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NOVEMBER 1957

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Wireless World

ELECTRONICS

Radio • Television



FORTY-SEVENTH YEAR OF PUBLICATION



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Specimens of polythene cable after heating at 200°C. Top: Normal sample. Bottom: Irradiated sample.

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Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: F. L. DEVEREUX, B.Sc.
Editorial Consultant: H. F. SMITH

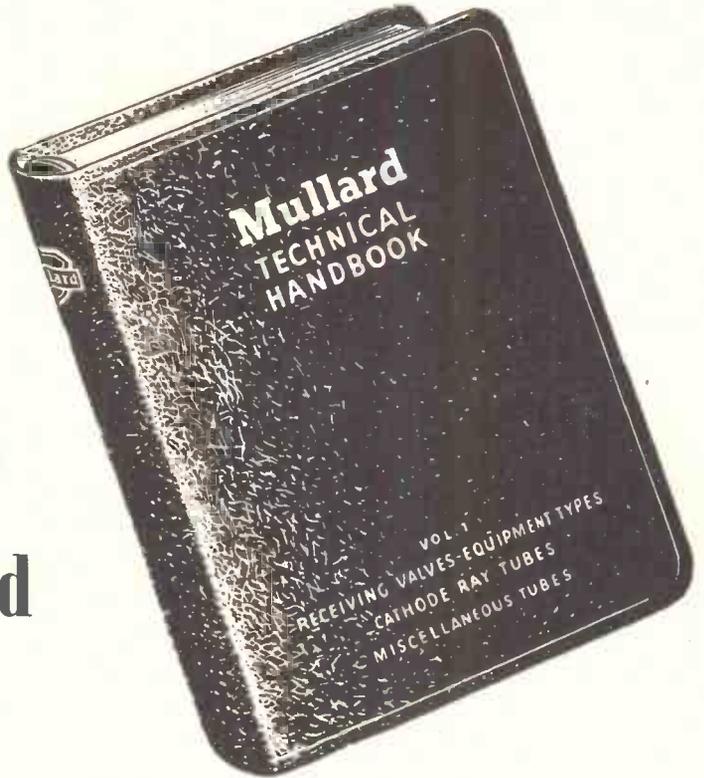
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Communication by Induction

AN amendment (Statutory Instrument 1957, No. 978) to the regulations governing the issue of wireless licences by the Postmaster General makes provision for a new "Induction Communication Licence . . . to establish and use, within a specified frequency band not being above 250 kilocycles a second, sending and receiving stations for wireless telegraphy the number whereof is not limited by the licence, for the purpose of sending and receiving messages concerning the business of the licensee between stations, or between one or some of the stations and another or others of them (not being a licence authorizing the transmission of messages directly between fixed stations)."

Resentment at the imposition of this charge is being expressed in many quarters.

One view is that the P.M.G. has exceeded his powers and that induction is not wireless telegraphy within the meaning of the Act. According to this view no use is made of the free-space, self-propagating electromagnetic field which is the basis of radio communication, as generally understood, and the selective calling systems of the largest hospitals and offices are contained within the induction field of even the highest permitted frequency.

Unfortunately, this argument cannot, in our view, be pressed home. The definition of "wireless telegraphy" by the Act of 1947 is much wider than that which would be given by practising wireless engineers. The term "radiation" is avoided and we are told that "wireless telegraphy" means the emitting or receiving, over paths not provided by any material substance constructed or arranged for that purpose, of electromagnetic energy of a frequency not exceeding 3 million Mc/s for conveying messages, sound or visual images, for the determination of bearing or distance or for gaining information of the presence or absence of objects. It is not much use arguing that in a loop-coupled system one is using only the magnetic field, because to convey information one must vary this field and by so doing a disturbance is propagated with the velocity of light to the tenuous extremities of the magnetic field, and this travelling disturbance will always be accompanied by a complementary electric field. This would be just as true if the field were varied by moving the keeper on a permanent magnet as it would be by varying a current.

Proof that low frequencies are propagated electromagnetically is provided by the "whistler" atmo-

spherics that follow a path through outer space and can be picked up by a sensitive audio amplifier connected to an elevated aerial. Incidentally, if an originating signal had a frequency of less than 2c/s the whole world would be within the induction field, and as far as the Act is concerned there is no low limit of frequency for "wireless telegraphy."

Another argument goes something like this. If the P.M.G. gets away with this induction licence what is to stop him, if he thinks fit, from demanding a licence fee for the use of transformers in communication equipment? Information is conveyed by electromagnetic energy from a transmitter (primary) to a receiver (secondary). True there may be a contrived intermediate substance (an iron core) which gives exemption under Section 19, but what happens if we use an air-cored transformer, and at what value of the coefficient of coupling does the device cease to be a transformer and become a communication system?

There is enough argument here to keep a technical committee or tribunal busy as long as funds hold out, though it would not take them long to discover that distance between source and sink of energy is the operative factor. Although all inductive communication systems are now used indoors and there is negligible outside field, in principle there is no limit to the range if power, loop area and receiver sensitivity are increased. We can vouch for experience for the fact that some magnetic measurements made a few years ago were plagued by interference from trams in a town eight miles away and had to be made at night after the last tram had gone into the depot. If a mobile service were developed on these lines would it be equitable to make no charge while still collecting from users of existing v.h.f. equipment?

Such arguments are a little far-fetched if only for the reason that adequate signal/noise ratio would be difficult to achieve at low frequencies. We bring them forward only to clear the ground before asking why a licence should be demanded so long as all calling systems are restricted to enclosed premises. The P.M.G. does not collect a revenue from house internal telephone installations; why does he insist on his legal right to do so when induction is used instead of a wire connection? If interference is caused outside the premises he could no doubt acquire the powers necessary to intervene, whether the apparatus is licensed or not.

"SOLID CIRCUITS"

Glimpses into the Future at Malvern Components Symposium

THE circuit designer of the future will have to be something of a sculptor and architect, as well as a physicist and engineer, if a new kind of electronic circuit described at the recent International Symposium on Electronic Components at Malvern really comes into existence. Known as a "solid circuit," it consists of a small block of semiconductor material which is specially "doped" and shaped and deposited with films of conductive, resistive and dielectric materials. This forms the equivalent of several transistors connected by resistors and capacitors into a complete functional circuit unit.

At the moment the solid circuit is little more than an idea. It is being investigated by the Royal Radar Establishment at Malvern (who organized the Symposium) in conjunction with Plessey's. A hypothetical example, described by G. W. A. Dummer of R.R.E. and displayed as a model in the Symposium exhibition, was a transistor flip-flop with two emitter-follower outputs—a total of four transistors—all contained within a tiny piece of silicon about $\frac{1}{8}$ inch square by $\frac{1}{8}$ inch thick. The semiconductor was "doped" to form a p-n-p structure and had various sections removed to leave thin bridges of material with relatively high resistances. These high-resistance paths formed the collector and emitter loads of the transistors connected to common power supply rails. Other resistors were provided by films of resistive material deposited on the surface of the silicon, while capacitors were constructed in a similar manner from thin metallic layers with insulators between.

It appears there is a possibility of incorporating inductors as well, and here the technique seems to link up with another suggested type of "solid circuit" using ferrite as the basic material. A good deal of work has already been done on printing conductors through holes in ferrite blocks to form the equivalent of cored inductors. The conjunction of these two techniques—semiconductor and ferrite—certainly offers some exciting possibilities for the future, and it was perhaps significant that a call for more work in this direction, away from conventional components, was made by John Sargrove, who designed some of the first "solid circuits" for automatic production in his ECME machine.

Other speakers mentioned devices already in existence which go some way towards the "solid-circuit" ideal. A. W. Rogers of the U.S. Signal Corps, for example, described piezo-electric bandpass filters in which ceramic titanate material replaces the resonant combinations

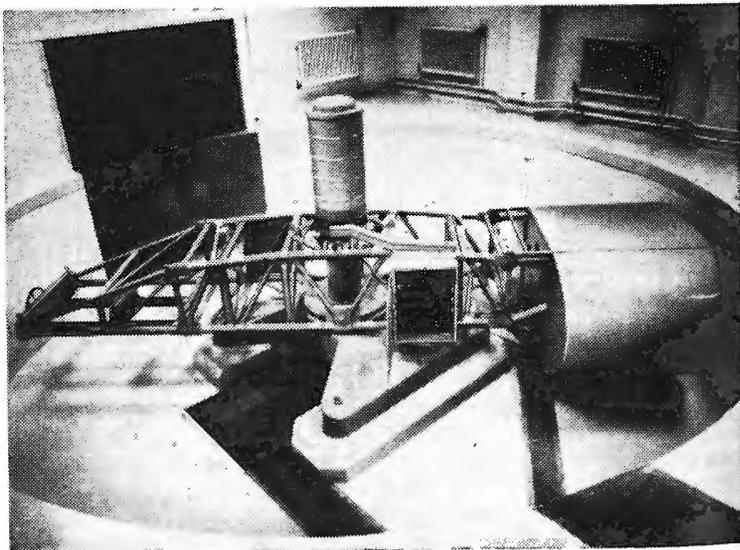
of L and C used in conventional circuits. Mr. Rogers was mainly concerned with the development of new components and techniques for transistor circuits, and he stressed the need for what might again be called "solidity" in circuits—in the sense of packing as much as possible into a small space. In achieving "volumetric efficiency" in military equipment, he felt there was too much emphasis on miniaturization of individual components and not enough on the efficient utilization of space by improved methods of mounting and packaging. The overall "volumetric efficiency" for an average equipment built up from packaged units was only about 15%, but it should be possible to attain at least 50%.

Heat Problems

As one might expect, a great deal of the Symposium was devoted to the design of components for operating under severe environmental conditions—extremes of heat, cold, humidity, shock, vibration and nuclear radiation. Of these, heat seems to be the major problem, and one speaker, Col. J. S. Lambert of the U.S. Air Force, said that his organization was giving its main attention to high-temperature operation because it was felt that any new techniques evolved would automatically solve some of the other problems. He was referring particularly to guided missiles, where temperatures in excess of 500°C—generated by air friction and the propulsive system—are quite common in flight.

