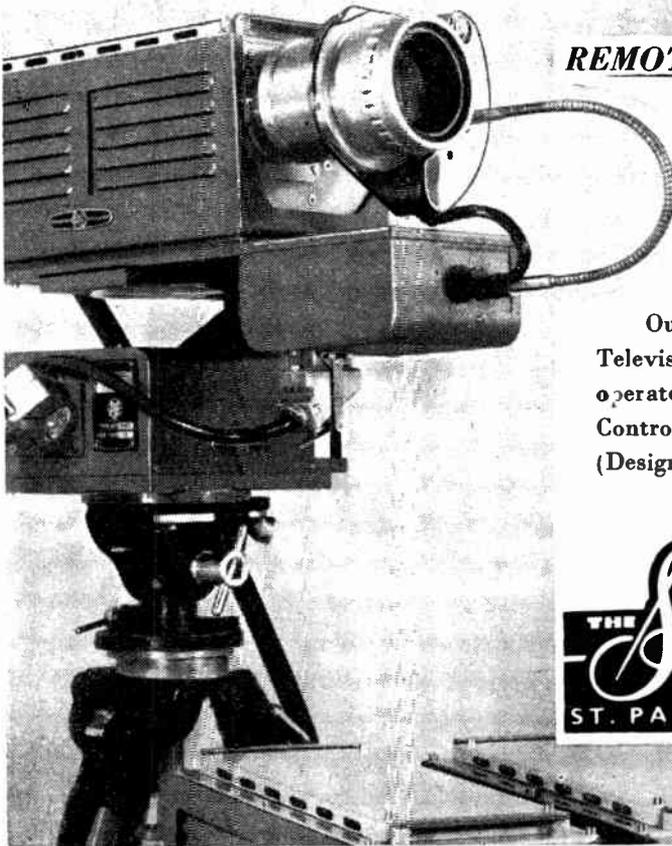
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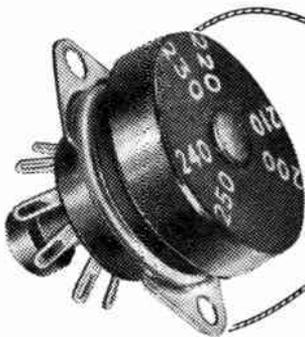
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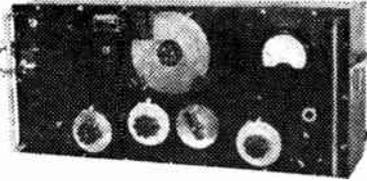
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BRAND NEW ORIGINAL SPARE PARTS FOR AR63 RECEIVERS.

- I.F. TRANSFORMERS** 1st, 2nd, 3rd, 4th (for type D) 12/6 each or complete set of 6, 60/-.
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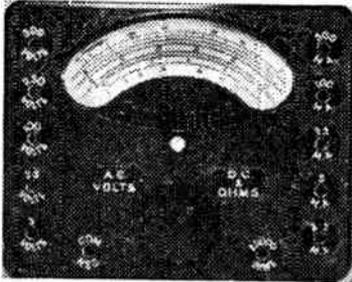
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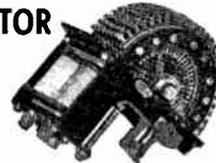
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HIGH SPEED POLARISED and A.C.
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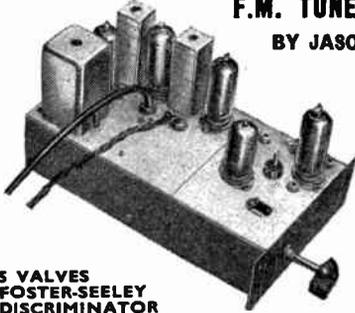
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THE MERCURY SWITCHED F.M. TUNER BY JASON



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Complete set of parts **£9.19.6** plus 2/6 can be purchased for p.p. All the components can be purchased separately. The main components are as follows.—
 Chassis 6/6
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 Prefabricated front-end completely wired and tested with IEF80 and IECF80 (incl. P.T.) £6/5/-
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Two ranges, D.C. 0-250 v., 0-25 v., complete with leads in canvas case. In leather case 1/6 extra.
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Cash £22/10/-, or credit terms £3/10/- deposit and 8 monthly payments of £2/14/8. H.P. Terms £11/5/- deposit and 12 monthly payments of £1/0/11. Packing and Carr. 7/6. This chassis has 8 valves and covers short, medium and long FM and Gram. Printed circuit on F.M. ensures a high degree of stability. Overall size 14in. long, 6½in. high, 9in. deep. Dial size 12 x 5½in.



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ONE VALVE BATTERY RECEIVER
 AS SHOWN ON B.B.C. T.V.
 This Receiver contains a DAF96 valve and a pair of 4,000 ohm headphones and is powered by a combined 67½ and 1½ volt battery.
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 Send for free diagram.

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Designed to play 12in., 10in. and 7in. Records intermixed in any order at 16, 33½, 45 or 78 r.p.m. Capacity 10 records. New reversible Dual Stylus Crystal Pick-up for use on 100/250 v. 50 cycle A.C. mains, £9/15/- plus packing and postage 5/-. Deposit 25/- and 8 monthly payments of 25/9.

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4-speed single player with Studio "O" head. A.C. Main. 200/250 volts, 50 c/s. Suitable for record speeds of 16, 33½, 45 and 78 r.p.m.

Special offer

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Carr. & Pkg. 5/-

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By Oldham, Dagenite, Exide. New and unused, unspillable. 7½ x 4 x 2.

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THIS RECEIVER WHICH HAS BEEN SPECIALLY DEVELOPED FOR THE AMATEUR CONSTRUCTOR PROVIDES COMPLETE COVERAGE OF THE SOUND BROADCAST BANDS—LONG, MEDIUM AND SHORT WAVE AM. WITH 87.5-100 Mc/s. V.H.F. FOR FM. WE HAVE PRODUCED A FULLY ILLUSTRATED BOOKLET WHICH GIVES INFORMATION ON THE ASSEMBLY AND ALIGNMENT OF THE 4-BAND SEVEN-VALVE RECEIVER, INCLUDING CHASSIS LAYOUT, CIRCUITS AND POINT-TO-POINT WIRING DIAGRAM.

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- ★ ALUMINIUM CHASSIS WITH ALL PUNCHING AND BENDING COMPLETE.
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THE "Petite" PORTABLE

MAY BE BUILT FOR
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Batteries extra.
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- ★ Size only 8in. x 8in. x 4½in.
- ★ Weight, including batteries, 5½lb.
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- ★ Designed in our own laboratory.
- ★ Backed by an up-to-date Technical Information Dept.
- ★ Components available separately if desired.
- ★ Simple to construct, using normal soldering methods.
- ★ Instruction book 1/6.

Mains unit now available for only 37/6 plus 2/- pkg. & carr. Send for leaflet.

Build this NEW TAPE RECORDER KIT



for only

£38-15-0

This Kit comprises:

- | | | | |
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| 2-speed lane Mk. VI Deck | £13 10 0 | De-luxe Cabinet with gilt fittings and detachable lid | £4 19 6 |
| Premier Tape Amplifier complete with separate plug-in-type power pack | £14 0 0 | Reel of Scotch Boy 1,200ft. | £1 11 6 |
| 7 x 4 Elliptical Speaker | £1 1 6 | Latest Type ASCOS microphone | £2 15 0 |

All the above sections can be purchased separately.

The New De-Luxe TAPE RECORDER TR3



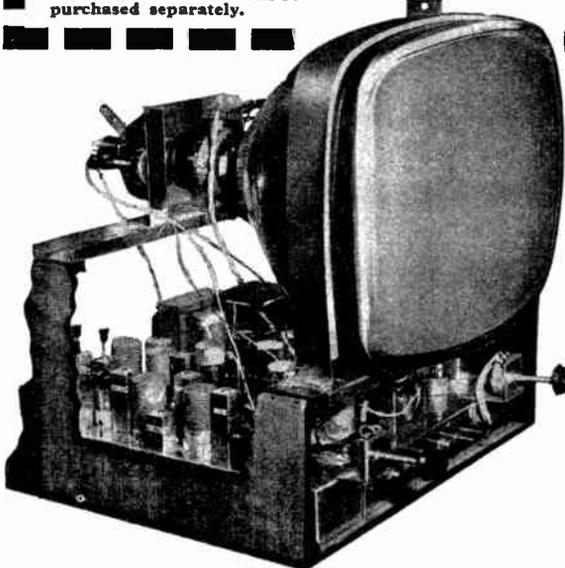
for £6-5-0 DEPOSIT AND 8 MONTHLY PAYMENTS of £5/17/11 OR CASH 45 gns. plus 2/- post & pkg.

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

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Build the NEW "MAYFAIR" TELEVISOR

which gives complete SAFETY to the constructor!



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

★ B.B.C. & I.T.A. DESIGN

WITH NEW TURRET TUNER MAY BE BUILT FOR **£33-7-11** PLUS COST OF C.R.T.

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

CONSOLE CABINETS with full length doors for 14in., 16in. and 17in. tubes. PRICE £14/14/- H.P. Terms: Deposit £7/7/6 and 9 monthly payments of 18/6.
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PREMIER RADIO COMPANY,

with PREMIER

The latest COLLARO

4-speed single player unit complete with pick-up and turnover cartridge... £4 14 6 plus 2/6 pkg. & carr.



CABINETS—PORTABLE

MODEL PC/2
Grey Lizard Rexine covered... 45/-
Overall dimensions 15in. x 13in. x 6in. Clearance under lid when closed 3in.



MODEL PC/2 DE LUXE
Two colours, wine and grey, with cut-out for speaker and amplifier... 55/6
Dimensions 15in x 14in. x 7in

MODEL PC/3
Grey Lizard Rexine covered... 69/6
Overall dimensions 16in. x 14in. x 11in. Clearance under lid when closed 3in.

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

THE ABOVE CABINETS ARE COMPLETE WITH CARRYING HANDLE FASTENERS AND PANEL.

Packing and Postage 3/- each.
Junction Transistors 10/- each
Equivalent of the OC70 Type

CONTINENTAL STYLE CABINET

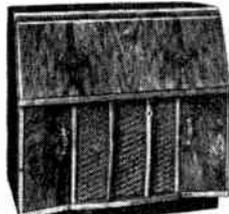


Dark Piano finished with gold and black styling, overall size 39in. long, 32in. high, 16in. deep. Two sliding doors, concealing on the left a black panel 18in. x 20in. finished in medium mahogany, and on the right a detachable board 12in. x 18in. and a shelf which may be used for record storage.

Cash Price 18 gns., plus 25/- pkg. and carr. Credit Terms: Deposit £2/18/- and 8 monthly payments £2/6/-.

The new Spencer West Band Three converter is now available at £6/5/- plus pkg. and post 3/-.

Spencer West Pattern Unit 25/- plus 1/- pkg. and post. For elimination of B.B.C. interference or I.T.A.



PREMIER BUREAU DE LUXE

A superb cabinet in finely figured walnut veneer. Interior light sycamore with rexine matching lining. Overall dimensions: 33in. high, 34in. long, 17in. deep. Uncut control panel on right-hand side approximately 16in. x 10in., uncut baseboard on left-hand side 15in. long, 13in. deep. Two full size felt-lined storage cupboard in the lower part of the cabinet.

Cash price 164 gns. Credit Terms: Deposit £2/6/6 and 8 monthly payments of £2/3/2. Packing and Carriage 25/- extra.

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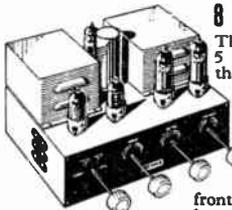


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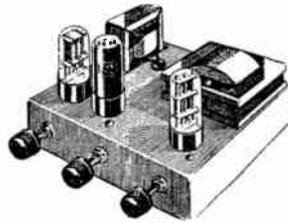
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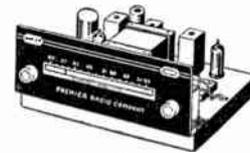
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ELECTRONICS, RADIO, TELEVISION

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JANUARY 1958

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Transistor



R.C. Coupled Amplifier Stages

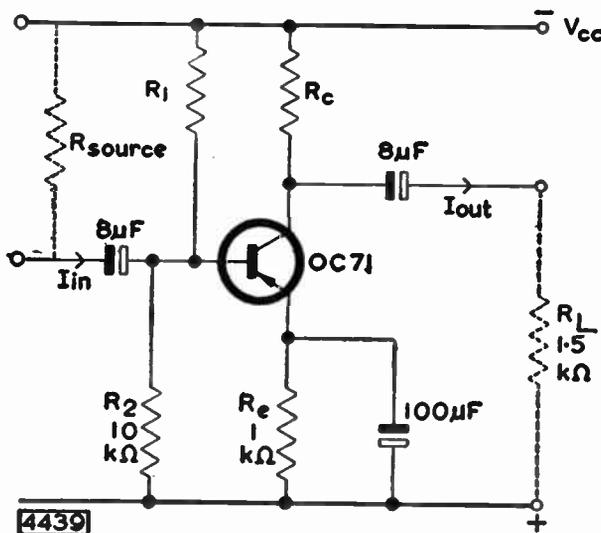
Although it is desirable to design a universal standard transistor amplifier stage, this is not possible because signal level, supply voltage and maximum working ambient temperature each introduce problems which must be overcome in different ways. It is possible however to design and publish typical amplifier stages for several supply voltages, assuming a maximum working ambient temperature, making a compromise between gain and output.

The first stage in an amplifier must be designed to provide as high a ratio of signal to noise as possible, because the accumulated input and circuit noise will give a very impure output over a number of stages. In all other stages the requirement is maximum gain for minimum distortion at the required output level.

The recommended circuit using a Mullard OC71 transistor, with capacitive coupling produces a good gain for a relatively distortion free output. The circuit is suitable for use with supply voltages of 6V, 9V and 12V, stabilised up to 45°C ambient working temperature. Some modifications are indicated below for the user's guidance. It is important when modifications are made to ensure that the collector current should not go below 0.3mA, otherwise the input resistance and collector-emitter gain α' become very non-linear. The distortion and gain data shown in the accompanying table are typical for one OC71 stage from a series of

identical ones in cascade. The source impedance R_{source} is assumed equal to the collector resistance R_C . A resistance of 1.5k Ω is used to shunt R_C , this value is equivalent to the input impedance $R_{i'}$ of the following stage. The current flowing in this 1.5k Ω is the output current considered in the distortion and gain measurements tabulated below. The gain figures apply to a transistor with average collector-emitter gain α' . These component values have been carefully chosen such that in each case the transistor operates satisfactorily up to an ambient temperature of 45°C. It will be seen from the table that the useful output current, for 5% total distortion, and stage gain increase with supply voltage. This distortion is predominantly second harmonic.

The performance obtained with $I_C = 1\text{mA}$ should be adequate in most cases, however the stage gain can be increased by reducing (not below 0.3mA) the collector current, this is only worthwhile at the lower supply voltages. For instance $I_C = 0.5\text{mA}$, $R_e = 2.2\text{k}\Omega$, $R_C = 3.9\text{k}\Omega$ gives 20% increased gain. Increased output can be obtained for a given distortion by increasing the collector current to, say, 1.5mA, altering circuit values accordingly. For minimum distortion it is preferable to keep the collector current in the range 1-2mA, in any case it should not be reduced below 0.3mA, and to keep the source impedance as high as possible.



CIRCUIT VALUES AND GAIN FOR SOME TYPICAL OC71 TRANSISTOR STAGES

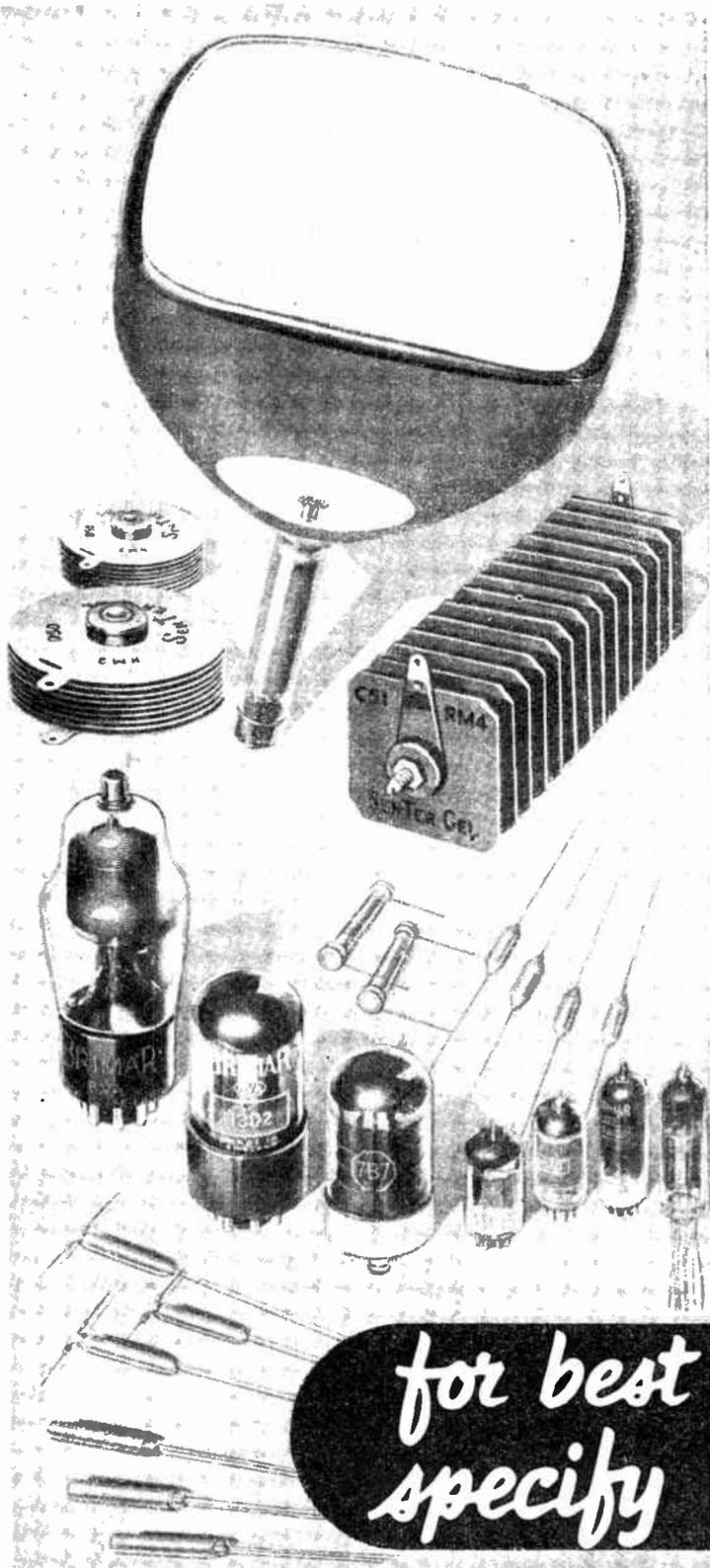
V_{CC} (V)	I_C (mA)	R_1 (k Ω)	R_2 (k Ω)	R_e (k Ω)	R_C (k Ω)	$\frac{I_{out}}{I_{in}}$	I_{out}^*
6	1.0	39	10	1	2.2	23	200
9	1.0	62	10	1	3.9	28	260
12	1.0	82	10	1	5.6	31	270

* For 5% total distortion



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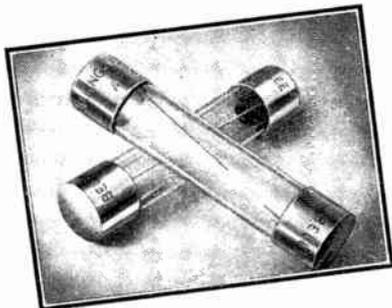


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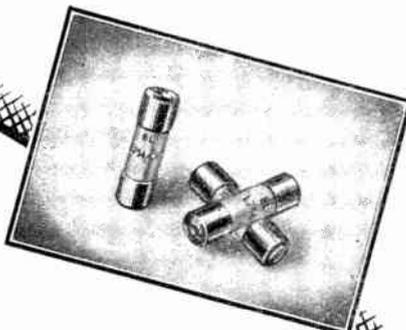
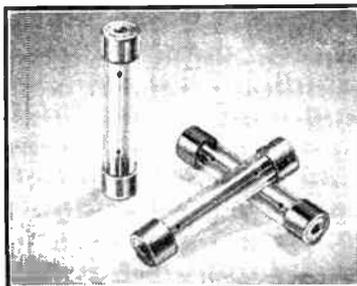
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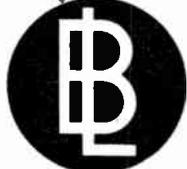


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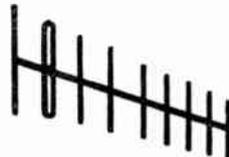
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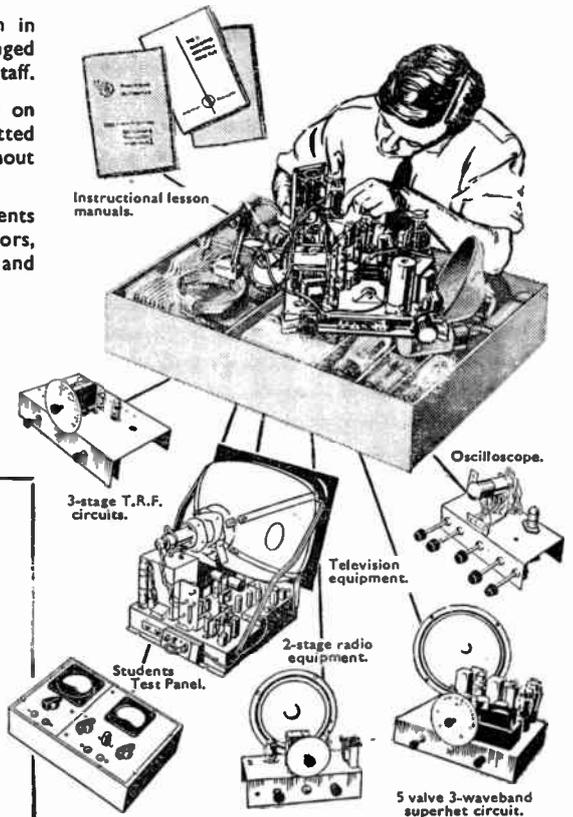
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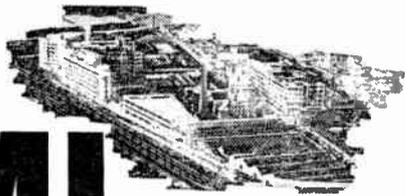
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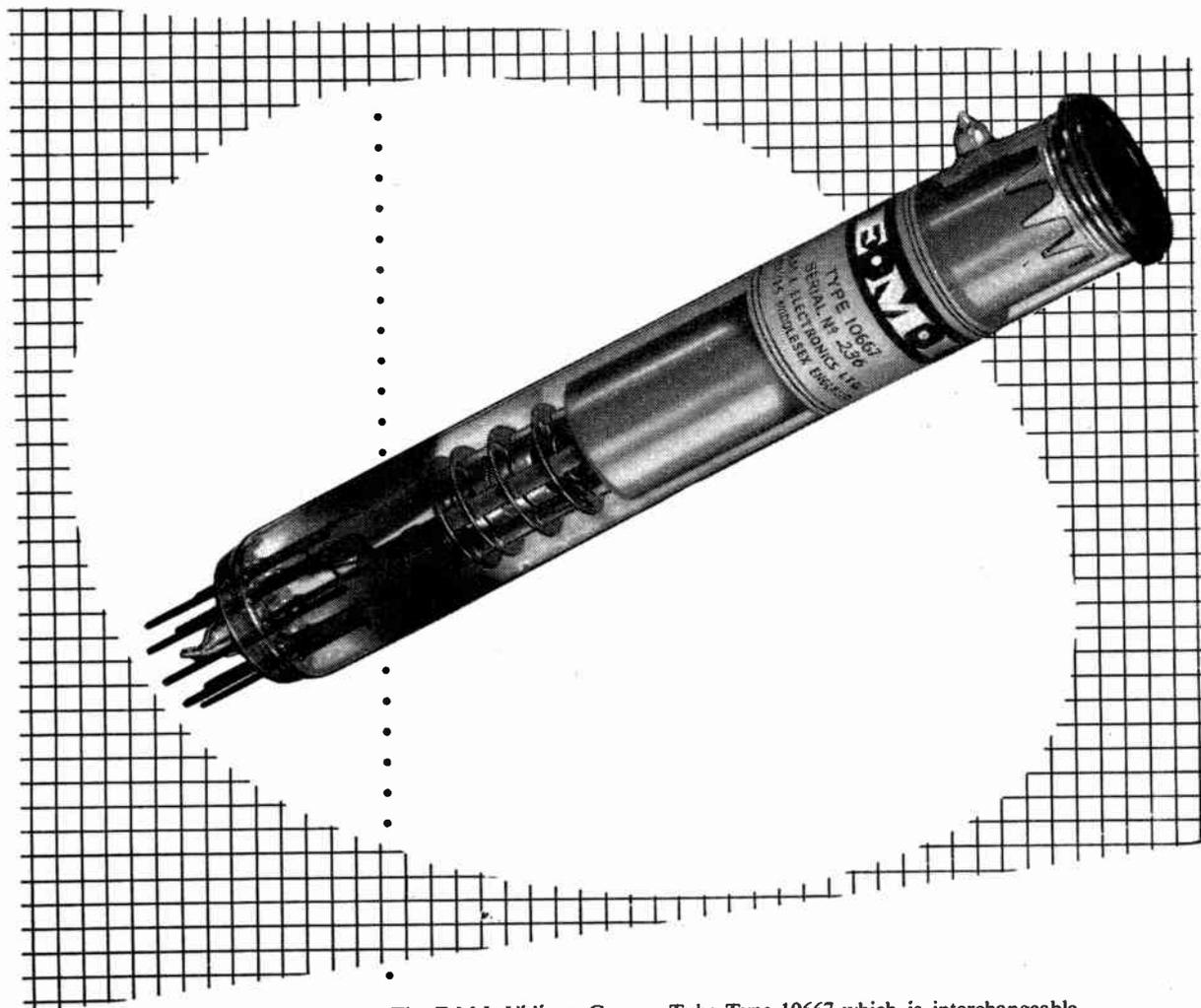
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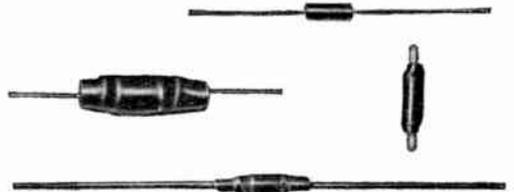
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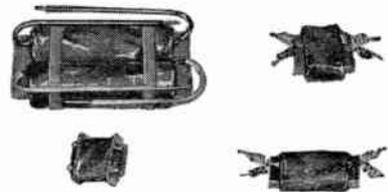
Television Interference Suppression Inductors



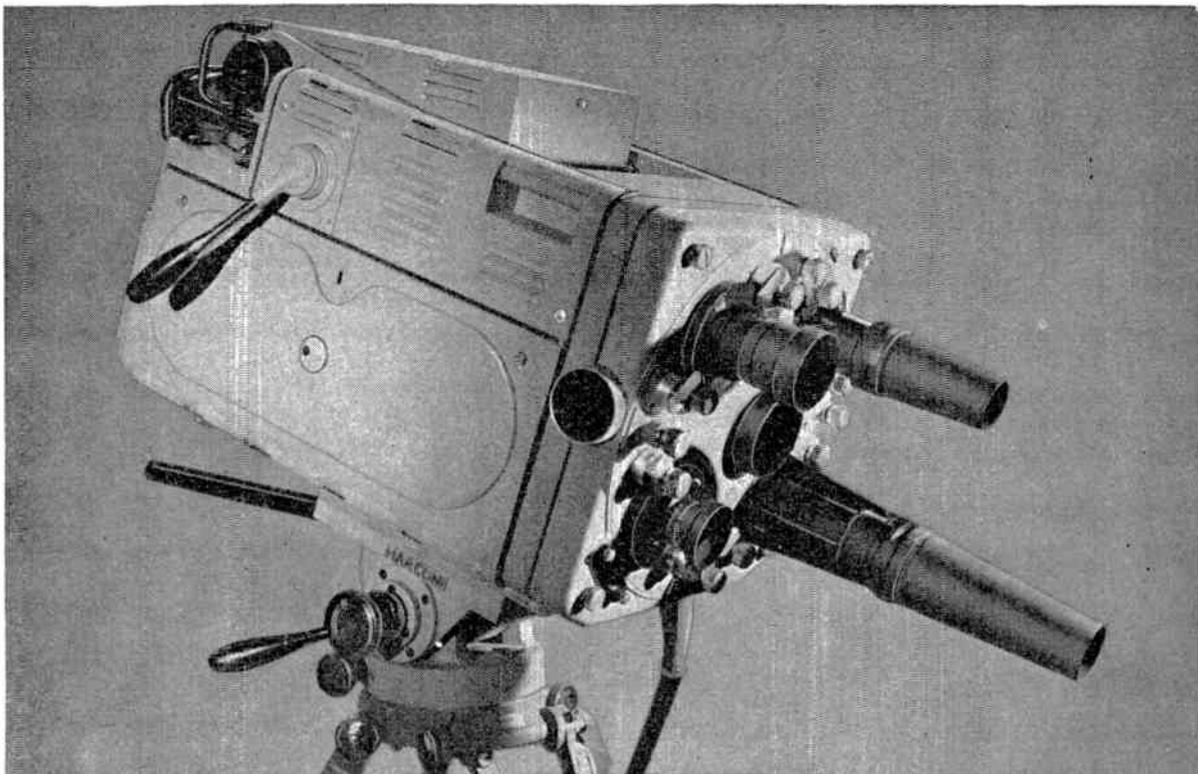
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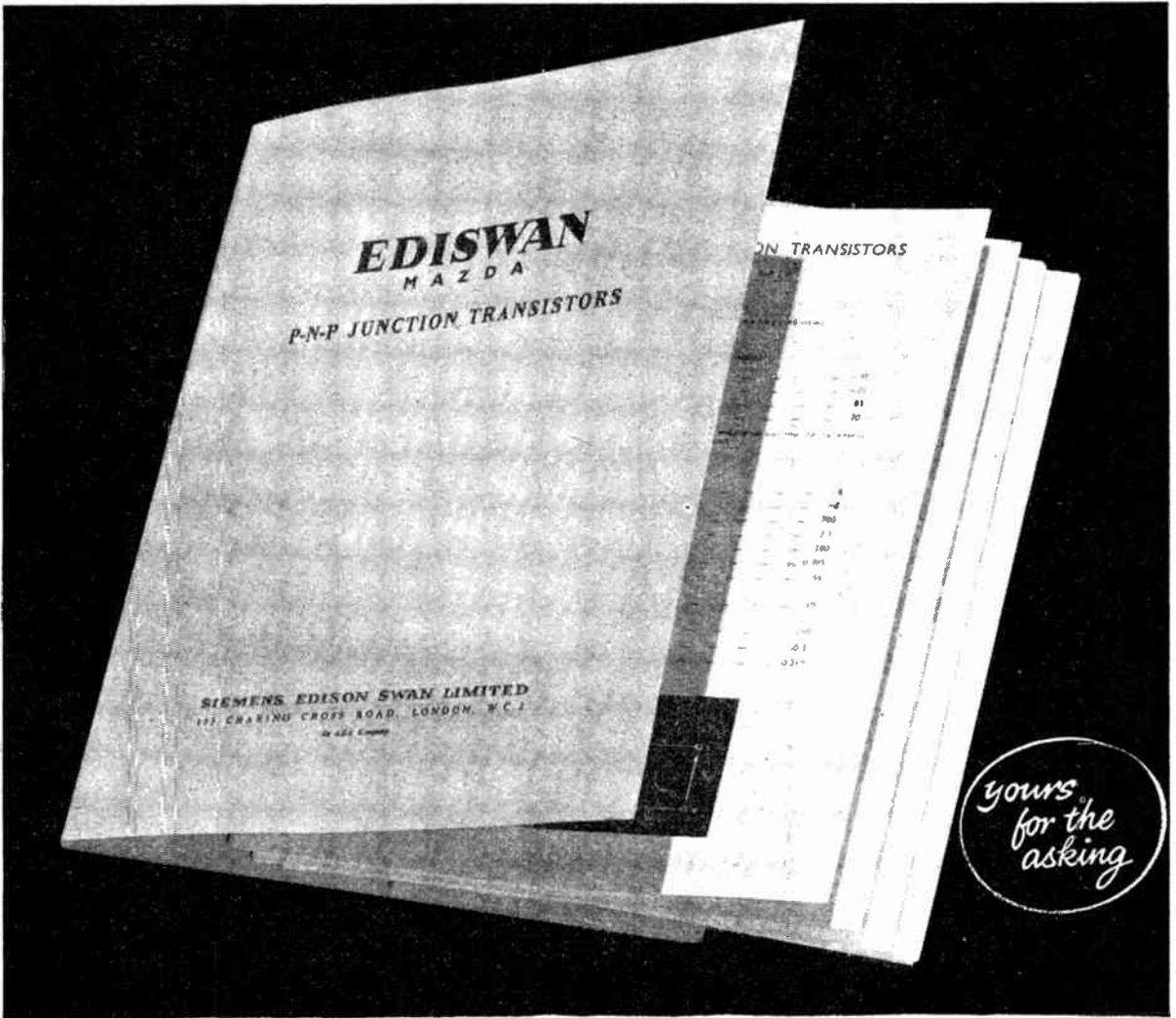
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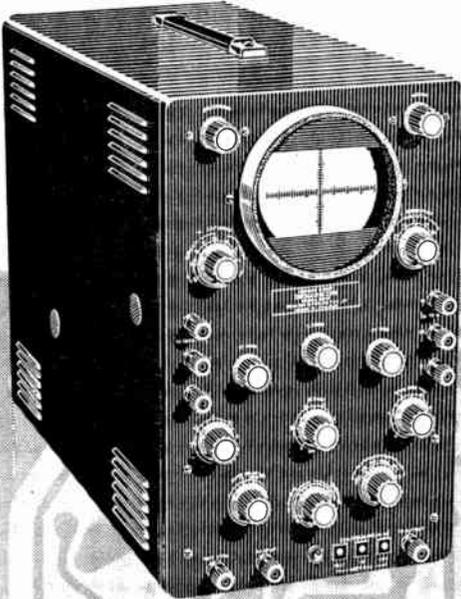
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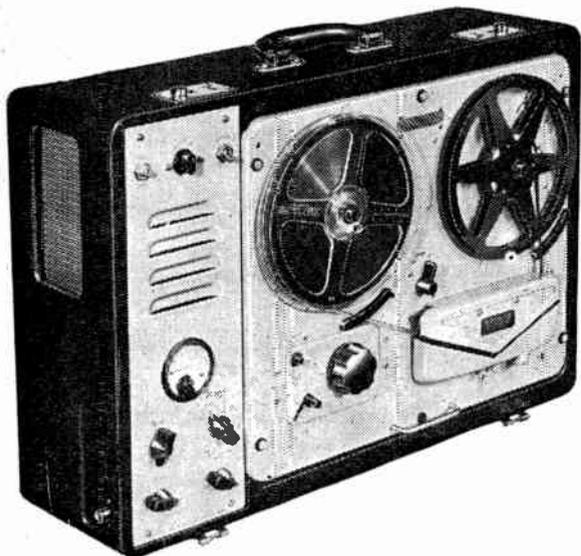
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TAPE RECORDERS and AMPLIFIERS



The above recorder uses a synchronous capstan motor and for use on 12 volt car battery a 50 c/s ± 1 cycle 230 v., 120 w. power supply unit is available.

T.R.G.10 MINIATURE AMPLIFIER AND VERSATILE PRE-AMPLIFIER. A modern miniature amplifier, measuring only 4½ x 5in. over front panel and projecting 1¼in. to the rear. Uses C core transformer material to obtain low external magnetic field and has less than 0.1% harmonic distortion at 10 watts output. The amplifier response is level 15 c/s. to 50,000 c/s. within 0.2 db. The 3-valve pre-amplifier will operate direct from recorder heads with correction networks for difficult tape speeds and switched inputs are provided for radio, microphone and gram. with correction for all recording characteristics.

"SUPER FIFTY WATT" AMPLIFIER. This heavy duty amplifier is available for long life under arduous conditions. The normal life being 5,000 hours without valve change.

★ The total hum and noise at 7½ inches per second 50-12,000 c.p.s. unweighted is better than 50 db.

★ 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 0.5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

★ 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 4 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.

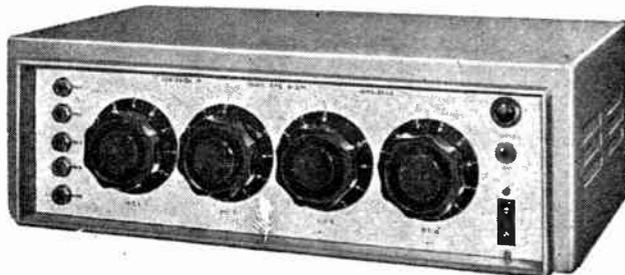
★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

CP20A AMPLIFIER. This standard amplifier for extreme tropical use will operate from 230 v. A.C. mains or 12 v. car battery and give 15 w. output for a consumption of 5.5a. Inputs for 30Ω balanced microphones, M.I. P.U. and Cr. P.U.

FOUR CHANNEL ELECTRONIC MIXER

An Electronic Mixer for four 30-50Ω balanced line microphones or special to order. Normal output 0.5 v. on 20,000Ω but 1 mW., 600Ω balanced or unbalanced is available as an alternative.

The 3-CHANNEL MIXER and PEAK PROGRAMME METER is similar to the above but is fitted with a meter reading peak signals with 1 second decay time and calibrated in db from zero level 1 mW., 600Ω to +12 and -20 balanced or unbalanced output by means of switch.



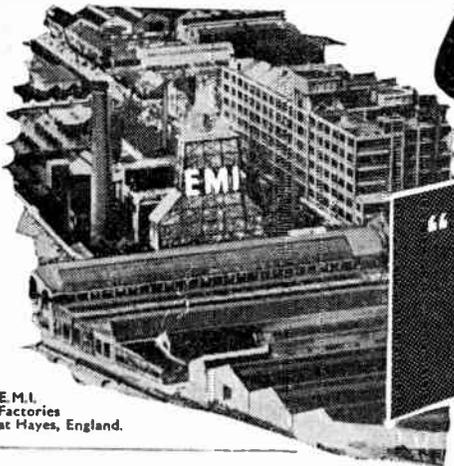
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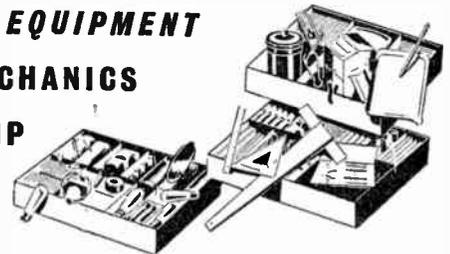
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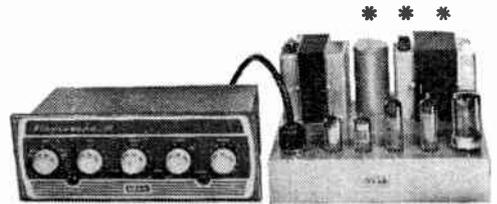
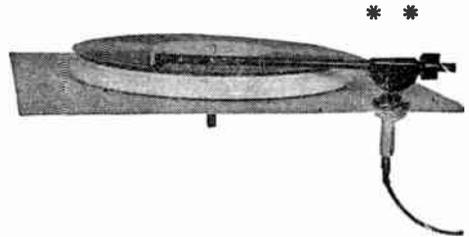
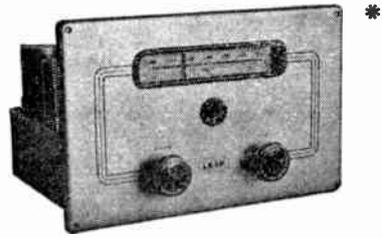
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The full test report appeared in the February, 1957 issue of "Wireless World," pages 22 and 23.



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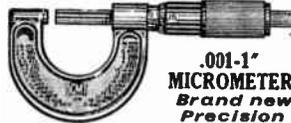
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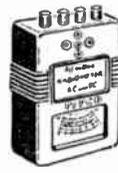
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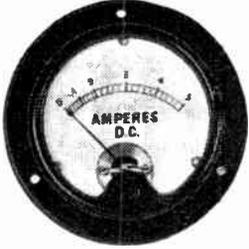
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170 1/2 in., 1373/6; 171 in., 1377/6; 171 1/2 in., 1381/6; 172 in., 1385/6; 172 1/2 in., 1389/6; 173 in., 1393/6; 173 1/2 in., 1397/6; 174 in., 1401/6; 174 1/2 in., 1405/6; 175 in., 1409/6; 175 1/2 in., 1413/6; 176 in., 1417/6; 176 1/2 in., 1421/6; 177 in., 1425/6; 177 1/2 in., 1429/6; 178 in., 1433/6; 178 1/2 in., 1437/6; 179 in., 1441/6; 179 1/2 in., 1445/6; 180 in., 1449/6; 180 1/2 in., 1453/6; 181 in., 1457/6; 181 1/2 in., 1461/6; 182 in., 1465/6; 182 1/2 in., 1469/6; 183 in., 1473/6; 183 1/2 in., 1477/6; 184 in., 1481/6; 184 1/2 in., 1485/6; 185 in., 1489/6; 185 1/2 in., 1493/6; 186 in., 1497/6; 186 1/2 in., 1501/6; 187 in., 1505/6; 187 1/2 in., 1509/6; 188 in., 1513/6; 188 1/2 in., 1517/6; 189 in., 1521/6; 189 1/2 in., 1525/6; 190 in., 1529/6; 190 1/2 in., 1533/6; 191 in., 1537/6; 191 1/2 in., 1541/6; 192 in., 1545/6; 192 1/2 in., 1549/6; 193 in., 1553/6; 193 1/2 in., 1557/6; 194 in., 1561/6; 194 1/2 in., 1565/6; 195 in., 1569/6; 195 1/2 in., 1573/6; 196 in., 1577/6; 196 1/2 in., 1581/6; 197 in., 1585/6; 197 1/2 in., 1589/6; 198 in., 1593/6; 198 1/2 in., 1597/6; 199 in., 1601/6; 199 1/2 in., 1605/6; 200 in., 1609/6; 200 1/2 in., 1613/6; 201 in., 1617/6; 201 1/2 in., 1621/6; 202 in., 1625/6; 202 1/2 in., 1629/6; 203 in., 1633/6; 203 1/2 in., 1637/6; 204 in., 1641/6; 204 1/2 in., 1645/6; 205 in., 1649/6; 205 1/2 in., 1653/6; 206 in., 1657/6; 206 1/2 in., 1661/6; 207 in., 1665/6; 207 1/2 in., 1669/6; 208 in., 1673/6; 208 1/2 in., 1677/6; 209 in., 1681/6; 209 1/2 in., 1685/6; 210 in., 1689/6; 210 1/2 in., 1693/6; 211 in., 1697/6; 211 1/2 in., 1701/6; 212 in., 1705/6; 212 1/2 in., 1709/6; 213 in., 1713/6; 213 1/2 in., 1717/6; 214 in., 1721/6; 214 1/2 in., 1725/6; 215 in., 1729/6; 215 1/2 in., 1733/6; 216 in., 1737/6; 216 1/2 in., 1741/6; 217 in., 1745/6; 217 1/2 in., 1749/6; 218 in., 1753/6; 218 1/2 in., 1757/6; 219 in., 1761/6; 219 1/2 in., 1765/6; 220 in., 1769/6; 220 1/2 in., 1773/6; 221 in., 1777/6; 221 1/2 in., 1781/6; 222 in., 1785/6; 222 1/2 in., 1789/6; 223 in., 1793/6; 223 1/2 in., 1797/6; 224 in., 1801/6; 224 1/2 in., 1805/6; 225 in., 1809/6; 225 1/2 in., 1813/6; 226 in., 1817/6; 226 1/2 in., 1821/6; 227 in., 1825/6; 227 1/2 in., 1829/6; 228 in., 1833/6; 228 1/2 in., 1837/6; 229 in., 1841/6; 229 1/2 in., 1845/6; 230 in., 1849/6; 230 1/2 in., 1853/6; 231 in., 1857/6; 231 1/2 in., 1861/6; 232 in., 1865/6; 232 1/2 in., 1869/6; 233 in., 1873/6; 233 1/2 in., 1877/6; 234 in., 1881/6; 234 1/2 in., 1885/6; 235 in., 1889/6; 235 1/2 in., 1893/6; 236 in., 1897/6; 236 1/2 in., 1901/6; 237 in., 1905/6; 237 1/2 in., 1909/6; 238 in., 1913/6; 238 1/2 in., 1917/6; 239 in., 1921/6; 239 1/2 in., 1925/6; 240 in., 1929/6; 240 1/2 in., 1933/6; 241 in., 1937/6; 241 1/2 in., 1941/6; 242 in., 1945/6; 242 1/2 in., 1949/6; 243 in., 1953/6; 243 1/2 in., 1957/6; 244 in., 1961/6; 244 1/2 in., 1965/6; 245 in., 1969/6; 245 1/2 in., 1973/6; 246 in., 1977/6; 246 1/2 in., 1981/6; 247 in., 1985/6; 247 1/2 in., 1989/6; 248 in., 1993/6; 248 1/2 in., 1997/6; 249 in., 2001/6; 249 1/2 in., 2005/6; 250 in., 2009/6; 250 1/2 in., 2013/6; 251 in., 2017/6; 251 1/2 in., 2021/6; 252 in., 2025/6; 252 1/2 in., 2029/6; 253 in., 2033/6; 253 1/2 in., 2037/6; 254 in., 2041/6; 254 1/2 in., 2045/6; 255 in., 2049/6; 255 1/2 in., 2053/6; 256 in., 2057/6; 256 1/2 in., 2061/6; 257 in., 2065/6; 257 1/2 in., 2069/6; 258 in., 2073/6; 258 1/2 in., 2077/6; 259 in., 2081/6; 259 1/2 in., 2085/6; 260 in., 2089/6; 260 1/2 in., 2093/6; 261 in., 2097/6; 261 1/2 in., 2101/6; 262 in., 2105/6; 262 1/2 in., 2109/6; 263 in., 2113/6; 263 1/2 in., 2117/6; 264 in., 2121/6; 264 1/2 in., 2125/6; 265 in., 2129/6; 265 1/2 in., 2133/6; 266 in., 2137/6; 266 1/2 in., 2141/6; 267 in., 2145/6; 267 1/2 in., 2149/6; 268 in., 2153/6; 268 1/2 in., 2157/6; 269 in., 2161/6; 269 1/2 in., 2165/6; 270 in., 2169/6; 270 1/2 in., 2173/6; 271 in., 2177/6; 271 1/2 in., 2181/6; 272 in., 2185/6; 272 1/2 in., 2189/6; 273 in., 2193/6; 273 1/2 in., 2197/6; 274 in., 2201/6; 274 1/2 in., 2205/6; 275 in., 2209/6; 275 1/2 in., 2213/6; 276 in., 2217/6; 276 1/2 in., 2221/6; 277 in., 2225/6; 277 1/2 in., 2229/6; 278 in., 2233/6; 278 1/2 in., 2237/6; 279 in., 2241/6; 279 1/2 in., 2245/6; 280 in., 2249/6; 280 1/2 in., 2253/6; 281 in., 2257/6; 281 1/2 in., 2261/6; 282 in., 2265/6; 282 1/2 in., 2269/6; 283 in., 2273/6; 283 1/2 in., 2277/6; 284 in., 2281/6; 284 1/2 in., 2285/6; 285 in., 2289/6; 285 1/2 in., 2293/6; 286 in., 2297/6; 286 1/2 in., 2301/6; 287 in., 2305/6; 287 1/2 in., 2309/6; 288 in., 2313/6; 288 1/2 in., 2317/6; 289 in., 2321/6; 289 1/2 in., 2325/6; 290 in., 2329/6; 290 1/2 in., 2333/6; 291 in., 2337/6; 291 1/2 in., 2341/6; 292 in., 2345/6; 292 1/2 in., 2349/6; 293 in., 2353/6; 293 1/2 in., 2357/6; 294 in., 2361/6; 294 1/2 in., 2365/6; 295 in., 2369/6; 295 1/2 in., 2373/6; 296 in., 2377/6; 296 1/2 in., 2381/6; 297 in., 2385/6; 297 1/2 in., 2389/6; 298 in., 2393/6; 298 1/2 in., 2397/6; 299 in., 2401/6; 299 1/2 in., 2405/6; 300 in., 2409/6; 300 1/2 in., 2413/6; 301 in., 2417/6; 301 1/2 in., 2421/6; 302 in., 2425/6; 302 1/2 in., 2429/6; 303 in., 2433/6; 303 1/2 in., 2437/6; 304 in., 2441/6; 304 1/2 in., 2445/6; 305 in., 2449/6; 305 1/2 in., 2453/6; 306 in., 2457/6; 306 1/2 in., 2461/6; 307 in., 2465/6; 307 1/2 in., 2469/6; 308 in., 2473/6; 308 1/2 in., 2477/6; 309 in., 2481/6; 309 1/2 in., 2485/6; 310 in., 2489/6; 310 1/2 in., 2493/6; 311 in., 2497/6; 311 1/2 in., 2501/6; 312 in., 2505/6; 312 1/2 in., 2509/6; 313 in., 2513/6; 313 1/2 in., 2517/6; 314 in., 2521/6; 314 1/2 in., 2525/6; 315 in., 2529/6; 315 1/2 in., 2533/6; 316 in., 2537/6; 316 1/2 in., 2541/6; 317 in., 2545/6; 317 1/2 in., 2549/6; 318 in., 2553/6; 318 1/2 in., 2557/6; 319 in., 2561/6; 319 1/2 in., 2565/6; 320 in., 2569/6; 320 1/2 in., 2573/6; 321 in., 2577/6; 321 1/2 in., 2581/6; 322 in., 2585/6; 322 1/2 in., 2589/6; 323 in., 2593/6; 323 1/2 in., 2597/6; 324 in., 2601/6; 324 1/2 in., 2605/6; 325 in., 2609/6; 325 1/2 in., 2613/6; 326 in., 2617/6; 326 1/2 in., 2621/6; 327 in., 2625/6; 327 1/2 in., 2629/6; 328 in., 2633/6; 328 1/2 in



0.5 amp. D.C. Meter. M.I. 2 1/2 in. F/M, as illustrated above. Ideal for Battery Chargers. New. 11/6. P. & P. 1/-.

0-300 v. A.C. Meter, M.I. 2 1/2 in. F/M. New. £11/5/- each. P. & P. 1/-.

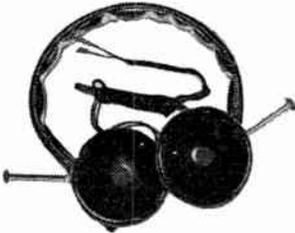
Dual range pocket volt meter 0-25 and 0-250 v. in wallec. New 12/6 each. P. & P. 1/-.

0-500 Microammeter, 2in. m/c., calibrated 0-15 and 0-600 v., as used on No. 19 sets. Ex equipment, but individ. tested. 14/6 each. P. & P. 1/-.

Oil filled Capacitors. U.S.A.
2 mfd. 1,000 v. 4/6 each. P. & P. 2/-
4 mfd. 600 v. 5/6 each. P. & P. 2/-
7 mfd. 600 v. 8/6 each. P. & P. 2/-
.2 mfd. 5 kv. 3/6 each. P. & P. 2/-

ARMOUR Recording Wire. U.S.A. Top Quality on original reels, length 3,700 yards. 17/6. P. & P. 1/6. New.

Rheostat, 12 ohm 4 amp. Ideal for Battery chargers, etc. New. 7/6. each. P. & P. 1/6.



Lightweight Headphones (imported). 4,000 ohms., res., as illus. above. New. 15/- each. P. & P. 1/6.

IVALEK lightweight British Headphones, 2,000 ohms. New. 12/6 each. P. & P. 1/6.

M/C Headphones by S. G. Brown fitted with ear pads. L.R. Good condition. 12/6 each. P. & P. 1/9.

H.S.30. U.S.A. miniature ear pieces fitting inside the ear. Magnetic type, L.R. New. 15/- each. P. & P. 1/6.

Low impedance Ear Pieces, as used in flying helmets. Type 13466. New. 3/6 each. P. & P. 1/-.

Throat Microphone, magnetic, British. New. 4/6 each. P. & P. 1/-.

Throat Microphone, carbon, U.S.A. New. 3/6 each. P. & P. 1/-.

No. 8 Microphone, carbon insert, with switch. New. 7/6 each. P. & P. 1/6.

Microphone, type 48, 10A/14381 as fitted in oxygen mask. R.A.F. patt. New. 3/6 each. P. & P. 1/-.

Telephone handsets, sound power, pair will work by simple connection without batteries. Good condition. 22/6 each. P. & P. 1/9.

Telephone Handsets, U.S.A. Similar to G.P.O., with switch, carbon insert. New. 12/6 each. P. & P. 1/6.

Morse Keys, 8 ampere. Service Patt. New. 2/6 each. P. & P. 1/-.

PHOTO MULTIPLIER, Type 931A, for alpha counting, film scanning, spectrography, etc. New. £2/5/- each. P. & P. 1/-.



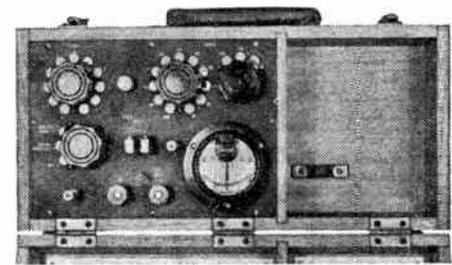
MINIATURE LEAD ACID ACCUMULATORS, made by famous British Manufacturer to most stringent service requirements. Brand new, uncharged, without acid, in original sealed cartons. Capable of being constantly charged. Conservatively rated.

12 volt 0.75 amp., size 4in. x 3in. x 1 1/2in. plus 3/4in. protrusion of terminals. Weight with acid 2lbs. 4oz. 22/6 each plus 2/3 P. & P. C.W.O.

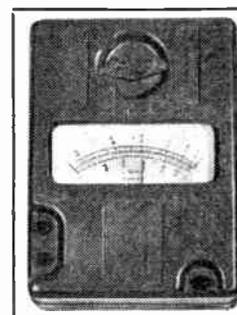
2 volt 1.5 amp. size 4in. x 1 1/2in. x 1 1/2in. plus 3/4in. protrusion of terminals. Weight with acid 11 oz. 7/6 each plus 1/6 P. & P. C.W.O. Special offer the two 28/- plus 2/9 P. & P.



AIRCRAFT CAMERA G45B. Mk. III, fitted with 1/3.5 triple anastigmatic lens. Takes 25ft. of 16 mm. film. Fitted with 24 volt motor. Mint condition, new in maker's original packing. £6/15/- each. P. & P. 3/6.



DEMOLITION TESTERS consisting two decade units and M/C Galvanometer. In solid wooden carrying case. Readily converted to Wheatstone Bridge. Excellent condition. 40/- each. P. & P. 3/6.



Evershed "MEGGER" Circuit testing ohms Meter. Pattern "S" complete with testing prods, inst. book etc., 2 ranges 0-3 ohms and 0-30 ohms. Brand new, guaranteed perfect, as illus. Offered at fraction of makers' price. £4/17/6 each. P. & P. 2/6.

250 Volt Evershed "WEE MEGGER" Insulation Testers. New condition. £10 each. P. & P. 2/6.

15in. RCA. U.S.A. P.M. Speaker, 15 ohms. Ideal for P.A. Will handle 30 watts. New, in maker's carton and case. £9/17/6 each. Carr. in England 15/-.

Londex Relay, 24 v. heavy silver contacts, two breaks. Fair condition. 4/6 ea. P. & P. 1/-.

High Speed Relay, Siemens, two bobbins 1,000 ohms, each. New. 10/6 each. P. & P. 1/-.

Fishing Rod Aerials, 12ft. (3 x 4ft. sections). Steel, copper plated, tapered top. Ideal aerial or fishing rod. Fair cond. 8/6 each. P. & P. 2/6.

Latest type Collaro Studio miniature Microphones, complete with screened jack plug. New. 37/6 each. P. & P. 1/-.

U.S.A. NAVY MODEL "MAN" Crystal Controlled Radio Transmitter and Receiver, for voice, by frequency modulated signals in the 30-40 megacycle band. Choice of eleven frequencies, powered by 6 v. battery. Complete with valves, crystals etc., and spares. Unused, £25. Carr. Eng. £1.



Muirhead Vernier Drive. Scaled 0-180° ratio 31/1, dia. 3in., as fitted to RF.26 Units. Complete with lampholder. In manufacturer's original packing. New. 8/6 each. P. & P. 1/6.

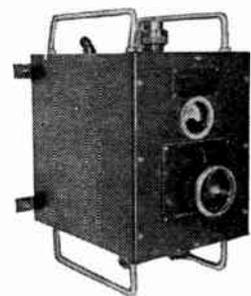
Neon Light, 230 v. A.C. M.B.C. Clear. 1/9 each. P. & P. 6d.

Neon panel mounting indicator lights, with flying leads, chrome bezel. 200/250 v. Red, clear and green. New. 3/9 each. P. & P. 6d.

Ultra Violet Bulb, AC/DC, 12 v. 36 watt. New. 5/6 each. P. & P. 6d.

Radial Stud Switch, 20 segs. 5in. sq. Complete with handle and housing. New. 5/- each. P. & P. 2/-.

Contacter Time Switch, two impulses per second. In sound-proof box. New. 11/6 each. P. & P. 3/6.



L.T. Transformer, input 230 v. Output 50 v., 50 ampere, but adjustable by voltage regulator switch on primary. In steel case fitted with mains switch, will take 100% overload. Grs. Wt. 150 lbs. Wound at 800 amps. per sq. in. As illus. above. New in manufacturer's cases. £15 each. Carriage in England £1.

Auto Transformer, step up, step down, 110 v.-200-220-240 v. Fully shrouded. New, not ex W.D.

300 watt type £2/2/- each. P. & P. 4/6.
500 watt type £3/3/- each. P. & P. 4/6.
1,000 watt type £4/4/- each. P. & P. 4/6.

Eddystone Mains Transformer, tapped primary, secondary HT 180-0-180 v. at 80 mA. L.T. 12.6 v. at 2 amp., 5 v. at 2 amp. In maker's cartons. 8/6 each. P. & P. 3/6.

Potted L.T. Transformer. Oil filled. Input 230 v. Output 2-4-14-22-30-38 v. at 7 amp. Conservatively rated. New £2/15/- each. Carr. in England 6/6.

Oil filled Transformers as above, input 230 v. Output 1-29-31-33-35V. at 4 amp. New £1/10/- Carr. Eng. 6/6.

24 V. Blower Motor. AC/DC, will run on 12 v. Operational condition. 12/6 each. P. & P. 3/-.

U.S.A. Geared Motors, 27 v. D.C. giving twin outputs of 20 r.p.m. and 6 r.p.m. Size 7in. x 1 1/2in. x 1in. shaft. Will operate on 12 volts. Operational cond. 19/6 each. P. & P. 3/6.

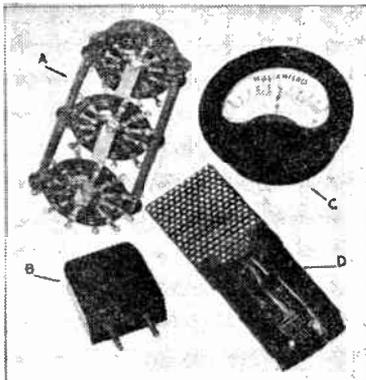
Miniature 24 v. D.C. Reversible Recorder Motors, fitted governor and right angle gear drive. 3in. x 1in. x 1 1/2in. New 12/6 each. P. & P. 2/-.

Dynamotor. Input 12 v. D.C., output 300 v. D.C. at 215 mA. Supplied tested. £1/10/- each. P. & P. 3/6.

SERVICE TRADING Co.

PERSONAL CALLERS ONLY : 9 Little Newport Street, London W.C.2. Tel : GER 0576.
ALL MAIL ORDERS : Early Closing Thursday
47.49 High Street, Kingston-on-Thames.

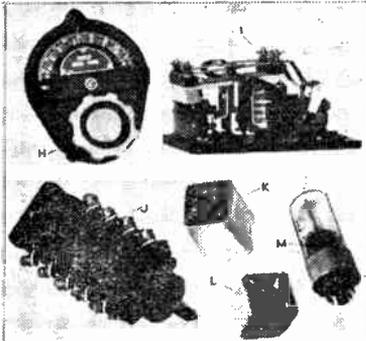
BARGAINS TO CLEAR



We wish to remind customers that with the new postage rates the minimum postage on a parcel is now 1/6. Orders for lightweight items which total over £3 will be sent post free otherwise sufficient must be included to cover postage. Also where a postage and insurance figure is specifically mentioned then this must be included regardless as these items have to be sent separately.

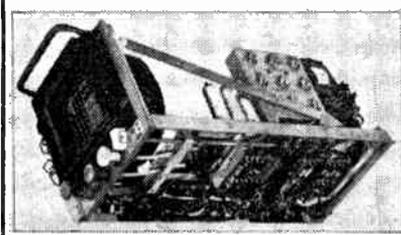
- A YAXLEY SWITCH. 4 position, 6 pole. 1/4 in. spindle of reasonable length. Price 2/6 or 24/- per dozen.
- B 500KC CRYSTAL, plug-in type, 6/6.
- C 5-0-5 CENTRE ZERO MILLIAMP METER. 2 1/2 in. moving coil, 17/6, plus 1/6 post and insurance.
- D THERMAL DELAY UNIT. 6.3 operated. Switches on or off, 3/6.

- E 15-AMP. ROTARY SWITCH, as fitted to small cookers, switching positions, "off" coil, "off" hot. 2/9 each, 30/- per dozen.
- F BALANCE METER (ref. No. 10D-13762) will function as sensitive relay, regret no other data available, price 45/-.
- G STAND OFF INSULATOR, metal inserts each end threaded, 2/- each, 18/- doz.



- H SLOW MOTION DIAL AND DRIVE, really beautifully made ex-American transmitter, 9/6.
- I DOUBLE POLE CONTRACTOR, contacts suitable for 15 amps. D.C. or about 50 amps. A.C. Has closing coil wound for 250 v. D.C. but quite O.K. for A.C. Also has economy resistance and arc blow out coils, 15/-.
- J CHANGE OVER SWITCH. 5 position, each 25 amps. 17/6.
- K PUSH-PULL OUTPUT TRANSFORMER, potted miniature construction, American made, 6/6.
- L PUSH-PULL INPUT TRANSFORMER, potted miniature construction, American made, 3/6.
- M GAS FILLED TRIGGER VALVE. Type No. G240/2D, on octal base. 9/6, post and insurance 1/6.

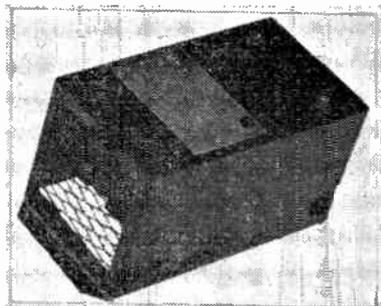
- N SINGLE HEAD PHONE with head band 6/6. Post and insurance 1/6.
- O STUD SWITCH, heavy duty contacts complete with handle and mounting frame (not shown in illustration), 3/6. Post and insurance 2/-.
- P VOLTAGE STABILIZER, type No. N8.2, striking volts 140—operating volts 87—regulation 5 v. at 30-150 mA. Mounted on 4-pin base. Price 8/6, plus 1/6 post and insurance.
- Q SOUND-POWERED INSERT, makes quite good loud-speaker for pocket transistor set. Also O.K. as microphone. 6/6 each.
- R DASHPOT DELAYED CONTACTOR, American make type No. R01D, adjustment to delay opening or closing. Heavy duty contacts and secondary micro switch. Operating coil voltage 110 at 50 cycles but can be used off 230 mains through resistor, choke or transformer, etc. Price 37/6, post and insurance 2/-.



THIS MONTH'S SNIP

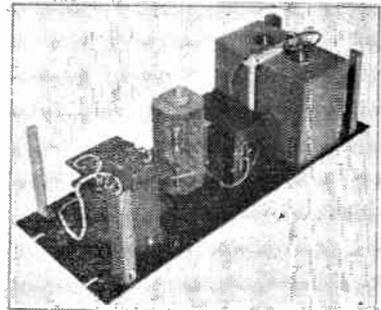
INDICATOR NO. 96. Contains many hundreds of very valuable spares including no less than 12 potentiometers. This indicator unit will take the VCR97 or the VCR517 and with relatively simple modifications can be turned into an oscilloscope. Limited quantity offered at the extremely low price of 10/- each, carriage and packing 4/6 up to 250 miles, beyond this distance at cost.

TRIPLETT A.C./D.C. MULTI-TESTER, as illustrated. Second hand cases have small blemishes and the instruments need servicing, but we feel that they are a good bargain at 30/- plus 2/- post and ins.



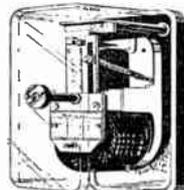
POWER PACK OR BATTERY CHARGER. Output voltage 160-200 v., at 1-amp but can be varied above or below this. Very robust and will make job in a metal case. Contains heavy duty mains transformer and metal rectifiers. Size approximately 12 x 6 1/2 x 6 1/2 in. Price 27/6, plus 5/- carriage and insurance.

KEYING RELAY. Made for U.S. Navy. Ex. high power Navy transmitter but unused and in very good condition. 47/6 each, post and insurance 2/-.



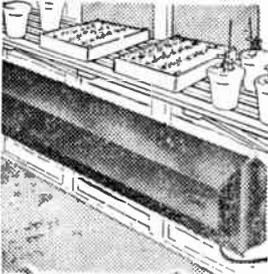
POWER PACK, EX. G.P.O. Beautifully made, unused and in perfect condition. Output voltage equals 75 v. at 200 mA. The output is almost ripple free, having swinging choke and 100 mFd. smoothing condenser. Overall size approximately 17 x 7 x 7 in. Price 37/6, plus 3/- carriage and insurance.

OVERCURRENT RELAY



Beautifully made by the famous American Westinghouse Company. These are the surface mounting through panel type with clear Pyrex glass covers. They have coils for remote push button resetting. Type A—calibrated for currents between .1 and .4 amps. Type B—calibrated for currents between 5 and 3 amps. Price, unused and perfect, £3/17/6 each.

INSTANTUS HEATER



Convector heater 1 kW. rating, 4ft. long made from heavy gauge sheet steel (galvanised). Can be used for greenhouse, workshop, aviary, etc. etc. Price £2/10/-, or with thermostat, £4/5/-, carriage 5/- (GUARANTEED) 5 YEARS. 2 KW MODEL. Free standing with copper-clad element... £5/17/6. Ditto with thermo-tatic control £6/17/6.



Wrap our heater cable around the pipes in your loft to prevent a freeze-up. 21 yards £1/1/- post free.

SMALL CLOCK MOVEMENT



7-day mechanical movement 1 1/2" x 1 1/2" made and fully jewelled few only sale price 18/6 each



WESTINGHOUSE (U.S.A.) METERS

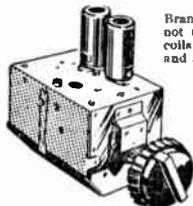
All moving coil finish mounting type outside diameter of face 3 1/2in.

0-500 v. D.C.	20/-
0-1.5 kV. D.C. external multiplier	25/-
0-2.5 kV. D.C. external multiplier	25/-
0-15 v. A.C.	15/-
0-1 mA.	25/-
0-50 mA.	15/-
0-100 mA.	15/-
0-150 mA.	15/-
0-250 mA.	15/-
0-500 mA.	15/-

BAND III CONVERTER

Suitable London, Midlands, North, Scotland, etc. All the parts including 2 valves, coils, fine tuner contrast control condensers and resistors. (Metal case available as an extra.) Price 13/6 plus 2/6 post and insurance. Data free with parts or available separately 1/6.

TURRET TUNER



Brand new stock, not surplus, with coils for Band I and III, complete with valves PC84 and PCF50-I.F. Output 33/38 Mc/s with instructions and circuit diagram 79/6.

With knobs 3/6 extra, post and ins. 2/6.

Build this in ONE evening. 17" T.V.



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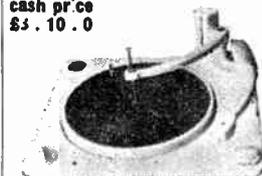


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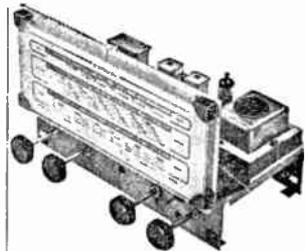


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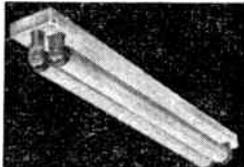
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AXIETTE SPECIFICATION

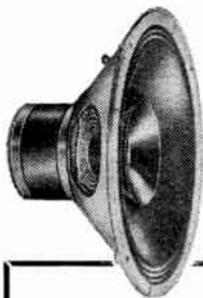
Type: Single diaphragm 8" direct radiator with plastic treated diaphragm suspension.
 Frequency Range: 40 c/s — 15,000 c/s.
 Fundamental Resonance: 65 c/s.
 Maximum Power Handling Capacity: 6 watts.
 Flux Density: 15,000 gauss on 1" dia. pole.
 Impedance: 3 ohms or 15 ohms, at 400 c/s.



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 Frequency Range: 30 c/s. — 15,000 c/s.
 Fundamental Resonance: 35 c/s.
 Maximum Power Handling Capacity: 20 watts.
 Flux Density: 17,500 gauss on a 1 1/2" dia. pole.
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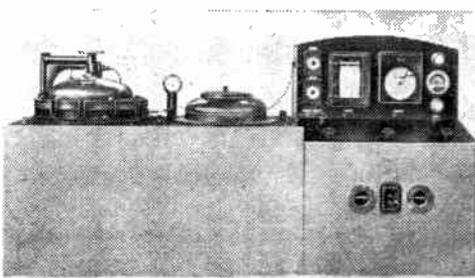
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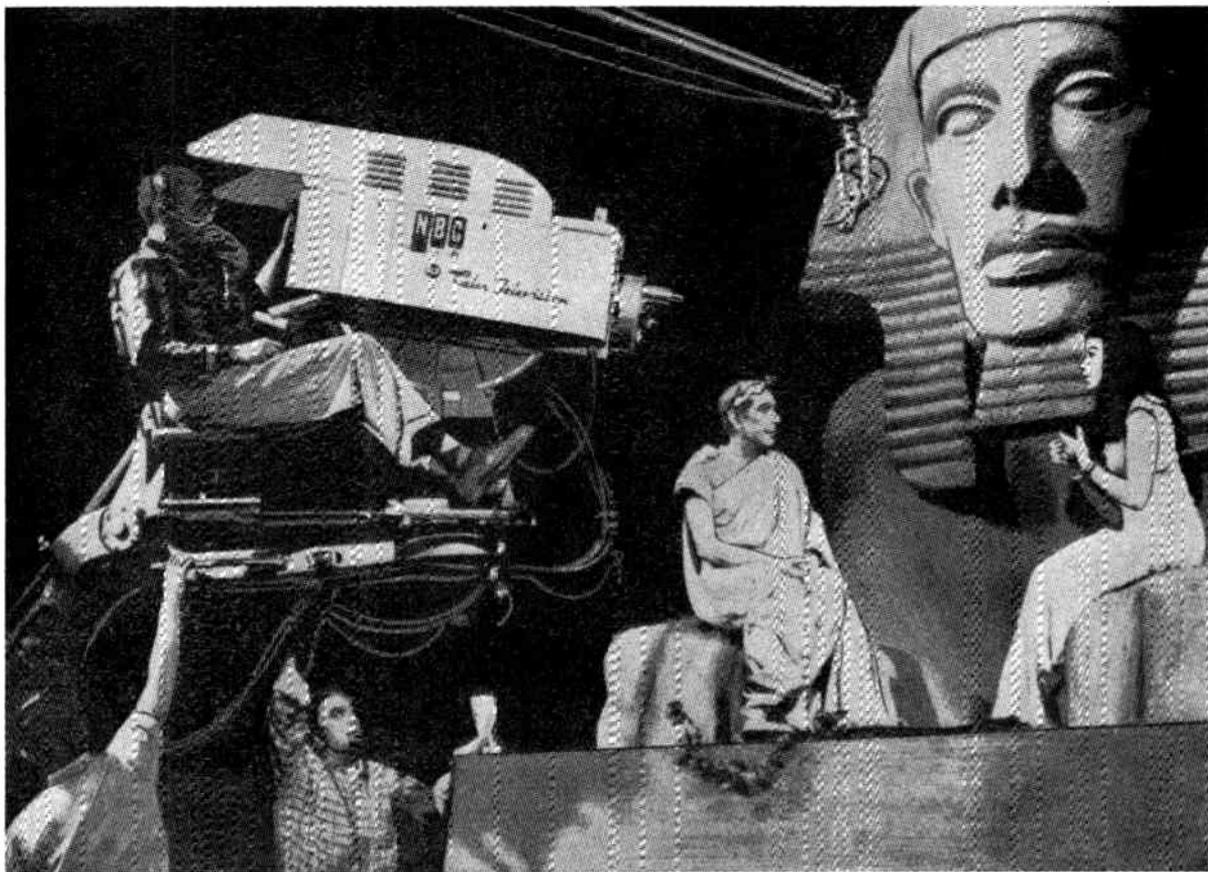
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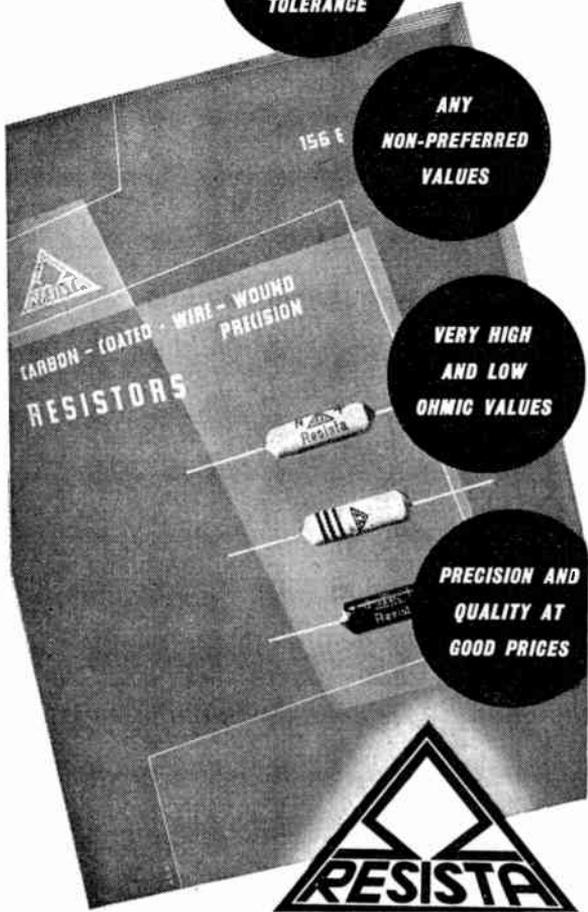
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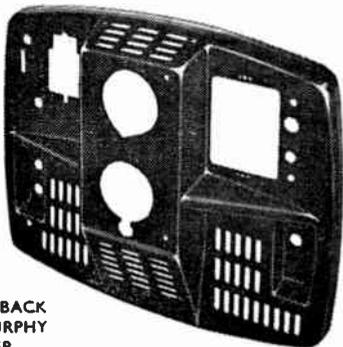
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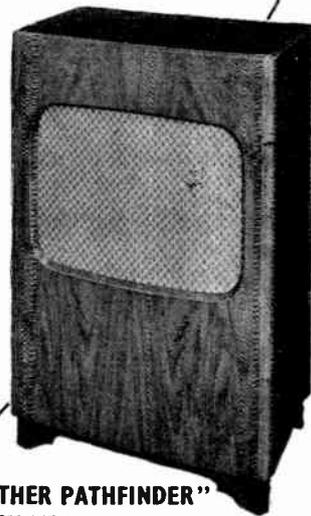
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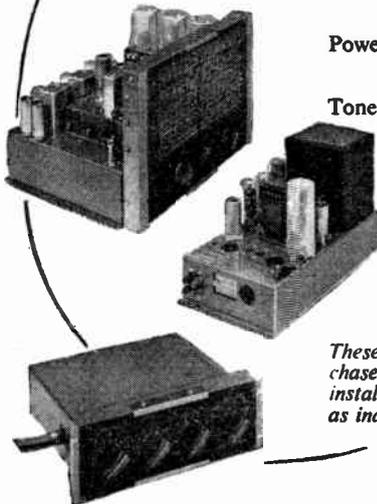
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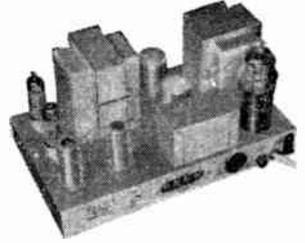
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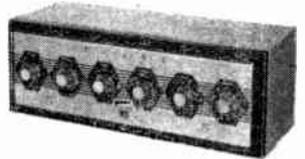
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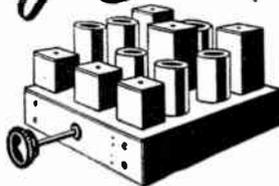
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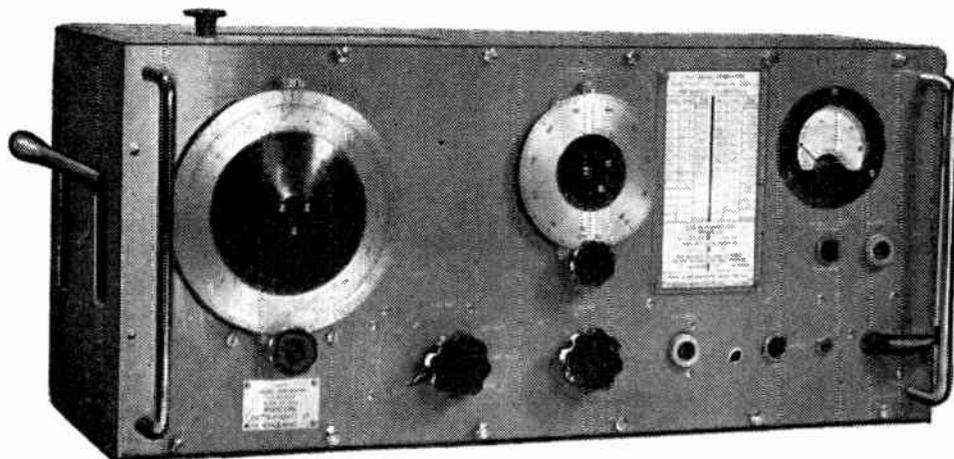
8U4G	6/6	6J6	5/-	12AU7	7/-	ECC81	9/-	EF91	8/-
6BA6	6/6	6L6	8/-	12BK7	5/6	ECC82	7/-	EV61	14/-
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6C4	4/9	6V6GT	6/-	EB34	1/8	EF50	2/6	SP41	2/6
6J5G	3/-	6X4	6/-	EBC33	7/-	EP80	8/9	SP61	2/6

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All items less 5% and post free for a dozen or more.
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In good, used condition, with charts, checked before despatch. ONLY Limited quantity. **ORDER NOW.**

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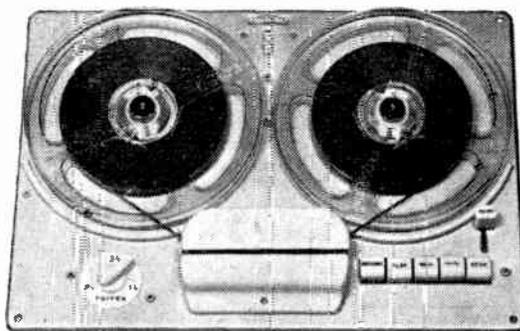
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THE NEW MOTEK K9 TAPE DECK



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Outstanding features include:

- ★ 3 speeds at turn of knob (7½ in. per sec., 3½ in. per sec. and 1½ in. per sec.).
- ★ Built-in rev. counter for precise tape location.
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OSCILLOSCOPE

This Ministry of Supply Monitor Type 61 is a First-Grade Synchroscope designed for D.C. Pulse and R.F. Envelope investigation, and employs a 3½in. CRT type VCR138A. The R.F. Frequency is 180-220 Mc/s approx.; and is tuneable in that range. Has internal 500 kc/s. Calibrating Oscillator on Y Plates. Existing Time Base Speeds are 50 cycles, 20 Micro-seconds fast, and 1,000 Micro-seconds slow. Conservatively rated Mains Power Pack is for nominal 115 v. and 230 v. Will make up into an excellent General-Purpose Oscilloscope at a cost of a few shillings, full modification date being supplied. Front panel size is 10½in. x 12½in., depth of unit being 19in. **BRAND NEW AND UNUSED, ONLY £12/10/-** (carriage, etc., 15/-).



RIISS SUPER SLOW-MOTION TUNING ASSEMBLY. As used on all late model 1155s. Easily fitted to "A" sets, etc. **ONLY 12/6.**

RCA RIBBON MICROPHONE. Table type, mounted on black-finished stand 7½in. high, with press switch in handle. **BRAND NEW AND UNUSED. ONLY 5/6.**

ROLA 6½in. P.M. SPEAKER. Mounted in Grey crackled metal cabinet 9in. x 9in. x 4½in., and with volume control. **BRAND NEW AND UNUSED. ONLY 27/6.**

12-VOLT 1-AMP BATTERY-CHARGER. Very robust, ex Admiralty. In Grey crackled metal case, size 6in. x 6in. x 4½in. **BRAND NEW AND UNUSED. ONLY 35/-.**

INSULATION TESTERS (MEG-GERS). Read up to 20 meg. at 500 volts pressure. Overhauled, and in perfect order. With leather carrying case. **ONLY £9/19/6, OR less case £8/10/-.**

POWER UNIT TYPE 3. Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA. and 6.3 v. 4 amps. Fitted with H.T. current meter, and voltmeter. For normal rack mounting and has grey front panel size 19in. x 7in. **ONLY 70/-** (carriage, etc., 7/6).

EHT TRANSFORMERS. 5.5 kV. (Rect.) with 2 v. 1 a., 79/6, 7 kV. (Rect.) with 2 v. 1 a., 89/6, 2.5 kV. (Rect.) with 2-0-2 v. 1.1 a., 2-0-2 v. 2 a. (for VCR 97 tube, etc.), 42/6 (postage 2/- per trans.).

500 MICROAMPS METER. 2in. circular as used on British No. 19 Wireless Sets. Calibrated 0-15 and 0-600 volts, resistance 500 ohms. A very fine instrument, and A SNIP AT **ONLY 15/-.**

WIRELESS SET No. 19 MK. II

The famous Army Tank Transmitter-Receiver. Incorporates "A" set (TX/RX covering 2.0-8.0 Mc/s., i.e., 37.5-150 metres); "B" set (VHF TX/RX covering 230-240 Mc/s., i.e., 1.2-1.3 metres), and Intercomm. Amplifier. Complete with 15 valves as follows: 6 of 6K7G, 2 of 6K8G, 2 of 6V6G, and 1 ea. 6BBG, 6H6, E1148, EF50, 807, and booklet giving circuits, notes, etc. Size 17½in. x 8½in. x 12½in. Of American manufacture as previously offered by us, but another large release by the Ministry of Supply enables us to make a substantial reduction in price. In magnificent condition. **BRAND NEW AND UNUSED, ONLY 65/-** (carriage, etc., 10/-). 12-volt Power Units available 25/- (carriage 5/-).

TCS TRANSMITTERS

The renowned American TCS Model designed by the Collins Company for static or mobile use. Covers 1.5-12.0 Mc/s. in 3 bands, and is complete with 7 valves, employing 2 of 1625 in P.A. Stage, 1 each of 1625 in Buffer and Modulator Stages, and 3 of 12A6 in Oscillator Stage. Provision for VFO or Crystal Control. 4 Crystal positions. Radio Telephone or Radio Telegraph. Has Plate and Aerial Current Meters. Power requirements 12 v. LT & 400 v. HT. In black crackle case, size 11 x 13 x 11in., condition **BRAND NEW AND UNUSED. ONLY £12/10/-** (carriage, etc., 15/-). The double Dynamotor Power Unit, Type 2188B for 12-volt operation, delivering 400 v. for Transmitter and 225 v. for Receiver, is available at **£12/10/-** (carriage, etc., 15/-).

METERS

F.S.D.	SIZE AND TYPE	PRICE
50 microamps D.C.	2½in. Flush circular	59/6
100 microamps D.C.	2½in. Flush circular	39/6
250 microamps D.C.	2in. Proj. circular	30/-
500 microamps D.C.	2in. Flush square	27/6
1 mA D.C.	2in. Flush square	22/6
150 mA D.C.	2in. Flush square	7/6
200 mA D.C.	2½in. Flush circular	12/6
10 amps D.C.	3½in. Proj. circular	20/-
20 amps D.C.	2in. Proj. circular	7/6
40 amps D.C.	2in. Proj. circular	7/6
15-0-15 amps D.C.	3½in. Flush square	25/6
15 volts A.C.	2½in. Flush circular moving iron	8/6
300 volts D.C.	2in. Flush square	10/6
300 volts A.C.	2½in. Flush circular	25/-

MARCONI SIGNAL GENERATORS TF-390G Frequency coverage 16-150 Mc/s. **BRAND NEW IN MAKER'S ORIGINAL TRANSIT CASES,** with instruction manual. For normal A.C. mains operation. A unique opportunity to acquire Laboratory Equipment at a fraction of original cost. **ONLY £25.**

MARCONI BAND III CRYSTAL CALIBRATORS. Frequency range 170-240 Mc/s. Incorporates 5 Mc/s. crystal for better than .001 per cent. accuracy. Directly calibrated dial, internal A.C. mains pack. Complete with spare set of valves and instruction manual in maker's transit cases. **BRAND NEW. ONLY £4/19/6.**

12-WAY SCREENED CABLE. In 10ft. lengths, fitted with plugs, originally made for use with the 19 Set. **UNUSED. ONLY 17/6** per lead.

POCKET VOLTMETERS. Not ex-Govt. Read 0-15 v. and 0-300 v. A.C. or D.C. **BRAND NEW AND UNUSED, ONLY 18/6.**

CRYSTALS. British Standard 2-pin 500 kc/s. 15/-, Miniature 200 kc/s. and 465 kc/s. 10/- each.

SPECIAL MAINS TRANSFORMER OFFER. Normal 230v. A.C. Primary. Secondaries 330-0-330v., 100ma. 4v. 3 amps. Ex V.D., **BRAND NEW AND UNUSED. ONLY 15/-** (Postage etc. 2/6).

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FILAMENT TRANSFORMERS. 6.3 v. 1½ amps. 7/6, 6.3 v. 3 amps. 10/6, 6 v. **VIBRATOR PACKS.** Output approx. 130 v. at 30 mA., fully filtered and smoothed. Complete. **ONLY 12/6.**

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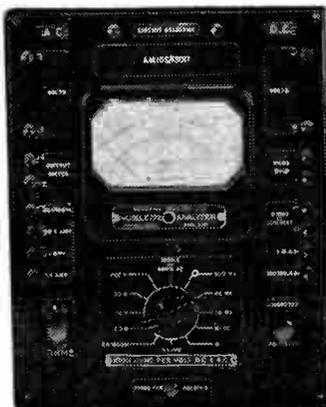
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CHARLES BRITAIN (RADIO) LTD.

AVOMETER Model D. 2. 19.6 (P. & P. 4/-)

D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
150 mV.	7.5 V.	15 mA.	75 mA.
300 mV.	15 V.	30 mA.	150 mA.
1.5 V.	75 V.	150 mA.	750 mA.
3 V.	150 V.	400 mA.	1.5 Amps.
15 V.	300 V.	1.5 Amps.	7.5 Amps.
30 V.	600 V.	3 Amps.	15 Amps.
150 V.	750 V.	15 Amps.	
300 V.	1.5 KV.	30 Amps.	
750 V.			Resistance
1.5 KV.			0-4000 ohms.
			0-10 K ohms.

Thoroughly overhauled. Complete with batteries and instructions. An extremely robust meter at a very reasonable price



SANGAMO WESTON Model E772 ANALYSER 10 Gns. (P. & P. 4/-)

A.C. and D.C. Volts	D.C. Current	A.C. Current
2.5 V.	100 micro-Amps.	0.3 Amp.
10 V.	1 milli-Amp.	1 Amp.
50 V.	10 milli-Amps.	5 Amps.
250 V.	50 milli-Amps.	
1000 V.	100 milli-Amps.	
	500 milli-Amps.	

Output meter

Supplied in neat black Rexine covered carrying case, complete with all batteries and instructions. Thoroughly overhauled and in perfect working order.

MULLARD C & R BRIDGE

£7.10.0 (P. & P. 3/6)

Resistance	Capacity
1/10th to 10 ohms.	10 to 1000 pFd.
10 to 1000 ohms.	0.001 to 0.1 mFd.
1 K to 100 K ohms.	0.1 to 10 mFd.
100 K to 10 Megohms.	

Minus 20% to plus 25% comparison scale. Provision for "Open Bridge" - "Galilbre" position. Large easily read scale. Sensitivity control. Operates from 100-250 v. A.C. mains. In very good condition. Carefully tested and checked before despatch.