The use of liquid cooling systems is a fairly new technique which seems to be gaining ground. One example in the R.R.E. exhibition was an experimental liquid-cooled chassis system. The components were

Acceleration test machine for airborne electronic equipment. The acceleration range is 2-40g. Connections to the apparatus under test are made by slip rings.



mounted on aluminium sheet containing integral ducts through which the coolant was circulated. Valves were clamped horizontally in split metal tubes fixed down to the chassis. Apart from increasing the transfer of heat beyond that normally obtained with air cooling, the system makes possible a greater thermal loading of the equipment, resulting in a saving in size and weight—even when the cooling apparatus is taken into account. The particular unit shown was dissipating 325 watts in a sealed drum 7 inches in diameter and 10 inches long, but the internal temperature was nevertheless quite safe for conventional components.

Liquid cooling is also used to some extent in individual components which lend themselves to this treatment—for example transformers and chokes mounted in containers. L. F. Kilham of Raytheon (U.S.A.) described transformers which, by the use of fluorine compounds to get the heat away quickly, could be made very much smaller in size than would be necessary with ordinary air cooling. Reductions in size and weight of about three or four times could be obtained. The liquids (which are similar to those used for refrigeration) are compatible with the materials used in transformers, are non-inflammable and non-toxic, and have a high dielectric strength and self-healing properties. Sometimes the coolant takes the form of a vapour and sometimes a boiling liquid (in which case it acts rather like a thermostat). The technique has been used for about two years in the U.S.A. and some transformers have been found to have lives of 10,000 hours or more.

High-temperature Transformers

It is now quite possible, however, to design transformers so that they will operate at very high temperatures—in the region of 100°C to 500°C—just as successfully as they do at normal room temperatures. Various British examples were described and shown in the exhibition. Glass-insulated wire is used for windings, sometimes treated with vitreous enamel, and silicon steel for the cores. Materials like glass cloth and ceramics are pressed into service, bobbins are made of metal or porcelain, while leads have to be brazed on to terminals instead of soldered. The windings often have metal plates embedded in them, or metal clamps around them, to conduct the heat away quickly, and are sometimes enclosed in evacuated cases.

Coming straight from the atmosphere of domestic radio, it was rather surprising to hear that printed circuits have so far penetrated very little into military equipment in this country. There were, however, a great many examples of potted circuits in the exhibition—and these, of course, are yet another variant on the idea of “solid circuits.” Epoxy resins are now widely used in preference to the polyester types because of their good adhesive properties and general toughness and resistance to chemicals. In addition to the conventional solid potting methods, it seems that R.R.E. are trying out a lightweight system of encapsulation in which the components are just dipped into the resin, to form a moisture barrier and prevent them from vibrating, and then the containers are sealed off with a ¼-inch layer of resin at top and bottom.

Solderless wrapped connections have come into the news again after many years of neglect (they were originally used in early telephone systems) and

appear to be highly thought of by the military electronics people. The end wires of a component are wrapped around rectangular terminal posts by an automatic tool, and the resultant stress is so great that the oxide film is crushed on both wire and terminal and the tin on the wire actually diffuses into the terminal after a certain period. The result is said to be inherently more reliable than soldered joints, even though the tension in the wire does relax eventually. Examples were shown which appeared to have been in a fire or at the bottom of the sea and yet still gave perfect connections.

Operation of components and equipment under severe environmental conditions means, of course, that a great deal of testing has to be done in which these conditions are simulated. The exhibition contained, in fact, several elaborate and expensive installations for doing such work—an acceleration test machine of the centrifuge type (see picture), an automatic component testing equipment (described in our last issue, p. 483), and—most impressive of all—a stratosphere test house, looking rather like the boiler room of a ship, in which wide ranges of temperature, pressure and humidity could be obtained inside a huge 750-cu ft stainless steel chamber.

One criticism made in the Symposium was that testing for reliability tends to take so much time that sometimes the components are obsolete before the results are available. Another speaker remarked that one of the test equipments did not give results compatible with the official specifications laid down. Whether these comments are valid or not, there is no doubt that the R.R.E. work is highly respected by the commercial manufacturers and provides information of immense value in the development of new components. Government “type approval” is becoming such an “O.K.” thing nowadays that, as Dr. D. H. Black, Director General of Electronics Research and Development, Ministry of Supply, remarked, firms are finding that they cannot sell their products without it!

B.S.R.A. COMES OF AGE

THE 9th Exhibition and Convention held at the Waldorf Hotel, London, by the British Sound Recording Association was made the occasion for celebrating the 21st anniversary of the foundation of the Association.

At the annual dinner the principal speaker was R. T. B. Wynn, chief engineer of the B.B.C., who paid tribute to the pioneers, professional and amateur, of disc and tape recording and to the part they had played in establishing the now very considerable recording resources of the B.B.C. There was still scope for originality in finding an economic solution to the problem of electrically recording television signals and he thought that amateurs could make valuable contributions, as they had in the past.

P. G. A. H. Voigt, one of the pioneers of high-quality sound reproduction, and now resident in Canada, contributed to the proceedings through the medium of tape recording.

In the competition for amateur-constructed equipment, the President's Trophy went to A. J. Harper for a four-channel mixer, the *Wireless World* Prize to W. Webber for a stroboscopic tape synchronizer for use with 8, 9.5 or 16mm film, and the Committee Prize to P. J. Baxandall for a 5-watt high-quality amplifier and equalizer unit.

WORLD OF WIRELESS

B.B.C. Television Coverage

TELEVISION is already available to 97% of the population and the B.B.C. coverage will extend to over 98% by about the end of this year, by which time it is expected that the power of the Crystal Palace station will have been increased, the temporary stations at Sandale (Cumberland) and Douglas (Isle of Man) will have been replaced by permanent stations, and the new station at Londonderry in Northern Ireland will have been completed; it is hoped also to introduce a temporary station near Dover.

The problem of serving the remaining 2% is a difficult one. Two new stations to serve about 140,000 people outside the service areas of existing B.B.C. stations are announced. One will be near Peterborough and the other in Orkney. Both stations will operate in Channel 5, the Peterborough station with horizontal polarization and the Orkney station, which will also radiate v.h.f. sound programmes, with vertical polarization.

The Norwich station, at Tacolneston, which has been operating on considerably reduced power to avoid interference with the Liège, Belgium, transmitter, will use increased power from December 1st. It will go up to its full power (varying from 1 to 10kW according to the direction) in the spring or early summer next year, when the power of the Liège transmitter will also have been increased.

Mobile Radio

PRIVATE mobile radio licences in force in the United Kingdom at the end of August totalled 1,561. They covered 1,805 base stations and 13,010 mobile stations. Of the mobile stations 11,411 were in land vehicles, 901 in ships and tugs and 696 portables and transportables.

The recently revised cost of a private mobile radio licence is £3 p.a. for each of the first two stations (base and mobile) and £2 p.a. for each additional station.

Two new types of licence were recently introduced. One providing for temporary mobile radio operation for up to 28 days, costing £1, and the other covering inductive "paging" systems (£2 p.a.). Regulations regarding these two new licences are given in Statutory Instruments 1957, No. 978.

Valves: Prospect and Retrospect

IN THE course of his inaugural address as president of the I.E.E. Mr. T. E. Goldup, a director of Mullard, referred to the changes which have taken place in the valve industry during the long period of his association with it. Some idea of the growth of the industry is given in these figures quoted by Mr. Goldup. In 1949 British manufacturers produced 19 million valves and 310,000 c.r. tubes; in 1956 the corresponding figures were 64 million and 2 million. The 1956 output of receiving valves in the U.K. was, however, but 9% of the world production of some 743 million, whereas the United States produced 67%.

Autumn Audio Fair

OVER 30 exhibitors have taken space at the Autumn Audio Fair to be held in the Grand Hotel, Harrogate, from October 25th to 27th. They are listed below. All the exhibitors have individual demonstration rooms in addition to stands.

Altobass	Lustraphone
Associated Electronic Eng.	M.S.S.
Champion	Mullard
C. T. Chapman	Pamphonic
Cosmocord	Philco
Dulci	Philips
Dynatron	Plessey
E.A.P.	Pye
E.A.R.	R.G.D.
E.M.I.	Sugden
Expert Gramophones	Tannoy
Garrard	Trix
Goldring	Vitavox
Grundig	W. & N. Electronics
Hi-Fi News	Whiteley
Jason	

Tickets for the Fair, which is open from 11.0 to 9.0 on each of the three days, are available from exhibitors or from this office. Applications should be accompanied by a stamped addressed envelope.

Radio Hobbies Exhibition

THIS year's R.S.G.B. amateur radio show has been restyled the Radio Hobbies Exhibition. It opens for four days at the Royal Horticultural Society's Old Hall, Vincent Square, London, S.W.1, on October 23rd. Admission to the exhibition, which will be open daily from 11.0 to 9.0, costs 2s.

The 22 exhibitors are:—

B.I. Callender's Cables	Panda Radio
British Amateur Television Club	Philpott's (Metal)
Clyne Radio	R.A.F.
Cossor Instruments	R.S.G.B.
E.M.I. Institutes	Royal Navy
Enthoven Solders	S.T.C.
K.W. Electronics	Short Wave Magazine
Labgear	Taylor Electrical Instruments
London U.H.F. Group	Wireless World and Electronic
Measuring Instruments	& Radio Engineer
Minimitter Co.	Whiteley
Mullard	

The B.A.T.C. is putting on a large-scale demonstration of home-constructed television equipment. On their stand will be six cameras and monitors and exhibitors will be given the opportunity of demonstrating equipment before the cameras. A television telephone link will also be demonstrated.

Television receiving licences in the United Kingdom increased during August by 61,459, bringing the total to 7,331,207. The overall total for broadcasting licences at the end of August, including the above and 322,085 for car radio receivers, was 14,685,231.

Comparisons.—"You can buy a top-quality 21-in. console, a first-class 17-in. or 21-in. portable, a good packaged hi-fi console with a-m and f-m radio and several three-way table radios for the price of a color console. No wonder the mass market doesn't want it now," Allen DuMont, chairman of DuMont Laboratories, quoted by *Electronics* business edition.

"**Mirror in the Sky**," the Mullard film on the work of Sir Edward Appleton on the ionosphere, was one of eleven films submitted by this country for showing at the 11th congress of the International Scientific Film Association meeting in Amsterdam.

St. Hilary.—Preparatory to the opening of the I.T.A. station at St. Hilary, near Cardiff, on December 17th, the stand-by transmitter will broadcast test transmissions in November, giving a much more powerful signal than that at present provided by the pilot transmitter. It is hoped to test the main transmitter, which will have an e.r.p. of 200 kW, for at least a week before programmes start. The transmitter operates in channel 10.

Long-distance v.h.f. propagation.—The I.E.E. Radio and Telecommunication Section is planning a symposium of papers on long-distance propagation above 30 Mc/s for January 28th. There will be two sessions at the Institution's headquarters. The first, on ionospheric forward scatter propagation, is at 2.30 and the second at 5.30 on tropospheric propagation beyond the horizon. Registration forms will be available in November. The fee for non-members will be about £1.

"An old problem in a new industry" is how Peter E. M. Sharp, writing in *Design*, summarizes the difficulties facing manufacturers of high-fidelity equipment in their efforts to combine appearance and functionalism. He surveys the problems which the purchaser has to face in making a united whole from the various components—tuner, amplifier, loudspeaker, turntable, and pickup.

"E.R.A. Weekly Abstracts," consisting on an average of 30 abstracts taken from British and foreign journals, issued up to now only to members of the Electrical Research Association, is being made available to the public. The lists, available if required typed on one side of the paper only, cover a wide range of electrical subjects. "Weekly Abstracts" is available from E.R.A. Information Bureau, Thorncroft Manor, Dorking Road, Leatherhead, Surrey, price 5 gns. a year.

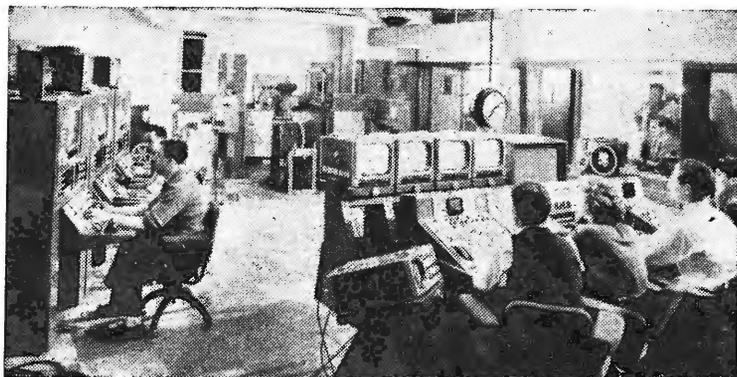
Institute of Navigation membership increased during the year ended June 30th by 107, bringing the total to 1,741. The annual report records that the finances of the Institute were adversely affected by the three-day conference on collisions held in June, which accounted for £580 of the £1,600 excess of expenditure over income.

E.I.B.A.—The radio and electronics industry is well represented in the list of donors to the funds of the Electrical Industries Benevolent Association given in the 1957 Year Book. The Radio Industry Council contributed £500 and collections at the luncheons of the Radio Industries Club totalled £350. The Association assists "any deserving and necessitous persons, but excluding manual workers, who are or have been engaged primarily in any branch of an electrical industry."

Technical Writing.—A course of six weekly lectures on the techniques of technical writing opened at Borough Polytechnic, Borough Road, London, S.E.1, on October 11th. The lectures are being given by G. Parr at 2.30 (fee 10s).

I.T.A. in the N.E.—The eighth transmitting station to be built by the I.T.A. will be at Burnhope, about five miles south-east of Consett, Durham. The station, which will have an e.r.p. of 100 kW, is expected to cover the area, roughly crescent shaped, extending from Alnwick in the north, through Middleton in Teesdale in the west and nearly to Whitby in the south. It is hoped to bring the station into service in about a year.

MASTER CONTROL ROOM of the Glasgow studios of the Scottish independent television service. The film recording equipment, control racks and master control desk are all in one room, adjacent to which is the announcers' booth. All the studio and control room equipment has been supplied by Pye.



International Instruments.—The fourth international instrument show, organized by B & K Laboratories, of 57 Union Street, London, S.E.1, will be held at Caxton Hall, Westminster, London, S.W.1, from 24th to 29th March, 1958.

FROM ABROAD

Transistor sales in the United States are expected to exceed 30 million units this year. Last year's figure was a little below 13M. Figures published in the business edition of *Electronics* estimate that 42% will go into "entertainment" equipment, 30% to the commercial-industrial field, and 28% into military equipment. All the transistors in the first category and all but a few in the second are germanium, but in the military equipment over a quarter are silicon.

Home "Tele-cine."—Cited as an attempt by American cinemas to counteract the effect of television, a cinema in Bartlesville, Oklahoma, is experimentally transmitting films by wire to television receivers in patrons' homes. The fee, according to our contemporary, *Electrical Journal*, is \$9.50 a month for 13 first-feature films, plus supplementary films, music, news, etc.

High-power V.L.F. Station.—The U.S. navy is to build a new high-power v.l.f. station in Washington County, Maine. It is reported that the transmitter, which it is planned to bring into service in 1961, will operate on about 15-20 kc/s with a power of 2,000 kW.

Aerial Safety.—The first three cities or municipalities to be given power under the Canadian 1956 Radio Act, enabling them to take action against owners of receiving aerials considered to be a public danger, are announced by the Department of Transport, Ottawa. These localities have applied for and been designated as areas in which local building inspectors may enforce aerial safety regulations. These include the ability to withstand stipulated wind pressures when the aerial is covered with a half-inch of ice.

Auckland University.—We have been asked by Auckland University College to announce the formation of the Auckland University Engineers' Association for past and present graduates and students. There are many men who have passed through the School of Engineering since its formation in 1906 who cannot be traced. Details of the Association are obtainable from J. H. Percy, Auckland University College, Auckland, New Zealand.

Swedish Chain of Decca Navigator stations, officially opened on October 3rd, is the fourth to be brought into service this year. The others are Nova Scotia, Newfoundland East and Newfoundland West. A fifth—the Quebec chain—will be opened on November 5th.

Australian V.H.F.—An enquiry into the question of the introduction of v.h.f. broadcasting in the Commonwealth has been held by the Australian Broadcasting Control Board.

Personalities

Professor H. S. W. Massey, F.R.S., leader of the United Kingdom delegation at the I.G.Y. conference on rockets and artificial satellites held in Washington at the beginning of October is Quain professor of physics at University College, London. From 1946 to 1950 he was a member of the Radio Research Board of the D.S.I.R. For his work on the ionosphere he received the Hughes medal of the Royal Society in 1955. The other members of the delegation were: Dr. J. G. Davies, Jodrell Bank Experimental Station, W. T. Blackband, Royal Aircraft Establishment, and Alistair Anthony, British Joint Scientific Mission in the United States. Among the subjects discussed was the tracking of artificial satellites by optical and radio methods.

Dr. M. V. Wilkes, F.R.S., director of the Cambridge University mathematical laboratory, is the first president of the recently formed British Computer Society. Dr. Wilkes is an acknowledged authority in the field of digital computer design, in which he was a pioneer, and is well known for his book "Automatic Digital Computers."

E. R. L. Lewis, M.A., A.M.I.E.E., who joined Marconi's in 1950 as education and training officer and since 1955 has been manager of the education and technical personnel department, has been appointed to the newly created post of controller of education for the English Electric group, of which the Marconi companies are members. Mr. Lewis, who is 42, graduated at Trinity Hall, Cambridge, and after war service in the Royal Air Force technical signals branch, was for three years in the Signals Planning Section of the Ministry of Civil Aviation.

Sir Ronald Nesbitt-Hawes, who has been chief of educational administration since 1949, becomes education adviser to the English Electric group. Before joining English Electric Sir Ronald was for three years chief engineer and for nine years director-general of Posts and Telegraphs, Burma.

R. S. Roberts, who, as announced last month, has accepted the appointment of executive technical director to Wolsey Electronics, Ltd., is retaining his position as senior lecturer in the Northern Polytechnic's department of telecommunications. **John Gilbert**, head of the department, encourages members of his staff to maintain such connections with industry.

F. H. Townsend has resigned from the managing directorship of Cathodeon, Ltd., and has gone to the United States to take up an appointment with Machlett Laboratories, Inc., of Springdale, Conn. He joined Pye in 1938 and was deputy head of the vacuum laboratory until 1946, when he transferred to Cathodeon, a subsidiary, as chief vacuum engineer and manager. Before joining Pye he was in Cossor's research department for seven years. He is 46.



DR. J. S. McPETRIE, the new chairman of the I.E.E. Radio and Telecommunication Section, whose inaugural address on "Some radio aids for high-speed aircraft" is being given on October 16th.

K. R. Sturley, B.Sc., Ph.D., M.I.E.E., head of the B.B.C.'s engineering training department, is visiting the United States to study methods of training in broadcasting and radio engineering. During his stay Dr. Sturley will be presenting three papers written by members of the B.B.C. engineering division for the Audio Engineering Society's annual convention in New York and the Society of Motion Picture and Television Engineers' convention in Philadelphia.

Harold J. Leak, M.Brit.I.R.E., chairman and managing director of H. J. Leak & Co., is visiting North America. He was at the New York High Fidelity Fair (October 7th to 12th) and will be in Toronto for the Canadian Audio Fair (October 31st to November 2nd) where Leak equipment will be exhibited by Astral Electrical Co., Ltd., of Toronto.

K. E. Harris, B.Sc., technical director of Cossor Radar & Electronics, Ltd., is on a five weeks' visit to North America during which he has attended the meeting of the International Civil Aviation Organization as a member of the United Kingdom delegation. He is also carrying out a survey of the evaluation trials which are being conducted on the Cossor secondary surveillance system by the Americans at Patuxent, Md. He is accompanied by **L. Perkins**, a Cossor engineer.

D. A. Lyons, managing director of Trix Electrical Co., succeeds **V. G. P. Weake** (Pamphonic) as chairman of the council of management of Audio Fairs, Ltd. This non-profit-making company was formed "to assume responsibility for future audio fairs in Great Britain."

Philip M. Thompson, who with John Bateson discusses transistor symbols in this issue, is in the transistor section of the Electronics Laboratory, Canadian Defence Research Telecommunications Establishment. He took the natural sciences tripos at Cambridge and after a short while at A.T. & E., Liverpool, returned to the Cavendish Laboratory. On leaving the laboratory he joined Salford Electrical Instruments and in 1950 emigrated to Canada. He is 31.

John Bateson, co-author of the article on page 525, served in the signals branch of the R.A.F. and was for some six years training "wireless trades" before his release from the Service in 1948. He then emigrated to Canada where he joined the radio propagation laboratory of what is now the Defence Research Telecommunications Establishment. He is 37 and is senior research technician in the establishment.