HIGH RESISTANCE AVOMETERS. £14 (P. & P. 4/-)

This is a special model, similar in appearance to the type illustrated, and particularly useful for radio, T.V. and electronic servicing. Sensitivity 20,000 ohms per volt on D.C. and 1,000 ohms per volt on A.C. D.C. current, 50 micro-A. to 1,000mA. D.C. Volts, 2.5 to 2600. A.C. Volts, 10 to 2500 Resistance, 0.1 ohm. to 5 Megohms. Supplied complete with batteries, and fitted with magnetic screen for protection from external fields. Has provision for offsetting the pointer by 30° for use as a Galvanometer.

JASON FM SWITCHED TUNERS

All three B.B.C. programmes at the turn of a switch. **MERCURY KIT.** Includes front-end unit already built and aligned. £9/19/- post free. Credit Terms. Deposit £1/10/6 and seven monthly payments of £1/7/-, Instruction Book 2/3, included in kits. Fully detailed price list free.

PREFECT TUNER. A ready-built unit. Less power supply. £15/12/6. Credit Terms: Deposit £2/5/6 and seven monthly payments of £2/1/-, illustrated leaflet free.

Both these tuners incorporate a good AFC system which ensures freedom from drift.

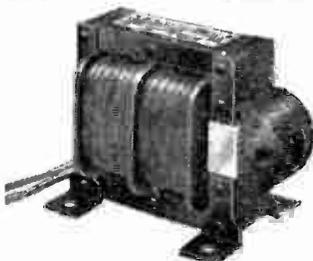
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TRANSCRIPTION MOTORS

Garrard 301 Transcription Unit	£26 8 0
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Lenco GL.55 Transcription Unit	£17 10 4
Lenco GL.56 Transcription Unit	£23 7 0
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Tannoy Dual Concentric 15in. with X-over	£35 12 0
Tannoy Dual Concentric 12in. with X-over	£29 5 4
Tannoy Direct Radiator 12in.	£14 0 0
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WB.HF.10/12	£4 19 9
Twoeters and a range of Wharfedale Units stocked, W.B. and Goodmans Cabinets. Amplifiers and Cabinets Custom built.	

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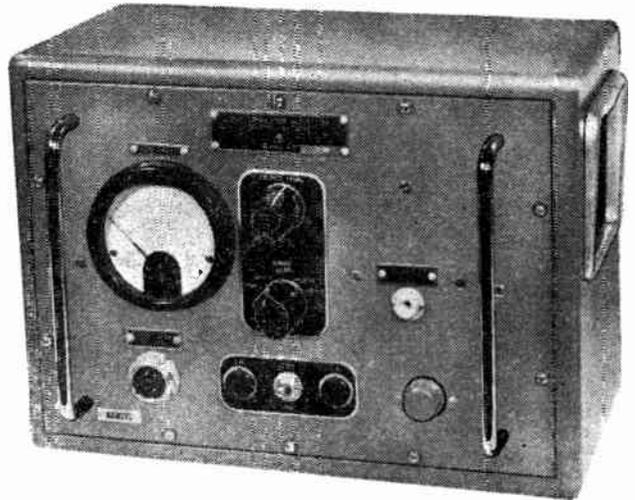
Leak Arm L.P. Head, diamond and Trans.	£13 16 5
Connoisseur Mk. II L.P. Head (Diamond)	£12 15 6
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EDDYSTONE Communications Receivers

Model 750	£78 0 0
Model 840A	£55 0 0
Model 870	£34 16 0

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MARCONI NOISE GENERATORS Type TF 987/1.



- ★ Frequency range 100 Kc/s-200 Mc/s.
- ★ Accuracy plus or minus .5 decibel.
- ★ Determines noise factor of AM AND FM receivers.
- ★ Noise output ranges 0-5, 0-10, 0-15, and 0-30.
- ★ Directly calibrated 3½ in. m/coil meter.
- ★ Output impedance 71 ohms nominal.
- ★ Fully stabilised HT supply.
- ★ For C.A.C. mains operation, 200-250 v., 45-65 c/s.
- ★ Size 15½ x 11 x 8½ in. deep. Weight 28 lb.
- ★ Finished in grey enamel and chrome.
- ★ Brand new, unused, and in original boxes.
- ★ Complete with mains socket, co-ax plug, and lead.

FRACTION OF ORIGINAL PRICE **£25.0.0**

BATTERY CHARGERS. Input 230 v. A.C. Output 12 v. D.C., 1.5 amps. In neat grey metal case, 7 x 6 x 5 in. Brand new, 35/-.
CERAMIC SWITCHES. Heavy duty (Wearite type), 4 pole, 3 way, 3/6. 2 pole, 6 way, 4 bank, 10/-. Brand new.

RCA OUTPUT TRANSFORMERS. As used in MI-1220 Amplifier. Primary for push-pull 6L6's. Secondaries 5, 7.5, 15, and 600 ohms, and tertiary for NFB. 25 watts power rating. Potted construction, with tag connections. Full circuit of RCA amplifier supplied. **BRAND NEW, 27/6.**

TRANSFORMER BARGAINS
Input 0-230/250 v. Output 240-0-240 v., 1.5 amps. RM5, 5 v. 1.75 amps., and 5 v. 12.5 amps. 7 x 7½ x 10½ in high. Wt 50 lb. Potted, oil-filled, by Gresham. Gives 2.1 amp. D.C. when rectified, OR as ISOLATING TRANSFORMER, to obtain two 240 v. 360 v lines. Brand new £3/10/-. Carr. 10/-.

Input 0-110/120-200/250 v. Output 275-0-275 v. 100 mA., 6.5 v. 7 amps., 5 v. 3 amps. (Govt. ratings). 4 x 4½ x 4 in. high. Upright mounting. Brand new, 25/-. Postage 2/6.
MAINS ISOLATING TRANSFORMERS (Vortexion). Fully shrouded. For testing A.C./D.C. sets in safety. 230 v. input. Output 230 v. 100 watts, 22/6, post 2/6.
U.S.A. potted type, input 210/220/230 v. 5 secondaries. 7.5 v. 4 a., 7.5 v. 4 a., 7.5 v. 8 a. and 2.5 v. 5 a. ALL center tapped, and 6.3 v. 4 a. These can be connected to give many useful voltages up to 31 v. 4 a. Size 6 in. x 5 in. x 4 in. Wt. 16 lb. Price 35/-.

HEAVY DUTY SLIDER RESISTORS. 0.4 ohms, 25 amps., 250 watts, worm drive, 7/6. 10 ohms, 3.5 amps., worm drive, 10/6. 1 ohm, 12 amps., 150 watts, 7/6.

MINIATURE STC RELAYS. 250 ohms coil. DP C/O (double contacts). 1½ x ½ x ¾ in. Wt. 1 oz. 6 v. operation, 7/6.

VIBRATOR PACKS. Input 6 v. D.C. Output approx 100 v. D.C. at 30 m/Amps., fully smoothed and R.F. filtered. Size 6½ x 5 x 2 in. Fitted with Mallory 629C vibrator. Brand new. Boxed. 12/6.
ANOTHER, but 230 v. D.C. 100 m/Amps. With OZ4 valve and vibrator. Brand new. Boxed. 25/-.

INSULATION TESTERS by Record Electric. 0-50 Megohms. Test voltage 500. In perfect working order. ONLY £9/19/6, OR, less case, £8/10/-.

JACK BOXES. A small metal box fitted with 9 miniature insulated Igranic jack sockets. Brand new. SNIP. 12/6.

HEAVY DUTY BLOWERS. For 200-250 v. A.C./D.C. mains, 300 watts. With 1½ inch diam. twin "V" shape outlets. 2 lengths of hose. 4 spare filters and brushes. Suitable for industrial use. forges, etc. Brand new. £4/19/6.

MINIATURE 373 IF STRIPS. For FM tuner described in April and May "Practical Wireless." Complete with 3 of EF91, 2 of EF92, and 1 of EB91. A fresh release enables us to offer these once again, **BRAND NEW**, with circuit, 42/6. OR, less valves, 12/6. Post either 2/6.

METER BARGAINS			
RANGE	TYPE	SIZE	PRICE
50 Microamp.	D.C. M/C	2½ in.	Flush circ., scaled 0-100 59/6
100 Microamp.	D.C. M/C	2½ in.	Flush circ., Ex-19 set 39/6
500 Microamp.	D.C. M/C	2 in.	Flush circular 12/6
500-0-500 Micro amp.	D.C. M/C	2½ in.	Flush circular, scaled 100-0-100 V. 25/-
1 Milliamp.	D.C. M/C	2 in.	Flush square, Fe/NFe 25/6
150 Milliamp.	D.C. M/C	2 in.	Flush square 7/6
200 Milliamp.	D.C. M/C	2½ in.	Flush circular 10/6
1 Amp. Thermo-couple	2 in.	Projecting circular 6/6	
1 Amp. Thermo-couple	2 in.	Flush square 6/6	
15 Volts AC. M/I	2½ in.	Flush circular 8/6	

METER RECTIFIERS. Full wave bridge. Brand new, Salford 1 mA. 3/6. 5 mA., 6/6. STC 2 mA., 5/6.

FLUXMETERS. Fitted with Ernest Turner 3½ in. mirror-scale meter and contained in polished wooden instrument case with carrying handle and hinged lid. Size 13 x 9 x 6 in. Brand new condition. SNIP, only 49/6.

AMERICAN METERS. Brand new Westinghouse flush panel mounting, circular 2 in. scale, 0-5 milliamps, with blank black scale. Boxed, 8/6, post 1/-.

AMERICAN MICROPHONES AND HEADSETS. Consist of carbon microphone with press-to-talk button, and two 300 ohm earpieces in series, complete with 7ft. cord. Phones are lightweight, and have rubber ear-cushions. As used with TBY-8 equipment, and should be very handy. **BRAND NEW.** A real SNIP at 15/-, post 2/-.

WIRELESS SET No. 19, Mk. 2.
Two Transmitter-Receiver and an Intercom Amplifier combined. "A" Set covers 2-8 Mc/s (37.5-150 metres), phone and CW. "B" Set freq. 235 Mc/s (1.25 metres), phone only. Complete with 15 valves, 6 of 6K7G, 2 of 6K8G, 2 of 6V6G, 1 of 6BBG, 807, EF50, EB34, E1148, and 500 microamp check and tuning meter, instruction booklet, and circuit. **ALL BRAND NEW**, air-tested. American made, 65/-. British made 50/-. OR, complete with 12 v. Dynamotor. American, 90/-. British 75/-. Carriage, sat 10/-, both 15/- Send S.A.E. for full details and price list of all 19 set equipment.

ADMIRALTY POWER UNITS. Equivalent to AM 234. Input 200-250 v. 50 c/s. A.C. mains. Outputs 240 v. D.C. 125 m/Amps., and 6.3 v. A.C. 6 amps. Dual purpose 2½ in. panel mounted 300 v. meter reads input and H.T. volts. Double smoothing with paper capacitors. Standard 19 in. rack mounting. **BRAND NEW.** 79/6. Carr. 7/6.
LOW VOLTAGE POWER UNITS. Input 200-250 v. A.C. mains. Outputs, 220 v. D.C. 110 m/amps, and 6.3 v. D.C. 13 amps. Fully smoothed. Metal rectifiers, £5/10/-, carr. 15/- As used for T1154.

HIGH VOLTAGE POWER UNITS. Input 200-250 v. A.C. mains. Output 1200v. D.C., 200 milliamps. Fully smoothed, Metal rectifiers, £5/10/- plus 15/- carriage

MARCONI LOOP AERIAL type 696. A small, compact, enclosed loop. On swivel mount with degree scale. Brand new, 69/6, post 2/6.

SPEAKERS (Eddystone). 3 ohms, 6½ in. diam. In grey wrinkled steel cabinet 9 x 9 x 5 in. Complete with volume control and transformer for 600 ohms line. Brand new 27/6, post 2/6.

VHF TRANSMITTERS. VC-950-A-130-A 100-150 Mc/s, 4 channel, crystal controlled transmitter. Complete with valves, 2 of 1625 2 of 832A, 1 of 815.

BRAND NEW. In original American packing. (Xtals not supplied.) £5/19/6. Carr. 7/6.

RT37/PPN2 BEACON TRANSMITTER-RECEIVER. 214-234 Mc/s. Size 13 in. x 10 in. x 5 in. Contains 5 3A5, 3 1S5, 1 IR5 and 2 2 v. synchronous vibrators. Operates from 2 v. accumulator via 2 built-in vibratorpacks. Complete with telescopic mast Antenna system (9½ ft.), lightweight headphones. Technical Manual, super-quality carrying faversack, cords, co-ax cables, plugs, etc. Total wt. 28 lb. **BRAND NEW**, boxed. American equipment, 72/6.

SCR522 TRANSMITTER/RECEIVERS. 100-150 Mc/s. Comprises BC624A rec., and BC625 trans. All complete with valves, and in first-class condition. BC624A, less relay, 39/6. With relay, 49/6. BC625, 49/6.

Two-Way MORSE TRAINING SETS, W/T Mk. 3. Consists of 2 valve oscillators (ARP12's) (one with pitch control), for 1 or 2 operators. Has provision for creating "atmospherics." In polished oak case 12½ in. x 10 in. x 8 in., wt. 16 lb. Complete with valves, leads, 2 keys, 7-way terminal board, circuit and instructions, but less batteries and phones. Ideal for Cadets, Scouts, etc. SNIP, 19/6 carr. 7/6.

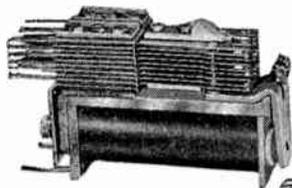
VARIAC TRANSFORMERS (Zenith). 200-230 v. input. Output voltage variable from 200-250 v. at 8 amps. Wt. 14 lb. Brand new, 87/6. Carr. 5/-.

MAINS DIMMERS. 300 ohms, 1 amp., 300 watts, twin ceramic formers, 15/-.
FIELD TELEPHONES. Army type D, Mk. 5 Buzzer calling. Ideal for building sites, farms, workshops, etc. Complete with handset and batteries. Tested, 39/6.

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RELAYS—HIGH SPEED. Miniature, sealed. 1700+1700Ω. 25/- each. Post 1/3.

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F.S.D.	Size	Type	Price
100 Microamps	2 1/2 in.	MC/FR	50/-
250 "	3 in.	MC/FR	55/-
500 "	2 in.	MC/FR	37/6
500 "	2 1/2 in.	MC/FR	37/6
1 Milliamps	2 in.	MC/FS	35/-
1 "	2 in.	MC/FR	17/6
5 "	2 1/2 in.	MC/FR	12/6
30 "	2 in.	MC/FR	12/6
100 "	2 1/2 in.	MC/FR	12/6
200 "	2 in.	MC/FR	12/6
300 "	2 1/2 in.	MC/FR	12/6
5 Amperes	2 in.	MC/FS	27/6
25 "	2 1/2 in.	MI/FR	7/6
50-0-50 Amp.	2 in.	MC/FS	12/6
20 Volts	2 in.	MC/FS	10/6
40 "	2 in.	MC/FS	10/6
300 " A.C.	2 1/2 in.	MI/FR	25/-
300 " A.C.	6 in.	MI/FR	150/-



CROSS POINTER METERS. With 2 separate 100 microamp movements. Brand new. 22/6, post 2/-.

CIRCUIT TESTER in case. Meter 50 milliamps, 17/6, post 2/6.

AVO TEST BRIDGES. 220/240 volt A.C. Measures capacities from 5 pf to 50 mfd and resistances from 5 ohms to 50 megohms, each in 3 ranges. Valve voltmeter range 0.1 to 15 volts, and condenser leakage test. BRAND NEW. Full working instructions supplied with instrument, £12/10/- Post 3/-.

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ELECTRIC MOTORS. 200/250 volt, self-starting, 1 r.p.m., 35/-, Post 1/6.

BRIDGE MEGGER TESTERS. 1,000 volts. 100 Megohms. Complete with the Evershed Resistance Box. Absolutely Brand New and unused, in maker's original packing. 27s.

TELEPHONES—SOUND POWERED—NO BATTERIES REQUIRED. Just connect with twin flex for clear speech. Transmitter/receiver units 4/6 each. Twin flex 4 1/4 yard. Post 1/-.

If 2 units are connected in series and one used for speaking and one for listening, perfect 2-way conversation can be made.

TELEPHONE SETS. For perfect communication between 2 or more positions. Wall Type, one pair of units, 25s. Batteries 5/6. Twin wire 54 yard. Desk Type, now available, latest modern style. Two complete units ready for use, 23/17/6. Wire 54, per yard. Post 3/-.

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Ideal for charging 24 volt batteries on electrically propelled vehicles. Rating 22 v. 10 amps., controlled by two 4-position rotary switches for fine and coarse control which enables 6/24 vt. Batts. to be charged. Input 200/250 v. A.C. 50 cy., fused for A.C. and D.C. Brand new £17/10/-. Carr. 15/-.

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JACK PLUGS. Cylindrical bakelite screw on cover. 2 Contact. Ideal for amplifiers etc., 2/6 each, 24/- doz., 29 per 100.

AIR BLOWERS. 230 vt. A.C. .57 h.p. 15in. fan, 6in. outlet. Brand new 22s. Carriage in England 20/-.

PORTABLE BLOWERS. 200/250 v. AC/DC 300 watts with switch and leads, 1 1/2 in. outlet. 25s. Carr. 7/6.

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RACKS—POST OFFICE STANDARD. 6ft high with U-channel sides drilled for 19in. panels, heavy angle base, 4ft. 10in also in stock.

VERNIER DRIVES. Muirhead scaled 0/180 deg. Ratio 38 to 1. Diam. 3in. 10/6. Post 1/6.

RADIO-ACTIVITY MEASURING INSTRUMENTS. Philips Type 1092c. A portable self-contained unit in haversack. Scaled 0 to 10 milliroentgens per hour, using Mullard Geiger Counter MX115, 22s.

HEADPHONES. Balanced Armature Type DHR. 17/6 per pair, post 1/6.

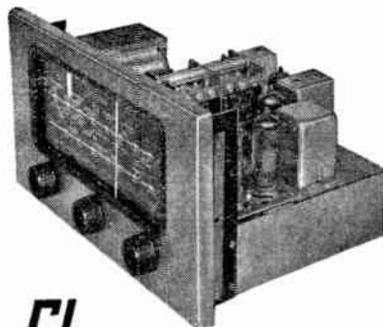
VENT-AXIA FANS—EXTRACTION OR INTAKE. 230/250 volts A.C. 6in. diam blades, 130/-, 12 volt D.C., 90/-, post 2/6.

RATIO ARM UNITS. Sullivan. 800 ohms + 600 ohms, 50/-, post 2/-.

WHEATSTONE RESISTANCE BRIDGE. 1 to 10,000 ohms. Plug type, 25s.

SWITCHES. 1 hole fixing, 3 amp. 250 vt. Single Pole change over, 1/6 each, 12/- doz. £37/10/- per 1,000.

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Compact and easy to instal. This chassis is the ideal tuner for the domestic High Fidelity system. Superb FM quality and AM sensitivity combine to give excellent BBC and Continental reception.

★ FM85 Medium, Long plus FM with tuning eye on all bands and volume control.
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For high and low voltage testing. Standard Model: range 100/250 volts A.C. or D.C. Dual Model: range 1/30 and 100/250 volts A.C. or D.C.

Write for interesting leaflet 30F. APPLY FOR 16 PAGE BOOKLET, POST FREE 1/-.

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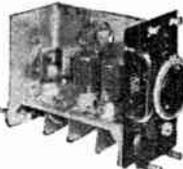
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R.F. UNITS

R.F. 25, 40-50 mc/s, 8/6 each.
R.F. 26, 50-65 mc/s, 20/- each.
All valved with circuit. Postage 3/6 on ea

RCAF AMPLIFIER UNIT. 12 v. input Vibrator Pack. 250 v. output OZ4. Microphone transformer into a 6K6 GT output valve with negative feed back. Size 8 x 5 1/2 x 8 1/2 in. Brand new, 35/- each, P. & P. 3/-.

WAVEMETER TYPE W1433. Frequency 154-260 mc/s, with crystal check and calibration chart. Mains 50 cycle. 50/-, carr. 10/-.

COMMUNICATION RECEIVER RA 1B. Covers 150 kc/s-15 mc/s in 6 bands. For 12 or 24 volt operation. Send for details.

INDICATOR UNIT SLC No. 5. Ideal for conversion into an Oscilloscope using a 139A or ACR 10 tube. Unit consists of 2-VR65's, 1-VR66, various resistors, condensers and pots. Size 11 x 6 x 3 in. Brand new, complete with modification circuit. 20/-, P. & P. 3/-.

PARMEKO CHOKES. 8 H. 100 mA. 7/6, P. & P. 1/6

AMERICAN GEARED MOTOR. 24 v. D.C. with built-in precision gear-box. No. 1 drive 24 R.P.M. No. 2 drive 6 R.P.M. On 12 v. No. 1 drive 16 R.P.M. No. 2 drive 4 R.P.M. Overall size of motor and gearbox 7 1/2 x 3 1/2 x 3 in., weight 1 lb. 14 oz. Brand new. Only 22/-, P. & P. 3/-.

POCKET VOLT METERS. Read 0-25 volts and 0-20 volts D.C. Brand new. Only 15/-, P. & P. 2/6.

DIPOLE AERIAL No. 4A. 52 feet hard drawn 7/22 copper wire with centre insulator, fitted with feeder sockets. Both ends have 3 link insulators and slotted wire adaptors. Brand new, price 9/-, P. & P. 2/-.

RELAYS. 6,500 ohms and 3,500 ohms, 8/- pair, post paid.

FM WOBULATOR CAPACITOR. Excellent for Sweep Generator. Frequency modulation unit permanent magnetic field and a moving mechanism driving a metal diaphragm supported at its rim. This diaphragm acts as a moving plate of the frequency capacitor. Tested. Price 7/- each, P. & P. 1/-.

DYNAMIC SOUND POWERED HEADPHONES. Type D.L.R. 5. 60 ohms. 7/6, P. & P. 1/6.

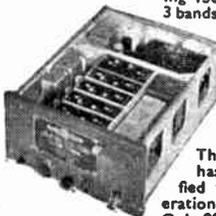
BENDIX RECEIVER RA 10. A 4 wave-band superhet covering 150 kc/s-10 mc/s. Valves 6SK7 1st RF, 6K8 Mixer, 6SK7 1st and 2nd I.F. 6R7 2nd Det, 6C5 B.F.O., 6K6 output. Size 6 1/2 x 15 1/2 in. Easily converted to mains operation as described on page 453 of the September "Practical Wireless." £5/10/-, carr. 7/6.

COMPLETE STANDING WAVE RATIO METER. 110 v. a.c. operated. From 60 c/s-1,000 c/s. with all coax. couplings and probe finders. To match all feeder line impedances and lengths. Calibrated matching bar. Direct standing wave ratio readings are shown on meter 50 micro-amp. movement. This magnificent instrument is precision built, complete with all spares and housed in oak carrying case. Brand new in original packing. £14 each, plus carriage 10/-.

HIGH RESISTANCE HEADPHONES. Type No. 2, 4,000 ohms. Brand new 11/6 each, P. & P. 1/6.

BENDIX RECEIVER MN26C. Covering 150-1,500 kc/s in 3 bands. Valves used

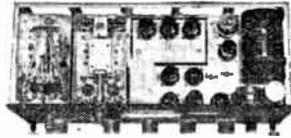
5-6K7,
2-6N7,
2-6J5, 1-6F6,
1-6L7. Complete with switching motor and dynamotor. This superb unit has been modified for 12 v. operation. With circuit. Only 80/- carr. 8/6.



COMMUNICATION RECEIVER R155

This magnificent receiver covers 5 ranges: 75-200 kc/s., 200-500 kc/s., 600-1,500 kc/s., 3-7.5 mc/s., 7.5-18.5 mc/s. Fully tested before despatch. Complete with circuit and instruction booklet. £8/10/-, carr. 10/-.

YOU CAN'T BEAT THIS FOR VALUE!!



**R.T-7/APN-1
ALTIMETER
TRANSCIVER**

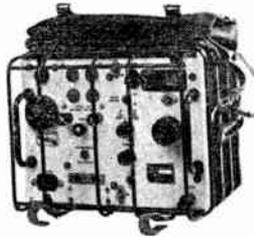
Brand New complete with 14 valves: 3-125J7, 4-125H7, 2-12H6, 1-VR150, 2-9004, 2-955. Famous Wobulator Unit, Dynamotor, Relays 3,500 ohms and 6,500 ohms. A.F. amplifier. Receiver section covers 400-450 mc/s. Transmitter sweeps 418 to 462 mc/s with manual. Only 35/-, carriage 10/-.

**No. 38 TRANSMITTER/RECEIVER
WALKIE TALKIE**

Range approx. 5 miles. Covering 7-4.9 mc/s. Absolutely complete with junction box, headphones, microphones, webbing, haversack. Brand New, only 60/-, carriage 7/6.

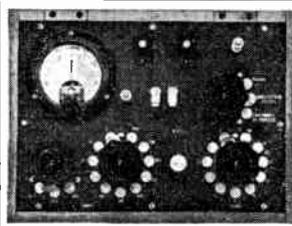
R109 RECEIVERS

8 valves, 5-ARP 12's, 3-AR 8's covering 1.8-8.5 mc/s on two frequency bands. Contains 6 v. Vibrator Pack and built-in 3 1/2 in. Goodman speaker, operates from 6 v. battery, consumption 1 1/2 amps. Housed in metal case 13 x 12 x 1 1/2 in. Designed for Mobile or Ground station. Operates with any normal aerial. Complete and tested, including circuit. Very good condition. Only 80/- carr. 7/6.



VIBRATOR PACK

12 volt input 300 volts output at 150 mA. As a bridge rectifier will handle 450 volts RMS at 120 mA. Pack consists of 12 volt vibrator, 4 metal rectifiers, chokes and smoothing condensers. ONLY 30/-, carriage 5/-.



WHEATSTONE BRIDGE. Consisting of four stud switches: 0-10 ohms, 0-100 ohms, 0-INF. Galvanometer centre zero F.S.D. 2.5 mA. Ranges easily extended. Housed in oak cabinet 16 x 7 1/2 x 6 in. Complete with instructions, 40/-, P. & P. 4/-.

TEST SET 102

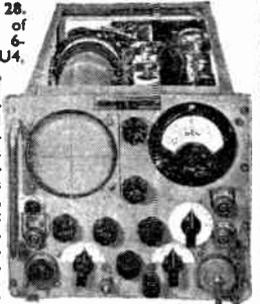
250 v. 50 c. A.C. Emits 25 x 50 cycles. Transformer 280 v. at 80 mA. 12 v. at 2 amps., 6 v. at 3 amps. 1-DET 19, 1-6J5. S.T.C. metal rectifier. Bulgin plugs, sockets, ind. lamps, circuit diagram 40/-, carriage 5/-.



(Dept. "W"), 32A, Coptic Street, London, W.C.1.
Phone: MUSEum 9607.

MONITOR TYPE 28

Consists of VCRI38 6-SP61, 1-5U4, 1-VU120, 3-EA50. 1 m/a sealed 100-0-100 volts incorporates Y shift, X shift in u/secs, Focus, sync. Bias. Input to X plates switched x 20. x 5 and direct, requires only suitable power pack for use as oscilloscope. 60/-, carr. 10/-.



TANNOY AMPLIFIER. With 4 6L6's in parallel, push-pull handling from 30 to 60 watts. 200-250 v. input. Complete with all leads, hand microphones, plugs and spares. Housed in wooden transit case 17 1/2 x 15 1/2 x 2 1/2 in., with full operating instructions and circuit. Fully tested. ONLY £20. Speakers for above, 25/- each.

FERRANTI TRANSFORMERS. Input 225 volts, output 4 volts at 2 amps. Potted type with ceramic bushes. Brand new, 7/6 each, P. & P. 1/-.

U.S.A. INDICATOR BC929A. Complete with 3 BPI, shield and holder. Aerial switching unit, 7 valves: 2-6HG7, 1-6X5GT, 1-2X2, 1-6G6, 2-6ZIN7. Brand new. Original cartons. With modification circuit, 60/-, carriage 7/6.

HOOVER ROTARY TRANSFORMERS. 11.5 v. input, 490 v. output at 65 mA. and 6 v. input 300 v. output at 75 mA. Guaranteed and tested, only 27/6, P. & P. 2/6.

373 MINIATURE 9.72 I.F. STRIPS. Supplied complete with 3-EF91, 2-EF92, 1-EB91. Ideal for modification to FM Tuner as described on page 107 of the April "Practical Wireless." Price 45/- each.

ORIGINAL AR88 MAINS TRANSFORMERS. Input 110-240 v. Output 345-0-345 at 150 mA. 5 v. at 2 amps. and 6.4 v. at 4.5 amps. Brand new, fully shrouded, 50/-, P. & P. 3/-.

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VIBRATOR PACK. 6 v. input, 230 v. output at 100 mA., complete 4-pin vibrator, OZ4 rectifier Fully smoothed, 25/6 each, P. & P. 2/6.

500 MICROAMPS METER. 2in. circular calibrated 0-15 and 0-600 volts, resistance 500 ohms. 12/6, P. & P. 2/6

PYE 45 mc/s. I.F. STRIPS, complete with seven valves, 6-EF50, 1-VR92, 6 tunable I.F. transformers. Only 30/-, post paid.

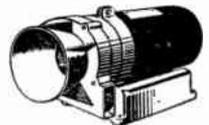
FILTER UNIT 503. Frequency 20-35 mc/s., with silver plated coil. Condenser 140 pF., Veeder counter, coax. input and output sockets. Suitable for conversion to absorption wavemeter. 12/6, P. & P. 2/-.

COMMAND RECEIVERS. 1.5-3 mc/s. fully valved, with circuit, 65/-, P. & P. 3/6.
B.C.733-D RECEIVER. 108.3-110.3 mc/s. 10 valves, 3-VT269, 1-12AH7, 2-12SR7, 2-12SG7, 1-12SQ7, 1-12A6. 6 crystals. 12 v. operation. £4, carr. 7/6.

WESTINGHOUSE PENCIL RECTIFIER. Type J.50 output 500 v. at 5 mA 5/-, post paid.

AMERICAN ROTARY CONVERTORS

With cooling Fan. Input 12 v. D.C. Output 300 v. at 90 mA. Completely suppressed. Brand new. 19/- each, plus P. & P. 3/-.



COMMERCIAL TELEVISION CONVERTER

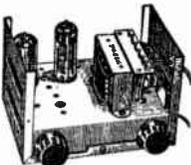
SUITABLE ANY T.V.

using lower side band

within 35 miles of any I.T.A. Station
NO ALTERATIONS TO SET

Complete with built-in power supply, 200-250 v. A.C. mains. Case 5 1/2 in. long, 3 1/2 in. wide, 4 1/2 in. high incorporating gain control and band switch. Complete with Wolsey 3-element I.T.A. outside or left aerial, 36 feet I.T.A. lead, two plugs (Wolsey 4-element 5/- extra). 25/- deposit plus P. & P. 5/- and 4 monthly payments of £1/5/6.

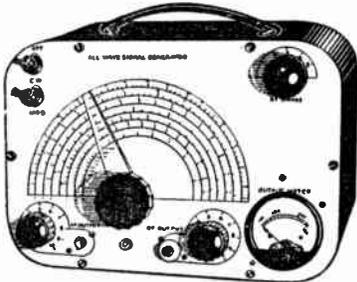
Cash £5/17/-, plus P. & P. 5/-
CONVERTER ONLY **£3/19/6**
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Coverage 120 Kc/s.-230 Kc/s., 300 Kc/s.-800 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s.-84 Mc/s.
Metal case 10 in. x 6 1/2 in. x 4 1/2 in. Size of scale, 6 1/2 in. x 3 1/2 in. 2 valves and rectifier. A.C. mains 200-250 v. Internal modulation of 100 c.p.s. to a depth of 30 per cent., modulated or unmodulated R.F. output continuously variable 100 milli-volts. C.W. and mod-switch, variable A.V. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%.

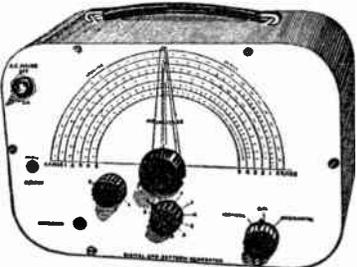
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and 3 monthly payments
25/- P. & P. 4/8 extra.

SIGNAL & PATTERN GENERATOR

Coverage 7.8 Mc/s.-210 Mc/s. in five bands, all on fundamentals, slow motion tuning audio output, 3 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ± 1%. A.C. mains 200-250 v.



£6/19/6
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Or £2 deposit, P. & P. 5/6
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27/6.

COMPLETELY BUILT PORTABLE AMPLIFIER

Approx. size 6 1/2 x 2 1/2 incorporating 2 valves, contact-coiled metal rectifier, bass and treble lift controls and double wound mains transformer 200-250 v. **39/6** Plus P. & P. 3/6.

5" P.M. SPEAKER AND O.P. TRANSFORMER
if purchased with the above 18/6. Plus P. & P. 1/6.

COLLARO 4-SPEED AUTOMATIC CHANGER

Model 456. 10 records. A. C. mains 200/250 v. Turnover crystal head. BRAND NEW. Fully guaranteed (suitable for use with above amplifier). 25/- deposit plus P. & P. 5/- and 7 monthly payments of 25/-.

Cash **£8.19.6.** Plus P. & P. 5/-.



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incorporating ferrite rod aerial

Medium and long waves. In grey leatherette Size 9 in. x 7 in. x 6 in. Valve line up IT4, IR5, IS5, 3V4. Complete kit of parts (less batteries)

£5/19/6 Plus 3/6 Post and Packing.



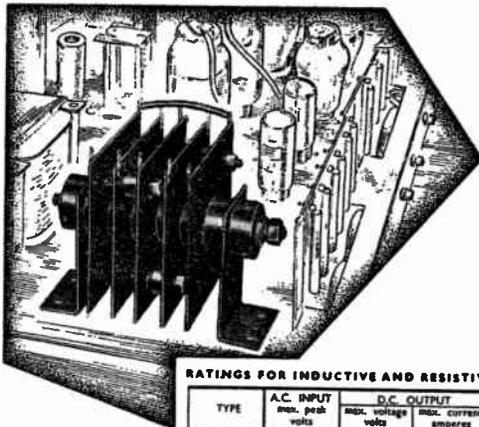
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GOODS NOT DISPATCHED OUTSIDE U.K.



GERMANIUM JUNCTION RECTIFIERS

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RATINGS FOR INDUCTIVE AND RESISTIVE LOADS

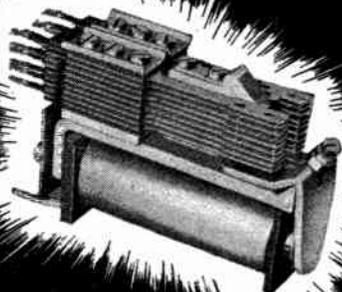
TYPE	A.C. INPUT max. peak volts	D.C. OUTPUT		OVERALL LENGTH inches	
		max. voltage volts	max. current amperes		
SINGLE-PHASE	GA31-A	140	125	2.0 at 40°C	3 1/2
	GA41-A	53	47	2.0 at 40°C	3 1/2
	GA51-A	210	167	2.0 at 40°C	3 1/2
	GA61-A	106	94	2.0 at 40°C	3 1/2
	GA52-A	340	303	2.0 at 40°C	5
	GA62-A	170	151	2.0 at 40°C	5
THREE-PHASE	GA33-A	510	455	2.0 at 40°C	6 1/2
	GA43-A	254	227	2.0 at 40°C	6 1/2
	GA31-A	140	108	3.0 at 35°C	4 1/2
	GA41-A	53	71	2.0 at 35°C	4 1/2
	GA51-A	210	203	3.0 at 35°C	4 1/2
	GA61-A	106	143	2.0 at 35°C	4 1/2
THREE-PHASE	GA52-A	340	458	3.0 at 35°C	6 1/2
	GA62-A	170	229	2.0 at 35°C	6 1/2

The well-known range of BTH germanium junction rectifiers is now available made up into convenient bridge units ready for incorporation in your equipment.

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THE BRITISH THOMSON-HOUSTON CO., LTD., RUGBY ENGLAND
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Still THE MOST RELIABLE MAGNETIC RELAY



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14"
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As supplied to the trade for the last seven years. Six months' full replacement, six months progressive. Made possible by the high quality of our tubes. Ins., carr., 15/6.
CONVERT YOUR 9, 10, 12in. to our SPECIAL OFFER of 14, 15, 16in. round T.V. TUBES at £5. Information on how to "do it yourself" in our FREE catalogue. Ins., carr., 15/6.
12in. T.V. TUBES, £6. 3 months' guarantee on all round tubes. Ins., carr., 15/6.



HEADPHONES, 1/9

Single earphone and headband. C-L.R. Ideal for crystal sets, extension on radio, etc. P. & P. 1/3.

5-VALVE MIDGET RADIO, £3/19/6
Superhet. Octal valves: 12K8, 12K7, 12Q7, 35L6 & 35Z4. 5in. speaker included. 2 wavebands (L. & M.) 3 control knobs. 100-240 volts. Universal supply. Wooden cabinet, size 17 x 8½ x 6in. Ins., carr., 3/6.

T.V. AERIALS, 25/6. For all I.T.A. and F.M. channels. For outdoor or loft. 3 elements. Famous manufacturer at half the normal price. Post 2/6.

T.V. MASKS... 7/9. 17in. Grey plastic. Brand new. Post 2/-.

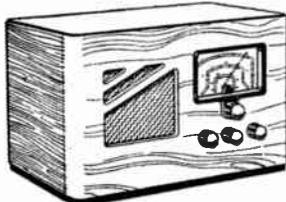
T.V. MASKS... 14/9. 17in. Halo lighting. New. Post 2/-.

T.V. MASKS... 10/9. 17in. White plastic. New. Post 2/-.

TORCH LANTERNS, 6d. each. X.W.D. Include 2 bulbs, use 800 battery. P. & P. 1/-.
Crate of 48 with 22 bulbs extra. 22/- (118 bulbs in all). Carr. 10/-.

HOME RADIO, 79/6

5 valve (octal) s/het. 3 w/ band receiver. A.C. gram. P.U. sockets. In wooden cabinet 18½ x 11½ x 8½in. Ins., carr., 7/6.



BEAUTIFUL EXTENSION SPEAKER, 29/9



Complete. Fitted with 8in. P.M. speaker, "W.B." or "Goodmans" of the highest quality. Standard matching to any receiver. 2-5 ohms. Flax and switch included. Unrepeatable at this price. Money back guarantee if not completely satisfied. Ins., carr., 3/6.

8in. P.M. SPEAKERS, 8/9. Let the lady of the house listen to music while she works in the kitchen. Complete with O.P. trans., 10/- P. & P. 2/9.

SPEAKERS, 12/9. Goodmans or Elac. High quality 8in. P.M. Money-back guarantee. With O.P. trans., 14/- P. & P. 2/9.

"SOLO" SOLDERING TOOL, 19/6

6-12 volt, 100-125 volt. Made for the American market. Car battery or mains. Export quality. Complete in light carrying case. Reel of solder and spare parts. P. & P. 2/9.

A few of the above in 6-12 volt, 200-240 volt. 35/6. Export enquiries invited.



MAINS TRANSFORMERS

350-0-350 v. 80 ma. 4 v., 4 v. heaters. 200-250 v. primary..... 3/9
350-0-350 v. 80 ma. 4 v., 12 v heaters. 200-250 v. primary..... 3/9
280-0-280 v. 80 ma. 6 v. 2 a., 4 v. 2 a., 200-250 v. primary. Drop-through half shrouded..... 5/9

(All above 2/6 post.)

425-0-425 v. at 250 ma, 5 v at 6 a., 6.3 v. at 12 a., 6.3 v. at 6 a., 200-250 v. screened primary (P. & P. 3/9)..... 17/6

0-200-250 v. heater transformer, 12 v. at 1½ amp. (P. & P. 1/9)..... 12/9

O.P. TRANSFORMERS, 1/3. Standard size 2-5 ohms. Post 1/3. 20 for £1. P. & P. on 20, 5/6.

MIDGET EVER READY BATTERY, 1/9

"B" type battery 22½ v. No. B155. Ideal for midget or personal radio, hearing aid or photography flash. Size ½ x 2in. Post 3d. 6 for 7/-, post 6d. 12 for 12/-, post 9d.

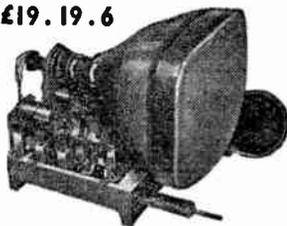
SIMULATOR UNITS, 19/6

Complete with valves. Telescopic aerial instruction booklet FREE with each order. Ideal for Walkie-Talkie conversion. Test set 172A. Ex-W.D. P. & P. 4/6

DUKE & CO. (Dept. C) 821/3 Romford Road, Manor Park, E.12 TEL.: ILF. 6001-3

17" T.V. CHASSIS £19.19.6

Latest improved circuits. Higher E.H.T. (brilliant picture). Improved sensitivity (for greater range). Chassis easily adapted to any cabinet, 17in. rectangular tube on adapted chassis. All channels. TURRET TUNER, 50/- extra. Less valves. With 5 valves, £21/19/6. With all valves, £25/19/6. Valve line-up (5 valves): 2-6D2s, 6SN7G, 6P25, EL38. Others: 7-6F1s, EL33, 6L18. 12 months' guarantee on tube. 3 months' guarantee on valves and chassis. Ins., carr., 25/- (incl. tube). Scate B.B.C. channel and I.T.A. if turret required.



14" T.V. CHASSIS, TUBE AND SPEAKER £13.19.6

As above with 14in. round tube. Less valves. Guaranteed 3 months. With 5 valves, £15/19/6. With all valves, £19/19/6. TURRET TUNER, 50/- extra. Ins., carr., 25/- incl. tube.



DENCO RADIOGRAM CHASSIS 97/6

3 and 4 waveband turret tuned. S/het. A.C./D.C. chassis with 6in or 8in. speaker. Size: 8½ x 10 x 12in. Valve line-up: CCH35, EF39, EBC33, CL33 & CY31. (C1C or dropper.) Ins., carr., 7/6.

SUPER CHASSIS, 99/6

5-valve superhet chassis including an 8in. speaker. 4 control knobs (Tone, Volume, Tuning), W.C. switch; 4 waveband with position for gram. P.U. for extension speaker. A.C./D.C. P. & P. 5/6.

ELECTRIC CONVECTOR HEATER, 99/6

Cleaner, cheaper, safer than paraffin. A.C./D.C. Switched for 1 or 2 k/watts. Illuminated grille. Ins., carr., 10/6.

ELECTRIC FIRES, 17/6. Hammered finish. A.C./D.C. 200-250 volt. 1 k/watt. Post 3/6.

R.F. EHT COIL, 30/- 6-10 k/volt. Drawing and data FREE with each order. Post free.



CONSTRUCTOR CHASSIS UNITS

POWER PACK AND AMPLIFIER, 19/6. O.P. stage 6V6 with O.P. trans. Smoothed H.T. 350 v. 250 ma., 6.3 v. 5 a., 22 v. 3a., 6.3 v. 4 a., 4 v. centre tapped. Less valves. FREE drawing. Carr 5/6

TIME BASE, 7/9. Including scanning coil focus unit, etc. Less valves FREE drawing. P & P. 2/6.

SOUND & VISION STRIP, 19/6. Superhet. Complete s/ vision strip. Less valves. FREE drawing. P. & P. 2/6.

T.V. CHASSIS TO CLEAR, 59/6. Complete chassis by famous manufacturer. R.F. EHT unit included. Drawing 2/6 or FREE with order. Chassis in three separate units (power, s/vision, timebase interconnected). These chassis can easily be fitted into existing console cabinets. Less valves and tube. Channels 1-2, 3-5. Easily converted to I.T.A. Ins., carr., 10/6.

RADIOGRAM CHASSIS, 39/9. 3 waveband and gram. superhet. 5-valve (octal). Ideal for table gram., giving high quality output. 4-knob control. 8in. P.M. speaker, 7/9, with order. Set of knobs 2/- chassis 12 x 6 x 7½in. Ins., carr., 4/6.

CHASSIS, 1/- each, 6 or 8 valve. Latest type midgut valve design for A.M. and F.M. New cadmium-plated on s.w.g. steel. 12½ x 7½ x 2½in. P. & P. 1/6. Post on 4, 3/-, 12 for 10/-, Carr. 5/-

Boxed VALVES 3 MONTHS' GUARANTEE

1A5	2/9	6H6M	1/9	12BE6	6/9	ECH42	8/9	EF50	2/9
1S5	4/9	6K7	3/9	12SG7	1/9	EF39	6/9	EL32	6/9
3A8	3/9	6N7GT	4/9	12SJ7	1/9	EF41	8/9	EL91	3/9
4D1	2/9	65G7	3/9	CV18	3/9	EBC41	8/9	EZ40	8/9
688	3/9	77	3/9	EAF42	8/9	EF91	7/9	PEN45	6/9
6F12	7/9	8D2	3/9	EB34	1/9	EF37A	4/9	TT11	6/9
6D2	6/9	8D3	7/9	EB91	6/9	EF37	4/9	X66	8/9
		12AU7	5/9	ECC81	8/9			Z77	7/9
				American Types	UX.	All at 3/9 each.			
18				75	80	6D5		6A7	
42				78	1D5	25RE		6C6	
				Barretors 301 and 302 also at 3/9 each.					

CAR AERIALS, 6/9. Whip antennae, 50in. long, collapsing to 11in. one-hole fixing. Post 1/-.

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All post orders please to:—162, HOLLOWAY ROAD, LONDON, N.7.
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JASON SWITCH TUNED FM FEEDER KIT



This excellent unit enables the selection of Home, Light or Third programme at the touch of a switch. Complete freedom from drift is ensured by the incorporation of Automatic Frequency Control. Valve line-up: 4-EP80, 1-8CF80. Front end completely prefabricated. When used in conjunction with a suitable amplifier superb quality is obtainable. The highest standards of efficiency and reliability that are the well-known features of the Jason Standard and Fringe Model FM Tuners have been maintained. Instruction booklet and our kitemised price list 2/- post free or the complete kit £9/10/6 plus P. & F. 9/6.

DULCI F.S.A.M. RADIOGRAM CHASSIS. We are very fortunate in being able to offer a further limited quantity of this very popular and efficient chassis at a greatly reduced price. Specifications: Three wavebands. Long, Medium and Short. Valve line-up: X79, 6BA6, 6AT6, EL84, 6X4 (or equivalent). Four controls: Tone, ON/OFF, Volume, Wavechange. Tuning. Output 4 watts matched to 3-5 ohms. Incorporates latest Ferrite Rod Aerial. Input sockets for crystal or magnetic pick-up. Provision for mains supply, to gram motor. Overall dimensions 12in. L x 7in. D x 7 1/2in. H. Attractive dial with Red, Gold and Green lettering on Black background. Dial size 1 1/2in. x 4 1/2in. Price whilst stocks last, only £10/5/-, plus 3/6 P. & F. Terms available.

DULCI H.3 AM/FM Chassis (7 valve). Covering Long, Medium and F.M. bands. Most attractive dial in RED and GOLD on BLACK background. £20/17/- plus 5/- c. & p. **DULCI H.4 Push/Pull AM/FM chassis** £25/3/10 plus 5/- p. & p. All Dulci products available ex stock. Illustrated leaflets and H.P. terms available. Demonstrating at both branches.

SPEAKERS & ENCLOSURE
Full range in stock by WHARFEDALE W.B., T.S.L., etc. Your enquiries welcomed.

JASON AM/FM KIT

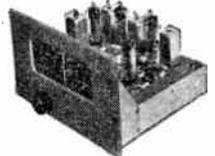
This is a very high quality chassis for medium waves and FM, incorporating 6 of the latest miniature valves, plus DM70 magic eye. Kits are available for chassis complete with output stage at £16/5/- Also less output stage but with own built-in power pack at £13/10/6 only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Fully illustrated Data Booklet with full construction details, plus individually priced component list, available per return of post 2/- post free. Both plus 3/6 P. & F.

THE RC 3/4 WATT AMPLIFIER KIT. Compare the advantages. Treble, base and middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250 v. Valve line-up: 6V6GT, 6B07 metal 6X50GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 3in. x 4in. x 1 1/2in. 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. & F. Hearing is believing.

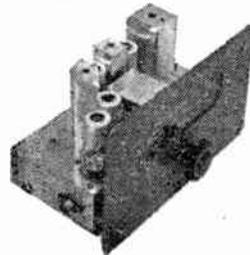
THE NEW R.C. TRANSISTOR/RECEIVER KIT
This receiver, covering medium waveband, which can be assembled in about 1 hour, will give amazing volume and tonal quality when used in conjunction with a good aerial and earth. Incorporating PNP Transistor and Germanium Diode. For telephone reception. Included with the kit of parts is a handsome plastic case in black and white, measuring 4 1/2 x 2 1/2 x 1 1/2in. This case accommodates the complete receiver, including battery. **PRICE OF COMPLETE KIT 25/-** plus 1/3 P. & F. Lightweight high resistance headphones can be supplied separately at 15/- pair. If, however, the kit is purchased complete with headphones (this will be supplied at a **SPECIAL INCLUSIVE PRICE OF 27/8** plus 1/6 P. & F. Optional extra. 100ft. coil single 7/8" coloured P.V.C. covered wire suitable for both aerial and earth. 2/6 only.



ANNOUNCING OUR NEW F.M. TUNER KIT (printed circuit). This is our printed circuit version of the Osaran 913 F.M. Tuner—using T.C.C. printed circuit and condensers, incorporating 5 valves and two germanium diodes. Attractive black and gold dial with gold esoucheon plate. Dial aperture only 5 x 2in. Osaran F.M. booklet plus our additional instructions and individually priced component list—2/6 post free or the kit absolutely complete at £3/8/- plus 2/6 P. & F. Alignment service available if required. We are demonstrating at both branches.



THE JASON FM TUNER



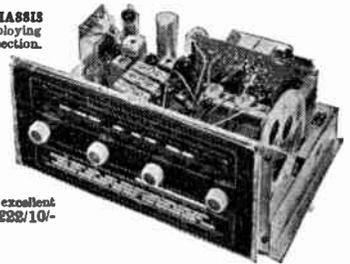
Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit includes drilled chassis with tuning condenser, scale calibrated in mc/s, and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 6in. x 5in. Chassis 7in. x 4 1/2in. x 1 1/2in. Complete standard kit £8/15/- plus 2/6 P. & F. Fringe area kit £7/15/- plus P. & F.

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★ **OUR NEW BRANCH is NOW OPEN AT** ★
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★ Corner. One minute from HOLLOWAY ROAD and DRAYTON PARK ★
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★ The service that we are noted for at Tottenham Court Road is available! ★
★ Old and new friends welcome! ★
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FM POWER PACK KIT. We can now supply complete kit for power pack suitable for the above F.M. tuner or any other similar type. Price for the complete kit is 37/6 only or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X6 and built on chassis size only 6in. x 4in. x 1 1/2in. Optional extra for power pack. Bulgin Octal Plug 2/3.

Have YOU had a copy of our 109 page comprehensive CATALOGUE? This invaluable publication is only 2/-, post free.

804FAM AM/FM RADIOGRAM CHASSIS
A new style AM/FM Chassis employing a printed circuit F.M. Tuner section. Valve line-up: 6 valves, 80C85 6B86, 12AH6, 6BA6, 6AL5, 6AT6, EL84, 6Y3. Most attractive dial 12 x 5 1/2in. fully illuminated with figures in green, red and white on black background. Four controls: Tuning, Volume, Wavechange and Tone/On/Off. Dimensions (overall): 15 x 9 x 6in. Frequency coverage (four wavebands), 1,000-2,000 m., 200-500 m., 15-50 m., 88-100 mc/s. This is an excellent and very efficient chassis. Price £22/10/- P. & F.



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TAYLOR "MONTROSE" POCKET TEST-METER. A most useful AC/DC multi-meter with eight ranges covering: 3 amp, 300 mA, 30 mA, 6 v., 30 v., 150 v., 300 v. and Circuit Test. Scale length approx. 2in. Complete with test leads. Size: 3 1/2in. x 3in. x 1 1/2in. **BRAND NEW, FULLY GUARANTEED 63/-.** Plus 1/- P. & F.

DUAL CONCENTRIC CONE LOUD-SPEAKER. 6 1/2in. dia., 3-5 ohm speech coil. Excellent quality, few only at 35/- each plus 1/- p. & p.

NEW PLASTIC RECORDING TAPE. 1,900 ft. on plastic spool. 21/-, plus 1/6 p. & p. 3 spools for 63/- post free.

VALRADIO T/V TUNER. Few only 16 mc/s. I.P. Series heaters. Employs POC84 and PCF80 valves. Covers all bands from 40-100 mc/s. and 170-225 mc/s. Whist stocks last £3/10/6 plus 2/6 p. & p.

UNIVERSAL AVO MINOR. Eleven D.C. ranges. Complete with test leads and battery. Ex-W.D. but BRAND NEW and fully guar. £7/10/- plus 1/6 p. & p.

AMERICAN SUPER-LIGHTWEIGHT HEADPHONES. Magnetic type. Fitted rubber ear-moulds. Impedance 50 ohms. Brand new 15/- or. plus 1/- p. & p.

Our advantageous H.P. and Credit Sale terms are available on any single item over £5. Your enquiries invited.

If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

Open: Tottenham Court Road: 9 a.m. to 6 p.m. Mon. to Fri., Sat. 1 p.m. Holloway Road: 9 a.m. to 6 p.m. daily Thurs. 1 p.m., Sats. 5.30 p.m.

THE "SUPERIOR FOUR" KIT.

Our superior four-valve receiver A.C. mains, 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 9 6B6GT, 6 X6GT and 6 V6GT. Chassis ready drilled. Cabinet size 10 1/2 in. x 10 in. wide. Maximum depth at base 5 in. Lapping to 3 1/2 in. 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. Booklets available at 1/6 post free. Our price for complete kit £28/9/6. Please add 2/6 P. & C. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket, wave-change switch, dial pointer, drum, pulleys, drive spindle, drive spring and knobs, at 45/-, plus 2/6 P. & C. N.B.—Our kits are even supplied with sufficient solder for the job.



THE E.C. 2 AMP. BATTERY CHARGER KIT.

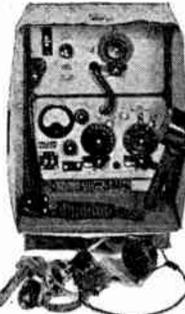
Includes handsome well-ventilated stove-enamelled steel box, size: 7 1/2 in. x 3 1/2 in. x 3 1/2 in. Fully enclosed first quality transformer, brand new G.E.C. rectifier. Mains fuse, etc., for charging 6 or 12 v. batteries at 2 amp. Absolutely complete kit with full practical and theoretical instructions. Price 36/6 plus 2/6 P. & F. Can be supplied assembled and tested at 45/- plus P. & F. Heavy duty crocodile clips suitable for car battery leads, optional extra at 1/6 per pair.

No. 39 TRANSMITTER/RECEIVER.

(popular Walkie-Talkie). We have been most fortunate in obtaining a further supply of these complete stations comprising TX/RX unit, aerial, junction box, battery set, and full operating instructions. Range: approx. 5 miles. FREQUENCY BRAND NEW. 65/-. Export enquiries invited.

No. 18 TRANSMITTER/RECEIVER UNIT:

We have just taken delivery of a quantity of these fine units, brand new and complete. This is a very good portable, self-contained transmitter/receiver designed for a short range telephony and O. V. Range approx. 5 miles. Frequency coverage 6 mc/s-9 mc/s. All accessories supplied, i.e., Headphones, Mils, Morse Key, Aerial, comprehensive instruction book with circuit diagram. Valve line-up: 3 6BP12, 2 6AR5, 1 6AT4. Weight: approx. 2 1/2 lb. Dimensions (overall): 8 1/2 in. x 10 1/2 in. x 1 7/8 in. UNREPEATABLE at 99/6 plus 7/6 P. & F.



THE "NEW LOOK" RAMBLER

Our most popular All-Dry Portable Superhet Kit is now being supplied with a new cabinet of even more attractive appearance. The new cabinet is covered with "LIONTIDE" which is washable and unscratches. Colour: two-tone GREY/RED. The standard cream plastic top panel with dial engraved in red completes the overall "air of quality." This receiver really has everything. Built-in frame aerial high quality, extremely sensitive and very adequate volume from the 6 in. loudspeaker. Valve line-up: 5V4, 1E5, 1E5, 1T4. The complete kit, including cabinet, can be supplied from stock at the original special inclusive price of £77/- plus 3/6 P. & F. (less batteries). Ever Ready 90 v. H.T. type B126 at 10/- and 1.5 v. L.T. type A.D.35 at 1/6. Instruction book available separately at 1/6 post free, contains easy to follow practical diagrams, circuit and individual component price list. RAMBLER MAINS UNIT. Enabling the above receiver to be used on A.C. mains. Very easily fitted. Complete kit, when assembled, fits snugly into battery compartment. PRICE ONLY 47/6 plus 1/6 P. & F. This unit is completely self-contained in metal box measuring 7 1/2 in. x 3 1/2 in. x 1 1/2 in. and is ideally suitable for most all-dry portables requiring 90 v. H.T. and 1.5 v. L.T. IMPORTANT: Please state valve line-up when ordering.



"FAMILY FOUR." Our new T.R.F. kit with handsome brown bakelite cabinet. This receiver gives results comparable to many commercially made receivers costing twice this price. ONLY £24/19/6 plus 2/6 P. & F. Instruction booklet available separately at 1/6 post free.



N.B.—All our T.R.F. Kit circuits include specially wound Denon "Max Q" coils on polystyrene formers. Improved performance. Price remains the same.

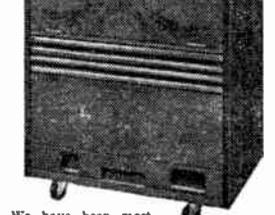
SURPLUS METER BARGAINS

We have large stocks of meters from 50 microamp to 500 v. and will be pleased to forward a complete list upon receipt of 3d. stamp.

METER RECTIFIERS. 1 ma. and 5 ma. each at 6/6. Brand new.

RETURN OF A WINNER !!!

(Exclusive)



We have been most fortunate in obtaining further limited supply of this fine and popular cabinet. Instantly recognised as being of leading High Quality manufacturer's stock, this trolley-type cabinet is finished in polished dark solid walnut. Can easily be adapted to accommodate tape recorder, amplifier, radiogram, etc. etc. External measurements: 24 1/2 in. x 18 in. x 29 in. The whole is mounted upon "easy run" castors. Unrepeatable at this price £25/19/6, plus 15/- P. & F.

SPECIAL PURCHASE from MINISTRY BRAND NEW No. 17 Mk. II TRANSMITTER/RECEIVER

Built into strong wooden cabinet 15 in. x 14 in. x 9 in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. Frequency coverage 44-61 mc/s. (5-7 metres). Uses 2 med. 120 v. H.T., and 2 volt L.T. batteries. Complete with full operating instructions. 59/6. Both plus 3/6 P. & F.

No. 17 Mk. II, as above, but secondhand, in good condition and complete. 45/-.

THE "ECONOMY FOUR" T.E.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: 6E7, 6J7 and 6V6. Chassis ready drilled. Cabinet size 12 in. long by 6 in. high by 6 in. 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 £51/0/- 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. Plus 2/6 packing and cart. for complete kit.

The R.E.P. 1-Valve RECEIVER. All dry battery operation. For use with headphones, the complete kit is available at 42/-, less battery, plus 2/- P. & F. or full instructions at 5d. post free.

GRAMOPHONE MOTORS are in SHORT

COLLARO AC 3/564; Three speed, single player for AC mains 200/250 v. Cream finish. Complete with turn-over crystal pick-up incorporating the well-known high output "T" type head. Strictly limited quantity at £20/19/6 plus 3/6 P. & F.

COLLARO 4-SPEED single record unit with separate pick-up and HGF69 crystal cartridge. Brand new, few only. £21/12/6 plus 3/6 P. & F.

FOUR-SPEED CHANGERS

Collaro R466 Mixer Auto-Changer in cream with Radio "40" insert. £29/19/6 plus 3/6 P. & F. H.P. Terms available. Stocks rapidly diminishing.

THE STAAR "GALAXY" Four speed Mixer Auto-Changer. Finger-clip stop, start and speed change control. Modern duo-tone finish. Beautifully made and moderately sized to fit almost any cabinet. For A.C. mains operation 110-250 v. Price £29/15/- inc P.T. STARR GALAXY complete with base £10/19/6 inc P.T. Both plus 3/6 P. & F.

RECORD PLAYER CABINETS—to suit all types of single record and autochanger units. Price from 45/- Send stamp for fully illustrated list.

PORTABLE GRAM AMPLIFIERS

EC1A. AMPLIFIER. A small high quality gramophone amplifier employing the latest circuitry and highly efficient miniature valves. Very neat chassis finished in bronze stove enamel. Size: (overall) 5 1/2 x 4 x 5 in. Valves 6X4, ECL82. Output 3 watts max. Con-tone. Volume. Tone/On/Off. For use on AC mains 200/250 v. Price £3/19/6 plus 2/- P. & F.

EC2A. Small PRINTED CIRCUIT single valve high gain amplifier for the smaller type of portable. Employs latest type EC120 valve. Further details on request. Price only 59/6 plus 2/- P. & F.

EC3A. A superior quality 3-valve amplifier employing E280, EL84 and EC283. With separate Bass and Treble controls. Further details on request. Price: £31/19/6 plus 2/6 P. & F.

EC4A (STALLION). This is supplied complete with high flux 8 in. P.M. Speaker and Baffle. Incorporating three octal type valves 6Q7, 6V6 and 6X5, this robust and well-made unit is ideal for use in the larger type of record player and is equally suitable for use in conjunction with a radio feeder unit. Separate bass and treble controls are provided; also provision is made for an extension speaker and mains supplies to gram. motor. Output approx. 4 watts. Size overall 13 1/2 in. x 4 in. x 9 in. high. For use on A.C. mains 100/200/250 v. PRICE £25/19/6 plus 2/6 P. & F. H.P. Terms £2/19/6 deposit and four monthly payments of 18/6 per month. Fits our portable cabinet "G" at 85/- without modification.

SPECIAL OFFER TRANSFORMERS AND CHOKES. These are beautifully made, potted transformers and chokes by a well known manufacturer, that will put the "finishing touch" to any equipment with which they are used. All are absolutely brand new.

- MAINS TRANSFORMERS (A) PRIMARY: 230 v. SECONDARY: 390-0-390 v. 150 mA. 2 v. 1.4 amp. 6.3 v. tapped 4.16 v. 9 amp. 4.12 v. 4 amp. 5 v. 2 amp. Size: 5 1/2 in. x 4 1/2 in. x 5 1/2 in. high. PRICE 45/-. (B) PRIMARY: 110, 200, 230, 250 v. SECONDARY: 350-0-350 v. 130 mA. 2 v. 1.4 amp. 6.3 v. tapped 4.16 v. 9 amp. 4.12 v. 4 amp. 4 v. 2.2 amp. Size: 4 1/2 in. x 5 1/2 in. x 5 1/2 in. high. PRICE 45/-. (C) PRIMARY: 200, 230, 250 v. SECONDARY: 390-0-390 v. 180 mA. 4 v. 2.2 amp. 4 v. 6.2 amp. Size: 5 1/2 in. x 4 1/2 in. x 5 1/2 in. high. PRICE 20/-. (D) PRIMARY: 200, 230, 250 v. SECONDARY: 290-0-290 v. 200 mA. 4 v. 2.2 amp. 6.3 v. tapped 4.2 v. 6.2 amp. Size: 5 1/2 in. x 4 1/2 in. x 5 1/2 in. high. PRICE 35/-. (E) PRIMARY: 110, 200, 230, 250 v. SECONDARY: 330-0-330 v. 100 mA. 4 v. 1.4 amp. 4 v. 9 amp. Size: 4 1/2 in. x 3 1/2 in. high. PRICE 17/6. (F) PRIMARY: 200, 220, 230, 250 v. SECONDARY: 6 v. 2 amp. 6 v. 2 v. 4 amp. 6 v. 3 amp. Size: 3 1/2 in. x 4 in. x 3 1/2 in. high. PRICE 15/-. (G) 40H. 50 mA. Size: 3 1/2 in. x 2 1/2 in. x 3 1/2 in. high. PRICE 10/6. (H) 10H 100 mA. Size: 2 1/2 in. x 2 1/2 in. x 3 1/2 in. high. PRICE 15/-. (I) 8H 100 mA. Size: 3 1/2 in. x 3 1/2 in. x 3 1/2 in. high. PRICE 12/6. (J) 6H. 150 mA. Size: 2 1/2 in. x 2 1/2 in. x 3 1/2 in. high. PRICE 10/-. (K) (Double choke) 3H. 60 mA. 4.5H. 30 mA. Size: 2 1/2 in. x 2 1/2 in. x 3 1/2 in. high. PRICE 5/-. (L) PRIMARY: 5K ohm. (suit 6V6 single ended, etc.). SECONDARY: 2.5-3 ohms. Size: 2 1/2 in. x 2 1/2 in. x 3 1/2 in. high. PRICE 10/-. VALVES. We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list of brand new imported valve types, fully guaranteed. P.T. price. Also all surplus types available such as 6V6GT, etc.

CONSTRUCTORS NOTE !! RADIO DATA BOOKS AVAILABLE, i.e. Valve guide, Colour code, etc. Send stamp for list.

CLYNE RADIO LTD. 18, Tottenham Court Road, London, W.1 And at 162, Holloway Road, London, N.7

SELENIUM BATTERY CHARGING EQUIPMENT

L.T. Types
 2/6 v. 1 a.h.w. 1/9
 6/12 v. 1 a.h.w. 2/9
F.W. Bridge
 6/12 v. 1 a. ... 4/11
 6/12 v. 2 a. ... 8/9
 6/12 v. 3 a. ... 11/9
 6/12 v. 4 a. ... 14/9
 6/12 v. 6 a. ... 19/9
 6/12 v. 10 a. ... 25/9
H.T. Type H.W.
 120 v. 40 mA. 3/9
 250 v. 50 mA. 5/9
 250 v. 80 mA. 7/9
 250 v. 150 mA. 9/9
 300 v. 250 mA. 12/11

ASSEMBLED CHARGERS
 6 v. 1 a. 19/9
 6/12 v. 1 a. 27/9
 6 v. 2 a. 29/9
 6/12 v. 2 a. 38/9
 6/12 v. 4 a. 56/9
 Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. and packing 3/6.

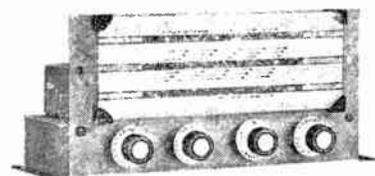
BATTERY CHARGER KITS
 Consisting of Mains Transformer F.W. Bridge. Metal Rectifier, well ventilated steel case. Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.
 6 v. or 12 v. 1 amp. ... 22/9
 6 v. 2 amps. ... 25/9
 6 v. or 12 v. 2 amps. 31/6
 6 v. or 12 v. 4 amps. 53/9
BATTERY CHARGER KIT
 Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and ammeter. Only 49/9. Post 3/-.

ASSEMBLED CHARGER
 6 v. or 12 v. 2 amps.
 Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only Carr. 3/6. **49/9**

All for A.C. Mains 200-250v., 50 c/s. Guaranteed 12 months
Assembled 6v. or 12v. 4 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. **75/-**
 Ready for use with mains and output leads. Carr. 3/9. Or Deposit 30/- and four monthly payments 13/-.



AM/FM RADIOGRAM CHASSIS. HIGH QUALITY. PUSH PULL. 6-8 WATTS OUTPUT

Current manufacture. 12 months' guarantee. For 200-250 v. mains. Covers L and M. Wavebands plus F.M. Includes 8 latest type miniature B.V.A. valves. Only 22 gns. plus 7/6 carr. Or deposit £2/12/- and 9 monthly payments of £2/12/-. Guaranteed 12 months.

CO-AXIAL CABLE. 75 ohms. 1/2 in., 8d. yard. Twin screened feeder 11d. yard.

ELECTROLYTICS (current production) Not Ex-Govt.

Tubular Types		Can Types	
8 mfd. 450 v.	1/9	16µF 450 v.	2/9
8 mfd. 500 v.	2/6	16 mfd. 500 v.	3/9
16µF 450 v.	1/11	32µF 350 v.	2/11
16µF 450 v.	2/9	100 mfd. 450 v.	4/9
16µF 500 v.	3/9	8-8µF 450 v.	2/11
8-16µF 500 v.	4/11	8-16µF 450 v.	3/11
25µF 25 v.	1/3	16-16µF 450 v.	3/11
50µF 12 v.	1/3	32-32µF 350 v.	4/9
50 mfd. 25 v.	1/9	32-32µF 450 v.	5/9
50µF 50 v.	1/9	100-100 mfd. 350 v.	5/9
100 mfd. 12 v.	1/9	64-120 mfd. 350 v.	7/6
100 mfd. 25 v.	2/3	v.	
3,000 mfd. 6 v.	3/9	100-200 mfd.	
6,000 mfd. 6 v.	3/11	275 v.	6/11

Many others in stock.

VOLUME CONTROLS with long spin dials, all values, less switch, 2/9; with S.P. switch, 3/9.

EX GOVT. STEP UP/STEP DOWN TRANSFORMERS. Double wound 80/100 watts. 10-0-100-200-220-240 v. to 5-0-75-115-125-135 v. or Reverse. Only 11/9, plus 2/9 post. 10-0-100-200-220-240 v. to 9-0-110-122-136-148 v. or Reverse. 200 watts, 35/9, plus 7/6 carr.

EX GOVT. METAL BLOCK PAPER CONDENSERS
 4 mfd. 500 v. 2/3 8 mfd. 500 v. 4/6
 4 mfd. 1,000 v. 3/9 10 mfd. 500 v. 3/9

THE SKY FOUR R.F. RECEIVER



A design of a 3 valve 200-250 v. A.C. Mains L. & M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type.

It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

EX GOVT. VIBRATOR UNITS. 12 v. input 280 v. output. Suitable for car radio, etc., 16/6.

VIBRATORS. Oak and Wearite. Synchronous 7 pin 2 v. 7/9, 6 v. 8/9.

EX. GOVT. 50 WATT AMPLIFIERS. Brand new. For normal 200-250 v. 50 c.p.s. A.C. mains. Designed for speech only but with suitable pre-amp. could be used with Gram. or Radio. Valves included. Four 6L6; used for output. Complete with hand microphone with good length of lead. Unused in original transit cases. Only 9gns. Ready for use. Carr. 15/-.

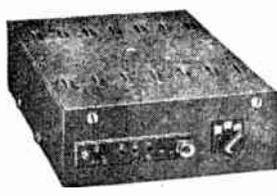
RE-ENTRANT SPEAKERS, 8 watt, 7.5 ohms suitable for above, 25/- each.

5 CORE FLEX. Henleys circular rubber 14/36. Each lead colour coded. 1/6 yard.

EX GOVT. MAINS TRANSFORMERS
 All 200-250 v. 50 c/s input.
 120-0-120 v. 40 mA. 5/9
 250-0-250 v. 60 mA., 6.3 v. 3 a., 6.3 v. 1 a. Potted 4/-31-3in. 11/9
 Pr. 0-110-200-230-250 v. 275-0-275 v. 100 mA., 6.3 v. 7 a., 5 v. 3 a. 18/9
 230-0-230 v. 80 mA., 12.6 v. 1.5 a. 5 v. 2 a. 11/9
 400-0-400 v. 250 mA. 5 v. 2 a., 5 v. 2 a. 18/9
 12.5 v. 3 a., 5 v. 3 a. 12/9

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator Size 5 1/2 x 4 1/2 x 2in approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram. 39/9 or ready for use 46/9.



Type BM2. Size 8 x 5 1/2 x 2 1/2in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions, 49/9, or ready for use, 59/6

JUNCTION TRANSISTORS For R.F. 17/6.

MINIATURE MOTORS. 24/28 v. D.C. or A.C. Size only 2 1/2 x 1 1/2in. Spindle 1 1/2in. long, 1/2in. diam. Made by Hoover Ltd., Canada. Price only 9/9.

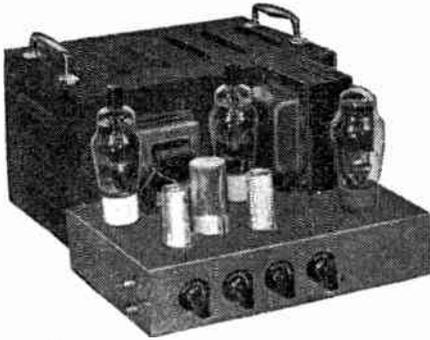
M.E. SPEAKERS. 2-3 ohms R.A. 8in. Field 600 ohms., 11/9.

R.S.C. TRANSFORMERS

FULLY GUARANTEED.		INTERLEAVED AND IMPREGNATED.	
MAINS TRANSFORMERS Primaries 200-230-250 v. 50 c/s.		FILAMENT TRANSFORMERS Primaries 200-250 v. 50 c/s.	
FULLY SHROUDED UPRIGHT MOUNTING			
250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a.	17/6	6.3 v. 1.5 a. ...	5/9 6.3 v. 3 a. ... 8/11
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	19/9	6.3 v. 2 a.	7/6 6.3 v. 6 a. ... 17/6
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9	0-4-6.3 v. 2 a.	7/9 12 v. 3 a. or
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	31/-	12 v. 1 a.	7/9 25 v. 1.5 a. 17/6
200-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9	CHARGER TRANSFORMERS All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1 1/2 a., 11/9; 0-9-15 v. 3 a., 16/9; 0-3.5-9-17 v. 3 a., 17/9; 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.	
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9	OUTPUT TRANSFORMERS Midget Battery Pentode 66:1 for 3S4, etc. 3/6 Small Pentode 5,000Ω to 3Ω 3/9 Standard Pentode, 5,000Ω to 3Ω 4/9 Standard Pentode, 8,000Ω to 3Ω 4/9 Push-pull 8 watts 6V6 to 5 ohms 8/9 Push-pull 10-12 watts 6V6 to 3Ω or 15Ω 15/9 Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω 16/9 Push-pull EL84 to 3 or 15 ohms 16/9 Push-pull 15-18 watts, sectionally wound, 6L6, KT65, etc., to 3 or 15 ohms. 21/9 Push-pull 20 watt high-quality sectionally wound, 6L6, KT65, etc., to 3 or 15Ω 47/9	
300-0-300 v. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a., suitable for Mullard 510 Amplifier	33/9	SMOOTHING CHOKES 250 mA., 5 H., 100 ohms 11/9 150 mA., 7-10 H., 250 ohms 11/9 100 mA., 10 H., 200 ohms 8/9 80 mA., 10 H., 350 ohms 5/6 60 mA., 10 H., 400 ohms 4/11 1 amp. 0.5 ohm. L.T. type 6/6	
375-0-375 v. 150 mA., 6.3 v. 4 a., 5 v. 2 a.	29/9		
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		
TOP SHROUDED DROP-THROUGH TYPE			
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9		
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9		
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	22/9		
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9		
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9		
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9		
ELIMINATOR TRANSFORMERS Primaries 200-230 v. 50 c/s.			
120 v. 40 mA., 5-0-5 v. 1 a.	14/9		
90 v. 15 mA., 6-0-6 v. 250 mA.	9/11		

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

NEW 1957 DESIGN, HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams. Cover as illustrated



Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 29 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B., 30-20,000 c/s., Tone Controls ± 12 D.B. at 50 c/s., + 12 D.B. to - 6 D.B. at 12,000 c/s., Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 x 9 x 9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc.,** Microphones, Speakers, 12 v. Rotary Converters, etc., at keen cash prices or on terms with amplifiers.

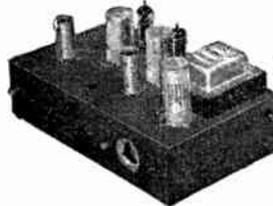
£10/19/6

Only 12 months' guarantee. **TERMS ON** etc. We can supply Microphones, Speakers, 12 v. Rotary Converters, etc., at keen cash prices or on terms with amplifiers. **EXPORT ENQUIRIES INVITED**

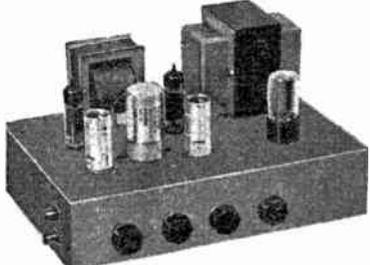
LT/45 HIGH QUALITY TAPE DECK AMPLIFIER

COMPLETE WITH POWER PACK and OSC. STAGE. Suitable for Collaro, Lane, Truvox, Asplen, Brennell, etc., etc. State make of Deck when ordering. Chassis size 13-7-3in. Overall size 13-7-6in. For 200-250 v. 50 c/s. A.C. mains. Output for standard 2-3 ohm speaker. Only 18 millivolts input required for full recording. Only 2 millivolts minimum output required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Negative feedback equalisation. Linear frequency response ± 3 D.B. 60-11,000 c/s. Facilities for recordings at 15in. 7 1/2in. or 3 1/2in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. Separate gain and output controls. Valve type ECC83 ECC83, EL84, E280 EM34. Output 4 watts Unit supplied with maker's 12 months' guarantee. We know of no other make which represents the same exceptional value. Leaflet 6d. Request Offer Collaro Deck, LT/45. 6in. speaker, and Studio "Mike" 29 gm. Carr. 10/-

12 GNS.



ALL ULTRA LINEAR 12-14 WATT AMPLIFIER



NEW 1957 DESIGN HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL PRE-AMP. STAGES

Two input sockets with associated controls allow mixing of "mike" and gram, as in A10. High sensitivity. Includes 5 valves, R0C33, ECC83, EL84, EL84, 6Y3. High quality sectionally wound output transformer, specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE** "Lift" and "Cut" Frequency response ± 3 DB 30-30,000 c/s. Six negative feedback loops. Hum level 60 DB down. ONLY 25 millivolts INPUT required for FULL OUTPUT. Suitable for use with all m.k.s. and types of pick-ups and microphones. Comparable with the very best designs. For STANDARDS or LOU3 PLATING RECORDS. For MUSICAL INSTRUMENTS such as STRIKE BASS, GUITAR, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx. 12-9-7in. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohm speakers. Kit is complete to last unit. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Despite improved performance due to use of latest miniature valves price remains as previous model but extra input now standard.

Only 8 GNS.

or factory built 45/- extra. If required loathed metal cover with 2 carrying handles can be supplied for 18/6. **TERMS ON ASSEMBLED UNITS. DEPOSIT 25/- and nine monthly payments of 25/6.**

LINEAR "DIATONIC" 10-WATT HIGH FIDELITY AMPLIFIER. Incorporating pre-amp. For A.C. mains input 200-250-250 v. 50 c/s. A compact attractively finished unit with two separately controlled inputs, and outputs for 3 and 15 ohm speakers. Separate Bass and Treble controls. Five latest type miniature Mullard valves. Only 18 Gns. Send S.A.E. for leaflet and circuit terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. 12in. 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. **£4/10/6.** Please state whether 3 ohm or 15 ohm required.

P.M. SPEAKERS 2-3 ohm 5in. Goodmans 17/6. 7 x 4in. Elliptical 19/9. 6in. Rola, 19/9. 8in. Rola, 19/9. 8in Goodmans 21/9. 10in. R.A., 28/9. 10-6in. Elliptical 28/9. 12in. Plessey 39/11. 12in. Plessey 3 ohms, 10 watts, 19,000 lines, 59/6.

SUPERNET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (especially suitable for use with any of our Amplifiers). A Triode Heptode Pick-up is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch., and Vol. Output will load most Amplifiers requiring 500 mV. input depending on A.C. location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-4-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is 24/15/-. Point-to-point wiring diagrams and instructions, 8/6.

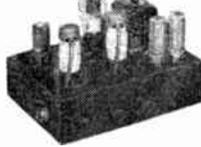
RECORDING TAPE. 1,200ft. Reos Puretone Medium Coercivity 15/8.

COLLARO JUNIOR 4 SPEED RECORD PLAYER with separate pick-up having dual magnetic stylus. Brand new, cartoned. For 200-250 v. A.C. mains only **£4/17/6.** Carr. 3/6.

L93 MINIATURE 3 WATT GRAM. AMPLIFIER For 200-250 v. 50 c.p.s. A.C. Mains. Overall size only 6 1/2 x 4 1/2 x 3 1/2in. Fitted vol. and Tone Control with mains switch. Designed for use with any kind of single player or record charging unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only **49/8.** Carr. 3/6.

R.S.C. AS 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250-250 v. 50 c/s. Output for 3-8 ohm speaker. Chassis is not active. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-**, or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.



R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for long playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 30 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only **£3/15/-**, carr. 3/6 or factory built 22/6 extra. Or Deposit 18/6 and five monthly payments of 18/6 for assembled unit.

COLLARO RC457 4 SPEED AUTO-CHANGER With studio pick-up with turnover head. BRAND NEW. Cartoned, latest model. For 200-250 v. 50 c.p.s. A.C. mains. Very limited number at only **£8/19/6.** Carr. 5/6.

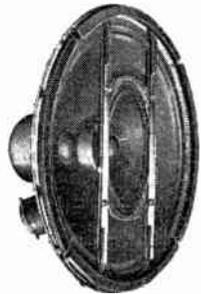
COLLARO RC54 3 SPEED AUTO-CHANGER

As above unit but for normal 3-speed requirements. Brand new cartoned but for 110 v. 50 c.p.s. A.C. mains. So that the unit can be operated from normal 200-250 v. A.C. mains we are supplying free with every changer a suitable auto-transformer with input and output voltages clearly marked. Limited number only. 7 gm. Carr. 5/6.

PORTABLE CABINETS. Exceptionally attractive design. Finished in 2 tone reds. Provision for speaker and amplifier. Inside dimensions 17 1/2 x 12 1/2in. **59/6** Depth 7 1/2in. plus lid 1 1/2in. Carriage 5/-.

LINEAR L45 MINIATURE 4 1/2 W. QUALITY AMPLIFIER. Suitable for use with Garrard, B.B.H. or any other record playing unit and most microphones. Total negative feedback 12 DB. Separate Bass and Treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves used. Size only 4 x 5 x 5 1/2in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£3/19/6.** Or Deposit 22/- and five monthly payments of 22/- Send S.A.E. for leaflet.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS



(15 ohms, consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as a tweeter. The high fidelity unit is highly recommended for use with our All or any similar amplifier. Rating is 16 watts. Price only **£5/17/6.** Or Deposit 13/- and nine monthly payments of 13/-.

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS, 2.

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2. 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5d. Open to Callers: 9 a.m. to 5.30. p.m. Saturday until 1 p.m. S.A.E. please with all enquiries.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

JOHNSON TX. CONDENSERS

Brand new and boxed, 500pf. variables, 15/6. P/P. 1/-. Also new, boxed 2 1/2 in. variable inductances by Johnson, 22/6. P/P. 2/6.

**HIGH RESISTANCE HEAD-
PHONES.** Brand new, boxed. S.G. Brown's, (ex-gov.) 4,000 ohms, 12/6 pr. P/P. 1/6.

MUIRHEAD VERNIER DRIVES. Brand new, 7/6. P/P. 1/-.
**R.1155 COMMUNICATION
RECEIVERS.**

R.1155 COMMUNICATION RECEIVERS.

New issue, in new condition fitted with super slow motion drive. Supplied thoroughly checked and reception tested, £8/19/6 each. P/P. 6/-.

HEAVY DUTY "C" CORE TRANSFORMERS. Input 230 volts. Outputs S10/0/510v. 300ma., 375/0/375v. 100ma. 6.3v. 9a., 2X6.3v. 2a., 2X6.3v. 1a., 6.3v. 1.5a., 6.3v. .5a. 5v. 3a. Brand new, 82/6. P/P. 5/-.

AR.88 WAVECHANGE SWITCHES. Spare for Model D. Ceramic, 8 bank, 6 pos. complete with all screens. Brand new, 17/6 each. P/P. 3/6.

FURZEHILL CRYSTAL CALIBRATORS.

Circuit incorporates 6 valves and 1mc/s. crystal, giving pips at 10,100 and 1,000kc/s. Built-in modulator, battery operated, 2v. and 120v. Supplied brand new and boxed, 59/6. P/P. 3/6.

TAPPED LT. TRANSFORMER. Input 200/250 volts. Output tapped, 3, 6, 9, 12, 24 or 36 volts 5 amps, 35/- each. P/P. 3/-.

WELDING TRANSFORMER. Input 230 volts. Output 17.5 volts 35 amps. New, 72/6 each. P/P. 5/-.

LT. TRANSFORMER BARGAIN. Input 200/250 volts. Output 12 volts 5 amps. New, 12/6 each. P/P. 2/-.

MUIRHEAD STUD SWITCHES.

Brand new and boxed. 4 banks, each bank 24 position. Heavy duty contacts. Only 17/6 each. P/P. 1/6.

R.1155 SUPER SLOW MOTION DRIVES. Improved version as fitted to models L and N. Suitable for Model A etc. Brand new, 12/6 each. P/P. 1/-.

AVO MODEL 7 MULTIPLIERS. Extended 1000 volt range to 4000 volts new and boxed 5/6. P/P. 1/-.

W.1191 WAVEMETERS.

Portable battery operated frequency check meters, frequency coverage 100kc/s to 20mc/s in 8 switched bands, directly calibrated on vernier scale. Circuit incorporates a 1mc/s. crystal. Supplied in first class condition, £5/19/6 each. P/P. 6/-.

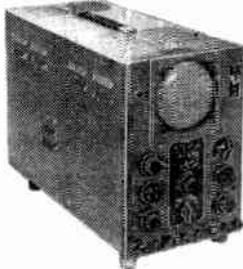
ROTARY CONVERTORS. Input 24 volts D.C. Output 230 volts A.C. 50 cycles, 100 watts. Supplied unused, 92/6 each. P/P. 5/-.



CRYSTAL MICROPHONE INSERTS

Sensitive, ideal for tape recorders, amplifiers, etc., 4/6 each. P/P. 6d.

COSSOR DOUBLE BEAM OSCILLOSCOPE TYPE 339



Operation 110/200/250 volts A.C. 120 watts. Time Base 10 positions. 6 cps. to 250,000 cps. Amplifier 10 cps. to 2,000,000 cps. Sensitivity, Y1.Y2.3.1 v. D.C. 1.1 v. rms. X. 2.25 v. D.C. .8v. rms. Supplied in good working order, £27/10/- each. P/P. £1.

MARCONI TF-643 U.H.F. WAVEMETERS. Frequency coverage 20 to 300mc/s. in 4 bands. Accuracy 1% up to 150mc/s. and 2% above. Supplied in perfect condition with all coils and calibration charts, £19/10/- each. P/P. 6/-.

RCA. ET.4336. PLATE TRANSFORMERS.

Special release, brand new in original makers' transit cases. Primary tapped 200 to 250 volts 50 cycles. Secondary 2000/0/2000 volts 400ma., tapped 1500/0/1500 volts. Price £12/10/- each. P/P. £1.

AUDIO BEAT FREQUENCY OSCILLATORS.

Frequency coverage 0 to 10kc/s. with separate 50 cycle check point. Output impedance 10 or 600 ohms. Built-in monitoring voltmeter. Operation 110/200/250 volt A.C. Not new but supplied in good working order, £9/19/6 each. P/P. 10/-.

SPECIAL OFFER

BRAND NEW AMERICAN/CANADIAN No. 19 Mk. II TRANSMITTER-RECEIVERS.

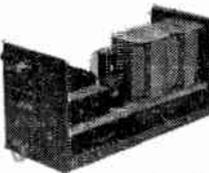


Complete with all valves. Frequency coverage 2 to 8 mc/s, 65/- ea. P/P. 10/-.
Limited number only available.

HEAVY DUTY MAINS ISOLATING TRANSFORMERS. Specifications—Primary 230 volts 3 amps. Secondary 230 volts 3 amps. (service rating, OK 5 amps.). Ideal for laboratory or workshop use. Supplied brand new in original transit cases. £6/10/- each. P/P. 10/-.

MAINS VOLTAGE REGULATOR TRANSFORMERS. For A.C. mains 50 cycles. Will give a variable output from 185 volts to 250 volts at 24 amps, £15 each. P/P. 10/-.
Smaller type available 200/240 volts 7.5 amps, 87/6 each. P/P. 5/-.

EDDYSTONE MAINS POWER PACKS



Supplied brand new and unused. Mains input 200/250 volts. Output 175 volts 60ma. and 12 v. 2.5a. Double choke and condenser smoothed. S24 rectifier. Housed in grey metal case. Only 32/6 each. P/P. 3/6.

EX-NAVY SOUND-POWERED TELEPHONES. This type requires no batteries to operate and can be fitted in moments to give complete inter-communication between two points. Hand generator calling. Only 45/- each. P/P. 4/6.

"C" CORE E.H.T. TRANSFORMERS. All new and unused. Input 230 volts. Type 1. Output 3850v. 5ma. 4v. 2.5a. 4v. 1a., 52/6. P/P. 3/-.
Type 2. 1250/0/1250v. 5.5ma. 6.3v. 1a. 6.3v. 1a. 4v. 1a., 42/6. P/P. 2/6.

6 VOLT VIBRATOR PACKS. Output 120 volts 30ma. Fully smoothed, uses standard Mallory 4-pin vibrator, new and boxed, 12/6 each. P/P. 2/6.

MIDGET RECORDER MOTORS. Size 1 1/2 x 1 x 2 1/2 in. Operates from 4.5 to 24v. D.C. Fitted with reduction gear. New and boxed, 12/6 each. P/P. 1/-.