H. D. Kitchin, who describes in this issue a television frame pulse separator, rejoined Mains Radio Gramophones, Ltd., a few months ago to work on colour television and to act as technical adviser to the company, which makes sets for Radio Rentals. He was previously with the company for five years until 1955 when he became senior development engineer with Ambassador Radio & Television, Ltd. He is 29.

OBITUARY

L. H. Daniel, the first director of the National Coal Board's central engineering establishment near Burton-on-Trent, who died on September 14th, aged 51, was for some years on the laboratory staff of the Electrical Research Association, where he was concerned with problems of radio interference. During the war he was temporarily engaged on investigations into magnetic mines at H.M.S. *Vernon* and from 1946 to 1954 was at the Fighting Vehicle Research Development Establishment, where he became deputy chief engineer.

Major Charles E. Prince, O.B.E., M.I.E.E., who died on September 25th at the age of 83, was for some years in the research department of Marconi's, which he joined in 1907. He was responsible for important improvements in the Bellini-Tosi d.f. system, and during the first world war developed the first aircraft radio-telephone. From 1929 to 1935 he was technical managing director of Radiovisor Parent, Ltd.

RETURN LOSS

By THOMAS RODDAM

I.—Standing Waves or Return Loss ?

*"Masculine will only be
Things that you can touch and see."*

THOUGH excellent as a mnemonic for the student of the classics this jingle, for that is what it is in contemporary language, represents one of the great untruths of science and engineering. Too many of the elementary texts on electricity, wireless or radar, persist in the assumption that we are all plumbers at heart and cannot understand anything which isn't disguised as a system of water pipes. Currents, valves, pressures, condensers (and don't think capacitance hasn't a touch of the water works), all our terminology keeps us in the same frame of mind. This attitude was, perhaps, in order when light-current electricity was a "new thing," but now most of us find circuits much easier to understand than plumbing.

I was set off on this line of thought by the sight of a picture of a water trough intended to help the student to understand the development of standing waves. Here we have one of those happy hydraulic analogies which can so easily create more difficulties than they resolve. Do we really need standing waves?

For work in the kilo-megacycle region I suppose that there is still a great deal to be said for operating with standing wave ratios, although improvements in the directional coupler have brought us to the position where we are no longer compelled to measure standing waves. I have, however, found this to me rather repulsive concept creeping in all over the place and leaving a certain amount of confusion in its train. I think it is possible to attack many of the problems of mismatched lines more easily and more clearly without using the idea of standing waves at all.

The traditional approach to the problem of a line which is not correctly terminated usually begins with a special case, that of the open-circuited line. The voltage wave travelling along the line is shown first. The author then draws another sine wave representing the reflected wave, adds the two together, and shows the instantaneous resultant voltage distribution along the line. He then repeats the process for a slightly later time, and finishes up, in one particular example, with sixteen little drawings showing that at some points the voltage is always zero, at others the current is always zero, and that at others the voltage and current reach maximum positive and negative values. The next step, I suppose, would be to show what happens if the line is terminated, but incorrectly: the textbook I looked in apparently found this too advanced.

I'm not a student any more, but when I looked at these little drawings I wondered what happened away to the left of the picture, where the wave started. Unless the line is matched there, the reflected wave will be reflected again and it looked as though it would not be too difficult to get into rather a muddle.

What is more, it seemed as though it was a rather unnecessary muddle, because it is only when asked to measure standing waves that anyone would move along a line looking at maxima and minima. I'm excluding interconnection problems in large power networks and one or two rather similar cases.

The real difficulty with the standing wave treatment of problems is that there is nothing in the ordinary simple theory to tell you whether standing waves matter, and if they do, how much. Let us consider a simple problem. From my window I can see a television aerial on a chimney stack: I suppose it is about 50 to 60 feet above ground level. The feeder wanders about rather, so I shall assume that it must be at least 20 metres long from aerial to set. Let us pretend we have carried out an experiment and found that there are standing waves along the feeder. What then?

The first conclusion we can draw is that the receiver at the bottom does not provide a perfect termination for the feeder. That means we will not get quite as much signal reaching the first grid as we might. Now we know that the standing waves originate in reflections at the receiver, but this simply means that a signal is sent back up the feeder to the aerial. There, perhaps, there is again a mismatch and the signal is re-reflected down to the receiver again. Ordinary television down-lead coaxial cable transmits signals at about 200 metres per micro-second, so that this delayed down-coming signal, after two reflections, arrives about 1/5 of a micro-second late. This means that the double echo of the white bars of the 2.5 Mc/s section of the test card will just turn up on top of the black bars. Here is something pretty practical: in this particular installation, if echoes are produced at top and bottom of the feeder this trouble will really be seen on the 2.5 Mc/s bars. Our simple standing wave test, however, doesn't help us to find out how serious this will be in our particular case.

Determination of Return Loss

I don't know how many readers remember Appleton and Barnett's experiments on the ionosphere. They used a c.w. signal, varied the transmitting frequency, and measured the maxima and minima produced by interference between transmitted and received waves. This is a good way of proving that the ionosphere really exists, but it would take from now to Christmas to produce just one of those apparent height versus frequency curves the automatic machines turn out in the odd minute or two. The method preferred nowadays for measurements on the ionosphere is that introduced by Breit and Tuve, who used pulses to keep the echoes separate from the transmitted signal. Standing wave measurements always remind me of the Appleton-Barnett technique, so simple for indicating that something's wrong, but so awkward for finding out exactly what.

It may come as a shock to those readers who have

ever had anything to do with line communications to learn that there are some living and breathing engineers who have never heard of return loss. Paddling happily in their troughs they have failed to notice that there is a much easier way of solving their problems, the method of return loss. Let us see what we mean by this.

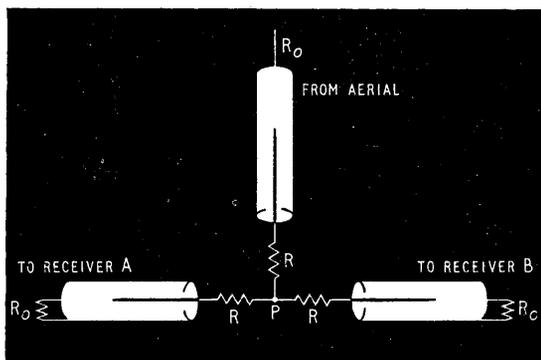


Fig. 1. A splitting network to avoid reflections.

Suppose we assume that we have a circuit consisting of a long line of characteristic impedance Z_0 and at one end, the end we can see, we terminate this line with an impedance Z_1 . The line is, of course, quite free from all losses, because we do not want to complicate matters with irrelevant effects. At the far end we shall assume that there is a pulse generator of impedance Z_0 giving an open-circuit pulse voltage $2V$. Each time the pulse generator delivers a pulse it operates as though the load on it were Z_0 , because the line is assumed to be long enough for any receiving end effects to happen too late to be noticed at the sending end. Thus the generator gives out a pulse V to the line.

When we start to observe matters at our own end we carry out a special experiment putting Z_0 across the line (instead of Z_1). We then measure a pulse amplitude of V , with our given generator voltage and impedance.

There is a very important point to notice here. When we terminate the line in the impedance Z_0 there is no join from an electrical point of view. Nothing distinguishes the terminating impedance from a very long bit of line of the same kind so that there is no reflection at the termination.

Now let us put back the Z_1 termination. We then have a very simple circuit consisting of a generator of impedance Z_0 and open-circuit voltage $2V$, and a load Z_1 . Across the load, then, by Thévenin's theorem, we have

$$V_1 = \frac{Z_1}{Z_1 + Z_0} 2V$$

The generator, however, is a pulse generator and, as we have seen, operates as though the load on it were Z_0 , so that on the line a bit back from the load the pulse amplitude is V . Suddenly, on reaching the load, the voltage has changed. Let us consider the available energy. We could deliver, in fact we are all set to deliver V^2/Z_0 into a load Z_0 . Actually the pulse only delivers V_1^2/Z_1 , that is $\frac{4V^2 Z_1}{(Z_1 + Z_0)^2}$ which

means that an amount $\frac{V^2}{Z_0} - \frac{4V^2 Z_1}{(Z_1 + Z_0)^2}$ must have been

rejected. It is, indeed, literally rejected, thrown back along the line as a pulse travelling back towards the source. How big is this pulse? It has energy, given by the expression above, which will all be dissipated when it reaches the impedance Z_0 of the generator. If the reflected pulse amplitude is V_2 , we must have then

$$\frac{V^2}{Z_0} = \frac{V^2}{Z_0} - \frac{4V^2 Z_1}{(Z_1 + Z_0)^2}$$

$$\text{i.e. } \left(\frac{V_2}{V}\right)^2 = 1 - \frac{4Z_1 Z_0}{(Z_1 + Z_0)^2} = \frac{Z_1^2 + Z_0^2 - 2Z_1 Z_0}{(Z_1 + Z_0)^2} = \frac{(Z_1 - Z_0)^2}{(Z_1 + Z_0)^2}$$

As we are only interested in amplitudes we can write

$$\left|\frac{V_2}{V}\right| = \left|\frac{Z_1 - Z_0}{Z_1 + Z_0}\right|$$

Usually we regard the operation as one providing an attenuation between the arriving and returning pulse. We work in decibels and say that

$$\text{Return Loss} = 20 \log \left|\frac{V}{V_2}\right| = 20 \log \left|\frac{Z_1 + Z_0}{Z_1 - Z_0}\right| \text{ dB.}$$

The return loss is a really useful concept. In ordinary language we say that a particular impedance has a return loss of so many decibels against 75 ohms, or 600 ohms, or whatever our standard is. Let us look quickly, before doing anything else, at my neighbour's television down-lead. We assume just for convenience, that the receiver has a return loss of 15 dB against the feeder impedance, and that the aerial has a return loss of 10 dB against the same impedance. We shall neglect the loss in the down-lead for this example. The signal, say 1 millivolt, comes down the aerial and at the set a signal of 15 dB below 1 mV is reflected back. When this reaches the aerial we have a new reflection with the echo 10 dB down on the signal moving up the feeder, so that the re-echoed signal is 25 dB below 1 mV. This, then, is the size of the delayed down-coming signal which we saw would disturb our 2.5 Mc/s bars. As you see, using return loss the mathematics is reduced to a matter of simple addition: you can hardly do better than that.