12 VOLT MIDGET ROTARY TRANSFORMERS. Type H.T.11., size 4 1/2 x 2 1/2 in. Output 310/360 volts 30ma. New and boxed, 22/6. P/P. 1/6.

FERRANTI POTTED FILAMENT TRANSFORMERS. Hermetically sealed, ceramic terminations. All new and boxed. Type 1, 200/250v. input. Output 6.3v. CT. 5.6a., tapped 5v. 6.3v. CT. 4.8a. tapped 4v. 6.3v. CT. 1a. tapped 4v., 19/6 each. Type 2. Input 200/250v. Outputs, 6.3v. CT. 3.3a. tapped 5v. 6.3v. CT. 1a. tapped 4v. 6.3v. C.T. .9a. 6.3v. CT. .6a, 15/6 each. P/P. 2/- each type.

300FT. COPPER AERIAL WIRE. Ex-U.S.A. dinghy aerial, 3/6. P/P. 1/-.

RCA. OUTPUT TRANSFORMERS.

Completely potted. Centre-tapped primary, 8000 ohms. Secondary tapped, 3, 7.5, 15 or 600 ohms. Separate feedback winding. 15 watts rating. Suitable for 6L6, EL84 etc., unused, 27/6 each. P/P. 2/-.

P/O JUMPER LEADS. 4ft. twin screened lead fitted with 2 standard P/O jack plugs, 3/- P/P. 6d. Panel jacks to suit, 9d.

12 VOLT D.C. MOBILE AMPLIFIERS. Ex-Admiralty. Separate mic. or gram inputs. Output 10 watts, matched to 3, 15 or 600 ohms. Supplied in good working order, £8/19/6 each. P/P. 5/-.

AMERICAN SUPER LIGHTWEIGHT HEADPHONES.

Res. 50 ohms. Fitted with rubber earmoulds to fit inside the ear. Extremely good quality, ideal for communication receivers, etc. New and boxed, 15/- pair. P/P. 1/-.

HEAVY DUTY SLIDER RESISTANCE. 1 ohm 12 amp, 6/6. P/P. 1/-.

MINIATURE H.T. TRANSFORMER. Input 220/240v. Output 220v. 25ma. 6.3v. 1a. new, 10/6 each. P/P. 1/-.
Midget contact rectifier to match, 7/6.

AMERICAN ROTARY TRANSFORMERS. Models available for either 6 or 12 volt D.C. input. Output 250 volts 80ma. Ideal for car radios or razors etc., new and unused, 22/6 each. P/P. 3/-.

AMERICAN GEARED MOTORS



Shaft dia. 1/4 in. P/P. 3/-.

American 24 volt D.C. motor with built-in precision gearbox giving twin outputs 20 r.p.m. and 6 r.p.m. Will also operate on 12 v. giving reduced outputs. Size 7 in. x 1 1/2 in. Supplied brand new only.

19/6 each.

SPECIAL OFFER OF MULTI-RANGE TESTMETERS

THE WESTON 772 A.C./D.C. TESTMETER. Sensitivity 1,000 ohms per volt, basic movement 50 microamps. 5 resistance ranges 100 ohms to 10 megohms. 5 A.C. or D.C. volt ranges, 2.5 to 1,000 volts. 5 D.C. current ranges 1,000 microamps to 500 ma. 3 A.C. current ranges, .5 to 5 amps. Supplied in perfect working order in rexine-covered carrying case, £10/10/- P/P 4/-.

THE FAMOUS AVO MODEL "D" TEST-METER. Another of the large series AVO meters. Incorporates 2 resistance ranges, 1k. and 10k. ohms. Can be extended by using external batteries). 5 D.C. volt ranges, .15 to 1,500 volts. 4 A.C. volt ranges, 7.5 to 1,500 volts. 4 D.C. current ranges, .015 amp. to 30 amps., 3 A.C. current ranges .075 amp. to 15 amps. Supplied in perfect working order, £8/19/6 each. P/P 4/-.

THE POPULAR UNIVERSAL AVOMINOR TESTMETER. A small and compact highly accurate instrument. Resistance measurements from 0 to 20k. ohms. D.C. voltage 0 to 500 volts. A.C. voltage 0 to 500 volts. D.C. current 0 to 500 ma. Supplied in perfect working order. Complete with leather carrying case and leads, £5/10/- each. P/P. 2/6.

SMOOTHING CHOKE BARGAINS. 10H. 60ma., 4/6; 15H. 60ma., 5/6; 8H. 100ma., 8/6; 9H. 100ma., 7/6; 10H. 100ma., 8/6; 5H. 200ma., 5/6; 20H. 120ma., 10/6; 50H. 120ma., 15/6; Swinging choke 3.6-4.2H. 250ma., 10/6. P/P. 1/- to 2/6.

CHEAP LOUDSPEAKERS. All new and unused, 3 ohm coils. Plessey, 2 1/2 in., 16/-; Elac, 6 1/2 in., 17/6; Elac, 5 in., 17/6; Goodmans 3 1/2 in., 17/6; Elac, 8 in., 19/6; Elac, 10 in., 27/6; Plessey 12 in., 32/6; Elac, 7 x 4 elliptical, 18/6; Plessey, 10 x 6 in. elliptical, 27/6; Postage 1/6.

DYNAMO EXPLODER UNITS. Used for detonating explosive charges. Operation is by hand generator, giving 1,800 volts across output terminals. Ideal also as photo flash. Brand new, only 29/6 each. P/P. 3/-.

G.E.C. SELECTEST MULTI-RANGE METERS. Basic movement 1 ma., ohms 0-1 megohm. D.C. volts .15 to 1,500 volts. A.C. volts 7.5 to 1,500 volts. A.C. current 75 ma. to 15 amp. D.C. current 1.5 ma. to 30 amp. Supplied in good working order. £9/19/6 each. P/P. 4/-.

METER BARGAINS

50 microamp 2 1/2 in. FM. M.C.	59/6
50 microamp 2 1/2 in. Pj. M.C.	49/6
100 microamp 2 1/2 in. FM. M.C.	39/6
200 m/amps. 2 1/2 in. FM. M.C.	9/6
1 amp. RF. 2 1/2 in. Pj.T.C.	5/-
300 volt A.C. 2 1/2 in. FM. M.I.	25/-
1.5 amp. A.C./D.C. 2 in. FM. M.I.	6/6
2 m/a. meter rectifier, STC	5/6

CHARGING AND MODEL TRANSFORMERS.

1. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 1 amp., 9/9.
2. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 2 amp., 14/3.
3. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 4 amp., 16/6.
4. Pri. 200/250 v. Sec. 6.3 v. 3 amp., 8 v. 1.5 amp., 9/6.
5. Pri. 200/250 v. Sec. tapped, 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volt 2 amp., 18/6. Postage 1/6 all types.

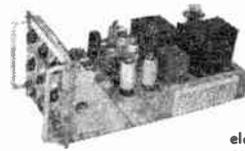
L.T. METAL RECTIFIERS. Full wave and bridged. 12 v. 1 amp., 6/3; 12 v. 2 amp., 9/3; 12 v. 4 amp., 13/9; 24 v. 1 amp., 12/6; 24 v. 4 amp., 22/6; 36 v. 4 amp., 27/6. P/P 1/- all types

PORTABLE PRECISION VOLTMETERS



Brand new and boxed instruments by famous manufacturer housed in polished teak case. Moving iron movement reading A.C. or D.C. volts on 2 ranges. 0-160 and 0-320 volts. 8 in. mirror scale. Accuracy within 2%.

Supplied at a fraction of original cost, only £5/19/6 each. P/P. 4/6.



ponents including switches, pots, condensers, resistors, etc. Supplied brand new with covers.

SPECIAL REDUCED PRICE 39/6 each P/P. 7/6

MODULATOR 67

A wonderful complete A.C. mains power pack containing the following components. Transformer 350/0/350 v. 200 ma. 6.3 v. 6 a. 5 v. 3 a. Input 230 v. 200 ma. choke, 5Z4 rectifier. Paper and electrolytic smoothing condensers. 11 other useful valves. Hundreds of components including switches, pots, condensers, resistors, etc. Supplied brand new with covers.

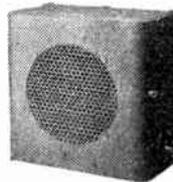
EDDYSTONE MAINS POWER PACKS S.441B. Supplied brand new and unused. Input 200/250 volts Output 300 volts 200ma. and 12 volts 3 amps Double choke and condenser smoothed, 5U4 rectifier Housed in grey metal case, fully fused, indicator etc. Only 49/6 each. P/P. 6/-.

AMERICAN BEACON TRANSMITTER, RECEIVERS

RT 37/PPN-2. Brand new and boxed, complete with instruction book. Equipment comprises transmitter/receiver with 9 valves (5 3A5, 3 1SS and 1 IRS), with built-in 2 v. vibrator power pack, spare vibrator, head-set connector leads and 10ft. collapsible aerial. Frequency coverage 214/238 Mc/s. Price 72/6 each. P/P. 6/-.

EDDYSTONE SPEAKER UNITS

Wonderful offer. All brand new and boxed 6 1/2 in. speaker fitted in grey metal case. Standard 3 ohm coil, built-in volume control and matching transformer for 600 ohm line. Ideal for all type receivers. Only 27/6 each. P/P. 2/6.



MARCONI SIGNAL GENERATOR TF144G

The famous laboratory standard. Frequency coverage 85kc/s. to 25mc/s. Output voltage from 1 microvolt to 1 volt. Operation 200/250 volts A.C. Offered reconditioned as new and guaranteed to be within original makers' specification, a certificate issued with each individual instrument. Price only £65 each. Carriage £1.

HEAVY "C" CORE H.T. TRANSFORMERS.

- Type 1 Input 230 volts Output 360/0/360 volts, 200 m/a. 360/0/360 volts 65 m/a. 6.3 v. ct. 5 a., 6.3 v. ct 2 a., 6.3 v. 5 a., 5 v 4a., 5v. 3 a. 65/- each P/P. 4/6.
- Type 2. Input 230 volts. Output 350/0/350 volts, 400 m/a., 25 v. 1 a., 21 v. 5 a., 6.3 v. 5a. 6.3v. 1a., 5 v. 4 a., 75/- each. P/P 4/6
- Type 3. Input 230 volts Output 450/0/450 volts 250 m/a., 2 x 6.3 v. 5 a., 2 x 6.3 v. 1 a., 5 v. 4 a., 69/6 each. P/P. 4/6.

"C" CORE H.T. TRANSFORMERS. Input 230 volts. Output 450/0/450 v. 220 m/a., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a., 59/6 each. P/P. 4/-.

CAMBRIDGE INSTRUMENTS CURRENT TRANSFORMERS. Input 50 cycles, 300, 150 or 75 amps. Output 15 amps. Brand new and boxed, £4/19/6 each. P/P. 4/-.

MAINS NEON PANEL INDICATORS. 200/250v Chrome escutcheon. Red amber green or clear, 3/9 each. P/P. 3d.

AMERICAN MINE DETECTORS. Type SCR-625c. Battery operated, portable and complete with instruction book. Ideal for detecting all types of metals. £12/10/- each. P/P. 10/-.

MINIATURE SLOW MOTION DRIVES. Dia 1 1/2 in. 180deg. scale calibrated 0-100. For 1/2 in. spindles. New and boxed 7/6 each. P/P. 1/-.

CHEAP PLASTIC RECORDING TAPE. 1,200 ft. by famous manufacturer on 7 in. universal spool, only 19/6 each. Brand new and boxed. P/P. 1/6.

INSTRUMENT POTENTIOMETERS. Brand new Colvern type. 100,000 ohms, 10 watts, 3 1/2 in. dia. Ideal for bridges, etc., 10/6 each. P/P 11/-.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS. Input 190 to 260 volts, A.C. 500 cycles. Output constant at 230 volts. Max. rating 150 watts. Supplied brand new in original crates, £8/10/- each. P/P. 5/-.

BARGAIN GRAM MOTORS. Garrard centre-drive motors complete with turntables. 200/250 volt A.C. Adjustable mechanically from 0 to 45 r.p.m. Only 22/6 each. P/P. 3/-.

0-1 MA. METERS



Brand new moving coil meters, round flush mounting with 2 1/2 in. scale calibrated 0/300 volts. Resistance 100 ohms. Supplied complete with rectifier, 25/- each. P/P. 1/-.

BENDIX COMMAND TRANSMITTERS. Complete with all valves and crystal. Frequency coverage 2.1 to 3 mc/s. Only 22/6 each. P/P. 3/-.

SPECIAL OFFER OF MARCONI SIGNAL GENERATORS TFS17.

Frequency coverage 16 to 58 mc/s. and 130 to 260 mc/s. Operation 200/250 volts A.C. Supplied in perfect condition at the ridiculous price of £12/10/- each. Carriage £1.

G.W. SMITH & CO (RADIO) LIMITED
 Phone: GERRARD 8204/9155
 Cables: SMITHEX LESQUARE
 3-34 LISLE STREET, LONDON, W.C.2



02A	5/6	6X4	7/6
1A3	3/6	6X6	7/6
1A5GT	6/-	6X5G	7/6
1A7	12/6	AC6/PEN	6/6
1C2	9/6	8X5GT	7/6
1H9GT	10/6	6J50L2	12/6
1L4	6/6	7B7	8/6
1LD6	3/6	7C5	8/-
1N6	10/6	7C8	8/-
1B5	8/-	7H7	9/-
1B4	10/6	7Q7	7/6
1R6	7/6	7F6	9/6
1T4	7/6	7Y4	8/6
2P	15/-	75	11/6
2X2	4/6	77	8/-
2A4	7/6	89	8/6
2D6	5/6	897	6/6
2Q4	9/6	8D2	2/9
2Q5	9/6	0D2	3/9
2S4	8/-	10C2	27/10
3V4	9/-	10P13	24/4
4D1	3/-	10F14	20/2
4T8	10/6	11D5	8/-
4T	8/-	9041	5/6
5B4GY	9/6	9002	5/6
5U4G	8/-	9003	5/6
5Y90	8/-	9004	5/6
6Y90G	8/-	9005	5/6
5Z4G	10/-	954	5/6
6A7	13/-	955	4/9
6A9B	10/-	956	3/6
6AC7	6/6	12A6	6/6
6AG6	5/6	12A8	11/6
6AK5	5/6	12B7	10/6
6AK7/6AG7	9/6	12A7T	8/6
6A7.5	6/6	12A7U	7/6
6AM6	9/6	12AX7	8/6
6AQ5	7/6	12BA6	9/-
6AT6	8/6	12BE6	9/6
6AU6	10/6	12BH7	11/6
6B1	5/-	12C8	7/-
6B8G	4/6	12H6	3/-
6BA6	7/6	12J6	4/6
6B2	8/-	12K7	10/-
6B2T	11/6	12K8	9/-
6B7	13/-	12K8	13/-
6BWS	8/6	12Q7	9/6
6B7W	10/-	128C7	2/6
6C4	7/6	128G7	7/6
6C3GT	6/6	128H7	8/6
6C5	5/-	128J7	5/6
6C7E	7/6	128K7	6/-
6D6	5/-	128L7	8/-
6F1	13/6	128Q7	8/6
6F9B	7/6	128R7	7/6
6F9M	7/6	128T7	10/6
6F13	14/-	14B7	14/6
6F23	6/6	15D2	7/9
6F15	14/-	20D1	16/-
6G6G	4/6	20P2	24/4
6H6	2/6	20P1	24/4
6J5G	5/6	20P2	13/6
6J5GT	5/6	20P5	11/6
6J5M	5/6	25A6G	20/2
6J6	6/6	35LGT	9/6
6J7G	6/-	25Y6	9/6
6K9GT	7/6	25Z4G	8/6
6K7	6/6	25Z5	9/-
6K9	8/6	25Z6G	10/-
6K9GT	9/6	25Z9GT	9/6
6K25	20/11	27B1	20/11
6L6G	9/-	30F5	12/6
6L7	9/6	30F11	12/6
6N7	7/-	30P4	15/-
6P25	13/6	35LGT	9/6
6Q28	27/10	35W4	9/-
6Q70T	9/-	35Z4GT	3/-
6S47GT	8/-	35Z5	9/-
6S07	7/6	41MXP	5/-
6S7	6/6	50C5	11/6
6S7.7	8/6	60L6GT	3/6
6S7.7	8/6	142BT	3/6
6S7.7	8/6	210DDT	5/6
6S7.7	8/6	210VPT	4/6
6S7.7	8/6	ACSPENDD	15/-
6S7.7	8/6	ATP4	3/6
6S7.7	8/6	DF96	9/6
6S7.7	8/6	DH73M	9/-
6S7.7	8/6	DK96	9/6
6S7.7	8/6	DL96	9/6
6S7.7	8/6	DM70	10/6
6S7.7	8/6	EABC90	13/6
6S7.7	8/6	EAC91	7/6

RAF43	10/6	PCF90	12/6
EB41	9/-	PCF82	12/6
EB41	9/-	PCL83	12/6
EB41	9/-	PL38	27/10
EB90	10/6	PL81	15/-
EB90	10/6	PL82	9/6
EB90	10/6	PL83	12/-
EC21	9/6	PP226	3/11
EC24	10/-	FX25	12/6
KCC58	9/6	PV81	9/6
KCC91	9/6	PV82	10/-
KCF90	12/6	PV83	12/-
KCF93	12/6	PY81	10/-
ECB3	9/6	PY82	12/-
ECB35	10/6	PY83	12/-
FCR42	10/-	QP21	7/6
RCH81	9/-	RP4	10/6
ECL90	9/6	SP19C	7/6
ECL92	12/6	TR41	12/6
EP22	9/6	TR333	15/-
EP40	12/6	U10	10/-
EP41	9/6	U17	12/6
EP80	9/6	U22	3/6
EP85	10/-	U25	13/6
EP86	9/6	U191	12/6
EP89	10/-	U445	15/-
EP92	8/6	U801	31/4
EK2	15/-	CAF42	11/6
EL3	12/6	UB41	9/6
EL32	9/6	UB41	8/6
EL33	9/6	URP40	9/-
EL38	27/10	UCH43	10/-
EL41	10/6	UCH81	11/6
EL42	11/6	VP41	10/6
EL51	10/6	UL41	10/6
EL52	10/6	UL84	12/6
EM80	10/-	UY41	8/6
EM81	11/6	UY45	10/6
EY81	12/6	VP13A	7/-
EY91	9/-	VP41	8/6
RZ40	9/-	VR21	2/8
RZ40	9/6	VR33	6/6
EZ90	2/6	VR54	2/6
EZ90	2/6	VR55	2/6
EL145	2/-	VR56	7/6
FC13	12/6	VR57	8/6
FW/500	10/-	VR65	8/6
QZ32	12/6	VR6A	8/6
H30	9/6	VR6A	8/6
HL24DD	9/6	VR66	3/6
HL92	12/6	VR66	3/9
HN399	13/6	VR61	4/6
HR210	9/-	VR61	4/6
K402	9/6	VR61	4/6
KBC32	9/6	VR62	11/6
KFC35	9/6	VR105/30	8/-
KLL32	9/6	VR116	4/-
KT24	4/6	VR138	6/-
KT24	4/6	VR137	5/6
KT33C	10/-	VR150/30	8/-
KT96	15/-	VP23	6/6
KW63	8/6	VR70	3/-
KT741	6/-	VT52	6/6
L19	13/6	VT801	5/-
M14	6/6	VU59	8/6
MH41	7/9	VU84	9/-
MKT4	13/6	VC111	2/6
M87	13/6	W77	3/6
N37	12/6	W79	13/6
N78	12/6	X65	13/6
PR1	10/6	X78	22/3
P215	3/11	X79	11/6
PRN44	15/-	Y63	9/-
PRN25	5/-	Z22	10/-
PRN41	12/6	Z308	11/6
PRN46	7/-	Z359	11/6
PRN20A	4/-	Z759	11/6
PCC24	10/-		

PACKING AND POSTAGE—6d. per valve. SAME DAY SERVICE.

MAINS TRANSFORMERS

3 Way Mounting Type.	
MT1	Primary: 200-220-240 v. Secondaries: 250-0-250 v. 80 mA/0-6.3 v. 4 amp. 0-4 v. 2 amp. Both tapped at 4 v. 20/9 each.
MT2	Primary: 200-220-240 v. Secondaries: 350-0-350 v. 80 mA/0-6.3 v. 4 amp. 0-5 v. 2 amp. Both tapped at 4 v. 20/9 each.
MT3	Primary: 200-220-240 v. Secondary 30 v. 2 amp. Taps at 3 v., 4 v., 6 v., 8 v., 9 v., 10 v., 15 v., 18 v., 20 v., 24 v., 20/9 each. Postage and Packing please add 2/- per transformer.
HEATER TRANSFORMERS	
220 v. Input 2 volt .5 amp.	5/-
230 v. Input 2 volt 3.0 amp.	5/3
230 v. Input 4 volt 1.5 amp.	8/6
230 v. Input 4 volt 3.0 amp.	10/-
230 v. Input 6 volt 2.0 amp.	10/-
230 v. Input 6.3 volt .5 amp.	5/6
230 v. Input 6.3 volt 1.5 amp.	6/9
230 v. Input 6.3 volt 3.0 amp.	10/-
230 v. Input 12 volt .75 amp.	5/9

HEADPHONES—MICROPHONES

EK-GOVERNMENT HEADPHONES AND MICROPHONES

CLB low resistance type 130 ohms 7/6 pair
 Thrust Microphones, American surplus.
 Complete with strap, lead and plug type
 T30B 8/- set
 High Resistance Phones, 4,000 ohms 13/6 pair
 High Resistance D.L.R. Phones 16/- pair

TRANSISTORS

Suitable for audio work yellow and green spot, ea. 10/-
 red spot, ea. 10/-
 R.F. for use up to 1.6 mc/s, white spot ea. 15/-
 R.F. for use up to 1.5 mc/s, to 5 mc/s, yellow and red spot, ea. 21/-
 J.B. gang condensers for transistor working "0" gang 1 or 2 gang 365 PF swing, aluminium vanes, steel chassis.
 1 gang 7/6 each; 2 gang 11/6 each. JB "00" twin gang condenser 308 PF front section 17/6; PF rear section price 9/6 each.



CHASSIS

Aluminium Un drilled with Reinforced Corner. Available in the following sizes:

6 x 4 x 2 1/2 in.	4/6 each
8 x 6 x 2 1/2 in.	6/3 each
10 x 7 x 2 1/2 in.	7/3 each
12 x 3 x 2 1/2 in.	5/9 each
12 x 5 x 2 1/2 in.	6/9 each
12 x 6 x 2 1/2 in.	8/6 each
12 x 8 x 2 1/2 in.	14/- each

All are four-sided—ideal for radio receivers, amplifiers, power packs, etc.

SPECIAL OFFER. BAND I-III TUNERS

Covering Channels 8-4 with provision for 10 more coil sets. 2 valves: Maxia 30L1 cascode r.f. amp. Maxia, 50C1 triode pentode i.c. Complete with power supplies for 200-250 v. A.C.I.F. output 16-19 Mc/s, easily modified to other outputs. Full circuit diagram supplied. **80/-**

SPECIAL PURCHASE

THE NEW APEX MARK II BAND III CONVERTER

● B.B.C. or Commercial Programmes at the touch of a switch.
 ● Built-in power supply for 200/250 v. A.C.
 ● Variable fine tuner and gain control. Separate mains on/off switch
 ● Robust construction for mounting on top or side of cabinet.
 ● Rise only 5 1/2 in. x 5 1/2 in. x 2 1/2 in.
 Retail Price £5/15/- complete. **11/6 each**

W.B. "STENTORIAN" HIGH FIDELITY SPEAKER UNIT

Model H.F. 1012. 10in. die-cast unit, incorporating 12,000 gauss magnet. Handling capacity, 10 watts. Frequency response, 20 c.p.s.-14,000 c.p.s. Base resonance 25 c.p.s., 24/19/8.

TELEVISION TRANSFORMERS TYPE T25

Small Main Transformers suitable for Television Converters, etc
 Specification:—
 Primary, 230 v. 50 c/s
 Secondary 1, 250 v. 10 mA.
 Secondary 2, 6.3 v. 1.5 a
 Overall Size:
 Clamp construction, 3 1/2 in. x 2 1/2 in. x 2 in. over windings. Pixed centres: 2.3 in. **15/-**

LOUDSPEAKER CABINETS



THE "EKE" QUALITY 3 WATT AMPLIFIER

Three International Octal Valves 6B8G, 6V6GT, 6X50GT. A.C. Mains fully isolated, negative feed back (voltage and current) controls, volume and tone, input network for modern crystal. Really low hum level and even frequency response. Price 84/- plus 3/- packing and post.

EX-GOVERNMENT HEATER TRANSFORMER. Universal Input 2 v. 6.3 volt windings at 1 1/2 amp. each. Price 7/6 each.

OUR 1957-1958 CATALOGUE IS NOW AVAILABLE TO ALL READERS OF THIS MAGAZINE. 48 PAGES OF COMPONENTS AND EQUIPMENT OF INTEREST TO ALL RADIO ENTHUSIASTS. SEND 1/- IN STAMPS FOR YOUR COPY.



103, LEEDS TERRACE,
 WINTOUN STREET,
 LEEDS, 7.

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 1/-; 20/- add 1/6; 40/- add 2/-; £5 add 3/- unless otherwise stated. Minimum C.O.D. fee and postage 3/-.
 For full terms of business see inside cover of our catalogue.
 Personal Shoppers 9 a.m. to 5 p.m. Mon. to Friday. Saturday 10 a.m. to 1 p.m.

WESTINGHOUSE RECTIFIERS

16RO.1-1-16-1	9/- each
18RA.1-1-16-1	6/6 each
18EA.1-1-8-1	4/- each
14EA.1-2-8-3	25/- each
14A.96	13/9 each
14A.97	13/6 each
14A.100	15/- each
14A.124	27/6 each
14B.130	31/6 each
LW7	23/9 each
WX6	3/6 each

UYLON "TELETUNER." All types available. Stations of your choice. Fit this Converter and your troubles are over. 27/7/- each. Aerial and Oscillator Coils (All channels)—all frequencies 7/6 pair. Also available from stock, complete range of spares.

CONTROL KNOBS

Long necked knobs for T.V. Receivers in walnut black and cream. 1/- each

SUPPRESSORS

Dabbler kits of condensers and chokes for Interference Suppression. 1 amp. kits 5/6. 2 amp kits 6/-. 3 amp. kits 6/6.

REVISED SECOND EDITION "POINTS ON PICK UPS"

A Replacement Guide to pick up heads cartridges, style. Over 103 illustrations. 5/- each

OMRON COILS FOR COLLARO TYPE DECK TRANSCRIBER.

Q18 Bias Filter coil	7/6 each
Q17 Treble Boost coil in Mu Metal can	21/7/6 each
Q19 Bias Coil	7/6 each
Omron Coils for the Beginners Shortwave Receiver. Radio Constructor Aug. 1957. SW Q1 31/11 Mo/s.	6/- each
SW Q2 12 4.5 Mo/s.	6/- each

SCRATCHOFF

Removes scratches from Radio and T.V. Cabinets. In Polythene Dispenser. 3/- each

All Components in Stock for BBC Television Studio "E" Building your own Radio set. Complete Kit including Headphones, etc. 45/-

MAIN DROPPING RESISTORS

Manufacturers Surplus Types.	each
945 ohms Zenith with tape	1/-
650 ohms tap at 375 ohms, 500 ohms, 5 ohms, 30 ohms.	2/6
Eric 1,490 ohms with Tape	1/-
Norman 2 amp. 1,000 ohms with sliders	4/6
Norman 3 amp. 1,000 ohms with sliders	4/6
Zenith Mains Dropper 910 ohms	2/-
Dabbler Type HY tapped 200-210, 220-230, 240-250 ohms	1/9
Eric Two Section Dropper, 150 ohms and 1,540 ohms with two taps	1/9
Bulgin Dropper with voltage taps	3/9

REPANCO COILS

TRANSISTOR COILS AND COMPONENTS	Each
Type OT1 combined 1ST IPT (315 Kc/s) and OSC Coil Medium and Base Log Wave	11/6
Type TT3 2nd if transferable 315 Kc/s	5/-
Type TT3 3rd if transferable 315 Kc/s	5/-
Type TT4 Push Pull interstage Transformer	8/6
Type TR5 Push Pull Output Transformer	8/-
Type DEX1 High Gain Dual Range Crystal Set Coil	2/6
Type DBE2 Dual Range High Gain Coil	4/-

EXPLOSION GUARDS. For 17in. tube Outside dimensions 17 1/2in. 13 1/2in. Brown/Pawn Escutcheon. Price 7/6 each. Post 3/6.

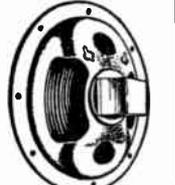
ACOS MICROPHONES

MIC. 30 SERIES
A good quality omni-directional microphone with flat response from 30 to 7,000 c.p.s.
MIC. 30-3 Table Model without switch.
MIC. 30-4 Table Model with switch.
MIC. 30-5 Without switch; with adaptor for a floor stand.
MIC. 30-6 With switch and adaptor for a floor stand.
The adaptor incorporates both a 3in. and a 3 1/2in. 30T.P.I. thread.
Without Switch — 23/3/- With switch 23/8/-
MIC. 30-1 without switch
A crystal based or desk microphone designed for the high quality public address and tape recording field, incorporating a specially designed acoustic filter giving a response flat from 30 to 7,000 c.p.s. With microphone in omni-directional and is housed in an attractive plastic case. Without switch — 23/10/-
MIC. 30-2 with switch 23/15/-
MIC. 30-1
A general purpose hand microphone of robust construction with substantially flat response from 50 to 5,000 c.p.s. Suitable for use in recording apparatus. Public address equipment, etc. 21/5/-
MIC. 30-2
The same as the MIC 30-1 but fitted with a small desk stand. 21/6/6

LOUDSPEAKER UNITS

Make	Type	Size	Price
Elac	Square	3 1/2in.	19/6 each
Lectrona, Plessey	Round	5in.	17/6 each
Goodmans, Plessey	Round	6 1/2in.	18/6 each
Goodmans, R. & A.	Round	5in.	19/6 each
Plessey, R. & A.	Elac Round	10in.	25/6 each
Plessey	Round	12in.	35/- each
Elac	Elliptical	7in. x 4in.	19/6 each
Elac	Elliptical	10in. x 4in.	25/6 each

All the above are PM units with 2 to 3 ohm speech coils.



RTC 12in. heavy duty 20 watt model 15in. ohms	5 0 0
Speech Coil	25 5 0
5in. Mains Energised Speaker	21 0 0

SPECIAL OFFER
Just a few 5in. units by Goodmans and Lectrona fitted with standard output transformer £1 1 6 each

SCOTCH BOY RECORDING TAPES, ETC.

SCOTCH BOY TYPE 150-9 "EXTRA FLAY" RECORDING.
500ft. on 5in. diameter spool, per reel. 23/- each.
1,000ft. on 7in. diameter spool, per reel. 50/- each. Immediate delivery from stock
SCOTCH BOY TYPE III STANDARD RECORDING TAPE.
500ft. on 5in. plastic spool, per reel. 16/- each.
1,200ft. on 7in. plastic spool, per reel. 27/- each.
Spare Spools: 5in. diameter, 3/6 each. 1in. diameter, 4/3 each

WB EASY TO ASSEMBLE CABINETS

JUNIOR BASS REFLEX CORNER CONSOLE.
A new contemporary-style cabinet, specially designed to give maximum reproduction quality from Stentorian 8in. or 10in. units, with provision for Tweeter Unit, if required. Measures 33in. x 23 1/2in. x 18 1/2in. Price 29/9/-.

SENIOR BASS REFLEX CORNER CONSOLE.
Carefully designed to ensure superb clarity of reproduction when used in conjunction with Stentorian 10in. or 12in. units. Provision is also made for Tweeter Unit, if required. Measures (approx.) 35in. x 30in. x 19in. Price 31/11/-.

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No. 134 **P.M. TUNER CONSTRUCTION** by W. J. Way. * Easy to Build * Point-to-Point Wiring * Super High Fidelity Response * 32 pages * All components for this Circuit available, ex stock, each 2/6
No. 138. **HOW TO MAKE AERIALS FOR TV** (Band 1 and 3) and V.H.F. (Band 2). Data for all Channels. Ten different designs for local and fringe areas, each, 2/6
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No. 140. **TELEVISION SERVICING FOR BEGINNERS** * 40 pages of Information each 4/6
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MULLARD. HIGH QUALITY SOUND REPRODUCTION Includes 20 watt Amplifier, F.M. Tubes, Pre-Amplifier, etc. each 3/6
Respect No. 5 **TV FAULT FINDING**. Profusely illustrated with Photographs taken from a Television Screen, each 5/-
LOUDSPEAKERS by G. A. BRIGGS. The Why and How of Good Reproduction. "Sound" information for the layman and the enthusiast, each 7/6
Wearite Manual of the Tape Deck, each 3/6
Postage 4d. each on all the above.

METERS

Instrument Meter Moving Coil, ex-Ministry 0-3KV. Round Panel mounting. Brand new 7/6 each.
Instrument Meter 0-100mA Square type. Panel Mounting. Ex-R.A.F. Equipment 7/6 each.
2 Range Pocket Voltmeter. Ex-Ministry Brand New. 0-15 volts, 0-250 volts, moving coil 345 ohms per volt, complete with leads. 16/- each.



HENLEY-SOLON ELECTRIC SOLDERING IRONS INSTRUMENT MODELS 25 WATTS

Weight 31 oz.	Length 9 in.	
(excluding box)		
Now available in a wide range of voltages as under:		
IRONS Voltage	List No.	Price
25 watt	12	618 26/-
50 watt	24	619 26/-
50 watt	50	620 20/-
MODEL fitted with		
straight	100/110	621 24/-
4W	120/130	623 24/-
	200/220	624 24/-
	220/240	625 24/-

MISCELLANEOUS COMPONENTS

TV SLIDER PANEL. Welwyn panel of 3 resistors, values 1 Meg. ohms, 150K ohms, 250K ohms, with black screw type locking knobs. Total size 3 1/2in. x 2in. Price 1/8 each.

RUBBER GROMETS. Mixed sizes, 6d. doz.

GRID CAPS. 1 Octal Push-on type, 6d. doz. British Screened type, 3d. each.

ARMOUR PLATED GLASS. Size 1 3/4 x 1 1/2in., rounded corners, 3/6 each.
3 Pin Mains Plug and Socket, 3/6 each.
Pliers Side Cutters, 2/9 pair. Line Cord. 3 amp., 3 core, 1/9 yd. Line Cord. 3 amp., 3 core, 1/9 yard. Electric Bussbars in Bakelite case. Loud tone, 2/6 each. Episcycle Friction Drive with Brass Brum. For use with Street Dial Drive Vrn, 1/6 each.

AMERICAN RELAY. 45 ohms Impedance with lead No. A20545, 1/9 each.

IRON LEADS. Black and white flat iron leads, booted ends, 1/8 each.

POTENTIOMETER PANEL. Four Potentiometers on Panel 50K ohms 5P: 750 ohms W/W; 25K ohms Carbon; 5K ohms W/W. All with long spindle, with leads of different colours terminating in an 11 pin plug, 7/6 each. Wavac choke, max. current 100 m/a. D.C. resistance 125 ohms, 6/- each. Westinghouse 1 m/a. Rectifier wire ends, 9d. each.
5 pin Vibrator Pack, complete with Vibrator, 17/6 each. Morphy Richards Type Replacement Iron Elements, 3/9 each.

INDICATOR LAMPS. Spring fixing type, 9d. each. "Aerovox" Condenser Claps, 1d. each. Penalt Rectifiers, Type J10, 2/- each.
5 pin Extension Speaker Volume Controls, 2 meg. S.F.P., 3/6 each. Extension Speaker Volume Controls 1/3 each. Vibrator Clips (Standard), 5d. each.

NINE-INCH TUBE MASK. White (Solled Condition), 4/9 each. Tri-Sol 2-Ove. Holder, Net weight 1lb 16 S.W.G 60/40 alloy, per carton, 6/6.

SURPLUS GEAR PARCELS. We have found, from time to time, stocks of components stripped from ex-Government equipment, along with discontinued lines, etc. These are in small quantities and therefore unprofitable to advertise. To make room for new items we offer at less than cost parcels of these components at 10/- each.

JUNCTION BOXES. Type 5X/2324, 20 way 1/6 each.

RECORD PLAYER UNITS



B-S-R. MONARCH

Four speed automatic record change unit. Plays 7in., 10in. and 12in. records automatically with "MAGIDISK" Selector Turn-over Pick-up. Unit plate 12 1/2 x 10 1/2in. 23/15/-. Postage, etc., 4/6.



COLLARO

Model 3/544. Three speed single player. Automatic stop. Fitted with "Studio T" pick-up. Cream finish 23/19/6. Postage, etc., 4/6.



COLLARO

Four speed automatic record change unit. A fully mixing automatic changer with many advanced features. Unit plate 12in. x 13 1/2in. 23/15/-. Postage, etc., 4/6.

TELETRON transistor superbet coils set of IF and oscillator coils with Ferrite Rod 35/- per set (circuits included). Long Wave Loading Coil to match 4/6 each.

RECORDING TAPE, 1,200 feet. "Pur-tone." 12/8 each.

NEEDLE CUPS. For Gram. Needles (Bako-Me), 1d each.

CRYSTAL DIODES. Wire Ends plastic case, 1/- each. Bulgin 7-pin Plug and Socket, 1/6 each. Insulated Coupler, 2in. dia., for standard 4in. spiro-disc, ceramic insulation. 9d. each. Pair of Instrument Handles 5/4in. between centres, 1 1/2in. back to front, 1/3 pair. Speaker Cones, 6A6P is 8in., one with 1in. cone piece, 4/6 each. 6A6P is 6 1/2in. cone with 1in. pole piece, 4/6 each. A Low-High Impedance Matching Unit for Headphones to be inserted in the cord, 3/9 each. Mains Transformer, Standard Type Primary Windings with a Secondary 325-0-325 20 m/a. 6.3 v. 3 amp., 11/6 each. Bulgin Indicator Lamp, single hold fixing for standard MBS bulb, red lens, 3/3 each. Tubular Condenser (Metal Box) Sprague 4 m/c 600 v., 4/- each. Sprague Block Condenser, 2 m/c. 1 mfd. 2,000 volts, 3/- each. Paper Block Condenser, 2 mfd. 250 volts, 9d. each. Kettle Element, 1,000 watts for 200/110 volts or 230/250 volts, 17/6 each. Relay Valve CV71, in Holder, 3/9 each.

BELL TRANSFORMER "CONCORDIA" 3 v., 5 v., 8 v., 1 amp. fused. In bakelite case 2/6 each.

SELF TAPPING SCREWS (P.K.). No. 4 1/2in. long, 3/4d. each.

"OLEN" TRAVELLING IRON with ASBESTOS STAND. Size: 4in. x 2in. x 2 1/2in., including handle, complete with lead and switch to enable it to be used on any voltage between 110 and 250 v. A B.C. adaptor is fitted on the lead. (Colour as available: Blue, Green, etc.), 21/- each. FUSES: 1, 1 1/2, 2, 3, 5 amp., 1 1/2in. Standard Cartridge Fuses, 3d. each.

CARRYING CASE. Suitable for use as a projector or recording case, size 10in. x 9 1/2in. x 1 1/2in. Internal dimensions 1 1/2in. long, 1 1/2in. deep, 6 1/2in. front H.T., 6 1/2in. rear H.T. With black resin finish. Weight 8 1/2lb. 12/6 each. Post and Packing 2/6.

576 MINIATURE VALVE PIN STRAIGHTENER. This is an American manufactured tool at a price every one can afford. Complete with plug, 2/6 each.

RADIO TRADERS LTD.

23 WARDOUR ST., LONDON, W.1. (Coventry Street end)
 Phone: No. GERard 3977/8 Grams: "Radiotrade"

SPECIAL OFFER OF CURRENT MANUFACTURE ELECTROLYTIC CONDENSERS

8 mfd. 450 v. 2/6 each; 16 mfd. 450 v. 3/-; 32 mfd. 450 v. 4/-; 8 x 8mfd. 450 v. 3/9; 8 x 16 mfd. 450 v. 4/-; 16 x 16 mfd. 450 v. 4/6; 32 x 32mfd. 350 v. 5/- Bias Condensers: 25 mfd. 25 v. 1/6; 50 mfd. 50 v. 1/9. Please note we can offer special discounts for quantities.

W.W. RESISTORS. 5 watt 1/6; 10 watt 2/6; 15 watt 3/-; 20 watt 3/6. We carry stocks of resistors from 2 watt to 150 watt W.W. Your enquiries invited.

HIGH STABILITY RESISTORS. 1/4 watt 5% 6d.; 1/2 watt 5% 9d.; 1 watt 5% 1/- A few values in 1% and 2% still available. ALL ORDERS FOR RESISTORS C.O.D. PLEASE, AS WE CANNOT GUARANTEE TO STOCK ALL VALUES.

ELECTROLYTIC CONDENSERS. Manufacturers' Surplus, in perfect condition. 100 mfd. x 200 mfd. surge 5/6 each; 100 mfd. x 100 mfd. 425 v. surge 5/6 each; 150 mfd. 450 v. wkg. 5/6 each.

BIAS CONDENSERS. 3,000 mfd. 6 v. 3/6 each; 2,500 mfd. 3 v. 3/6 each; 1,000 mfd. 12 v. 1/6; 25 mfd. 25 v. 1/3; 50 mfd. 12 v. 1/-.

TRANSISTORS: Junction type Red Spot by well-known manufacturers 10/- each.

TRANSISTOR CONDENSERS: Miniature Electrolytic Capacitors 32 mfd. 3 v., 25 mfd. 25 v., 25 mfd. 6 v., 16 mfd. 12 v., 8 mfd. 6 v., 5 mfd. 12 v., 2.5 mfd. 25 v., 1.6 mfd. 6 v., 1 mfd. 12 v. All these types of condensers are 3/6 each. SPECIAL DISCOUNTS FOR QUANTITIES.

AIR-SPACED TRIMMERS, 5, 10, 15, 20, 25, 50; and 75 of pre-set and spindle types 2/- each..... doz. 21/-

PYE PLUGS AND SOCKETS 1/6 per pair "T" pieced ... each 1/9

GROMMETS, 1 grs. assorted grommets, 1/2 in. to 1 in. gross 8/6

WESTECTORS. WX6, WX12, W4 1/- each doz. 9/-

SIGNAL LAMP HOLDERS. Panel mounting, complete with adjusting lampholder 2/- each doz. 21/-

BELLING-LEE PLUGS AND SOCKETS, 5 pin 1/9; 7 pin 2/-; 10in. doz. 2/6

MANUFACTURERS PLEASE NOTE. We hold large stocks of Nitrogol, Visconol and other block-type Condensers, your enquiries are invited.

6-100 amps. 50 c.p.s. 4 1/2 in. METERS. £2/10/-; 0-50 amp. Moving Iron Gin. Meters, £3/10/- each. All brand new and boxed.

MIDGET MICA CONDENSERS. .0001, .0002, .0003, .0004, .0005 5/- per dozen.
 200 Assorted Moulded Mica Condensers, popular value £2 10 0
 200 Assorted Silver Mica Condensers, popular values £2 10 0
 200 Assorted Carbon Resistors, 1/2, 1 and 1 watt. Good selection £1 10 0

PAXOLIN SHEET. 18 x 4 1/2 x 7 1/2 in. 1/6; 10 x 10 x 1 1/2 in. 1/6; 20 x 10 x 1 1/2 in. 3/-; 10 x 10 x 1 1/2 in. 2/-; 20 x 10 x 1 1/2 in. 4/- Minimum P. & Pkg. 1/6.

BARGAIN OFFER OF BATTERIES.

4 1/2 v. Heavy Duty Bell Battery. Size 6 1/2 x 4 1/2 x 2 1/2 in. 2/6
 72 v. H.T. 1.5 v. L.P. Size 6 x 5 x 1 1/2 in. 2/6
 150 v. H.T. Size 2 1/2 x 5 1/2 x 1 1/2 in. 5/6
 6 1/2 v. Size 2 1/2 x 3 1/2 x 2 1/2 in. 6/6
 60 v. H.T. 1.5 v. L.T. 3 1/2 x 3 1/2 x 1 1/2 in. 4/6
 All batteries sealed and unused. All plus 1/6 post and pkg. Special reduction for quantities.

4-way Push Button Units 2/6 each. Knobs for same 3/- per doz.

WEARITE COILS. PA4, PO4, PA5, POS, 1/3 each. doz. 12/-

VALVE HOLDERS. Moulded B9A 7/6; B7G 6/-; Int. Oct. 9/-; Eng. Oct. doz. 4/6

VALVE HOLDER FITTED WITH LOWER CAN 1/6 per doz. extra. Screening cans for B7G and B9A doz. 6/-

JONES PLUGS AND SOCKETS. 4 pin 2/6 per pair; 6 pin 3/6 per pair; 8 pin 4/6 per pair; 12 pin 6/6 per pair. If cover required send 1/6 extra per cover.