Reflection Loss

While we have our mathematics handy, and before we go on to a further discussion of return loss, there is another important factor connected with the mis-termination of the line, the reflection loss. We have just seen that some energy was reflected back along the line. Obviously, then, we did not get as much energy into the load as we might have done. In fact the available energy was V^2/Z_0 , and the amount not reflected was $4V^2 Z_1 / (Z_1 + Z_0)^2$, so that reflection

$$\text{loss} = 10 \log \frac{V^2}{Z_0} \cdot \frac{(Z_1 + Z_0)^2}{V^2 \cdot 4Z_1} = 20 \log \left|\frac{Z_1 + Z_0}{2(Z_1 Z_0)^{1/2}}\right| \text{ dB.}$$

This is usually a pretty small quantity and is difficult

to measure. For example, if $Z_0 = 100$ ohms and $Z_1 = 110$ ohms then

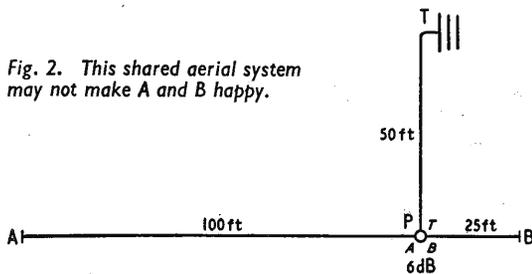
$$\text{Return loss} = 20 \log \frac{210}{10} = 26.4 \text{ dB}$$

$$\text{Reflection loss} = 20 \log \frac{210}{2(11000)^{1/2}} = 20 \log \frac{105}{104.9}$$

an amount well below slide-rule errors. The return loss is much easier to deal with and, as we shall see in another article, it is the return loss combined with the time delay which makes matching important.

Now let us consider a more complicated problem to see how we can use return loss in practice. Two men, whom we will call A and B, decide that they will share a television aerial. The aerial is erected on a convenient chimney-stack, and a lead run down to a suitable point near the ground. From here, two separate leads are to run to the two receivers. Obviously, says A, we cannot just parallel up the two leads or we shall have a shocking mismatch. They therefore make up a matching network, which takes the form shown in Fig. 1. You will notice that all three resistances are equal, because if all three feeders have the same impedance the system is a symmetrical one. (Most people drawing it will, if they want to accentuate this feature, show the resistors spaced 120°

Fig. 2. This shared aerial system may not make A and B happy.



apart.) To match the downcoming lead we must have $R + \frac{R + R_0}{2} = R_0$ or $3R = R_0$. At the input to this network we have a signal V . At P we have

$$V \cdot \frac{R + R_0}{2} / \left(R + \frac{R + R_0}{2} \right),$$

and at the receiver feeder itself we have

$$\left[V \cdot \frac{R + R_0}{2} / \left(R + \frac{R + R_0}{2} \right) \right] \cdot \frac{R_0}{R + R_0}$$

$$= V \cdot \frac{R + R_0}{3R + R_0} \cdot \frac{R_0}{R + R_0} = V \cdot \frac{R_0}{2R_0} = \frac{V}{2}$$

This little pad therefore costs us 6 dB. If we hadn't worried about matching and had just paralleled up the feeders, we should have found that we got

$$2V \cdot \frac{R_0/2}{R_0 + R_0/2} = \frac{2V \cdot R_0}{3R_0} = \frac{2}{3}V, \text{ a loss of } 4.4 \text{ dB.}$$

What reward do we get for the extra 1.6 dB? If we leave out the pad there is a bad mismatch at the junction, and the return loss at this point is

$$20 \log \frac{R_0 + R_0/2}{R_0 - R_0/2} = 20 \log 3 = 9.5 \text{ dB.}$$

Leaving out the attenuation in the cable itself, as in

our previous example, we get a delayed echo 20 dB down if the aerial has a return loss of about 10 dB.

But now let us look more closely into the problem that A and B have set themselves and us. Fig. 2 shows a view of the sort of installation they might be sharing and I have assumed a rather large-scale affair because then we get more interesting numbers. The signal is received by the aerial at T, and we will take its level at this point as zero level. The cable used has an attenuation of 2 dB per 100 feet so that at the bottom of the downlead, P_T , the signal is at a level of -1 dB. At P_A and P_B it is -7 dB, and at A -9 dB, and B $-7\frac{1}{2}$ dB. So far so good; but now say that A decides to watch the other programme and in switching round his turret leaves his input a short or open-circuit to the signal B is using. (It makes no difference which of the two he does for this calculation.) The return loss at A is then zero, so that from A a signal starts to travel back at a level of -9 dB. At P_A this signal is -11 dB. From P_A to P_B the loss is 6 dB, so the reflected signal reaches P_B at -17 dB and goes on to B where it is $-17\frac{1}{2}$ dB, or just 10 dB below the level of the direct signal to B. In addition, the reflected signal reaches P_T at -17 dB, goes up to T where it is down to -18 dB and is then reflected back at a level depending on the goodness of the aerial matching. An aerial giving 10 dB return loss will send down a new echo at -28 dB and this, by the time it reaches B will still be 28 dB below the direct signal.

The first echo has travelled 200' extra, the second 300' extra. At 200 metres/microsecond the first echo is delayed about $\frac{1}{3}$ μ sec and the second about $\frac{1}{2}$ μ sec. Just what this does to picture quality must be discussed at some other time, but you can see that when A changes programme it can show up on B's screen. We can work out something else, too. The echo from A is 10 dB down on the direct signal. This means that the echo voltage is 0.316 times the direct voltage. If the carriers are exactly in anti-phase, i.e. assuming that AP is the appropriate length, the carrier voltage received by B will drop to 0.684 times its previous value, a fall of 3.3 dB. Of course if B's receiver has a good a.g.c. system he will not notice this; but if the a.g.c. is not too good B will have a busy time with the contrast control if A can't decide which programme to watch.

We can carry out the same calculations of the effect at A's set assuming that B keeps altering the termination. The echo from B will be less delayed, but the possibility of change of level is somewhat greater—I'm not going through the whole analysis here. There is a solution of the problem we have created which is also worthwhile analysing. Attenuators placed in the two feeders A- P_A and B- P_B will each protect the other receiver. An attenuator of 6 dB at A will improve the echo effect by 12 dB for B, and an attenuator of 6 dB at B will improve the echo effect by 12 dB for A. As you can see, the total signal attenuation is 12 dB, so that we have a very simple theorem "Protection equals loss". Obviously neither A nor B will put in an attenuator unless the other does, so we can expect the two attenuations to be equal, and their sum is equal to the protection afforded to either of the receivers.

The protection equals loss theorem is a useful one to remember if you ever have anything to do with what the telephone transmission people call two-wire/four-wire circuits. As you know, the ordinary local telephone system is a two-wire

system, with speech travelling in both directions on the same pair of wires. Two-wire repeaters, and, more important, all carrier telephone systems, are four-wire systems in which the go-circuit is different, either in frequency band or in wire-pair, from the return-circuit. At the junction of 4-wire and 2-wire circuits something has to be done to prevent the incoming speech on the 4-wire circuit from going back along the out-going 4-wire circuit. A bridge network of some kind is used, and on the balance of this bridge depends the level of the echo which is sent back to the speaker. This is a very important part of the circuit, because in a normal carrier system there may be, and in a two-wire repeater there certainly will be, enough gain for the echo to arrive back at a higher level than the original signal. The goodness of balance is expressed as the return loss of the 2-wire line against the balancing network in the bridge. At regular intervals someone has the bright idea of putting a pad in the two-wire line to improve its impedance characteristic. However, after you have increased the gain in both go and return circuits to make up for the loss of the pad you are back where you started.

The only other thing for which we now have space this month is a rather useful expression for the return loss caused by bridging an impedance across

a line. This crops up in problems of what the Americans call "Community Antenna Systems". Of course you can just work out the load provided by the ongoing feeder in parallel with the bridged load and then go on to calculate the return loss. It is useful, however, to have a separate expression for this. Let us write $Y_0 = 1/Z_0$ and let G be the admittance bridged across the line. The return loss is produced by the termination $G + Y_0$ (admittance), so that it is

$$20 \log \left| \frac{Z_0 + Z_1}{Z_0 - Z_1} \right| = 20 \log \left| \frac{1 + Z_1/Z_0}{1 - Z_1/Z_0} \right| = 20 \log$$

$$\left| \frac{1 + Y_0/Y_1}{1 - Y_0/Y_1} \right| = 20 \log \left| \frac{2Y_0 + G}{G} \right| \text{ dB}$$

In most practical cases this will be near enough equal to $20 \log |2Y_0/G|$, or, since we usually think in impedances, $20 \log |2Z/Z_0|$. As an example, a 750-ohm resistor bridged across a 75-ohm line will produce an echo 26 dB down.

I think that I have made a case for the use of return loss as a basic design concept. Two topics remain to be discussed: how can we measure return loss, and what sort of values should we hope to get. I hope to be able to deal with these soon.

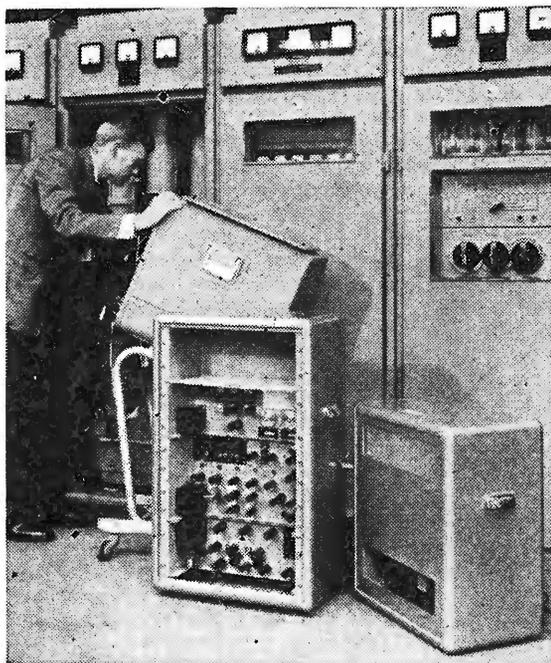
Television Transmitter Sideband Analyser

TEST and adjustments carried out on television transmitters when in service are often tedious, and in some cases unreliable. By means of a new Marconi Instruments equipment called a sideband analyser this kind of work can be done in a very much shorter time than is possible by existing methods. The instrument displays the overall response of any Band-I or Band-III

transmitter using 405-, 525-, or 625-line standards. It does this by providing a sweep signal for modulating the transmitter, and by scanning the resultant r.f. output signal in such a way as to display the upper or lower sideband response, either separately or both together, in their correct amplitude and frequency relationship to the carrier. In addition, the response of a complete transmitter modulator chain, or any part of it, can be measured. The test signal is actually a composite signal. The normal television waveforms are combined with the video test signal, and the transmitter operates on test at any level in the grey scale, under the same conditions as in normal service. The effect on the transmitted spectrum of any adjustment to the transmitter is immediately visible to the operator.