POINTER KNOBS. Small black with white line, standard 1/2 in. spindle doz. 7/6

WANDER PLUGS. Red and black doz. 2/-

PHILIPS TRIMMER TOOLS 1/- each doz. 10/6

CASH WITH ORDER OR C.O.D. ALL ORDERS DEPT. W.1.

ALL ORDERS FOR LESS THAN £2 ADD POSTAGE.

● We invite your enquiries for items not listed

Trade Counter open 9 to 6 Monday to Friday.

Also 9 to 1 Saturdays. Callers welcomed.

WHOLESALE MANUFACTURERS AND EXPORT ENQUIRIES INVITED

PRE-SET CONTROL LOCK

Designed to lock the spindles of pre-set potentiometers or trimmers without rotational or lateral displacement of shaft.



Will accept wide range of panel thicknesses.

TYPE P

Very attractive appearance for panel mounting



TYPE C

Send for leaflet A.1



"KNOB LOCK"

The ideal method of locking panel mounted controls. Positive guard against vibration, etc.

This development of our popular pre-set control lock is finished in black plastic and embodies control knob and instantaneous finger-tip locking knob.

Send for List No. A.6

SUTTON COLDFIELD ELECTRICAL ENGINEERS

Reddicap Trading Estate, Sutton Coldfield. 'phone 8UT 3036 & 5885



CR50 BRIDGE measures from 10pFd to 100mFd and from 1 ohm to 10 Megohms in fourteen ranges, having a total scale length of over 120 inches. Leakage test for condensers. Indication of balance is given by a magic eye fed from a high gain pentode. Internal standards of "Constants" 1% resistors. Robustly constructed for bench use, complete and ready for use from A.C. mains. £8/2/6 plus 4/6 carr./packing.

SG50 SIGNAL GENERATOR covers 100kc/s to 80Mc/s in six ranges on fundamentals (not harmonics) either modulated 400 cps or CW. Frequency accuracy 2%. Uses 6AG5, 6C4 and RMI with double wound mains transformer. A de luxe instrument housed in grey hammer finished case size 9 x 13 x 4in., with engraved Perspex scale. £9 plus 6/- carr./packing.

VV50 VALVE VOLTMETER. Price £8/2/6 plus 4/6 carr./packing. Further details sent by return of post on receipt of self addressed stamped envelope.

TRADE supplied direct. CALLERS always welcome.

GRAYSHAW INSTRUMENTS

124 Sandgate High Street, Folkestone, Kent
 Phone: Folkestone 78613

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

AUTO-CHANGERS

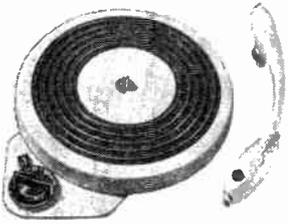
See us for your requirements or send for our latest list.



COLLARO 4-SPEED MIXER AUTO-CHANGER

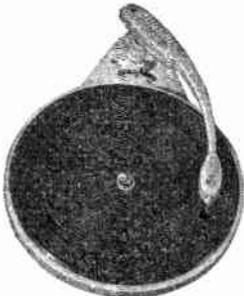
Latest model RC 456 incorporating auto and manual control enabling records to be played singly or automatically. Complete with Studio crystal pick-up and sapphire stylus. List £13/17/-
LASKY'S PRICE £8.19.6
 Post 5/-

SPECIAL OFFER! COLLARO "JUNIOR" 4-SPEED MOTOR AND PICK-UP



Collaro "Junior" 4-speed motor and pick-up with HGP59 cartridge. Post 5/-.
£4.12.6

Motor only, 5/6, post 2/6.
 Pick-up only, 3/6, post 2/6.



Collaro 4/564 4-speed Single Player with Studio T p.n. crystal cartridge and stylus. Automatic stop.
LASKY'S PRICE £7.7.0
 Carr. 5/-

COLLARO 4-speed Transcription Turntable
 4T200/PX, £19/10/0. Carr. 7/6
 Less pick-up £14; 18/-

BUILD YOURSELF A HIGH GRADE RECORD PLAYER!

We have the biggest selection of Auto-Changers, Single Players, Amplifiers and Cases, and you can make your own Record Player for as low as
£10
 Come and see us.



TRANSISTORS AT A REASONABLE PRICE

R.F. P.N.P. Junction type, suitable for medium and low frequency oscillators, frequency changers and I.F. amplifiers 1.5 to 8 Mc/s (double spot—yellow & red) **21/-**

AUDIO P.N.P. Junction type, suitable for high gain and low frequency amplifiers, and for output stages up to 250 milliwatts, (double spot—yellow and green). **10/-**
 Post Free.

- ★ **TESTED AND GUARANTEED EFFICIENT**
- ★ **HERMETICALLY SEALED** and unaffected by temperature variations.

Full operating data and circuit diagrams for a simple receiver superhet, T.R.F., multi-vibrator, relaxation oscillator, audio amplifier, oscillators, signal tracers, etc., supplied with each Transistor.

MULLARD TRANSISTORS				BRIMAR TRANSISTORS	
OC70 or OC71	OC72	OC16	TS1	TS2	TS3
21/-	30/-	60/-	TS4	TP1 or TP2	40/-

LASKY'S TRANSISTOR SUPERHET TUNER FOR HOME CONSTRUCTION ON PRINTED CIRCUIT

Uses three R.F. Transistors and one Germanium Diode, three I.F. transformers. Ferrite rod aerial. Operates on one 6 v. battery and one 1.5 v. cell. Printed Circuit, 3 1/2 in. x 3 1/2 in.

CAN BE BUILT FOR. Post 3/6. £5.12.9

Full details and illustrations post free on request.

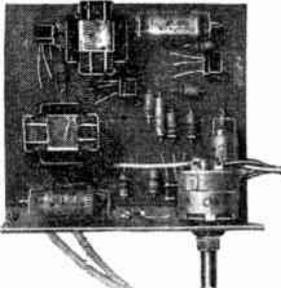
Demonstrations at both addresses.

NOTE:—This Tuner in conjunction with our Transistor Amplifier (see below) makes an excellent Transistorised radio. Cabinets available.



LASKY'S TRANSISTOR AMPLIFIER KIT

(200 milliwatts) For construction on a Printed Circuit



All components available separately

Size: 3 1/2 in. x 3 1/2 in. Height can be under 1 in. Uses our new hermetically sealed Transistors and operates from 6-volt battery. Output impedance 3 ohms.

FULL DETAILS, CIRCUIT DIAGRAM AND SHOPPING LIST 1/- post free.

COMPLETE KIT including 4 Transistors, all brand new components, latest T.C.C. miniature condensers, printed circuit and full instructions, **79/6** Post 3/6.

DEMONSTRATIONS AT EITHER OF OUR ADDRESSES

SUB-MIN. TRANSISTOR TRANSFORMERS 4/6 Post 1/-
 45-1 ratio each.

ALL TRANSISTOR COMPONENTS. Trans., midget, min. and sub-min. Coils, Ferrite Rods, sub-min. Condensers, etc.

PICK-UP BARGAIN "RONETTE" Lightweight Crystal Pick-up with 2 cartridges.
LASKY'S PRICE 45/-
 Post 2/6

CARTRIDGES
 ACOS HGP37 p.n. Cartridges. I.p. and standard, complete with stylus. List 41/7.
LASKY'S PRICE 18/-
 Post 1/-

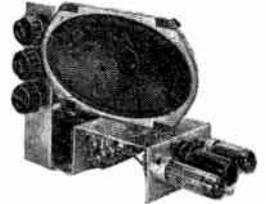


Teletron "Companion"

3-TRANSISTOR POCKET RADIO. T.R.F. circuit covering medium and long waves, with balanced armature output. Ferrite aerial. Note small size: 4 1/2 x 3 x 1 1/2 in. You can build this novel transistorised pocket receiver for only **89/6**
 Full instructions and price list, 6d. post free. All components available separately.



Season's Greetings
 to the thousands of customers we have served in person or by post



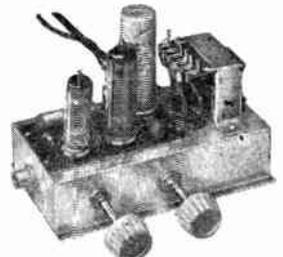
LASKY'S 4-WATT PORTABLE GRAM AMPLIFIER

Will suit any type of crystal or magnetic pick-up. Uses 3 valves: EL84 output, L63 and EZ80 rect. Speaker and controls are completely separate and can be mounted as shown or on anywhere in cabinet where most suitable.

COMPLETE with 3 valves and knobs, less Speaker. **79/6**
 Carr. 5/-

7 in. x 4 in. Elliptical Speaker, if required, 19/6 extra.

Details and circuit diagram post free on request.



LASKY'S PORTABLE GRAM AMPLIFIER KIT

2 watts. Note small dimensions, approx. 6 1/2 in. x 3 1/2 in. max., height 5 in. Uses EL84 output and 6X4 rectifier, double-wound transformer, tone control, output transformer, etc. Built on a T.C.C. **PRINTED CIRCUIT** which greatly simplifies construction and eliminates wiring errors.

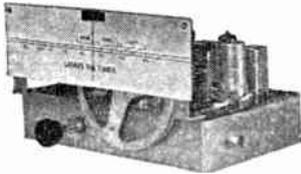
COMPLETE KIT including valves, printed circuit, full instructions, less Speaker. **58/-**
 Carr. 2/6

7 in. x 4 in. Elliptical Speaker, if required, 19/6 extra.

★ **H.P. TERMS** and **CREDIT SALES** available on certain items.

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

LASKY'S RADIO



LASKY'S F.M. TUNER PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION

Note these star features:—

- ★ HIGH SENSITIVITY.
- ★ ALL BRAND NEW T.C.C. CONDENSERS.
- ★ AERIAL COIL AND R.F. COUPLING COIL PRINTED ON CIRCUIT.
- ★ 5 VALVES AND 2 GERMANIUM DIODES.

By the use of a printed circuit the I.F. and R.F. amplifiers are extremely stable at maximum gain and results are consistent on all tuners.

Valve line-up:—

- R.F. Amplifier, Z719 or EF80.
- Mixer and Osc. B719 or ECC85.
- 1st. I.F. amp., W719 or EF85.
- 2nd I.F. amp., W719 or EF85.
- 2 Germanium Diodes GEX.34.
- Driver Limiter, Z719 or EF80.

CAN BE BUILT FOR 8 gns.

(Including valves)

Post and Pkg. 2/6

G.E.C. F.M. Tuner Book plus our full data and shopping list 2/6 post free.

All parts available separately.

ALIGNMENT SERVICE available.

JASON F.M. TUNER

Special Parcel containing data book, chassis, front panel, dial, drive, tuning condenser, full sets of coils, I.F.s, ratio detector, etc.

68/9

Post 2/6

DATA BOOK with price list 2/-. This tuner uses 4-6AM6 and 2 crystals and can be built for £6/15/-, plus 3/6 post.

JASON "ARGONAUT"

Super-sensitive Tuner for F.M. and medium waves. Complete parcel with power supplies.

£13. 19. 6

Post, 3/6

DATA BOOK 2/- post free. Chassis Assembly 57/9 post 2/6. I.F. and Coil Set 78/- post 1/6.

All components available separately.

OTHER F.M. TUNERS

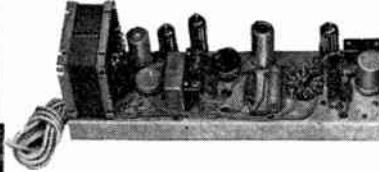
TSL £17/10/- DULCI £17/10/-.

Also Quad, Leak, RCA, Rogers, Pamphonic, etc.

DULCI H4/T 4-wave AM/FM Tuner, £20/17/-.

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

SCOOP! — PORTABLE TAPE RECORDER AMPLIFIERS



Mains 200/250 v. A.C. 6 watts output. 4 valves: EZ41 rect., EL41 output, EF40 and ECC81. Tone, volume and record/play back controls. Neon level indicator. Microphone and gram inputs. Can be used as a straight amplifier. Circuit diagram supplied.

LASKY'S PRICE £6. 19. 6

Complete with valves. Post & Pkg. 5/-.

BUILD THIS 4-VALVE S/HET PORTABLE FOR ONLY 7 GNS.

The PRINTED CIRCUIT supplied makes construction amazingly easy and accurate. You can build this fine 4-valve superhet portable in an hour or so, and performance equals ready-built sets costing pounds more!

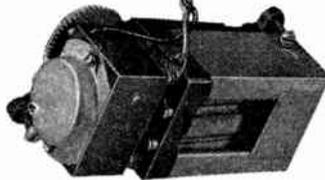


FOR ONLY £7/7/- plus 3/6 carr. and pkg., you can build this Portable using all brand new components and valves, only batteries extra. Printed circuit, circuit diagram, and full instructions supplied.

If you would first like to study the layout of this portable send 1/6 for Circuit Diagram, illustrations and full data.

FOR ONLY £9/9/- plus 3/6 carr. and pkg., you can build this job as a mains and battery Portable using our specially designed build-it-yourself Power Unit for 200-250 v. A.C. Demonstrations at both addresses.

6-12 volt MINIATURE MOTORS



Complete with gearbox. Overall size. 2 1/2" long x 1 1/2" x 1". Works with any voltage from 6 to 12. Ideal for models, remote control etc. Original cost over £2. **LASKY'S 12/6 PRICE.**

Post 1/6.

HI-FI SPECIALISTS!

Selective Demonstrations of all the latest and best Hi-Fi equipment are given at our Tottenham Court Road showrooms. See our large and comprehensive stocks.

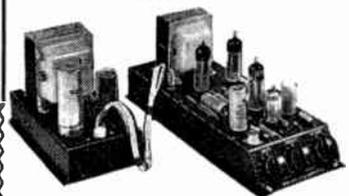
PICK - UPS. Garrard, | **SPEAKERS.** Wharfedale, Leak, Connoisseur, Orto- | Goodmans, G.E.C., Lowther, Lorenz, etc., etc.

TRANSCRIPTION TURNABLES. 3 and 4 speed Garrard, Connoisseur, Collaro, Lenco, etc.

AMPLIFIERS. Quad, Rogers, Leak, RCA, Pamphonic, Unitelex, W.B., etc.

CABINETS. Wide selection of Cabinets and Cases to house your speakers and hi-fi equipment.

The New AVO MULTIMINOR. 19 ranges A.C. and D.C. 10,000 ohms per volt D.C. 1,000 ohms per volt A.C. Pocket size: 5 1/2" x 3 1/2" x 1 1/2". Complete with leads and clip £9/10/- Post 3/6.



MULLARD 510 AMPLIFIER KIT WITH T.C.C. PRINTED CIRCUIT

All specified components and your choice of transformers and chokes by Partridge, Haddon, W/B, Ellison or Gilson.

COMPLETE KIT of parts and printed circuit as low as **£9.9.0** Details on request.

Book 3/6 post free.

Printed circuit separately 22/6.

Also available built ready for use. Price according to transformers used.

All components for above Amplifier available separately. Price List on request.



NEW BRENELL MARK IV DECK

Now available! Entirely redesigned to permit of conversion to stereophonic sound with 4 heads for dual channel operation when required.

DECK only 22 gns.

DECK WITH PRE-AMP. UNIT and magic eye indicator ready for use with any standard amplifier. 38 1/2 gns.

COMPLETE MARK IV TAPE RECORDER, as illustrated. Counter 30/- extra 53 gns.

Come and inspect the new Brenell Mark IV and have a demonstration. Full details post free on request.

TAPE DECKS

Collaro "Tape Transcriptor," Mk. III, £22. Fitted pre-amp., £43. Truvox Deck, Mk. III, 23 gns. Truvox Deck Mk. IV, £27/6/-. Lane Deck, £18/10/- Wearite Decks, £35 and £40.

TAPE RECORDERS

Leading makes—Grundig, Elizabethan, Truvox, Sound, Vortexion, etc.

COLLARO TAPE DECK MOTORS, set of 3, clockwise, anti-clock capstan. List £5/15/- **LASKY'S PRICE 95/-**

Post 5/-

SPECIAL PURCHASE RECORDING TAPE

Famous manufacturer's surplus P.V.C. base, 1,200ft. on 7in. plastic spool, **21/-** post 1/-.

ALL LEADING MAKES OF RECORDING TAPE IN STOCK.

SPECIAL SPOOL OFFER

7in. Metal Spools 1/6. All other types and sizes of spools in stock.

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN

TRUVOX 'SENIOR' SPEAKER DRIVING UNIT (pressure type) Power handling cap. 15 watts peak. With 12ft. cinema horn reproduces down to 17 cps.

List £7/15/- Lasky's Price **59/6**
Carr. 5/-

MOVING COIL P.M. SPEAKERS

- 2 1/2 in. 17/6. 3 in. and 3 1/2 in. 19/6
- 5 in. 19/6. 6 1/2 in. 17/6. 8 in. 21/-
- 10 in. 29/6. 12 in. 29/6
- 6 1/2 in. with transformer 21/-
- 7 x 4 in. Elliptical 19/6
- 10 x 7 in. Elliptical 32/6

SPECIAL OFFER DUAL CONCENTRIC SPEAKERS (15in.)

Famous make. High Fidelity. 25 watts, 15 ohms imp., full freq. range 20 c.p.s. to 17,000 c.p.s., resonance 20 c.p.s. Complete with crossover unit. List £27/4/6.

LASKY'S PRICE **£16.19.6**

Carr. 7/6 plus 30/- for wood packing case (returnable).

4-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES

Famous Manufacturer's Surplus. 6-valve 3-wave Superhet. 13.50 in. short. 200-550 m. medim. 1,000-2,000 m. long. LASKY'S PRICE **£10/19/6**
Carriage and packing 7/6 extra.

3-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES

3-wave superhet. 16.50 in. 200-550 m., 1,000-2,000 m. Brand new Mullard and Mazda valves—6C9, 6F15, 6LD20, N108, U107. Overall diam. 13in. long, 8in. deep. 7in. high approx. for A.C. mains 200/250 v. LASKY'S PRICE **7 GNS.**
complete with all valves
Carr. and Pkg. 7/6 extra.
Price without valves 25/4/-

HI-FI ELECTROSTATIC SPEAKERS ("TWEETERS")

Easy to fit to any radio, TV receiver or amplifier. Full data and circuit diagram supplied. LSH75. For outputs up to 6 watts, 8/-.
LSH518. For outputs of 10-12 watts, 12/6.
LSH100. For outputs up to 20 watts, 14/-.
Post free.

LPH65. MOVING COIL TWEETER. Imp. 5.5 ohms. freq. range 2,000-2,200 50 cps. For outputs up to 6 watts. 2 1/2 in. diameter. All post free. 39/6.

SPEAKER COVERINGS. Large stocks of Tygan and "Sonicweave" Speaker Coverings. Any size piece cut. Send for samples and prices.

ALL-DRY POWER UNITS

By Decca. Suitable for any battery radio using 1R5, 1T4, etc., 67 1/2 volts H.T., 1 1/2 volts L.T. LASKY'S PRICE **29/6**
Post 3/6

INEXPENSIVE EASILY BUILT RADIO SETS

Lasky's Radio Constructors' Parcels contain everything to build up-to-date and very efficient sets at low cost.



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 x 6 1/2 x 5 1/2 in. 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 waves. Uses 6K7G, 6J7, 6V6 and nielal rectifiers. Neat plastic cabinet, walnut or ivory finish, or wood cabinet. Size 12 x 6 1/2 x 5 1/2 in. deep.

CAN BE BUILT FOR **£5/10/0**
Carriage and packing 2/6

INSTRUCTION BOOK for either above sets, or post free
CABINETS ONLY, plastic or wood. 17/6 Post 2/6.
All components available separately.

MAKERS' SURPLUS TV COMPONENT BARGAINS

- WIDE ANGLE 38 mm.**
- Line E.H.T. trans. ferrox-cube core. 9-10kV. 25/-
- Scanning Coils, low imp. line and frame 25/-
- Ferrox-cube cored Scanning Coils and Line Output Trans. 10-15 kV., EY61 winding. Line Trans. Complete with circuit diagram, the pair Frame Output Transformer 50/-
- Scanning Coils, low imp. line and frame 6/6
- Frame or line blocking osc. transformer 17/6
- Focus Magnet 200-250 v. 4/6
- Focus Magnet 200-250 v. 19/6
- P.M. Focus Magnets. Iron Cored .. 22/6
- 300 m/a. Smoothing Chokes 15/-
- Electromagnetic focus coil with combined scan coils 25/-
- STANDARD 34 mm.**
- Line Output Transformers 6.9 kV. E.H.T. and 6.3 v. winding. Ferrox-cube 19/6
- Scanning coils. Low imp. line and frame 12/6
- Duo by Ignite 14/6
- Frame or line blocking oscillator transformer 4/6
- Frame output transformer 7/6
- Focus Magnets 12/6
- Without Vernier 17/6
- Focus Coils, Electro-magnetic 12/6
- 200 m/a. Smoothing Chokes 10/6

BARGAIN OFFER!



***H.P. TERMS & CREDIT SALES available on certain goods**

BAND III CONVERTERS TURRET TUNERS AERIALS, Co-Ax. CABLE

Very large stocks. We have what you require.

CO-AX. CABLE

80 ohms semi-airspaced, finest quality, stranded. Per yard, 9d. Dozen yards 7/6
Any length supplied.

17 in. C.R. TUBES

Rectangular, aluminium or ion trap 0.3 heater. Brand **£12/19/6**
Carr. and Insur. 22/6.

LASKY'S NEW MIDGET T.R.F. CONSTRUCTOR PARCEL



CAN BE BUILT FOR ONLY 99/6

Post & Pkg. 5/-

Handsome contemporary design case, overall size 8 1/2 in. wide, 4 1/2 in. deep, 5 in. high. 2 latest double-purpose valves EBF9 and ECL80, contact cooled rectifier. For A.C. mains 200-250 v. Med. and long wave, 5in. P.M. speaker. Plastic cabinet in cream, pastel green, pink, blue. FULL DATA, instructions, circuit diagram and shopping list, 1/6 post free.
All components available separately.
CABINET only, as illus., 12/6 plus 4/6 post and pkg.

LASKY'S RADIO

CHASSIS

We have the largest stocks of chassis, A.M. and AM/FM. A.M. chassis, 1, m, s, from 7 Gns. AM/FM chassis from 14 Gns.

FERRITE RODS

Large selection of Ferrite Rods, all lengths, in stock. Price, per rod, 2/6 to 3/6.

MAINS TRANSFORMERS

All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.
MBA/3. 250-0-250 v. 90 mA. 6.3 v. 4 a. 5 v. 2 a. Both filaments tapped at 4 volts. **18/6**
MBA/7. 250-0-250 v. 90 mA. 6.3 v. 3 a. 5 v. 2 a. Both filaments tapped at 4 volts. **19/6**
AT/8. Auto trans. 0-10-120. 200-230-240 v. 100 watts **19/6**
M.T./34L. Tapped input 250-0-250. 120 mA. 6.3 v. 5 amps., fully shrouded. **27/6**

FILAMENT TRANSFORMERS

All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.
6.3 v. 1.5 amp. **5/11**
6.3 v. 3 amp. **9/6**
0-30 v. 2 amp. tapped voltages. **19/6**

GERMANIUM CRYSTAL DIODES

GEX.00 1/6, GEX.34 3/6, WG5 3/6, GEX. 54 and OAT 5/-, GD3 3/6, GD4 3/6. CG12E 6/-.

20,000 VALVES IN STOCK

Here are a few examples of brand new surplus and imported valves:
EBB1 7/6 EV41 10/6 HY86 14/6
EBB41 7/6 EP80 10/6 E240 8/6
EABC30 10/- EP83 10/6 E280 8/6
EAP42 10/- EP86 12/6 PCL82 12/6
EBC41 10/- EP89 10/- PCC84 12/6
ECC85 10/- 6K8 10/6 P141 13/6
ECC84 15/- 6V6 8/6 P142 10/6
ECC83 9/- 6K7 5/6 P143 11/6
ECC83 9/- 6Q7 10/6 PY80 10/6
RACN1 9/- 6B7 6/6 PY81 10/6
12AT7 8/6 8Z4 9/6 PY82 10/6
12AU7 8/6 12AP6 10/- PY83 10/6
12AX7 9/6 DL98 10/- GAT8 7/8
EBB9 10/6 DK96 10/- GAT7 7/6
EPC82 15/- DP96 10/- 1A5 7/6
ECH42 11/6 DM70 9/- 3A4 9/-
ECH81 11/6 EV31 12/6 1T4 9/-
ECL90 10/6 EC34 11/6 1R5 7/6
Also full stocks of B.V.A. Valves and C.R. Tubes at the new lower list prices.
WRITE FOR COMPLETE LIST

SPECIAL RECTIFIER OFFERS

RM.0, 125 v. 30 m/a. 4/11
RM.1, 125 v. 60 m/a. 5/11
RM.2, 125 v. 100 m/a. 6/6
RM.3, 125 v. 120 m/a. 7/6
RM.4, 250 v. 125 m/a. 16/-
RM.5, 250 v. 150 m/a. 21/-
Post extra.
All makes and types in stock. Send to us for your requirements.

LASKY'S (HARROW ROAD) LTD.

42 TOTTENHAM COURT ROAD, W.1.

Nearest Station Goodge Street MUSEum 2605

370 HARROW ROAD, PADDINGTON, W.9.

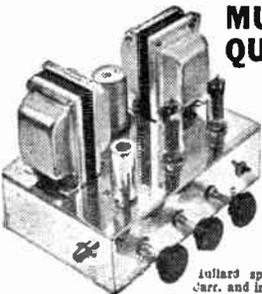
(Opposite Paddington Hospital) LAD 5075 and CUN 1979.

Open all day Saturday. Early closing Thursday (both addresses)



ALL MAIL ORDERS TO HARROW ROAD PLEASE

MULLARD "3-3" QUALITY AMPLIFIER



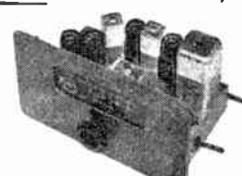
An ideal companion unit to the JASON Tuner. A really first-class 3-valve 3-watt amplifier with E.L.V. quality at a reasonable cost. Mullard's latest circuit. Valve line up: EF85, EL84, EZ80. H/duty mains trans. giving extra HT and LT for Tuner Unit addition.

Variable treble out and bass boost controls. Sensitivity 100 MV for 3-watt output. Frequency response + or - 1db. 40 c/s to 25 kc/s.

Complete amplifier wired and tested with quality sectioned output transformer to Mullard specification (less spacers) £8.8.0 Carr. and ins. 4/6.

Wire power output socket with Additional Smoothing 10/6 extra.

JASON F.M. TUNER UNIT 87-105 mc/s



F.M. TUNER UNIT (87 mc/s-105 mc/s) by Jason. As described in Radio Constructor. Designer Approved Kit of parts to build the modern highly successful unit. Directed chassis and superior type duals as illustrated coils, cans, and all quality components, etc. for unit. 5 gns. post free. Set of 4 spare 12P01 or 12P02 valves 30/- post free. Illustrated handbook with full details 2/-. Post free. Free with Kit: 42-hr Alignment Service. 7/6 and 2/- A.C.P.

EDDY'S
(N O T T M)
L T D
(D E P T W W)

THIS MONTH'S SPECIAL OFFERS

TRIPLETONE AMPLIFIERS. List price £6/19/6. Our price £5/19/6 plus 2/6 postage, etc. 200-250 v. A.C. 4 watts matched output for 2-3 ohms. Size only 8 x 4 x 4 1/4 in.

VALVES—6S17GT, 6V6GT, 6X5GT.

Special Feature of Treble, Middle and Bass Controls.

ALL NEW & GUARANTEED

SINGLE-PIECE THROAT MIKES. 1/- each. Post etc. 3d. each. Could be used for electrifying musical instruments.

MIDGET BATTERY ELIMINATORS. To convert all low consumption Portables for Mains operation. Mains input 200/240 v. A.C. H.T. output 85 v. 10 mA, L.T. output 1.3 v. 125 mA. Size 3.7 x 2.5 in. Actually smaller than H.T. battery alone! SPECIAL PRICE OF 55/- plus 2/6 post, etc.

NEW & GUARANTEED

ANY PARCEL INSURED AGAINST DAMAGE IN TRANSIT 6d. extra.		SURPLUS, NEW & GUARANTEED VALVES ALL TESTED BEFORE DESPATCH.		Post, etc. 6d. per valve extra over £2 free.	
DAF93	9/6	PCL83	13/11	4B80	3/11
DP94	9/6	PY80	8/3	6A6	6/6
DL96	9/6	PY81	8/6	6B76	7/-
DM70	7/11	PZ30	11/6	6F1	13/6
DH76	7/6	PL36	17/6	6C9	12/6
EA080	7/6	U11	8/-	6K70	2/11
ET81	8/6	U141	9/11	6L60	7/11
EC83	8/6	UGH13	8/-	6Q70	8/3
ECC84	10/-	UL81	11/6	6X0T	8/11
ECC85	9/6	U25	13/6	6V6GT	6/11
ECH85	9/6	UY41	7/6	10F1	14/11
EC180	8/11	U76	7/6	10F9	11/6
EP41	9/-	W76	7/6	12A7	7/6
EP80	8/3	1A70	12/6	12K70	7/6
EP86	12/6	1C50	10/6	12Q70	7/6
EP89	9/11	1H30	10/6	1A87	13/6
EP91	6/11	1N50	10/6	25L6GT	9/-
EL93	3/11	1R51	7/11	25Z40	9/-
EL81	8/-	1S5	7/-	33A5	11/6
EV31	11/6	1T4	7/-	33W4	7/6
EZ80	8/-	3Q4	9/-	35Z40	6/11
EZ81	9/6	3Q5	9/6	407	7/6
GZ82	12/6	3R4	9/-	934	1/6
GZ84	13/11	3V4	8/-	955	3/11
MA	8/11	3Y3GT	7/6	956	2/6
PCC84	8/-	5Z40	9/6	958	3/11

ELECTROLYTICS ALL TYPES NEW STOCK

TUBULAR

25/25 v. 50/25 v. 1/3
50/50 v. 4/50 v. 2/-
100/250 v. 1/9
8/450 v. 2/3
8/500 v. 2/9
8+8/500 v. 4/3
8+16/450 v. 5/-
16/450 v. 3/6
16+16/450 v. 6/6
32/350 v. 4/-
32+32/350 v. 5/-
32+32/450 v. 6/6
32+32/500 v. 6/6

CAN TYPES

8+8/450 v. 4/6
8+16/450 v. 5/-
8+16/500 v. 5/6
16+16/450 v. 6/6
16+16+3/250 v. 5/6
32+32/250 v. 5/6
32+32/275 v. 4/6
50+50/250 v. 6/6
60+50 v. 6/6
60+250/275 v. 12/6
64+120/275 v. 11/6
100+200/275 v. 12/6
130/270 v. 6/6

MIDGET FRAMPTON TYPE 22. 2uF. 2uF
4uF 6V 3/6. 6uF 10uF 15uF 3V. 3/6.
2uF 11V 3/6.

SPEAKER FRET.—Expanded Bronze

anodized metal. 4 x 4 in., 2 3/4 x 12 x 8 in., 3 1/2 x 12 x 12 in., 4 1/2 x 12 x 12 in., 4 1/2 x 12 x 18 in., 6 1/2 x 24 x 12 in., 9 1/2 x 24 in., etc. Any unperfected size cut.

TYGON FRET (Murphy pattern) 12 in. x 12 in.

2 1/2 x 12 x 12 in. 3 1/2 x 12 x 24 in. 4 1/2 x 12 in.

ALL GUARANTEED BOXED VALVES

1B5, 1T4 7/6	8AB020 9/6	EZ80	3/6
185 184 7/6	EB91	6/6	MU11 9/6
2N1 3V4 8/6	ECM41 9/6	PL44	10/6
2Z4 9/6	ECCM3 10/6	PCP80	10/6
6AT6 8/6	ECCM4 12/6	PC82	10/6
6C7 8/6	ECF90 12/6	PC83	12/3
6K9 8/6	ECF82 12/6	PL82	10/6
6Q7 8/6	ECH42 10/6	PL83	11/6
6SN7 9/6	ECM11 10/6	PV30	9/6
4V6 7/6	ECL91 10/6	PV81	9/6
6X4 7/6	EF41 10/6	PY82	8/6
6X5 7/6	EP40 10/6	PY83	10/6
7C8 9/6	EPM4 12/6	U22	8/6
7Y4 8/6	EP91 8/6	UBC41	9/6
DAF96 9/6	EL41 10/6	UCH43 10/6	
DP96 9/6	EL84 11/6	UF11	10/6
DK96 9/6	EY31 10/6	UL41	10/6
DL96 9/6	EZ40 8/6	UY41	8/6

CONDENSERS.—Mica, Silver Mica. All pre- values, 3 pt. to 1,000. pt. 6d. each. Ditto ceramic 6d. each. Tubular, 450 v. Houis and T.C.C. .001 mid. -0.1 and 1/350 v. 9d. each. .02-1/500 v. 1/- each. 25 Houis, 1/6. 5 Houis, 1/6. .001 mid. 6k. 5/6. 601 mid. 20k. 7/6.

CLOSE TOLERANCE CONDENSERS 8/Mica.

10 x 10 Type. 5 pt. -500 pf., each 1/-; 600 pf. -5,000 pf. each 1/3. 1 1/2 x 1 1/2 pf. -50 pf. (Tot. 1 pt. n. 1/9; 50 pf. -500 pf. each 1/6; 575 pf. -5,000 pf. each 2/-.

RESISTORS.—Prof. val. 10 ohms 10M ohms.

CARBON WIRE-WOUND

20% Type. 1 w. 3d. 1 w. 5d. 1 w. 6d. 1 w. 9d. 10% Type. 1 w. 9d. 1 w. 1/6. 1 w. 1/3. 1 w. 2/6. 1 w. 4/6.

WIRE-WOUND POT:

Pre-set Min. T.V. Type Knurled Blot- Type Knob. All values 25 ohms to 50 K. 3/- ea 50 K. 4/-, Ditto, Carbon Track 50 K. to 2 Meg. 3/-.

SPECIAL PRICE PER SET

25, 1T4, 185 184, or 354, or 3V4 27/6
DK96, DP96, DAF96, DL96, ... 35/-
6K9 6Q7 6V6 3Z4 or 6X5 35/-

TRANSISTORS. Mica surplus PNP Junction type. Audio Type, 800 kc/s 250 uW 9/6; R.F. and L.O. Mixer Type, 2.5 Mc/s. 19/6. All tested and guaranteed 1.

Vol. Controls 80 ohm COAX

Log ratio, 10,000 ohms—2 Megohms, 1 yr. guarantee. Midget Ediswan type. No Sw. 3/-; 5 P. Sw. 4/-; U.P. Sw. 4/6. Lines: Rectos 10,000 ohms—2 Meg. ohms. Lens switch, 3/ each. Coax plugs 1/2. Coax sockets 1/-. Couplers 1/2. 50%. Outer boxes 4/6.

STANDARD 1/2 in. diam. Polythene insulated GRADE "A" ONLY.

8d. yd.

SPECIAL— Semi-air spaced polythene. 80 ohm Coax 1/2 in. diam. Standard core. 10000 cut. 9d. yd.

IDEAL BAND 3

SMOOTH BOY. EMITAPE, etc. 1,200 ft. 27/-.

Long paying 1,800 ft. reels 45/- each. 1 1/2 in. 3/-. 5 in. 3/8. 7 in. 4/3.

FENTRECEL RECTIFIERS. E.H.T. Type. Fly-Back Voltage. K3/25 2 kV. 5/-; K3/40 2.5 kV. 9/9; K3/45 3 kV. 7/3; K3/50 4 kV. 7/9; K3/100 v. kV. 13/6. Type. 12.5 p.f. **RAIN TYPE.**—RM1 125 v. 40 mA. 4/8; RM2 125 v. 100 mA. 5/6; RM3 125 v. 130 mA. 7/6; RM4 250 v. 250 mA. 16/-; RM4B Type 270 mA. 17/6. RM5 250 v. 300 mA. 21/-.

TRIMMERS, Ceramic, 4 pf. -70 pf., 9d. 100 pf., 150 pf., 1/3; 250 pf., 1/6; 600 pf., 1/8. PHILIPS Bective Type—2 to 8 pf. or 3 to 50 n. 1/- each.

LOUDSPEAKER.— PM. 3 ohm. 4 1/2 in. Flac. 17/6. 3 1/2 in. Goodmans 18/6; 5 in. Box 16/6; 4 in. Flac. 13/6; 7 x 4 in. Goodmans 18/6; 8 in. Flac. Box 20/-; 10 in. R. and A. 25/-; 10 in. WB-HP1012. 99/9; 12 in. Plesey 15 ohm with 6 x 4 in. Tweeter and Cross Over Filter 97/3.

TRS RADIO COMPONENT SPECIALISTS

70 BRIGSTOCK RD., THORNTON HEATH, SURREY

Phone: THO 2188. Hours 9 a.m.—5 p.m., 1 p.m. Wed. Open all day Saturday By THORNTON HEATH STATION.

TRANSFORMER & COIL/WINDING CAPACITY AVAILABLE FOR PROTOTYPES & SMALL RUNS.

172, ALFRETON RD., NOTTINGHAM

ASK ARTHUR FIRST

LARGE STOCKS OF VALVES and C.R.T.s. METERS, Avo, Advance, Taylor, and Cossor Oscilloscopes in stock. AMPLIFIERS, Leak, Trix & Quad. GRAM UNITS, Garrard & Collaro. Collaro TRANSCRIPTION UNIT 2010PX.

LOUDSPEAKERS, Goodmans, Wharfedale, WB Tannoy and leading makes. PICK-UPS and STYLIs of most makes. TAPE RECORDERS, Grundig, Philips, Truvox, Playtime & Ferrograph.

LATEST VALVE MANUALS Mullard, 10/6; Osram & Brimar No. 6, 5/- each; Osram Part 2, 10/-.

Postage 9d. each extra.

PARTICULARS ON REQUEST Terms C.O.D. OR CASH with order.



EST. 1919
PROPS: ARTHUR GRAY, LTD.

GRAY HOUSE, 150-152 CHARING CROSS ROAD, LONDON, W.C.2
TEmple Bar 5833/4 and 4765 Cables: TELEGRAY, LONDON

Terms: C.W.O. or C.O.D. Kindly make cheques, P.O.s, etc., payable to A.R.S. Post and Packing up to 10d 7d. 1lb. 1/1. 3lb 1/6. 5lb 2/-. 10lb 2/9. Bargain Lists 3s.



Stern's "fidelity" TAPE RECORDER

"IT REALLY DOES SOUND BETTER THAN ANY OTHER"

TESTED AND APPROVED AT THE TRUVOX LABORATORIES

IT INCORPORATES: The NEW TRUVOX Mk. IV TAPE DECK together with the "fidelity" MODEL HF/TR2 TAPE AMPLIFIER (both fully described on this page), and a Rola 10x6in. P.M. speaker.

BEFORE CHOOSING YOUR TAPE RECORDER YOU SHOULD HEAR THIS MODEL—TRULY "Hi-Fi" RECORDINGS ARE OBTAINABLE and it is comparable to much higher-priced Recorders.

Alternatively send S.A.E. for ILLUSTRATED LEAFLET.

PRICE . . . Including CRYSTAL MIKE and 1,200ft. reel of PLASTIC TAPE.

£49.10.0. (OR £3 EXTRA WITH REV. COUNTER.)

(Plus £1/10/- carriage and Insurance, of which £1 is refunded on return of Packing Case.)

CREDIT SALE: Deposit £12/8/- and 1 monthly payments of £1/10/3.

HIRE PURCHASE: Deposit £23/15/- and 12 monthly payments of £2/5/11.

A COMPLETE KIT OF PARTS TO BUILD The "fidelity" TAPE AMPLIFIER Model HF/TR2 including POWER SUPPLY UNIT FOR ONLY £12.0.0 (Plus 5/- carr. and ins.)

This amplifier has been expressly designed to meet the requirements of the enthusiasts for High Fidelity reproduction. It is based on the very successful design, completed by the Mullard Technicians and only really high-grade components are incorporated; truly HIGH FIDELITY Recordings are obtainable whilst "Hi-Fi" reproduction is assured by use of a high-quality Output Transformer by Gilman. It incorporates a "magic eye" Recording Level indicator, a two-position equaliser for 3 1/2in. and 7 1/2in. speeds, and an effective Tone Control arrangement. Monitoring and Extension Speaker Socket are incorporated and in addition a provision is provided to enable it to be used as an independent Amplifier for Gramophone Records or Radio Tuning Unit. Overall size: 11in. x 8in. x 6in. high. Suitable for nearly all makes of Tape Decks. When ordering, please advise make of deck in use. THE ASSEMBLY MANUAL PRACTICAL DIAGRAMS, etc. are available for 2/6 or send S.A.E. for brief details.



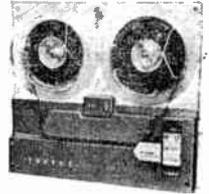
WE ALSO SUPPLY THE HF/TR2 ASSEMBLED AND READY FOR USE FOR £16.0.0. (Plus 5/- carr. & ins.) H.P. TERMS: Deposit £3 and 9 monthly payments of £1. CREDIT TERMS: Deposit £4 and 9 monthly payments of £1/9/4.

THE NEW TRUVOX MkIV TAPE DECK UNDOUBTEDLY ONE OF THE BEST TAPE DECKS ON THE MARKET.

PRICE **£27.6.0** (Plus 10/- carr. and ins.)

CREDIT TERMS: Deposit £6/17/- and 9 monthly payments of £2/10/-.

H.P. TERMS: Deposit £13/13/- and 12 monthly payments of £1/5/4.



SPECIFICATION:—● 3 B.T.H. shaded pole motors with silent friction drive elimination wobble and flutter. ● Push-button controls, electrically and mechanically interlocked (patented). ● Patented electric-type push-button controlled brake. ● Inching to assist editing; tape loading on the drop-in principal accommodation for reels of 7 1/2 diameter. ● Tracking sense. To British and American standards. ● Playing times; Up to 3 hours with L.P. Tape or 2 hours with Standard Tapes. ● Two tracks side by side with safety gap. ● Playing time indication by precision revolution counter or large visual type indicator plate according to choice. ● Positive Asimuth adjustment of Record Player Head. ● High Impedance Heads. ● The metal work is Gold Hammered finish. ● Overall size 14 1/2in. x 12 1/2in. from top of face of panel, overall depth 5in.

The Mk. IV DECK CAN ALSO BE SUPPLIED INCORPORATING PRECISION REV. COUNTER for £30/9/-. H.P. TERMS: Deposit £15/4/8 and 12 months of £1/8/3. CREDIT SALE: Deposit £7/12/ and 9 months of £2/15/10.

Home Constructors!
BUILD YOUR OWN "Hi-Fi" TAPE RECORDER WE OFFER YOU

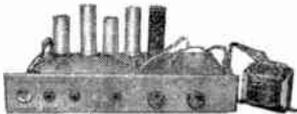
- a) The model HF/TR2 AMPLIFIER and POWER UNIT, both fully assembled, together with the TRUVOX MK IV TAPE DECK for . . . **£38 10 0**
ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS **£35 0 0**
- b) The model HF/TR2 AMPLIFIER and POWER UNIT both fully assembled, together with the TRUVOX TAPE DECK incorporating PRECISION REV. COUNTER **£41 10 0**
ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS **£38 0 0**
- c) The model HF/TR2 AMPLIFIER and POWER UNIT both fully assembled, together with the COLLARO TRANSCRIBTOR **£35 0 0**
ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS **£31 10 0**
plus 12/6 Carr. and Insurance.

TO COMPLETE THE RECORDER . . . WE OFFER

The Portable Carrying Case, . . . Also
Crystal Mike . . . Rola 10" x 6" P.M.
SPEAKER . . . 1,200 ft. Plastic Tape
ALL FOR **£8.10.0** (plus 7/6 carr. & ins.)

STERN'S TAPE PRE-AMPLIFIER and ERASE UNIT

Provides the "Link" between the HIGH-QUALITY AMPLIFIER and TAPE DECK.



MODEL HF/TR1P . . . A completely assembled Pre-Amplifier with own Power Supply. Can be supplied correctly matched for use with Truvox, Brenell or Collaro Decks, and incorporates Recording Level Indicator and Monitoring facilities. Please send S.A.E. with any inquiry.

PRICE **£11.10.0** (plus 5/- carr. and insurance)

WE MAKE SPECIALLY REDUCED PRICES FOR COMBINED ORDERS

OR ADD TAPE TO YOUR EXISTING AMPLIFIER . . . WE OFFER YOU

- (a) The Model HF/TRIP TAPE PRE-AMPLIFIER together with the TRUVOX MK IV TAPE DECK **£31 0 0**
- (b) ALTERNATIVELY as in (a) above but Truvox Deck incorporating PRECISION REV. COUNTER **£33 0 0**
- (c) The model HF/TRIP TAPE PRE-AMPLIFIER together with the COLLARO TRANSCRIBTOR Tape Deck **£31 10 0**

PLEASE INCLUDE 12/6 to cover cost of Carriage and Insurance.