Test signals are generated in the following manner. The video sweep signal is derived from two oscillators, one fixed and the other swept, to provide either a sweeping difference signal from a lower limit of 100 kc/s to any frequency up to a maximum of about 20 Mc/s, or a sweep symmetrical about zero frequency and extending to a maximum of not less than 7 Mc/s each way. The output level is held to within ± 0.1 dB throughout the sweep. Line and field blanking and sync pulses are applied to the analyser from a standard source, and are combined with the sweep signal.

This output can be applied to (a) the video stages under test, the output of which is detected by a circuit in which the detector is immobilized during the period while the sync and blanking are present, and applied to the display for measurement; or (b) as modulation for the transmitter. In this last-mentioned condition, one of the two sidebands produced at any instant decreases in frequency at the same rate as the output frequency of the swept oscillator. By mixing the outputs of the transmitter and swept oscillator, a constant-frequency signal is produced, whose amplitude is directly proportional to the sideband amplitude. This constant-frequency signal is fed to a narrow-band amplifier whose output, after detection, is applied to the display unit. Markers, which occur at 1-Mc/s intervals, are available on the display for reference purposes.



Television sideband analyser (Marconi Type OA 1241).

Semiconductor Symbols

Logical System for Diodes, Transistors and Other Junction Devices

By P. M. THOMPSON* and J. BATESON*

THE number of articles written on the subject of transistor symbols is growing at an alarming rate. If, indeed, the present rate of production is maintained it will soon be reasonable for the Editor of *Wireless World* to introduce a symbol representing an article on transistor symbols. In view of the foregoing the reader might be forgiven for asking why we are adding to the alarm. The answer would be that this article is not only about transistor symbols; what we have developed and would like to present here is a logical, self-consistent, graphical nomenclature which can be used to depict any device depending for its action upon p-n junctions. Thus, by means of this nomenclature one may represent, and distinguish between, junction transistors; junction diodes, both of the common-or-rectifier type and the Zener type; photo-diodes and -transistors; solar batteries and the like.

Since the days of Archimedes mankind has been attracted to the idea of getting, or only apparently getting, something for nothing, and the transistor showed such promise in this direction that many people were led to consider it the only significant device to come out of the field of semi-conductor research. One result of this has been that symbols proposed to represent "the" transistor have tended to be unique and incapable of extension to related semiconductor devices. The Bell (Telephone Laboratories) symbol has historical significance since it is a depiction of the earliest point contact transistors. However, it is noteworthy that the early and also pictorially derived symbols for valves gave way to symbols which could be helpful in explaining the action of a valve. This could be interpreted as indicating that the symbol, for any device, which finally becomes universally accepted is that which proves most helpful to the student.

Engineers coming upon the transistor late in their training, or in post-training years, would be expected to incline towards adoption of a valve-like symbol since they tend to explain the action of a transistor (at least to themselves) in terms of a valve amplifier. However, it is interesting to speculate upon the symbol that would be adopted (or invented) by the student who, familiar with semiconductor amplifiers, or, perhaps magnetic amplifiers, was then introduced to the valve as an amplifier. We feel it is not improbable that in future training courses students will be introduced to transistor amplifiers before going on to consider the less elegant evacuated bottles of metal and mica which are variously known as valves or vacuum tubes.

Historically and technically the junction transistor evolved from a successful attempt to create a continuous, tetravalent crystal lattice which contained,

in adjacent regions, precisely controlled amounts of an impurity selected from the group III or group V elements. Two such regions with their different "doping" but with similar conductivity gave us the p-n junction rectifier. The creation, then, between two like-doped, relatively high conductive regions of a physically and conductively slender, other-doped region gave us a device that would amplify small currents.

We feel, therefore, both that the bond between the junction diode and the junction transistor is one that is logically not easily broken and that there is no real reason for trying to break it. We do not, then, propose a special system of symbols so much as a philosophy of an integrated and self-consistent system. Being self-confessed traditionalists we have accepted the traditional rectifier symbol and have extended it to fit related devices in this new field. It was this philosophy that led to the "Canadian system" and what follows has been abstracted from a memorandum which is used as an approved guide by the research laboratories of the Canadian Government.

The purpose of a semiconductor symbol is to represent the semiconductor device in a schematic diagram. In order to do this it should suggest to the reader the characteristics of the device; it should be easily recognizable, and easily distinguishable, from other parts of the diagram. Other important requirements for the symbols are that they should be easy to draw, easy to remember, and adaptable to any new semiconductor device.

Since there are many devices to be represented and since each has its own symbol, if the symbols are to be easy to remember the system of nomenclature must be based on the logical development of a few simple rules. Furthermore the system should be capable of remaining accurate when used in part, in whole, or just approximately. Although based on only a few rules, it should not be necessary for a user to know the whole system to use but part of it.

It was with all of these considerations in mind that the following system was developed.

Fundamentals.—Semiconductor devices such as diodes and transistors consist of p-n junctions. In this system of nomenclature there are symbols for the various types of junctions, and the devices are represented as combinations of these junctions.

The junctions are distinguished as to the direction of essential current flow. If the current flows from *p* to *n* (in the forward direction) as in a transistor emitter, the junction is shaded. Where the current flows from *n* to *p*, as in a transistor collector or a Zener diode, the junction remains unshaded.

A second connection to a region, such as in a transverse field junction tetrode, is indicated by displacing the connection or by a dot. There are

* Defence Research Telecommunications Establishment, Ottawa, Canada.

distinctive symbols to indicate special sensitivity to light or heat, or the presence of an intrinsic layer. Any semiconductor device, which consists of points, junctions or both will have a logical symbol within the system.

The Standard Symbols.—In order to indicate the size of the symbols for semiconductor devices with relation to the other circuit components, a resistor, capacitor, and inductor are drawn.



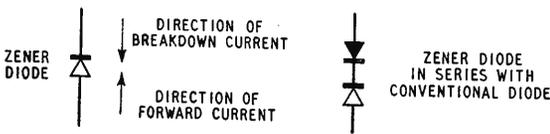
The photoresistive device and the thermistor indicate the symbols for light and heat sensitivity respectively.



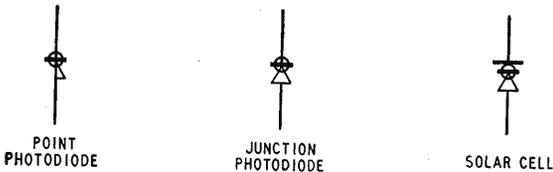
Among the single junction devices there are several types of diode and "field effect transistor." Point and junction diodes have distinctive symbols. They are shown shaded because the essential current flow is from *p* to *n*.



In a Zener diode the breakdown current flows in the reverse direction, so it is shown as an unshaded junction diode.

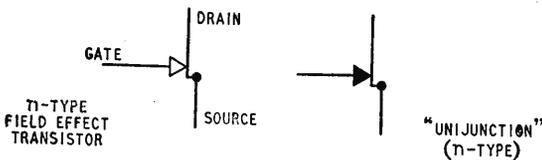


In photodiodes reverse current flows when light falls upon the junction, so they are shown as unshaded diodes with the circle to indicate sensitivity to light. For a solar cell the "battery" symbol can be added.



An *n*-type field effect, unipolar, or analogue transistor would have its gate shown unshaded, and the source shown as a second connection to the base. (This bears some similarity to the bias connection in a junction tetrode.)

"Unijunctions" or "double base diodes" are

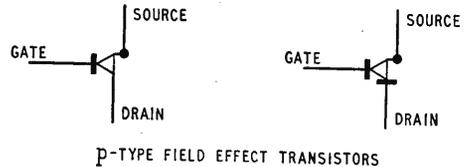


similar to the last-mentioned types, except that they are operated with a forward current through the junction.

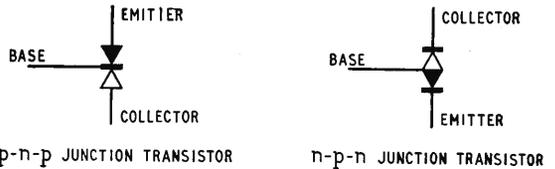
A field effect transistor with injecting drain has the normal drain connection replaced by a junction.



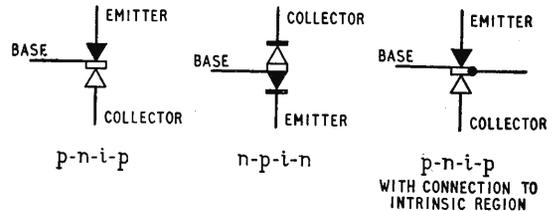
The complementary *p*-type field effect transistors will be shown as follows.



Triode junction transistors, both *p*-*n*-*p* and *n*-*p*-*n*, consist of two junctions. The current flows in the forward direction through the emitter and in the reverse direction through the collector junction. The emitter is therefore shaded.



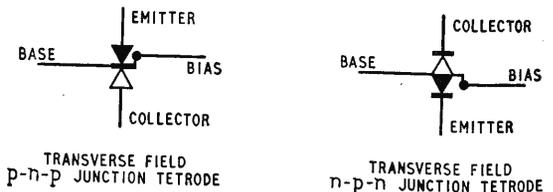
There are several types of junction triode referred to as alloyed, fused, surface barrier, grown, rate grown, diffused base, etc. Although all have their own particular characteristics they do not differ electrically sufficiently to warrant separate symbols. However, the *p*-*n*-*i*-*p* transistor has special properties, and the presence of an intrinsic layer in the base is shown by drawing the base as a narrow "box."



The *p*-*n*-*i*-*p* transistor may be regarded as an extreme case of the graded base *p*-*n*-*p* transistor, so a graded base transistor may be represented as above.