HIRE PURCHASE and CREDIT SALE TERMS are available on all equipment (excepting Kits of Parts). Send S.A.E. for details.

NOTE . . . The Collaro Transcriber is in short supply and there may be a delay in delivery. We will however book an order.

The Deck switches of the Transcriber have to be "wire l-up." We will complete this wiring, for use with either the HF/TR2 or the HF/TR1P for an extra charge of £1.1.

ADVANCE NEWS!! Our "fidelity Junior" Tape Recorder will be available mid-January. It incorporates as the TRUVOX Mk. III TAPE DECK and the correctly matched HF/TR1A TAPE AMPLIFIER. Price is only 39 0/6.

Open Monday to Friday 9 a.m.—6 p.m. Saturday 9 a.m.—1 p.m.

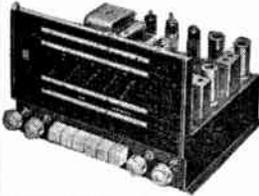
STERN RADIO LTD.
(DEPT 109/W)
109 & 115 FLEET ST., LONDON, E.C.4
Telephone: FLEet St. 5812/3/4

IT'S MUCH BETTER

MODERNISE YOUR OLD RADIOGRAM

IT'S MUCH CHEAPER

THE NEW ARMSTRONG P.B.409 AM/FM RADIOGRAM CHASSIS



£29.8.0

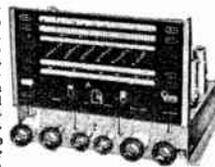
(Plus 7/6 carr. & ins.)

TERMS: Credit Deposit £7/7/- and 9 monthly payments of £2/14/- H.P. Dep. £14/- and 12 monthly payments of £1/7/3.

BRIEF SPECIFICATION:-

A 9 valve line up employing the latest MULLARD preferred-type valves. Provides complete coverage of the VHF/FM Transmissions, plus the SHORT, MEDIUM and LONG waves. Has Push-Pull output, with negative feedback, for 6 Watts Peak output. Quick action "Piano" Key Selectors and separate Bass and Treble Controls. Has "Magic Eye" Tuning Indicator. Dimensions 18in. x 9in. x 8in. high. Dial size 1 1/2in. x 5 1/2in.

THE ARMSTRONG MODEL A.F. 105 AM/FM RADIOGRAM CHASSIS
A Genuinely Hand Made Chassis

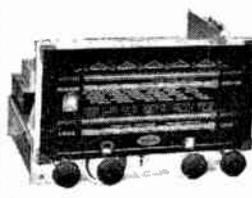


Developed to meet the needs of those who require really high quality radio and record reproduction but who, for reasons of expense or lack of room in existing or proposed cabinets, cannot consider the normal high-fidelity system. The A.F.105 is as good as, or better than, many of the high quality amplifiers, and Associated units. Independent and continuously variable Bass and Treble controls give a wide range of control. **SEND S.A.E. FOR DETAILS.**

PRICE £37 (Plus 7/6 carr. and ins.)

CREDIT SALE TERMS: Deposit £9/5/- and 9 monthly payments of £3/7/10.
HI-RE PURCHASE TERMS: Deposit £18/10/- and 12 monthly payments of £1/14/4.

THE DULCI MODEL H.4



COMBINED AM/FM RADIOGRAM CHASSIS

A 4 Waveband Receiver designed for first-rate reproduction of Radio and Gram.

PRICE £24.6.6

(Plus 7/6 carr. & ins.)

CREDIT TERMS: Deposit £2/2/- and 9 monthly payments of £2/4/7. **H.P. TERMS:** Deposit £12/3/3 and 12 monthly payments of £1/3/7.

BRIEF SPECIFICATION:-

- Covers Short, Medium, Long and F.M. Wavebands
 - Employs full A.V.C.
 - The Latest 7-valve line-up
 - For 3 or 15 ohm P.M. Speakers.
 - "Magic Eye" Tuning Indicator.
 - Excellent Tone range up to 4 watts output.
 - Internal aerial for local stations.
 - Overall size 12in. x 9 1/2in. x 7 1/2in. high.
- A good Quality Chassis and Well Recommended.

THE DULCI MODEL H.4T

Combined AM/FM Tuning Unit incorporating own Power Supply.

MODEL H.4T. This model is the "TUNER UNIT VERSION" of the H.4 Radiogram Chassis illustrated and described above. It has the same coverage of A.M. and F.M. Wavebands (4 altogether) and precisely the same in size and appearance, except that it has three Controls only, being: TUNING, WAVECHANGES and Volume On/Off, mounted centrally on the chassis. A self-contained Tuner incorporating own Power Supply.

PRICE

£20.17.0

(plus 7/6 carr. & ins.)

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/13/4. **H.P. TERMS:** Deposit £10/8/6 and 12 monthly payments of 19/4.

HOME CONSTRUCTORS !! BUILD YOUR OWN "Hi-Fi" LOUDSPEAKER SYSTEM

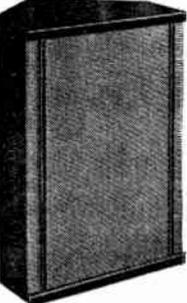
WITH W.B.'s WELL KNOWN RANGE OF READY-TO-ASSEMBLE CABINETS, ALL ARE BEAUTIFULLY MADE AND FINISHED AND VERY EASILY ASSEMBLED. ONLY A SCREWDRIVER IS REQUIRED. THEY ARE PACKED FLAT IN CARTONS AND COMPLETE WITH SCREWS.

WE SHOW A FEW HERE BUT OTHERS ARE AVAILABLE. SEND S.A.E. FOR LEAFLET.

CALL IN AND LISTEN TO THEM.

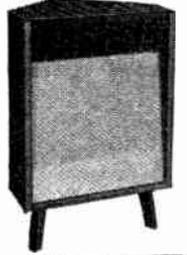
THE JUNIOR BASS REFLEX CORNER CONSOLE

A new contemporary-style cabinet, specially designed to give maximum reproduction quality from Stenorian 8in. or 10in. units, with provision for Tweeter Unit, if required. Measures 33in. x 22in. x 18 1/2in. Price £9/9/- or with the 8in. Stenorian Speaker £13/12/6 or with 10in. Stenorian Speaker £14/8/6.



The "PRELUDE" HI FI CONSOLE CABINET

Takes any make of tape-deck or record player amplifier, pre-amplifier control unit, and radio tuner. Size 33in. x 19in. x 19 1/2in. Height above baseboard is 6 1/2in. Price £13/13/-.



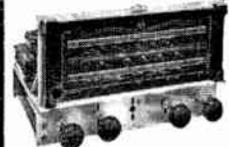
THE "PRELUDE" BASS REFLEX CORNER CONSOLE

This most attractive cabinet has been specially designed to utilise the natural acoustic properties of the walls, and is also obviously suitable for use where space-saving is a consideration. It is sturdily constructed to take every advantage of Stenorian 8in. or 10in. units, with provision for Tweeter Unit. Size 33in. x 21in. x 17in. Price £10/10/0 or with the 8in. Stenorian Speaker £14/13/6 or with the 10in. Stenorian Speaker £15/9/6.

The "PRELUDE" HI FI TABLE CABINET

Designed to take any make of Tape Deck or Single Record Player (not Auto-changers) Amplifier, Pre-amplifier Control Unit, and Radio Tuner. Price £20/18/6. Size 19 1/2in. x 19in. x 19 1/2in.

HIRE PURCHASE AND CREDIT SALE TERMS ARE AVAILABLE. SEND S.A.E. FOR DETAILS. WE ALSO HAVE THE GODMANS SHERWOOD ENCLOSED IN STOCK.



THE DULCI MODEL H3. COMBINED AM/FM RADIOGRAM CHASSIS

This model is very similar to the model H.4 described above but covers 3 WAVEBANDS instead of 4 (omitting the Short Band) and is for 3 ohm Speakers only. Overall size is as for the H.4.

PRICE £20.17.0 (Plus 7/6 carr. and ins.)

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/13/4. **H.P. TERMS:** Deposit £10/8/6 and 12 monthly payments of 19/4.

Stern's "fidelity" F.M. TUNING UNIT

A 5-Valve Tuner incorporating the latest Mullard Permanently Tuned Unit. Price assembled less Power Supply:

£14.10.0

(Plus 7/6 carr. and ins.).
TERMS: (a) H.P. Deposit £7/5/- and 9 monthly payments of 18/4; (b) Credit Deposit £3/12/6 and 9 monthly payments of £1/6/7. Provides "Hi-Fi" reproduction with any make of Amplifier and many Radio Receivers. It incorporates: 6 The latest Valve line-up—ECC82, 2 type EF34, EF91 and EM80. A "Magic Eye" Indicator. Power consumption is 1.7 amps at 6.3 volts and 25 m.a. at 250 volts.

STERN'S "fidelity" COMBINED A.M. and F.M. TUNING UNIT

This is IDENTICAL to the Stern's F.M. Tuner illustrated above, but in addition incorporates the MEDIUM WAVEBAND and thereby also provides a selection of foreign stations. **PRICE £18.18.0** (Plus 7/6 carr. and ins.)

TERMS:—(a) H.P. Deposit £9/9/- and 10 monthly payments of £1/1/-; (b) Credit Deposit £4/15/- and 9 monthly payments of £1/14/7. Send S.A.E. if further data required.

HOME CONSTRUCTORS... You can build

(a) The "fidelity" F.M. TUNING UNIT FOR **£10.0.0**
(b) The "fidelity" AM/FM TUNING UNIT for **£13.0.0**

THE COMPLETE ASSEMBLY DIAGRAMS and INSTRUCTIONS CAN BE OBTAINED FOR 1/6 each

STERN'S POWER SUPPLY UNITS

Fully smoothed with all output connections terminated to connecting Blocks, thereby enabling ease of connecting to a Radio Tuner Unit or Amplifier, etc. (The Compact 5 Amplifiers are immediately connected in this way). Overall size of Units is 9 1/2in. x 3 1/2in. x 4 1/2in. high. **TWO MODELS ARE AVAILABLE.** Type "A" Unit provides 250-300 volts at up to 70 m.a. and 6.3 volts at 3 1/2 amps.

PRICE £2.17.6 (Plus 2/- carr. and ins.)

Type "B" Unit provides 250-300 volts at up to 100 m.a. and 6.3 volts at 3 1/2 amps.
PRICE £3.3.0 (Plus 2/- carr. and ins.)

WE ALSO SUPPLY THESE UNITS AS COMPLETE KITS OF PARTS

A detailed wiring-up leaflet is supplied (this is available separately for 9d.), and they are very quickly and easily assembled.
Type "A" Unit Complete Kit **PRICE £2/9/6**
Type "B" Unit Complete Kit **PRICE £2/15/-** (Carriage and insurance is 2/- extra.)

"FRUSTRATED EXPORT ORDER"

The Cosmor Model 527X 4 Valve "All-dry" Battery Portable. Offered For **£6.15.0** Plus 5/- carr. & ins.



Consists of a 4 valve Superhet Receiver covering Medium Waveband 187-575 metres, and two Short Wavebands 15.6 to 136 metres. The new low consumption valves are incorporated and the whole is accommodated in an attractive robustly made case. Battery required is 90 volts and 1.4 volts (price 19/8) and is external to case.

RECORD PLAYERS THE VERY LATEST MODELS ARE IN STOCK

MANY AT REDUCED PRICES !!! TRANSCRIPTION UNITS—AUTOCHANGERS SINGLE RECORD PLAYERS

Send S.A.E. for ILLUSTRATED STOCK LIST

CASH ONLY OFFER !!!

This latest Brand New B.S.R. MONARCH 4-SPEED AUTOCHANGER **£38.7.6** (Plus 5/- carr. and ins.)

Minimum baseboard size required 14in. x 12 1/2in., with height above 5 1/2in., & height below baseboard 2 1/2in.



WE ALSO HAVE A FEW ONLY COLLARO MODEL 458 4-Speed "Mixer" Autochangers. The Units are BRAND NEW and incorporate the STUDIO "O" Pick-up. **PRICE £8.19.6** (Plus 5/- carr. and ins.)

Open Monday to Friday 9 a.m.—6 p.m. Saturday 9 a.m.—1 p.m.

STERN RADIO LTD.

**AMPLIFIERS
PRE-AMPLIFIERS**

**HIGH FIDELITY
FOR THE
HOME CONSTRUCTOR**

**TUNING UNITS
RADIO RECEIVERS**

—COMPLETE KITS OF PARTS FOR THE "Hi-Fi" ENTHUSIAST—

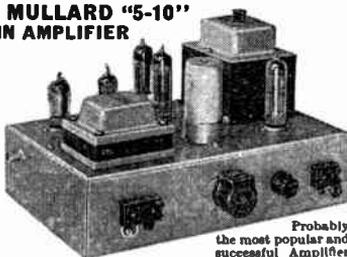
QUALITY OF THIS NATURE HAS NEVER BEFORE BEEN OFFERED AT SUCH LOW COST

STERN'S REMOTE CONTROL UNIT
Designed in particular for use with the MULLARD 5-10 Main Amplifier.

Ideally suited for simple domestic installation as an alternative to the more elaborate Pre-amplifier (shown and described opposite). Tone Control facilities are really excellent and in conjunction with the "5-10" Main Amplifier reproduction is of very high quality. Perfectly suitable for use with all the popular Record Players (B.S.R., Colilar, Garrard) and the modern Radio Tuner Units. Front Panel contains: (a) Coloured Indicator; (b) Separate BASS and TREBLE CONTROLS; (c) 3 position Selector Switch; (d) Volume Control. Inputs on back for Radio and Gram and Gram equalising is incorporated. FULL DATA is contained in the 5-10 MAIN AMPLIFIER MANUAL at 1/6.



The MULLARD "5-10" MAIN AMPLIFIER



Probably the most popular and successful Amplifier yet designed and certainly needs no recommendation from us. Our kit is complete to MULLARD'S specification including the latest PARBEKO ULTRA LINEAR OUTPUT TRANSFORMER and the recommended Mullard Valve line-up. All specified Components are supplied and Power Supply is available to drive a Radio Tuner Unit.

PRICE OF COMPLETE KIT OF PARTS £9.10.0
(Plus 5/- carr. & ins.)
or alternatively we supply—
FULLY ASSEMBLED AND TESTED for £11.10.0
(Plus 5/- carr. & ins.)

WE ALSO OFFER THE "5-10" INCORPORATING THE LATEST PARBEKO ULTRA LINEAR OUTPUT TRANSFORMER FOR AN EXTRA £1/6/-
The ASSEMBLY MANUAL containing FULL SPECIFICATION is available for 1/6. It also includes full data on the REMOTE CONTROL UNIT.

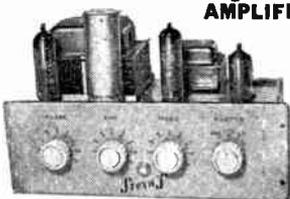
STERN'S "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT

"A design for the Music Lover"



This unit can be used with any Main Amplifier. Briefly it has inputs for all types of MICROPHONES, HIGH and LOW GAIN PICK-UPS and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL. (b) STEEP CUT FILTER. (c) Continuously variable BASS and TREBLE CONTROLS, a variable OUTPUT CONTROL which enables its use with any type of Amplifier, and Jack Sockets are incorporated for TAPE RECORD and TAPE PLAYBACK. Used with the "5-10" the reproduction is comparable to that normally associated only with the very expensive commercially made High Fidelity Amplifiers. **£6.6.0**
PRICE OF COMPLETE KIT OF PARTS
WE ALSO OFFER IT ASSEMBLED READY FOR USE £8 (plus 5/- carr. & ins.)
The ASSEMBLY MANUAL contains full specification and is available for 1/6.

THE MULLARD "3-3" QUALITY AMPLIFIER



A small Compact Amplifier capable of VERY HIGH QUALITY REPRODUCTION on both RADIO and GRAM.

PRICE for Complete KIT OF PARTS... £6.19.6
(plus 5/- carr. & ins.)
Alternatively supplied ASSEMBLED and READY FOR USE... **£8.12.6**
(plus 5/- carr. & ins.)

The complete SPECIFICATION and ASSEMBLY DIAGRAMS are available for 1/6.
Developed from the very popular 3 valve 3 watt Amplifier designed in the Mullard Laboratories. We strictly adhere to their specification but in addition we have added switched equalising for L.P. and 78 records and a position for Radio Inputs, plus additional power to feed a Radio Tuning Unit. Extremely simple to assemble and ideally suitable to incorporate with an F.M. Tuner and Record Player in a small installation.

BRITAIN'S FINEST "Hi-Fi" AMPLIFIER

The GENUINE WILLIAMSON

"Still sets the standard for all amplifiers." Many versions of the Williamson have been offered to the public at various low prices,



but the "only Williamson" is the Amplifier built to the designer's

specification and employing the very highest grade Components that he specifies, i.e. PART-EDGE TRANSFORMERS, CHOKES, etc. It is only in doing this that the exceptionally high standard that has made this Amplifier so famous, particularly in America, is obtained... WE HAVE DONE THIS!!!... and we offer these KITS OF PARTS, including Partridge and other high-grade Components, at follow—

- (a) To build the MAIN AMPLIFIER ONLY **£14.10.0** (illustrated above)
- (b) To build the TWIN POWER SUPPLY UNIT only... **£13.10.0**
- (c) COMPLETE KIT to build both above **£27.0.0**

We will also supply COMPLETELY ASSEMBLED and will be pleased to quote. Credit and H.P. Terms are available. The complete SPECIFICATION and general ASSEMBLY INSTRUCTIONS are available for 3/6.

Our "fidelity" PRE-AMPLIFIER, illustrated and described above, or alternatively the RCA Pre-Amplifier at £16/5/-, is recommended for use with the Williamson.

DEPT. 109/W

**109-115 FLEET ST.
LONDON, E.C.4**

Phone: FLEet Street 5812-3-4.

WE ALSO OFFER THE "5-10" INCORPORATING THE LATEST PARBEKO ULTRA LINEAR OUTPUT TRANSFORMER FOR AN EXTRA £1/6/-
The ASSEMBLY MANUAL containing FULL SPECIFICATION is available for 1/6. It also includes full data on the REMOTE CONTROL UNIT.

- (a) The COMPLETE KIT OF PARTS to build both the MULLARD 5-10 and the REMOTE CONTROL **£11.11.0**
 - (b) The COMPLETE KIT OF PARTS to build both the MULLARD 5-10 and the "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for **£15.15.0**
ALTERNATIVELY WE WILL SUPPLY ASSEMBLED and FULLY TESTED, as follows:—
 - (a) The MULLARD 5-10 and the REMOTE CONTROL UNIT for **£14.0.0**
CREDIT SALE TERMS: £3/10/- Deposit and 9 monthly payments of £1/5/8. H.P. TERMS: £7 Deposit and 9 monthly payments of 17/6.
 - (b) The MULLARD 5-10 and the "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for **£18.18.0**
CREDIT SALE TERMS: £4/15/- Deposit and 9 monthly payments of £1/14/7. H.P. TERMS: £9/8/- Deposit and 12 monthly payments of 17/6.
- THE ABOVE PRICES ARE SUBJECT TO 1/6/- EXTRA IF PARTRIDGE TRANSFORMER IS PREFERRED.
WHEN ORDERING PLEASE INCLUDE 7/6 to cover cost of Carriage and Insurance

**SPECIAL PRICE
REDUCTIONS—WE OFFER**

A COMPLETE KIT OF PARTS, STERN'S "HIGH QUALITY" 8-10 WATT AMPLIFIER



Has power supply available for Radio Tuning Unit. Price of COMPLETE KIT OF PARTS **£7.10.0** (plus 5/- carr. & ins.)

WE ALSO OFFER IT ASSEMBLED and READY FOR USE for £9.10.0 (plus 5/- carr. & ins.)

This amplifier has proved one of the most popular models yet offered to the HOME CONSTRUCTOR. It provides really excellent reproduction up to 8 watts, employing 8V6's in push-pull and incorporating negative feedback. Provides for the use of both 3 and 15 ohm Speakers. The complete SPECIFICATION and BUILDING INSTRUCTIONS are available for 1/6.
"Wire-to-Wire" Diagrams are included and all Components are available separately

SPECIAL CASH ONLY OFFER!!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched 6 1/2" P.M. SPEAKER, ALL FOR **£8.7.6** ONLY (plus 7/6 carr. & ins.)



The Amplifier consists of a 2 Stage design incorporating the modern B.V.A. valve types ECC83, EL84 plus EZ80 Rectifier and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Maroon and Grey colour Bexins—**WE ALSO SUPPLY SEPARATELY:—**
(a) The 2-Stage (plus Rectifier) AMPLIFIER **£4/2/6**

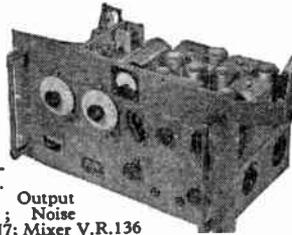
THE FOLLOWING HIGH FIDELITY AMPLIFIERS ARE IN STOCK

- STERN'S COMPACT "5-2." A 2-stage high sensitivity Amplifier having separate BASS and TREBLE Controls and GRAM EQUALISING. Developed for high quality reproduction, includes separate Power Supply Unit with spare power available to drive **£8.16.0** Radio Tuner.
 - THE DULCI MODEL D.P.A.10. A 10 watt "Ultra Linear" High Fidelity Amplifier with separate PRE-AMP-TONE CONTROL UNIT **£19.19.0**
 - THE DULCI MODEL H11. A self powered AM/FM Tuning Unit combined with a "Hi Fi" Pre-Amplifier Tone Control Unit—all on one **£29.3.10** Chassis.
 - THE ARMSTRONG MODEL A.10 MR. II. With associate PRE-AMP-TONE CONTROL UNIT, this model is perfectly consistent with Armstrong's very high reputation. **£32.0.0**
 - THE NEW LEAK "VARISLOPE" PRE-AMPLIFIER together with the TL12 plus AMPLIFIER **£34.13.0**
 - THE "VARISLOPE" is available separately for **£15.15.0**
 - THE ROGERS "JUNIOR." With associate PRE-AMP-TONE CONTROL UNIT **£26.0.0**
 - THE RCA "ORTHOPHONIC." 12-20 watt high Fidelity Amplifier and associate PRE-AMPLIFIER TONE CONTROL UNIT **£41.0.0**
- HIRE PURCHASE and CREDIT TERMS are available on all models.
Illustrated and Descriptive leaflets are available. Send S.A.E.
F.M. TUNING UNITS by MOST OF THE LEADING MANUFACTURERS.

- (b) The PORTABLE CARRYING CASE... **£3/17/6** (c) 6 1/2" P.M. SPEAKER **16/9**
- We also have a smaller PORTABLE CASE ideal for Record Players. PRICE ONLY £2/3/- (plus 3/- carr. & ins.). Attractively finished in high-grade Bexins and robustly constructed with initial measurements at 1 1/2" x 1 1/2" high. It will therefore accommodate all makes of Record Players including Autochangers. An uncut baseboard is also supplied.

**RECEIVER
TYPE R.1392**

Frequency 95-150 Mc/s (2-3 Metres). Air Tested 15 Valve Superhet. Valve Line-up: 1st and 2nd R.F. Amp. VR.136 (EF54); 1st Local. Oscillator V.R.65 (SP61); 2 Oscillator Multipliers V.R.136 (EF54); 3 I.F. Amp. V.R.53 (E.F.39); A.G.C. 6Q7. Output 6J5; Muting V.R.92 (EA.50); Noise Limiter V.R.92 (EA.50); B.F.O. 6J7; Mixer V.R.136 (EF.54); De Mod. 6Q7. Normally Crystal Controlled but can be tuned over 95 to 150 Mc/s. Power supply required: 240-250 volts at 80 mA. 6.3 volts at 4 amps. Size 19 x 10in. x 10in. Standard Rack Mounting. **£6.19.6**
Complete with valves and circuit diagram
Packing and Carriage 10/- extra.



**All these fine offers
PROOPS**

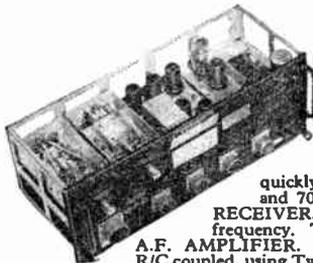
Shop and Head Office: Telephone: LAngham 0141
Mail order enquiries: Telephone: EUSton 8812
Carriage prices quoted apply only to England and Wales.

TRANSMITTER/RECEIVER No. 19. Mk. II

Frequency coverage 2 to 8 mc/s. for R/T. MCW. CW. Superhet Receiver 465 kc/s. I.F.'s BFO etc. Receiver line-up: 6K7 RF; 6K8 Mixer; Two 6K7 I.F.'s; 6B8 Det. Transmitter line-up: 6K8 Mixer; VFO EF50 buffer; ADC EB34; 807 P/A. This unit incorporates a TX/RX 229 at 241 mc/s. with a local range of 1 mile. Valve line up: CV6. Two 6K7's and 6V6. Also intercom. set two valve AF amplifier 6K7 and 6V6. As new condition and American manufacture. Fully valved. **£3.5.0**
Plus 10/- Packing and Postage

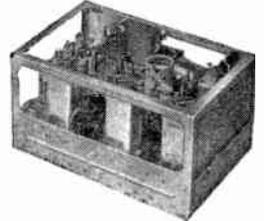
AN/APN.1. TRANSMITTER/RECEIVER

Frequency approx. 400-485 mc/s. R.F. TRANSMITTER. Operating 67.42 cm. (445 mc/s) with a band width of 40 mc/s. Modulation of its carrier is by means of a moving coil Transducer. Two 955 (VT.121) valves; quickly converted for Radio control and 70 cm. RECEIVER. Tuned to the Transmitting frequency. Two 9004 valves. A.F. AMPLIFIER. An audio frequency amplifier R/C coupled, using Two 12SH7's and One 12SJ7 valves. The AN/APN.1. has a vast amount of useful components including: 3 Relays one being a 4 pole change over type (3 off 1 megohm. 1 per cent Resistors (wire wound), Potentiometers and the following valves; 3 12SH7's; 1 12SJ7; 1 VR. 150/30 (OD.3) and 2 12H6's making a total of 14 valves in all. Brand new **£1.10.0**
Plus 7/6 Packing and Carriage.



**RECEIVER UNIT
EX. 1143a**

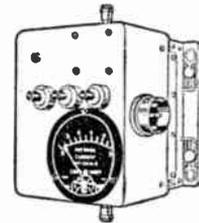
Suitable for conversion to 2 Metres or FM Wrotham transmissions. Valve line-up: Four EF.50's; One EL.32; Two EF.39's; One EBC.33; One EA.50. Circuit diagram supplied with each unit. Fully valved. **£1.5.0**
Plus 3/6 Postage



**DESYNN TYPE ANTENNA
or Beam position indication system**

This comprises a transmitter unit and Indicator which will operate on 12 or 24 volts D.C. and will indicate with instantaneous and smooth pointer movement. The Transmitter is a specially designed potentiometer and will operate the receiver on a simple three-wire system and the receiver in this instance is calibrated in gallons but dial could be easily altered to indicate a 360 deg. sweep. Transmitter and receiver with full instructions. **12s. 6d.**
Plus 2/- Packing and Carriage

ANTENNA RELAY UNIT



U.S. manufacture, containing change-over relay, 2jin. panel mounting meter (measuring aerial current) with separate thermocouple. Meter movement 2 mA. basic contained in metal case 3 1/2 x 4 1/2 x 3jin. with ceramic stand off terminals. **12s. 6d.**
Post paid

AN/APN.1 TRANSDUCER

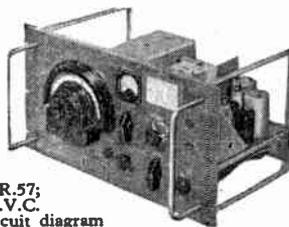
This unit consists of Magnet and Coil which is attached to an aluminium diaphragm suspended freely and perforated to prevent air damping. Mounted on a Ceramic cover which sits over the diaphragm in a form of 2-gang capacitor which has a swing from 10-50 pF. The above unit is used as part of Wobbulator described on page 252 of the June, 1956, *Wireless World*. Price **7s. 6d.**
Post paid

**WALKIE TALKIE TRANSMITTER/
RECEIVER TYPE 38**

Frequency 7.4 to 9 mc/s, valved with four VP.23's and one ATP.4. Brand new and complete with two pairs of earphones two throat microphones, whip aerial, junction box and canvas satchel. **£3.5.0**
Plus 5/- Packing and Postage.

**RECEIVER TYPE
R.1132**

Frequency 95-126 mc/s. 11 Valve Superhet. Valve line-up: R.F. Amp. VR.65; Frequency Changer VR.65; Local Oscillator VR.66; Stabilizer VS.70; I.F. Amplifiers V.R.53's; B.F.O. V.R.53; Detector V.R.54; A.F. Amplifier V.R.57; Output V.R.37 (6J5). Switchable A.V.C. and A.G.C. Variable B.F.O. Circuit diagram supplied with each unit. Easily converted to receive Wrotham band with no alteration to wiring. Conversion instructions available to each purchaser. Size 19in. x 10in. x 10in. Standard Rack Mounting. **£3.7.6**
Packing and Carriage 10/- extra



GYRO UNIT AND INVERTER

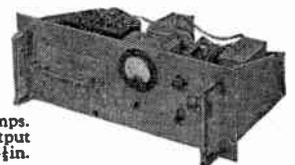
Inverter: 12 volt d.c. input 3-phase 190 cycle output. (These inverters can be used successfully as 12 volt d.c. Motors for Models). Gyro Unit: Operates on 3-phase output from Inverter. Peak speed 11,400 r.p.m. Caged. Precision made equipment. These units are ideal for experimenting and demonstration purposes. Size: Inverter 4 x 4 x 3in.; Gyro 4in. dia. incl. cage. **12s. 6d.** per pair
Plus 3/- p.p.

NEW TANNOY SPEAKERS

External 8 watt unit 7 ohm impedance complete with matching transformer. **£1.0.0** each
Plus 3/6 Packing and Postage

**MAINS POWER
UNITS. TYPE 234**

Double smoothed 200 to 250 v. 50 cycle input. Output: 200 or 250 volts at 100 mA 6.3 volts at 6 amps. Voltmeter reading input and output voltages. Size: 19in. x 10in. x 6jin. Standard Rack Mounting. **£4.10.0**
Plus 10/- Packing and Carriage



are on display at

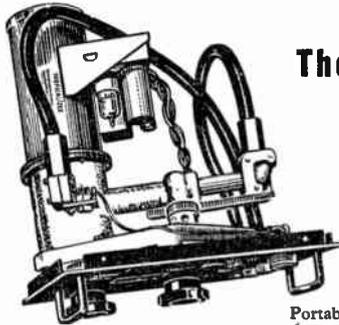
BROS Ltd.

DEPT. 'W'

52 TOTTENHAM COURT ROAD, LONDON, W.1.

Shop hours 9 a.m. to 6 p.m.—Thurs.: 9 a.m. to 1 p.m.

OPEN ALL DAY SATURDAY.



The TS184 A/AP

Real 70 cm. Test Gear, brand new in carrying case for only

£5.10.0

Carriage Paid

Portable Precision for Mobile Hams, Amateur T.V. Telearchics (with acknowledgements to Free Grid) and those monitoring the latest U.H.F. allocations.

RESONANT CAVITY WAVEMETER, calibrated 400-430 mc/s. Tuning stops adjustable to any 30 mc/s band within the 400 to 470 mc/s coverage. Calibrated scale rack and pinion drive piston input attenuator—and alternative fixed coupling loop input provides facilities for use as a signal generator. Plug-in "Telescopic Probe Antenna" 6J6 detector and Monitor amplifier, 2-600 ohm phone jacks for modulated signals. Panel output terminals for metering 6J6 output current. Power required 6 volt at 300 mA and 30 volts at 0.5 mA.

24-page booklet supplied with each unit giving comprehensive circuit descriptions, diagrams and suggested modifications Etc.

SIGNAL GENERATOR TYPE 52A

Frequency 6 to 52 mc/s. Internal mains power pack.

£10.0.0

Plus 10/- Carriage

SIGNAL GENERATOR AND WAVEMETER

Type W.1649. Frequency of signal generator: 140 to 240 Mc/s. Accuracy +0.5 Mc/s. Frequency of Heterodyne Wavemeter: 155 to 255 Mc/s. Accuracy +0.2 Mc/s. Containing VR.135 and 4-VR.91. 5 meg. crystal. Retractable aerial. Power requirements: 6.3 volts and 120 volts. Unit housed in copper lined wooden case. Size: 15½in. x 13in. x 14½in. In good used condition.

£2.10.0

Plus 10/- Packing and Carriage

G.93 WAVEMETER

£12.0.0

Post paid

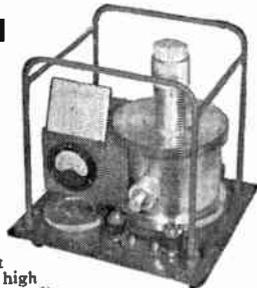
'S' BAND PRECISION WAVEMETER

2900 to 3150 Mc/s. TEST SET 288 A.M. Ref. 105B/6161.

Comprising exceptionally rugged silver-plated Wavemeter Type 1665, resiliently mounted and directly tuned by 7½in. dia. calibrated micrometer with 6½in. thimble scale. Temperature correction for micrometer attached. Resonance indicated on 100 microamp meter. Equally suitable for laboratory using milliwatt powers or, with loose coupling, for high powers. UR21 connecting cable and coupling probe supplied. Brand new in robust moisture-proof case with jacking-off screws and tool.

£15.0.0

Plus £1 Packing and Carriage



AMPLIDYNE MOTOR GENERATOR

Type 74. Brand new.

£1.15.0

Post paid

ELECTRIC TIME SWITCH

Beautifully made clockwork mechanism automatically wound by 6 volt Solenoid. The time switch can be set for any period between 30 minutes and 44 days. This robust unit is housed in strong Bakelite case 4in. in diameter.

12s. 6d.

Post Paid



BENDIX DYNAMOTORS

24 volts input 235 volts at 100 mA. D.C.

9s. 0d. each
Post paid

BINOCULAR TYPE INFRA RED VIEWING EQUIPMENT

Complete with EHT supply operating from 6 or 12 volt D.C. Originally designed for night driving. Complete with cleaning fluids and canvas carrying cases. Packed in transit cases.

£3.10.0

Carriage 7/6

PETROL ELECTRIC CHARGING SET

12/18 volts, 80 watt. Ideal battery charging unit or for Field Days. Size: 14½in. x 7½in. Weight 46lbs. Brand New, with complete set of running spares and Canvas cover.

£11.10.0

Plus 10/- Packing and Carriage



THROAT MICROPHONES TS.30.

Including socket.

3s. 0d.
Post paid

CRYSTAL MIKE INSERTS

4s. 6d. each
Post paid

HIGH RESISTANCE EARPHONES

2,000 ohms, single units

3s. 6d.
Post 1/-

AMERICAN TANK PERISCOPE

7s. 6d.
Post paid

STANDARDISE YOUR RIG

With British to American or American to British Co-axial adaptors. Plug or Socket fittings.

1s. 6d.
Post paid

TRANSFORMERS

HEATER TRANSFORMERS

6.3 volt, 1½ amps.; brand new, 6/6, plus 1/- p.p.

SMALL MAINS TRANSFORMERS

Input 230 volt 50 cycles, output 250 volt 40 mA., 6.3 volt 1.5 amp. Size 3.9in. x 2.4in. x 2in. Ideal for TV converters. Price 12/6 each, plus 1/- p.p.

CHARGER TRANSFORMERS

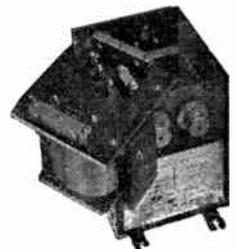
For 6 or 12 volt; 230 volt 50 cycles input, 9 and 17 volt 3 amp. output. Price 15/6 each, plus 1/- p.p.

MAINS CHANGING TRANSFORMER

(Admiralty Pattern) 230/100-110 130 V. Separate primary and secondary with earthed screen winding between. Totally enclosed in 7in. x 6in. x 8in. black steel case with detachable lid exposing terminal block and tapping link. Secondary very conservatively rated at 0.44 amps. (core size 3 sq. in.), tested to 2,000 V. Weight 19lb.

£1.0.0

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C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit and for C.R. Tubes with fulling emission. Type A. Low leakage windings. Ratio 1:1.25 giving a 25% boost on Secondary.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg. 1 w. 4d.; 1/2 w. 4d.; 1 w. 6d.; 1 1/2 w. 9d.; 2 w. 1/4. HIGH STABILITY. 1/2 w. 10% 6d. All preferred values 100 ohms to 10 meg. Ditto 10% 6d.

I.F. TRANSFORMERS 7/6 pair 465 Kc/Slug tuning Miniature Can 2 1/2 x 1 1/2 in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.

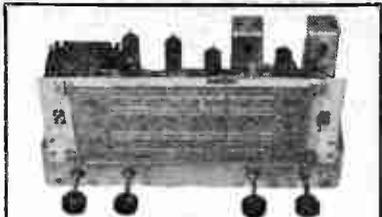
HEATER TRANS. Tapped 200/250 v. 8.3 v. 11 amp. 7/6. ALADDIN FORMERS and cores. 1in. 8d. 1in. 10d.

CRYSTAL MIKE INSERT by Acos Precision engineered. Size only 14 x 13.6 in. Bargain. Price 6/6. No transformer required.

SUPERHET COIL PACK 27/6 Miniature size 2 1/2 x 2 1/2 in. High Q dust cored coils. SHORT, MED., LONG. GRAM switching with connection diagram and 5 valve circuit. 465 Kc/S.I.F.

VALVE HOLDERS. Fax int. Oct. 4d. EF50, EA50, 6d. B12A, CRT. 1A3. Eng. and Amer. 4, 5, 6, 7 and 9 pin 1/2 in. MODIFIED Mazda and Oct. 6d. 6/6, 8/6, 8A, 8B, 8C, 8/6, 9d. 8/6 with can 1/6, VCR87, 2/6. 8B8 with can 2/6.

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BRAND NEW £10.10 Carr. 4/6. TERMS: Deposit £5/5- and 6 monthly payments of £1. MATCHED SPEAKERS FOR ABOVE CHASSIS: Min. 17/6; 10in., 25/6; 12in., 30/6.

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Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in., 12in. Lightweight Kit pick-up, turnover head. Two separate amplics styl. for Standard and L.P. Each plays 2,000 records. Voltage 200/250 A.C. OUR PRICE £8.15.0 each. Post free.

GARRARD. 4-speed Single Record Player with GP2 HI FI Turnover Head for 78 r.p.m. and L.P. Suitable Player Cabinets 49/6. Model 458 - BARGAIN 25/- Post Free.

FAMOUS B.S.R. 4-speed Motor and Turntable with selecting switch for 16, 33, 45 and 78 r.p.m. records. 200/250V. A.C. 50 c.p.s. Also P.U.L.P.I. pick-up with Xtal turnover head, separate Supply system for L.P. and standard records. SPECIAL OFFER, THE TWO £4/12/6. post 2/6. 14 x 12 1/2 in. Cut Out board 6/-.

COSSOR COMPANION MODEL 527/X FOR ALL DRY BATTERY OPERATION S.W. I 13.6 to 43 metres, S.W.2 42.8 to 136 metres, Medium 187 to 575 metres.

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JASON F.M. TUNER COIL SET. 26/- H.F. coil aerial, coil, Oscillator coil, two I.F. Transformers 10.7 Mc/s. Detector transformer and heater choke. Circuit and component book using four 6AM6, 2/-.

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NEW ELECTROLYTICS. FAMOUS MAKES. TUBULAR TUBULAR CAN TYPES 1/350 v. 2/- 100/25 v. 3/- 8+16/800 v. 4/6 16+16/800 v. 6/-

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2 or 12 v. 11amp. 8/9; 2a. 11/3; 4a. 17/6. CHARGER TRANSFORMERS. Tapped 200/250 v. for charging at 2.6 or 12 v. 1 1/2 a., 15/6; 2 a. 17/6; 4 a. 22/6.

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This Portable 8 Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent Commercial Transistor Set. Simplified construction enables this set to be built easily and quickly into an attractive lightweight cabinet supplied.

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THREE WAVE BAND SUPERHET, 200/250V A.C./D.C.

(With Internal Aerial)

Short Wave 16-50m. Medium Wave 187-575m. Long Wave 900/2000m (With Gram. Switching)

Well-known Manufacturer's product complete with Five Marconi Valves, type: X109, W107, DH107, N108 and U107 and 7 x 4 Elliptical Speaker. Ideal for Portable Radio-Gram. Chassis size: 10 x 4 x 4in.

£7/12/6 P.P. 7/6

Also available as above at the same price, similar chassis with following specifications: Short Wave 11.27—31.9m. Short Wave 31.2—91m. Medium 187—575m and Gram. Switching.

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Brand new, complete with valves, 2 pair Headphones, 2 Microphones, Junction Box, Canvas carrying bag, 4 Section Aerial and spare set of valves and circuit.

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1588.68	1930	3310	10,511	11,851
1613.25	1981	3317.5	10,534	11,876
1650	2012	3390	10,545	12,600
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1680	2067.5	3850		AT
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MADRS BLOWER. 200/230 v. A.C./D.C., 1 amp., 5,000 r.p.m., consists of the motor with attached enclosed fan, and tunnel intake 1 1/2 in. dia., side outlet 1 in. x 1/2 in., plinth base 5 in. x 4 1/2 in. finish black crackle and die cast aluminium, size overall 9 in. long, 4 1/2 in. wide, 5 in. high, weight 7 1/2 lb., a very superior blower, offered at a fraction of original cost, new unused 25/-, post 3/6.

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HUGHES MOTORS, shunt wound, 12-v. 1 1/2-amp., speed 5,000 r.p.m., reversing, size 3 1/2 in. long, 1 1/2 in. dia., 1/2 in. shaft, weight 20 oz., a very superior motor designed for anti-radar equipment, new unused 10/-, post 1/6, 25 per doz. carriage paid, ditto fitted reduction gear giving a final drive (1/2 in. shaft) of either 320 or 100 r.p.m., state which required, 12/6, post 1/9; 26 per doz. carriage paid.

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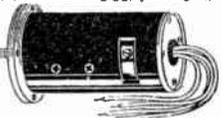
CRYSTAL SETS. All parts to construct an efficient set, Repanco low-loss 9-band coil, Wavomaster var. conds. with pointer knob, switch, Germaulium detector, Clix plug and sockets wiring diagram, 10/- post paid. Browns headphones, low resistance, 6ft. leads fitted jacking, new boxed, 7/6 post 1/4.

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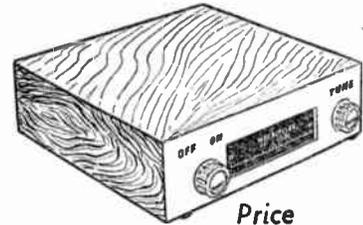
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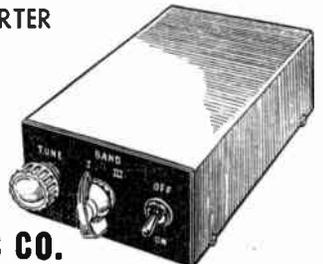
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Ferrite Rod Aerials. Wound on high permeability Ferroxcube rod, Medium wave 8/9, Dual wave 12/9.

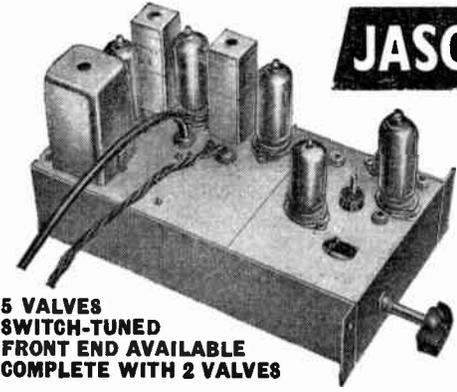


Type HAX. Selective crystal diode coil for tape and quality amplifiers, MW 3/-, LW 3/6. Dual wave TRF Coils, matched pairs (as illustrated) 7/- pair. Type S.S.O. Supersonic Tape Osc. coil, provides 6.3 v. 3 a. RF for pre-amp heater. Eliminates induced hum, 40/100 kc, 15/- ea. Transistor coils, etc. Available from leading stockists. Stamp for complete data and circuits.

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5 VALVES SWITCH-TUNED FRONT END AVAILABLE COMPLETE WITH 2 VALVES

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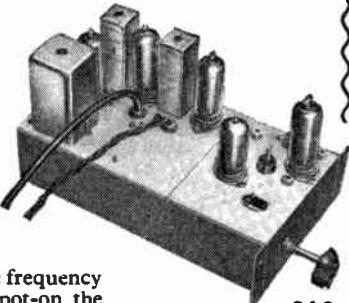
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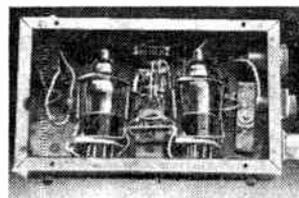
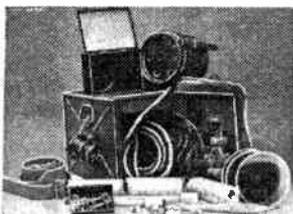
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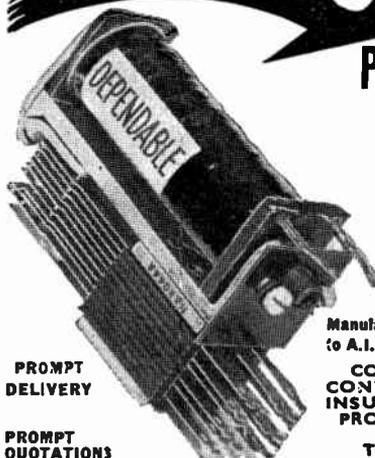
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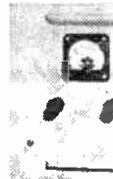
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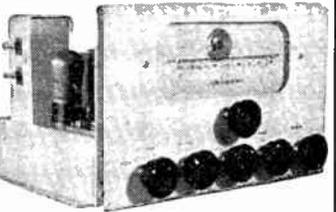
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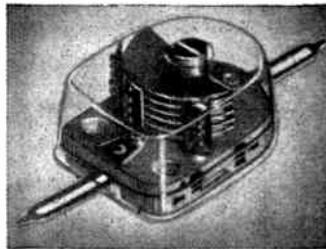
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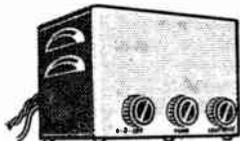
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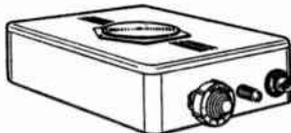
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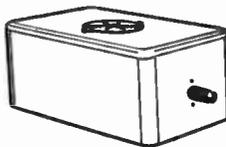
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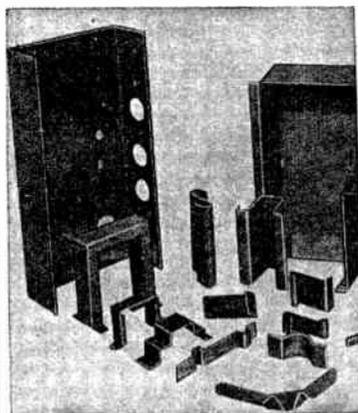
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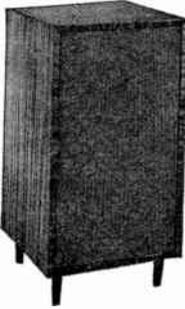
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A VACANCY EXISTS

in the Radio and Television Laboratories of a leading manufacturer, situated in eastern London, for a project leader to engage in the development of domestic and car radio. Must be familiar with current circuit techniques, including transistors, and production design for conventional and printed wiring. Minimum qualifications, H.N.C. with at least five years' experience in a similar capacity. A contributory pension scheme is in operation and good canteen facilities are available. Please reply, giving full details of experience and qualifications to Box No. 3031 c/o. "Wireless World."

MARCONI INSTRUMENTS LTD.

This Company has immediate vacancies at St. Albans in its Technical Literature (Telecommunications) Section; applicants should have electrical engineering qualifications and/or experience in the design or development of electronic equipment; the duties are varied and interesting and the posts provide permanent and pensionable positions in a well-established Company.

Apply to Dept. C.P.S., 336/7, Strand, W.C.2, quoting Ref. W.W. 2970H.

TELEVISION INSTRUMENTATION DEVELOPMENT ENGINEERS

DUTIES: To undertake the design and development of test equipment for television, including work on special television camera applications. Considerable personal responsibility and freedom is given, and there are no set rules regarding the number of people engaged on a project, the allocation of project leaders, etc.

QUALIFICATIONS: The ability to design and develop equipment and aggressively progress a project through to the stage where a model is made and the information is available for a production drawing office. Candidates should preferably be of degree standard, or Corporate Members of one of the Professional Institutions, but consideration will be given to others who have considerable practical experience in the field. The ability to progress the project through to a satisfactory conclusion is the prime requirement. Due to expanding activities men with drive and initiative can be sure of progressive advancement.

Comprehensive pension and assurance schemes are in operation, and Canteen and Social Club facilities are provided.

Call any day including Saturday mornings at:

**MARCONI INSTRUMENTS LTD.,
LONGACRES, HATFIELD ROAD,
ST. ALBANS, HERTS.**

or write giving full details to Dept.: C.P.S. Marconi House
336/7, Strand, London, W.C.2, quoting reference WW
2970K.

MARCONI INSTRUMENTS LTD., TECHNICAL PERSONNEL REQUIRED Senior & Junior Electrical Design Engineers SENIOR & JUNIOR MECHANICAL DESIGN ENGINEERS

DUTIES: To undertake the design of Test Equipment covering practically the whole electronic field, including Telecommunication, Guided Weapons, and Nuclonics. Considerable personal responsibility and freedom is given, and there are no set rules regarding the number of people engaged on a project, the allocation of project leaders, etc.

QUALIFICATIONS: The ability to design equipment and aggressively progress a project through to the stage where a model is made and the information is available for a production drawing office. Senior engineers are usually of B.Sc. standard with practical experience in measuring techniques, while Junior engineers are often Graduate Members of one of the Professional Institutions, or have similar qualifications, but this is in no way mandatory. The ability to progress the project through to a satisfactory conclusion is the prime requirement. Due to expanding activities, men with drive and initiative can be sure of progressive advancement.

Comprehensive pension and assurance schemes are in operation, and Canteen and Social Club facilities are provided.

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or write giving full details to Dept. C.P.S., Marconi House,
336/7, Strand, London, W.C.2, quoting reference WW 2970J.

High Sensitivity Miniature moving coil LOUD SPEAKER

as used in the Perdio Pocket Transistor Radio. Diameter 2½". Depth ½". Impedance 3 ohms. Price, including tax, post and packing, 27/6. Cash with order. For this and other miniature components, apply—

SPECIALISED ELECTRICAL COMPONENTS

9-11, Monmouth Street, London, W.C.2

VACANCIES IN GOVERNMENT SERVICE

A number of vacancies, offering good career prospects, exist for:—

Radio Operators — Male

Cypher Operators — Male & Female

Apply, giving details of education, qualifications and experience, to:—

**Personnel Officer, G.C.H.Q. (FOREIGN OFFICE)
53 Clarence Street, Cheltenham.**

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LIMITED ARMAMENTS DIVISION

The following personnel are required to fill interesting vacancies in the

ANALOGUE COMPUTER GROUP

ELECTRONIC ENGINEERS. Applications will be considered from Senior and Junior Engineers between the age of 26 years and 35 years, with experience of radio communication, carrier telephone or radar display equipment. A knowledge of servo systems would also be advantageous. The desirable qualifications for these posts would be a University Degree, but candidates with an H.N.C. will be considered.

DRAUGHTSMEN. Applications will also be welcomed from Senior and Junior Draughtsmen with design experience of small radio transmitters, radio telephones, carrier telephone or radar equipment. In addition, practical experience of precision mechanisms would be an advantage.

The Armaments Division is situated in the midst of the Warwickshire countryside, and our newly built Design Offices and Laboratories offer excellent working conditions.

The posts are permanent and pensionable and will afford considerable scope to applicants interested in making a career in this type of work.

If you possess the appropriate qualifications and experience you are invited to apply, in the strictest confidence to:

**Technical Appointments Officer,
Sir W. G. Armstrong Whitworth Aircraft Ltd.,
Baginton, Nr. Coventry. Quoting Reference Comp19.**

VACANCIES FOR RESEARCH AND DEVELOPMENT CRAFTSMEN IN GOVERNMENT SERVICE AT CHELTENHAM

INSTRUMENT MAKERS with fitting and machine shop experience in light engineering.

There are also vacancies where applicants with experience in one or more of the following can be considered:

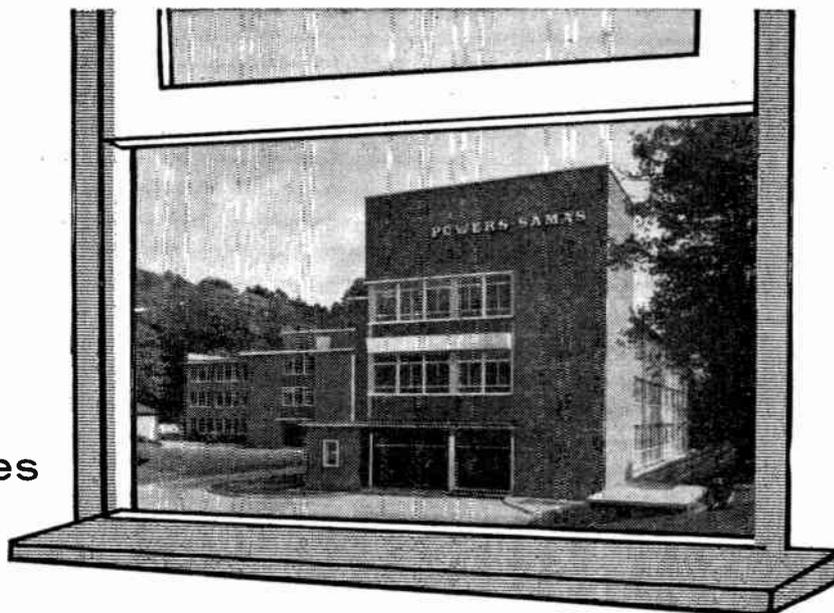
1. Maintenance of radio communication receivers.
2. Sub-assembly lay-out, wiring and testing of radio type chassis.
3. Cabling, wiring, and adjustment of telephone type equipment.
4. Fault finding in, and maintenance of, electronic apparatus.
5. Maintenance of Teleprinters or Cypher Machines and associated telegraph equipment.

BASIC PAY: £9/2/4 plus merit pay, assessed at interview and based on ability and experience, as under:

ORDINARY RATE: 10/- to 32/-
SPECIAL RATE: 38/- to 70/-.

Opportunities for permanent and pensionable posts. Five-day week, good working conditions, single accommodation available.

**Apply to: Personnel Officer,
G.C.H.Q. (FOREIGN OFFICE),
53 Clarence Street, Cheltenham.**



Opportunities

for

scientists and engineers at

POWERS-SAMAS research establishment

The continuing expansion of this leading Company in the accounting machine industry offers exceptional opportunities for scientists and engineers to engage in the absorbing work of designing and developing electronic, electrical and mechanical equipment for the world market.

The vacancies are all for permanent, pensionable staff appointments at the Research Establishment at Whyteleafe, Surrey. Completed in March, 1957, the Establishment is one of the finest and best-equipped in Britain. It is in a most pleasant country setting yet is only some 35 minutes from central London by Southern Region to Whyteleafe South Station.

Generally (and subject to any specific qualifications stated below), applicants should have an engineering degree, H.N.C., O.N.C., or similar qualifications, and previous shop and design experience in the electronic, electrical or mechanical fields. A five-day week is in operation and working conditions and amenities are those to be expected in a modern, well-equipped research establishment. Applicants should send a brief description of their qualifications and experience to the Personnel Officer at the address shown below.

openings

exist

for

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Senior Designers and Draughtsmen with experience in either the mechanical field or the electrical and electronics field, for work on design and development of modern accounting machinery.

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Men with previous process planning and/or methods, engineering experience both electrical and mechanical, for liaison between research, design and production.

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Mathematicians or others with an aptitude for logical design and some knowledge of computer programming for commercial accounting.

PRODUCT IMPROVEMENT

Senior and junior mechanical engineers with technical qualifications, and design and production experience in light engineering to join teams improving the design and performance of the current ranges of machines. A knowledge of mechanism design using modern techniques, and an open enquiring mind, are essential requirements.

RESEARCH

Senior and junior research engineers and physicists to engage in applied research in the field of Data Processing. Applicants should have a degree in electrical engineering or physics, or be Corporate or Graduate members of the I.E.E., or Associates or Graduates of the Institute of Physics. Applicants for senior positions should have some experience in digital computing or allied fields. Vacancies also exist for Laboratory Technicians to assist in research and development projects. Applicants should have technical qualifications or experience in electronics or physics.

Research Development

Design and Prototype
Development of Audio-
Electro Devices and
Equipment.

Box No. 2336
c/o "W. World"

MULTITONE ELECTRIC CO. LTD.

invite applications from
Intermediate and Junior

ELECTRONIC ENGINEERS

for work on the development and testing of an interesting range of new electronic projects. There are vacancies for engineers with a wide range of qualifications and experience up to and including H.N.C. standard. Experience of development work or fault-finding advantageous. Preferred age range 20/30 years but applications will also be considered from young men who have recently left school with Higher School Certificate in Science. Apply stating age and giving particulars of education, training and experience to 12/20, Underwood Street, London, N.1.

FERRANTI LIMITED

Wythenshawe,
MANCHESTER

have vacancies
in the Laboratories for
DEVELOPMENT ENGINEERS

to work on the design and development of electro-mechanical instruments for use in Guided Weapons.

Applicants should be of at least H.N.C. standard and although previous experience of this type of work is not essential, preference will be given to those who have a sound knowledge of gyroscopic techniques.

The laboratories are housed in a modern building which is situated in pleasant surroundings on the Cheshire boundary. The Company has a Staff Pension Scheme and an Assurance Scheme for Dependants.

The commencing salary will depend on qualifications and experience.

Forms of application can be obtained from

**T. J. Lunt, Staff Manager,
Ferranti Ltd., Hollinwood,
Lancs.**

Please quote reference DBW.

JAMES H. MARTIN & CO.,
CADENZA dual Impedance Microphone & table stand £10/10/-. TRIX T43 Amplifier £19/19/-. APEX band III Converter £5/15/-. TSL LORENZ Concert Soundcorner, £13/16/3. Richard Allen 'Golden unit' speaker 10in. diam. £7/5/6. AM/FM Radiogram chassis from £24. Stamp (only) for Lists. **James H. Martin & Co., Finsthwaite, Newby Bridge, Ulverston, Lancashire.**

PHYSICISTS AND ELECTRICAL ENGINEERS

Progressive positions are open to qualified people of degree standard for work on development and manufacture of special radio valve and micro-wave devices.

Initial training at the Research Laboratories of the G.E.C. will be available for certain selected candidates.

Canteen, pension fund and social club.

Apply quoting T/1 to:—

**Personnel Officer, THE
M.O. VALVE CO. LTD.,
Brook Green,
Hammersmith, W.6.**

MANUFACTURERS of VALVES for G.E.C.

Test Department at Marconi's, Basildon

Have vacancies for men to take technical responsibility for the quality of equipments in the fields of

**Airborne transmitters, receivers and navigational aids,
Radar;**

V.H.F. transmitters and receivers.

Applicants must have at least five years' experience in one of the equipment fields specified and preferably be educated to H.N.C. standard.

Houses are available to rent in Basildon New Town for successful applicants. Write to

Central Personnel Services,

336/7, Strand, W.C.2, quoting Ref. WW 2600R.

E.M.I. ELECTRONICS LTD.

SALES ENGINEERS

ELECTRONIC INSTRUMENT DIVISION

Keen and energetic young sales engineers are required to deal with a large range of electronic instruments and industrial equipments. Applicants should be competent car drivers, prepared to travel within the U.K. or abroad as required. Please reply giving full details to the

**Personnel Department (EL/B.27),
E.M.I. Electronics Ltd.,
Hayes, Middx.**

TEST ENGINEERS

required for interesting work in connection with Radar, Computers, Machine Tool Control Units, Camera Channels, Microwave Links and similar electronic equipment. Applicants must have sound theoretical knowledge of electronics backed by practical experience in H.M. Forces or industry. Staff positions and Superannuation Scheme. Single accommodation available. Apply, giving full details to Personnel Department (C.E./21), E.M.I. Ltd., Hayes, Middx.

TEST ROOM PERSONNEL REQUIRED

Duties: Testing and calibrating a wide range of telecommunication and industrial electronic instruments.

Qualifications: We shall be pleased to receive applications from any man with or without academic qualifications, who is able to demonstrate suitable experience and training.

Call any day including Saturday mornings at

**MARCONI INSTRUMENTS LIMITED
LONGACRES, HATFIELD ROAD
ST. ALBANS HERTS.**

or write giving full details to Dept. C.P.S., Marconi House, 336/7, Strand, London, W.C.2, quoting reference WW 2970G

RADIO TECHNICIANS IN CIVIL AVIATION

A number of appointments are available for interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids at aerodromes and radio stations in various parts of the United Kingdom.

Applications are invited from men aged 19 or over who have a fundamental knowledge of radio or radar with some practical experience. Training courses are provided to give familiarity with the types of equipment used.

Salary £600 at age 25 rising to £705. The rates are somewhat lower in the Provinces and for those below age 25. Prospects of permanent pensionable posts.

Opportunities for promotion to Telecommunications Technical Officer are good for those who obtain the Ordinary National Certificate in Electrical Engineering or certain City and Guilds Certificates. The maximum salaries of Telecommunications Technical Officers are Grade III £870, Grade II £1,030, Grade I £1,250.

Apply to the Ministry of Transport and Civil Aviation (ESB1/RT), Berkeley Square House, London, W.1, or to any Employment Exchange (quoting Order No. Westminster 2109).

THE WAYNE KERR LABORATORIES require ELECTRONIC ENGINEERS & DRAUGHTSMEN

for development work in the following fields:

ELECTRO-CHEMICAL AND
ELECTRO-MECHANICAL MEASUREMENTS.
A.F., V.H.F., U.H.F. AND
MICROWAVE MEASUREMENTS,
INDUSTRIAL PROCESS CONTROL EQUIPMENT,
PULSE TECHNIQUES.

Measurements techniques introduced by The Wayne Kerr Laboratories are finding increasing outlets in a world-wide field of Laboratory and Industrial use.

Attractive and interesting positions offering scope for initiative and ability are available for Senior and Junior Development Engineers and Draughtsmen.

For Senior posts a minimum of Honours Degree Standard or equivalent professional qualifications is required, with several years' experience in the development of electronic instruments. For Junior posts qualifications ranging from O.N.C. to Degree Standard are acceptable. Draughtsmen are required to have experience in the mechanical design of Electronic apparatus.

All appointments are permanent, carry attractive salaries and qualify for membership of the Staff Pension Fund.

Applications, which will be treated in strict confidence should be addressed to:

The Chief Development Engineer,
Wayne Kerr Laboratories Ltd.,
3, Sycamore Grove, New Malden, Surrey.
Telephone MALden 2202.

FERRANTI LTD ELECTRONICS DEPARTMENT

have the following vacancies for

(1) **JUNIOR ENGINEERS** for development work on MICRO-WAVE VALVES at the Company's Wythenshawe, South Manchester, branch. A standard of approximately Higher National Certificate in Electrical Engineering is required.

(2) **A GRADUATE ENGINEER** interested in production, for work on technical problems in the production of SEMI-CONDUCTORS at the Company's Chadderton, Oldham, branch. Previous experience in the Semiconductor field is not essential since an initial period of training in the laboratory would be provided.

The Company has a Staff Pension Scheme and an Assurance Scheme for Dependents.

Forms of application can be obtained from

T. J. Lunt, Staff Manager,
Ferranti Ltd., Hollinwood,
Lancs.

Please quote reference PDH1 or 2.

DESIGN AND DEVELOPMENT ENGINEERS (Senior, Intermediate and Junior)

Required for the Modern Laboratory of a progressive Engineering Company engaged in the advanced development of Electronics and Mechanical Engineering in connection with guided weapon and other applications. The Design Laboratory is expanding rapidly and, therefore, opportunities exist which give full scope for individual initiative and advancement to applicants who possess H.N.C. and who have also had previous experience in this field. A salary of up to £1,500 per annum will be paid to the selected candidates according to grade. Applications, which will be treated in utmost confidence, should give full details of qualifications and experience and be addressed to:

BOX No. 2911 c/o WIRELESS WORLD

SENIOR TECHNICAL ENGINEERING STAFF

A London Engineering Company invite applications from project engineers who are capable of taking charge of electronics and mechanical engineering development in connection with guided weapon and other applications. These positions are permanent and offer ample opportunity for further advancement. The commencing salaries, which will be in the region of £1,500 per annum upwards according to qualifications and experience, will be subject to review on a generous scale. Engineering degree or H.N.C. Replies, which will be treated in utmost confidence, should give full details of qualifications and experience and be addressed to Box No. 2686 c/o "Wireless World."

SPECIAL PURPOSE COMPUTERS

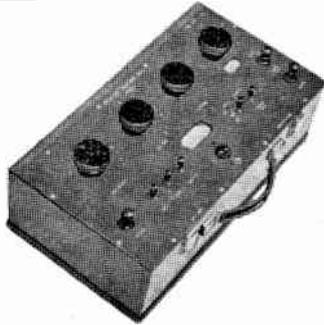
The Kidsgrove Works of the English Electric Company are considerably expanding their activities in the field of Special Purpose Digital Computers, and are building new development laboratories, pleasantly located on the Cheshire-Staffordshire border. There are a number of vacancies for Senior Engineers in the Computer team. Candidates should have had experience of logical and circuit design of computers, but consideration will be given to candidates having experience in the design of other complex pulse circuitry. The Company operates a Staff Pension Scheme and unfurnished tenancies of recently built houses will be available for successful candidates immediately.

Applications giving full details of qualifications and experience should be made to:

Dept. C.P.S. 336/7 Strand, W.C.2,
quoting Ref. WW 306D.

Z & I AERO SERVICES LTD.

A.R.B. Approved Stockists



THOMSON-VARLEY POTENTIAL DIVIDER

Manufactured by H. Tinsley. This is a precision potentiometer having three decades plus divided wire, total resistance 70,000 ohms; resolution 1/100,000 of total resistance. Built-in galvanometer appr. 1 micro-amp. F.S.D. Accuracy .01%

PRICE £25

BRAND NEW AMERICAN TEST KITS

as illustrated in November issue, consisting of Frequency Meter BC-906D (150-235 Mc/s); Test Oscillator I-196 (150-235 Mc/s); Test Receiver BC-1066 (150-235 Mc/s); Range Calibrator BC-949 (8 to 81 kc/s), and Indicator BC-936 (R.F. Rectifier with video output). All these are portable battery-operated instruments working off 135 v. or 45 v. H.T. and 1.5 v. L.T.

PRICE of complete set of five units as above, brand new £5 10 0
Packing and carriage £1 0 0

MARCONI OUTPUT METER TF-340

Meter scale 0 to 50 mW/0 to 17 dB; Meter Multiplier 0.1-1.0-10-100; Impedance values 25-30-40-50-60-80-100-125-150-200 ohms; Impedance Multiplier 0.1-1.0-10-100.

PRICE, fully overhauled £32 10 0

TAYLOR MODEL 160A OUTPUT METER

Meter Calibration: 0 to 25 mW.
Meter Multiplier: .01-1.0-10-100.
Impedance settings: 2.5-5-100-125-150-600-4000-8000-10,000-20,000 ohms.

PRICE, fully guaranteed £21 0 0

EDDYSTONE 358X COMMUNICATION RECEIVERS



40 kc/s to 31 mc/s with ten plug-in coils.

PRICE, tested and aligned, complete with set of 10 coils £12 10 0
Packing and Carriage £1.

COILS, range "A" to "J" inclusive 17/6 each. Per set of ten, in wooden tray £6 10 0
Packing and carriage 2/6 per coil or 10/- per set of ten.

For details see November issue.

SIMPLE TWO-DECADE WHEATSTONE BRIDGES

0 to 200 ohms in one-ohm steps (no ratio arms); built-in galvanometer 2.5-0-2.5 mA.
PRICE £2 10 0
Packing and carriage 7 6

METERS

2½in. centre zero plain scale M.C. Galvanometer, 600-0-600 microamps, projection mounting, plug-in type 12 6
2½in. round projection mounting M.C. Milliammeter, 0 to 500 mA 8 6
2½in. round flush-mounting M.I. Voltmeter, 0 to 300 v. A.C., with internal matched resistance 22 6

V.H.F. AIRCRAFT TRANSMITTING & RECEIVING EQUIPMENT

Crystal controlled, range 115 to 145 Mc/s; power output 4 watts; total weight approx. 26 lbs.

TR1520 4-channel installation.
TR1936 10-channel installation.
STR9Z 44-channel automatically tuned installation.

All released to A.R.B. requirements and supplied ready for use, complete with mounting rack, aerial, control unit, plugs and receiver head-gear assembly.

Prices and details on application.

SCANNERS RC-94 for SCR-720 RADAR EQUIPMENT, complete or components.

Prices and details on application.

BEAT FREQUENCY OSCILLATORS

Furzehill No. 1, or equivalent, 0 to 10,000 c/s, mains operated £22 0 0
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Marconi TF-195L, 0 to 40,000 c/s, mains operated £45 0 0
Marconi TF-195L4 (Wide range), 0 to 150 kc/s £72 0 0
B.S.R. Type LOSO, two-dial type, 0 to 16,000 c/s, mains operated £30 0 0
General Radio Type 700A (Wide range), 0 to 5 Mc/s, mains operated £55 0 0

FOSTER MODEL "D" PORTABLE THERMOCOUPLE POTENTIOMETER

Ranges: 0 to 20 mV and 0 to 60 mV
Calibration:
0 to 1600°C. for Pt-Pt13%Rh.
0 to 1300°C. for Chromel/Alumel.
0 to 1040°C. for Iron Constantan.

PRICE, complete with Standard Cell £32 0 0
Ditto, with Potential Divider £35 0 0
Packing and carriage £1 0 0

BD-71 and BD-72 6-line and 12-line AMERICAN TELEPHONE SWITCHBOARDS.

EE-8 AMERICAN FIELD TELEPHONES and Spares.

UC 10-line SWITCHBOARDS and large assortment of spares, including P.O. 201 Plugs.

COLLINS TCS TRANSMITTING & RECEIVING EQUIPMENT, 1.5 to 12 Mc/s; complete installations and spares. BC-191 (12 v.) TRANSMITTERS, Spares and Tuning Units.

AMERICAN COMMUNICATION RECEIVERS BC-312, BC-342 and BC-348. R.C.A. AR-88 COMMUNICATION RECEIVERS and large assortment of Spares.

SCR-269G and ARN-7 RADIO COMPASS INSTALLATIONS, and all Component Units.

ARC-1 V.H.F. AIRCRAFT TRANSMITTER-RECEIVERS.

Large assortment of Plugs and Sockets: British 5X and 10H series, American Cannon and Amphenol, etc. American and British Aircraft Headset and Microphone Equipment

Prices and details on application.

INSULATION TESTERS

EVERSHED "WEE" MEGGERS:
100 v. £8 10 0
250 v. £11 10 0
500 v. £12 10 0
RECORD "MINOR" 500 v. INSULATION TESTER £10 0 0
EVERSHED Series I, 500 v. MEGGERS £22 10 0
EVERSHED Series I, 1000 v. 100 megohm MEGGERS, from £27 10 0
All Fully Guaranteed.

A.C. MAINS POWER PACKS for 200/250 v. mains, output 300 v. H.T. at 200 mA and 12 v. 3 amps A.C., L.T. Size 7½ x 7 x 13½in.

PRICE, brand new £3 0 0
Packing and carriage 10 0

MARCONI VALVE VOLTMETER

TF428B/1, 10 to 150 v. in five ranges; resonant frequency approx. 400 Mc/s. Brand new, with spares, in transit case £35 0 0
Service equivalent of the above, overhauled and guaranteed £17 0 0
Packing and carriage 15 0

2.5 kVA WELDING TRANSFORMERS

for 230 v. mains. Two output sockets 25 amp and 50 amp at 50 v. Output voltage adjustable by means of "off-load" tappings. Permissible momentary overload up to 100%. Waterproof input and output sockets.

PRICE, brand new £15 0 0
Carriage £1 10 0

Please write for further details of the above equipment and for Complete Catalogues of Radio/Aircraft and Test Equipment to:

Z & I AERO SERVICES LTD.

14, South Wharf Road, London, W.2

Telephone AMBassador 0151/2

We are always buying American Test, Aircraft and Radio Equipment, such as: BC-221, BC-312, BC-342, BC-348, ARC-1, ARC-3, ART-13, ARN-6, ARN-7, etc.

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Rate 7/- for 2 lines or less and 3/6 for every additional line or part thereof, average lines 6 words. Box Numbers 2 words plus 1/- (Address replies; Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, E.C.1.) Trade discount details available on application. Press Day February 1958 issue, Thursday, January 2nd. No responsibility accepted for errors.

WARNING

Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantees. Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

AM/FM chassis, with or less o/p. stages: £14.—Bel, Marlborough Yard, N.19. [0183]

FM. Tuner, switch-tuned, 4A.F.C. temp. comp. I.P.S. 7 valves, vol. A.F. output, 6.3v. 2A. 250v. 50mA. 8in x 5in x 4in, very smart, brand new, few only; £12.—"Williams Sound," 32, Marlborough Park Ave., Sidcup, Kent. [7518]

HI-FI at low cost; our AM/FM R/G chassis and feeders are grand performers at highly competitive prices; we particularly emphasize our Model A/F834, and 8 valve 3 waveband 4 watt chassis with gram switching; also Model A/73 AM/FM feeder; trade enquiries invited.—Bayly Bros., 46, Pavilion Drive, Leigh-on-Sea, Essex. [7551]

SHIRLEY LABORATORIES, Ltd., 3, Prospect Place, Worthing, Sussex. Tel. 30536.
THE TWA/1515 stereosonic tape recording and replay amplifier, separate meter monitoring on record and playback on both channels, 13watts O/P each channel, 96gms. TWA/15 tape recording and reproducing amplifier, 13watts O/P for Wearite and Collaro decks, 45gms; TW/PA recording and replay pre-amplifier, 30gms; both with valve voltmeter monitoring; type SB/1-15E high-fidelity amplifier, exceptionally wide tone-control system, 40mv sensitivity, 20gms; with two inputs and 3-position gram filter, 22gms; specialized amplifiers for the musical and scientific industries including the Mullard 20watt. [0095]

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

FOR sale, 2 only, 1155 transmitter receivers and Power Paks; at £7 each.—Ailwyses, Ltd., Manchester Airport. Gat. 5502. [7517]

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd, London, E.11. Ley. 4986. [0053]

R.C.A. orthophonic amplifier, pre-amplifier, v.h.f. tuner, Collaro 3-speed transcription motor, studio P pick-up in W.E. cabinet with large record space; W.B. T.12 tweeter, 1214 woofer and crossover unit in console corner cabinet, cost £150; best offer over £85; h.p. available.—Hayes Radio, N.7. North 1358. [7558]

RECEIVERS AND AMPLIFIERS WANTED

£30 reward Aeromagic Receiver 1935/1936. Cash for Servicing Manual, Box No. 3023. [7546]

TV RECEIVERS—SURPLUS AND SECOND-HAND

FOR sale, white Ibbotson projection T.V. set, suitable for use in staff recreation room; can be inspected at City Hospital, Chester. Offers to Secretary, Chester & District Hospital Management Committee, 5, King's Buildings, Chester. [7513]

LOUDSPEAKERS—SURPLUS AND SECOND-HAND

A PAIR Voigt loudspeakers; £7/10 each.—Broadcast & Electronic, Ltd., Tomland, Norwich. [7520]

TEST EQUIPMENT—SURPLUS AND SECONDHAND

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986

VOLTMETERS 0-20 M.I., F.G., Res. 20ohms P/V 3in 20/-; 0-20 M.C., sq. face, black dial, 2in 15/6; 0-80 M.C., round, white dial 2in 17/6; 0-500 M.I., F.G., with ext. res., 4in 35/-; Electrostatics 0-2,000 flush fitting 2 1/2in 20/-; 0-3,500, plug-in, 2in 25/-; also 0-300 m/A, M.C., 2 1/2in 17/6.—F. R. Barrett, 155, Humberstone Rd., Leicester. [7542]

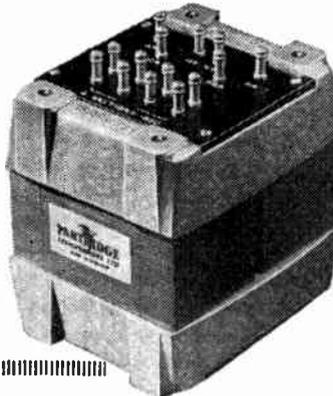
CLEVER STICKS?

no!

clever hands... and clever brains

keep Partridge transformers in the lead. The finest possible materials, constant research and development ensure that, almost inevitably, in any amplifier specification, the words "Partridge Transformer recommended" will appear.

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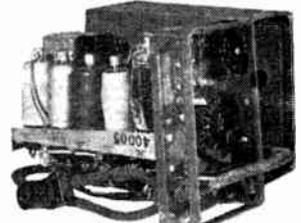
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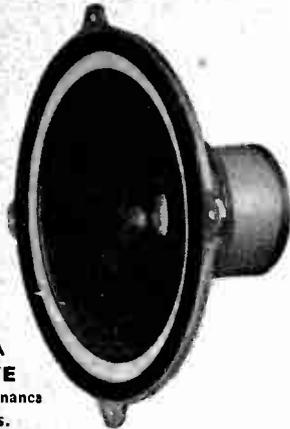
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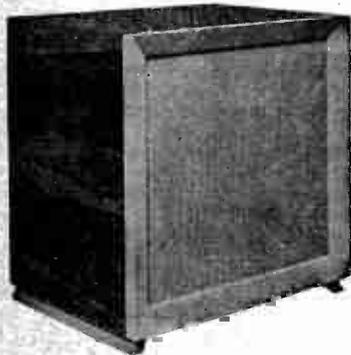
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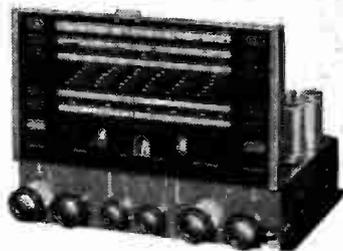
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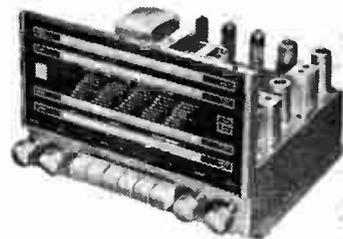


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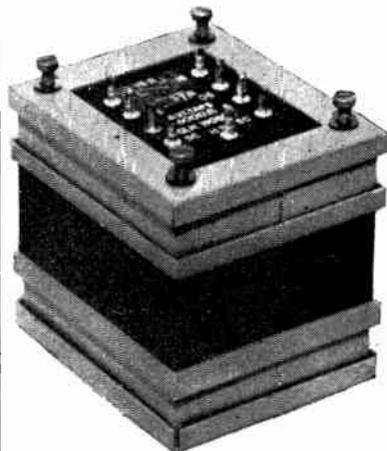
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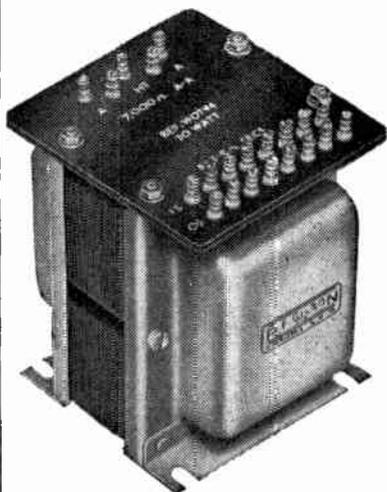


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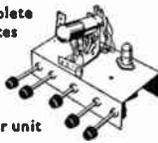
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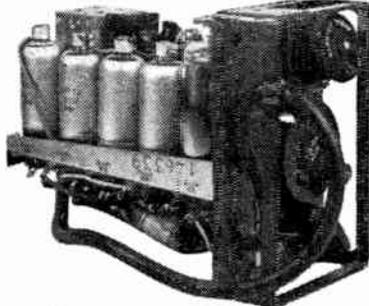
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METEOROLOGIST is required by radar manufacturers in London area to maintain technical liaison with meteorological services and to specialise in the application of radar to meteorological problems.—Applicants should preferably have forecasting experience and should apply in writing, stating age, experience and salary required, to "JMD," Box 2871. [7531]

ELECTRONIC test engineer required by Sunvic Controls, Ltd., for interesting work on nucleonic equipment; preference will be given to applicants with experience in pulse techniques; housing available if required.—Write, giving full details of experience, salary required, etc., to the Personnel Officer, Sunvic Controls, Ltd., No. 1 Factory, Temple Fields, Jarlow, Essex. [7509]

ENGINEERS required for installation and service duties in connection with nucleonic instrumentation and V.H.F. A.M. and F.M. communication equipment; applicants should have sound technical electronic training and, preferable, servicing experience in the electronic field.—Write, stating age and details of experience to Personnel Manager, E. K. Cole, Ltd., Southend-on-Sea. [7533]

INSTRUMENT development engineer (senior) required for circuit design work connected with ultrasonics and electronic measuring instruments; must be capable of carrying out development projects to production stage with minimum of supervision.—Apply, giving full details of experience, qualifications and salary required, to Chief Engineer, Dawe Instruments, Ltd., 99, Uxbridge Rd., Ealing, London, W.5. [7538]

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ASSISTANT sales engineer is required by radar manufacturers in London area to handle technical sales correspondence in their radar sales division; applicants should have good knowledge of commercial procedure and radar installation practice; a working knowledge of meteorology will also be of assistance.—Applicants should apply in writing, stating age, experience, salary required, etc., to "JMD," Box 2870. [7530]

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RADIO technicians of all grades are invited to apply for interesting and varied positions in car radio servicing installation and development. Vacancies occur from time to time for our dealers at all parts of the country; a high standard of practical and theoretical knowledge of radio technology is required.—Apply in the first instance to: Personnel Officer S. Smith & Sons (Radiomobile), Ltd., North Circular Rd., London, N.W.2 [0270]

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WEST SUSSEX COUNTY COUNCIL: Bognor Regis Technical Institute.—Applications are invited for the post of assistant Grade A for radio and television servicing subjects; candidates should have served an apprenticeship in the radio servicing or manufacturing industry and hold the appropriate City & Guilds Certificates.—Application forms are obtainable from the Director of Education, County Hall, Chichester, Sussex, on receipt of stamped addressed envelope. Completed forms should be returned direct to the Principal, at the Bognor Regis Technical Institute, Southway, Bognor Regis. [7519]



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TECHNICAL Sales Representative to promote sales of Nucleonic and Electronic instruments to industry, hospitals and Universities. A sound engineering background and established contacts essential. Applicants should also have a good personality and address. Salary offered will be in the range £700—£850. Car supplied. expenses, pension scheme. Write giving full details and qualifications: J. F. Hendrie, Nucleonic and Electronic Department, Dynatron Radio Limited, Castle Hill, Maidenhead, Bucks. [7540]

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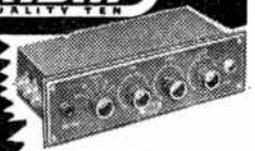
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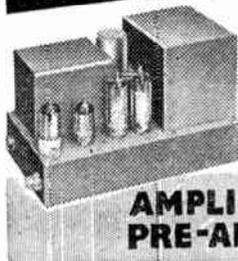
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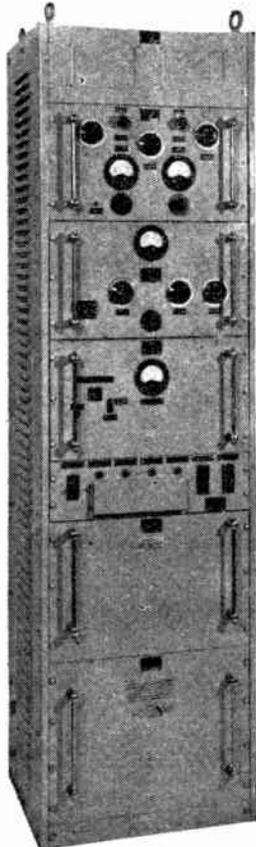
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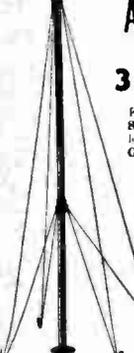


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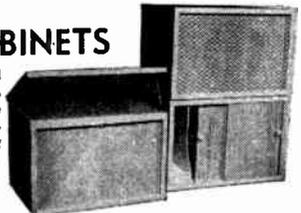
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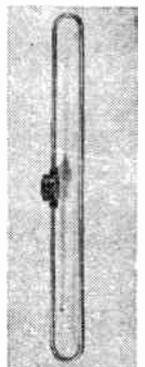
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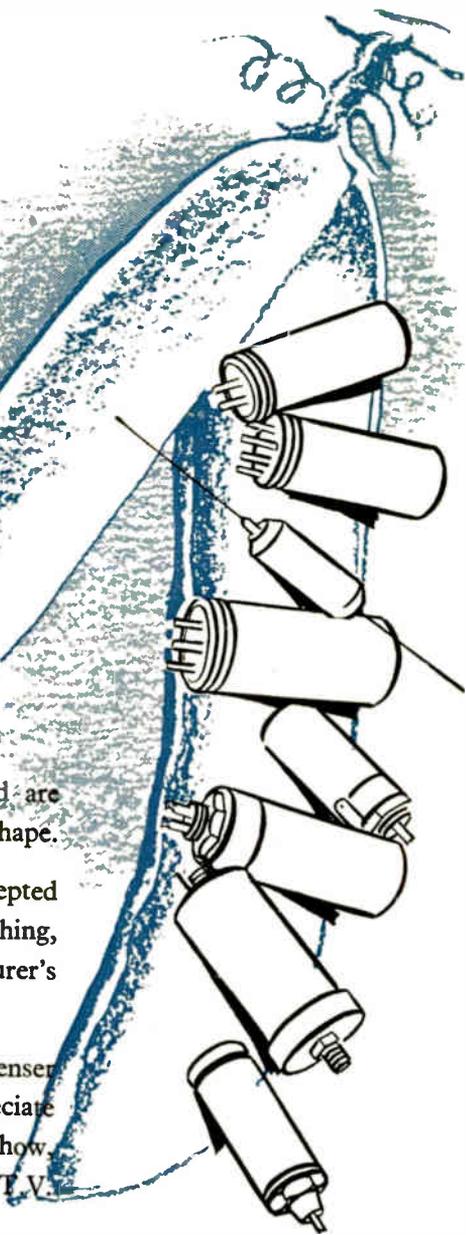
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Yet there can be a considerable difference in condenser performance and dependability. That set makers appreciate this is evidenced by the fact that, at every Radio Show, T.C.C. Condensers are to be found in more radio and T.V. sets than those of any other make.

The letters T.C.C. are a visible assurance of invisible quality, quality that results from more than half a century's specialisation in condenser research and development. That assurance may cost you a few pennies more, but in terms of customer satisfaction it may well be worth pounds.



THE TELEGRAPH CONDENSER CO. LTD

Radio Division · NORTH ACTON · LONDON · W.3 · Telephone: ACORN 0061

Manufacturers, Service Engineers, Radio enthusiasts rely on

Ersin Multicore Solders AND ACCESSORIES

Throughout the world, Multicore Solders Ltd. have established Ersin Multicore Solder in the field of radio, television and electronic equipment, as the most reliable type of cored solder. The 5 separate cores of flux in Ersin Multicore Solder prevent breaks in the flux stream; there are no wasted lengths of solder without flux, and the risk of making dry joints through insufficient flux is eliminated.

Ersin Multicore Type 1 Savbit Alloy containing 5 Cores of non-corrosive flux has now received Ministry approval under No. DTD/900/4535. It may be used for soldering processes on equipment for Service use in lieu of solder to B.S. 219. Ersin Multicore Savbit Alloy reduces absorption of the copper from soldering iron bits and increases the life of bits by up to 10 times, as Savbit keeps soldering iron bits in excellent condition for a considerable period greater efficiency of soldering processes is achieved.

If you have a soldering problem, please write to the Multicore Technical Dept., who will be glad to advise you.

SAVBIT FOR FACTORIES



Ersin Multicore Savbit Type 1 alloy containing 5 Cores of non-corrosive flux is supplied to factories at bulk prices on 7 lb. reels. 16 and 18 s.w.g. are the diameters most suitable for the majority of soldering processes. Supplies are also available on 1 lb. reels.

SAVBIT FOR THE SMALL USER

The Size 1 Carton contains approximately 53 ft. of 18 s.w.g. SAVBIT. It is also supplied in 14 s.w.g. and 16 s.w.g. Obtainable from radio and electrical stores. Ersin Multicore 5-Core Solder is also supplied in 4 specifications of Standard Tin/Lead alloys. Price 5/- each (subject).



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Approx. 170 ft. of 18 s.w.g. SAVBIT is supplied on a 1 lb. reel packed in a carton. Price 15/- each (subject).

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Ersin Multicore 5-core Solder is available in the following standard alloys:
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