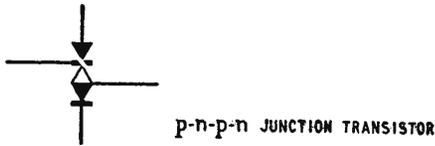
If the transistor is symmetrical it has no defined emitter and is left unshaded.

A transverse field junction tetrode is a junction

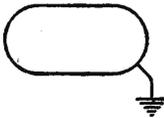


transistor with a second connection (the bias connection) to the base.

When extra junctions are added to the system making such devices as the p-n-p-n transistor, it will have a logical symbol within the system.



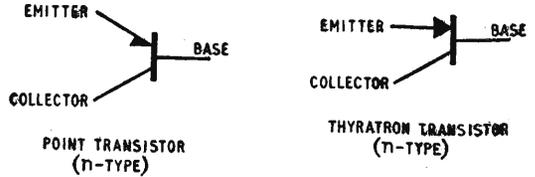
A shield or earthed case for a device is shown as follows.



It is drawn to enclose the device or the part of the circuit which is shielded.

For point transistors the emitter is drawn as a point diode, with which it is very similar. It is

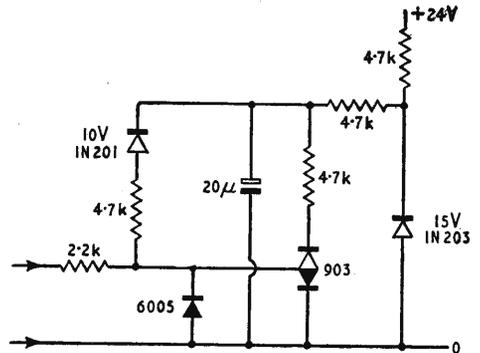
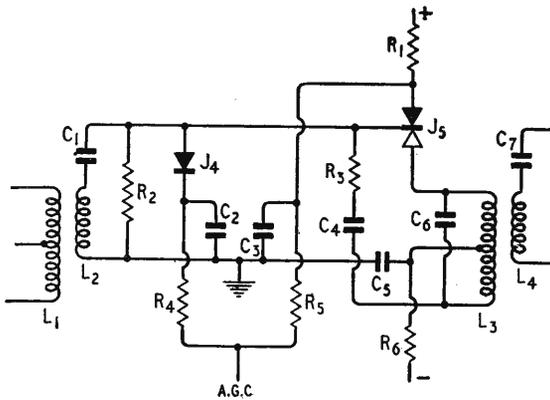
suggested that the collector, which bears no resemblance to any type of single junction, should not be drawn as one, but should have its own distinctive symbol, as shown here (below left).



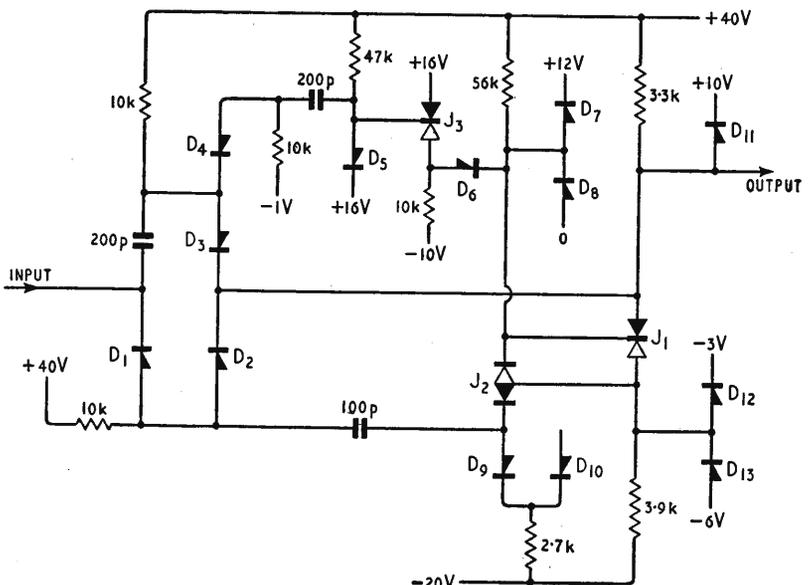
A thyatron transistor (above right), a transistor with a junction emitter and a point collector, is similar in characteristics to a point transistor.

The above examples of semiconductor devices have been in use up to the time of writing. Although all possible variations have not been illustrated, the reader will probably see already how the system can be applied to any new device. As it is inevitable that there will be devices which do not fall clearly into any classification (e.g., gold-bonded diodes), they should be drawn as the device with which they are most similar in their application.

Complete Circuits.—Schematic circuit diagrams



Examples of the use of the proposed symbols in some typical circuit diagrams.



are line expositions of circuits. These line pictures should be as easy to read as the word pictures or descriptive texts that go with them. If a convention exists for a sub-circuit which is being operated in a conventional manner, it should be used, since the reader is not then compelled to derive the circuit every time from first principles. In general, it should be remembered that the contribution made by the eye when reading a diagram is greater than that made when reading words. The appearance of a diagram, therefore, is not unimportant.

Rules.—(1) Connections to positive supplies should be drawn going upwards on diagrams, while connections to negative supplies should go downwards. Connections to intermediate potentials or to earth should be between these two extremes.

(2) The signal should travel from left to right through the circuit.

(3) Any separate part within the circuit, such as an audio amplifier, should be kept together, and not be mixed in with parts performing other functions, such as an oscillator or pulse shaper.

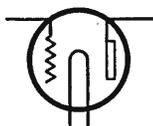
(4) Parts of the circuit which are normally recognizable, such as a bridge or a p-n-p-n trigger circuit should be drawn in their recognizable form, and not distorted so as to disguise their function.

Components may be labelled as desired, to allow the circuit to be built, or to simplify the understanding of its operation. It is suggested that J is used for a *junction* transistor and P for a *point* transistor as V is for a *valve*. T should be kept for transformers. Diodes could be given D numbers or P and J numbers, depending on whether it is more important to emphasize the difference between transistors and diodes, or different types of diode.

To conclude, it may be instructive to compare the symbols of the Canadian system with some of the other symbols in use to-day, both in relation to self-consistency, and their potentialities for expansion to represent related devices. In this connection it may be possible to draw a parallel between the Bell transistor symbol and an early triode symbol.

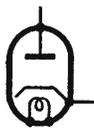


BELL TRANSISTOR

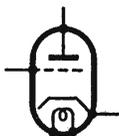


TRIODE VALVE

Neither of these can be developed to represent related devices easily, and neither takes a form which suggests the operation of the device. The above triode symbol gave way to a nomenclature based on symbols for anodes, grids, cathodes, etc.



DIODE



TRIODE



PENTODE etc

These symbols for valves are self-consistent, e.g., the anode is always shown the same way. However, one finds a surprising lack of self-consistency

in the symbols that have been suggested for transistors. If, for example, we consider the ways a collector (which is a p-n junction where the essential current flow is from *n* to *p*) is drawn, we find that it differs considerably between the p-n-p, and the n-p-n.

In Chaplin's symbols



while in the Bell, R.C.A. and several other systems there is nothing about the way in which the junction is drawn which indicates which side is *p*, and which is *n*. This depends on whether the transistor is p-n-p or n-p-n.

It is probable that the junction transistor will not be the last widely used device to emerge from the laboratories of the semiconductor researches; and unless a self-consistent nomenclature is adopted one will be faced with a repetition of the present situation each time a new semiconductor device is produced.

CLUB NEWS

Birmingham.—Two R.S.G.B. tape-recorded lectures —“Astronomy and cosmology” by the Astronomer Royal and “Interplanetary travel” by W. A. Scarr— will be given at the November 8th meeting of the Slade Radio Society. The club meets at 7.45 at the Church House, High Street, Erdington. Sec.: C. N. Smart, 110 Woolmore Road, Erdington, Birmingham, 23.

Bury.—The November meeting of the Bury Radio Society will be held at 8.0 on the 12th at the George Hotel, Kay Gardens. The speaker will be T. C. Platt (G2GA) and his subject “An old-timer looks back”. Sec.: C. L. Robinson, 56 Avondale Avenue, Bury, Lancs.

Edinburgh.—The Lothians Radio Society has recommenced holding meetings in the Chamber of Commerce Rooms, 35 Charlotte Square, on alternate Thursdays at 7.30. The next meeting is on October 24th. Sec.: J. S. Nicholson, 10 Hawkhead Crescent, Edinburgh, 9.

Leeds Amateur Radio Society meets most Friday evenings at Swarthmore Educational Centre, Woodhouse Square. On November 1st the subject to be discussed will be simple gramophone amplifiers and on the 15th there will be a talk on wartime radar. Sec.: J. R. Hey, 40 Richmond Avenue, Headingley, Leeds, 6, Yorks.

Sidcup.—The next meeting of the Cray Valley Radio Club will be on October 22nd and will be devoted to an exhibition of members' home-constructed gear. The club meets on the fourth Tuesday of each month at 8.0 at the Station Hotel, Sidcup. Sec.: S. W. Coursey (G3JJC), 49 Dulverton Road, London, S.E.9.

Wellingborough.—At the October 31st meeting of the Wellingborough and District Radio and Television Society, A. C. Homer will give a talk entitled “Reminiscences of a Post Office engineer”. On November 28th F. W. Tyler (G3CGQ) will speak on “The International Geophysical Year and the radio amateur”. Meetings are held every Thursday at 7.30 at the Silver Street Club Room. Sec.: P. E. B. Butler, 84 Wellingborough Road, Rushden, Northants.

LOUDNESS

By "CATHODE RAY"

PHONS OR SONES?

REGULAR readers (if any) of these ramblings may have formed the opinion that in spite of their apparently random titles they all sooner or later lead to critical remarks about terms, symbols, units and so forth. If so, this one will be no exception. For "loudness" is very much a question of definition, and has in no way been spared the muddle-headedness with which the experts (unconsciously, we will charitably assume) make things difficult for the earnest plodder.

The first and most important thing to grasp about loudness is that it is subjective. That is to say it is our human impression of something, and not that something itself. That something is sound, which is a physical disturbance that would exist even if there were no living creatures to hear it. (I am not stopping to argue with the philosophers who hold that everything is subjective.) Before considering subjective loudness, we had better make a quick review of objective sound.

Fig. 1(a) shows, in cross-section, a small part of a gong or other sound-making device; the uniformity of the shading in front of it represents the uniformity in pressure and density of the air around before the gong is struck. The same thing is represented in a different way by the constant height of the line above. An increase in air pressure anywhere can be shown by a darkening of the shading and by a rise in the level of the line, which is really a pressure graph. The graph method is the most used, because it is less tedious to draw; but since it represents the condition of the air less directly, and no expense is spared, I will use both sorts together at this stage.

When the gong is struck its metal plate is jerked forward, as indicated by the arrow in Fig. 1(b), and it compresses the layer of air between itself and the whole mass of air beyond. This compressed air compresses the layer next to it (c), and so on, causing a wave of compression (but *not* of compressed air) to travel continuously forwards.

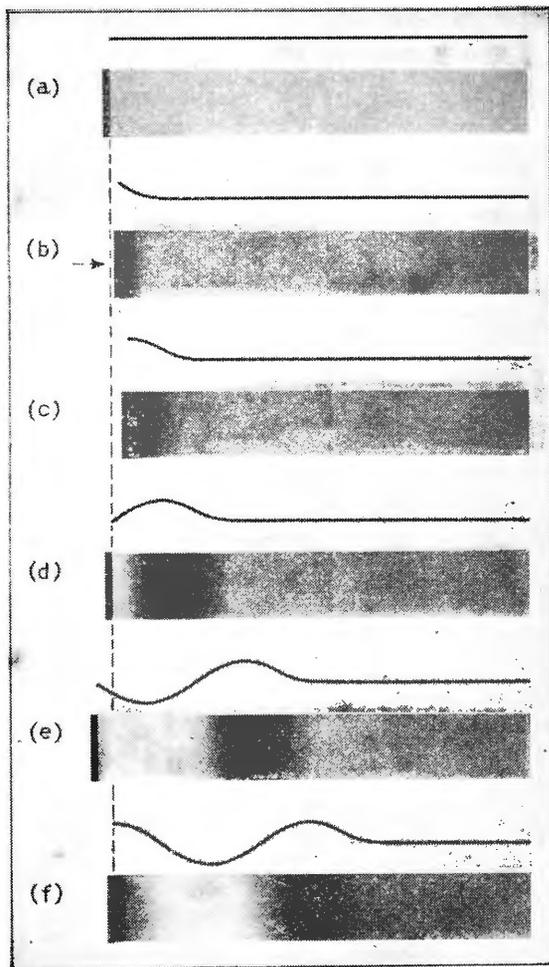
The metal, being elastic, springs back (d); and so the air which had been compressed by it now moves backwards to equalize the pressure. The inertia of the metal carries it behind its static position, so the pressure falls below normal (e). The backward movement of the air is passed forwards in just the same way as the previous forward movement. So a state of rarification spreads along behind the state of compression, completing one whole wave (f). As the gong continues to vibrate, successive waves follow the first one.

The sound of the gong (or of anything else) therefore consists in every particle of air around it vibrating forwards and backwards a short distance around its normal position of rest; imitating, in fact, the motion of the thing that caused it.

There are several ways in which the strength

of a sound can be reckoned. It can be reckoned in terms of these alternating variations in pressure, above and below atmospheric pressure. They correspond quite closely to alternating signal voltages, often superimposed on relatively large steady voltages. Like them, they can be reckoned in instantaneous, peak, mean or r.m.s. values. The units could be pounds per square inch, but c.g.s. units—dynes per square centimetre, which are 69,100 times smaller—are preferred. For one thing, the peak pressure of even the strongest sounds is quite

Fig. 1. Section of a sound-generating diaphragm, with the air in front of it. The pressure of this air is represented by depth of shading and also by the height of the horizontal line above.



small. One dyne/sq cm is only about one millionth of atmospheric pressure; even so, the standard "reference level" for sound pressures is as little as 0.0002 dyne/sq cm—the reason for which will appear later. Most people who have had the misfortune to hear a pneumatic drill at close quarters would be surprised to learn that it disturbs the normal atmospheric pressure (which they bear all the time without noticing) by only about one ten-thousandth part. Before a sound reached 1% of atmospheric pressure it would be quite literally ear-shattering.

The greater the sound pressure, the faster the air vibrates. By "faster" I don't mean a greater number of vibrations per second, but a greater to-and-fro velocity. To distinguish this velocity of the air from the onward velocity of the air waves, it is called particle velocity. It corresponds to electric current, because it is proportional to the pressure and inversely proportional to something corresponding to impedance. This thing is, in fact, called acoustical unit-area impedance, and depends on the medium in which the sound waves are travelling. Since the only medium we are considering is air, we can regard the ratio of pressure to velocity as fixed.

Sound Intensity

Seeing that the power delivered to a given electrical impedance is proportional to the square of the voltage or current, acoustical power is presumably proportional to the square of pressure or velocity. While this is true, we must bear in mind that for simplicity we have been comparing sound waves with electrical circuits instead of with electromagnetic waves. So just as sound pressure is in dynes per square centimetre, what is called the intensity of sound is the amount of power the waves carry away through each square centimetre at right angles to the way they are going.

In Fig. 2, S represents a point source radiating sound equally in all directions. (Such things do not exist, but no matter.) At any radius r , the total area

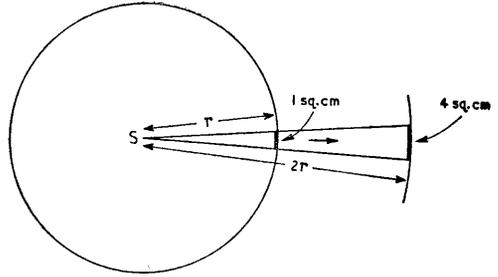


Fig. 2. S represents a source of sound, radiating equally in all directions. Knowing the total power radiated, one can easily calculate the intensity of sound at any distance from S. (It is assumed that there are no external obstructions.)

through which the whole power is being radiated is $4\pi r^2$, so if that power is known the intensity at that radius is given by dividing it by $4\pi r^2$. At twice the radius, the same power is spread over four times the area, so the intensity is one quarter as much.

Power is rate of doing work, and the c.g.s. unit of work is the dyne-centimetre or erg. So the c.g.s. unit of sound intensity is the erg per second per square centimetre. Because there is a fixed rate of exchange between mechanical (including acoustical) and electrical power, we can alternatively reckon sound intensity in watts per square centimetre (or per square metre if we are m.k.s. minded). There are ten million ergs per second to a watt, which is too large a unit to be convenient for sound intensity so is usually divided into a million microwatts.

The standard intensity reference level (to which the aforementioned pressure of 0.0002 dyne/sq cm corresponds, if air is the medium) is 10^{-16} watt/sq cm, which is 10^{-10} microwatt/sq cm or 10^{-9} erg/sec/sq cm. I am mentioning all these alternative units because some people use one and some another, and it is useful to have a table connecting them. But before coming to that we must understand why

it is that a standard reference level has been fixed. The main idea is to enable sound levels to be given in decibels. As we ought to know, decibels are simply ratios, so cannot be used to specify quantities such as sound intensities or signal strengths except by comparison with some standard level to which zero on the decibel scale can be attached. The statement one often encounters, that "the decibel is a unit of sound," is true only on this understanding. Here then, on the left, is the table.

Everything so far has been plain sailing, because it refers to an objective thing that can be measured with suitable instruments, in the same systems of units that serve for all other physical quantities. There are always some people who will misuse or misunderstand decibels, but that is a very elementary

dB	Sound Intensity			Sound Pressure*	
	Watt/sq metre	Micro-watt/sq cm	Erg/sec/sq cm	Newton/sq metre	Dyne/sq cm
120	1	100	1000	20	200
110	0.1	10	100	6.3	63
100	0.01	1	10	2	20
90	10^{-3}	0.1	1	0.63	6.3
80	10^{-4}	0.01	0.1	0.2	2
70	10^{-5}	10^{-3}	0.01	0.063	0.63
60	10^{-6}	10^{-4}	10^{-3}	0.02	0.2
50	10^{-7}	10^{-5}	10^{-4}	0.0063	0.063
40	10^{-8}	10^{-6}	10^{-5}	0.002	0.02
30	10^{-9}	10^{-7}	10^{-6}	0.00063	0.0063
20	10^{-10}	10^{-8}	10^{-7}	0.0002	0.002
10	10^{-11}	10^{-9}	10^{-8}	0.000063	0.00063
0	10^{-12}	10^{-10}	10^{-9}	0.00002	0.0002
-10	10^{-13}	10^{-11}	10^{-10}	0.0000063	0.000063

*In air at normal atmospheric temperature and pressure.

fault. It is when we come to the human response to sound that things become difficult. One difficulty is that no two human beings are the same, and even an individual's hearing varies with age. It is also enormously affected by a variety of conditions such as the frequency and character of the sound being heard and the presence or absence of other sounds.

Threshold of Hearing

If a sound is very weak indeed it cannot be heard at all by anyone. So the obvious starting point for a loudness scale is the intensity of sound that marks the dividing line between just audible and not audible. It is called the threshold of hearing, and is defined as the minimum r.m.s. pressure of a pure sound wave that can be heard, under certain specified conditions. To measure this without bringing in individual characteristics, the average is taken of tests on a reasonably large number of people, all aged 18 to 25 and without any hearing defects. The background must be perfectly quiet, and the standard frequency is 1,000 c/s.

The last condition is vital. A 50 c/s sound, for example, is too weak to be heard even if it is 1,000 times the 1,000 c/s threshold intensity. In other words, the intensity corresponding to the threshold of hearing (zero loudness) varies tremendously with frequency. Fig. 3 shows how it varies. In this kind of diagram, sound level (as set forth in our table) is marked as horizontal lines across the whole band of audible frequency. We see how normal hearing becomes steadily less sensitive (i.e., the sound has to be stronger to be heard) as frequency falls below about 800 c/s, but rises slightly about 1,000 and then falls off steeply at the high-frequency end. The dotted line is the curve obtained in the celebrated tests by Fletcher and Munson* in 1933; the solid line was published last year by Robinson and Dadson† and is claimed to be more accurate.

As a matter of fact, Fletcher and Munson's measured threshold at the standard 1,000 c/s agreed more closely with the newer results than the curve indicates, but it seems that they distorted it a little at this frequency in order to bring it to a convenient round number (10^{-16} watt or 10^{-10} μ W per sq cm). It is generally agreed that only exceptionally acute hearing can detect a 1,000 c/s tone at this level.

So right at the start there seems to have been a bit of a fiddle in connection with the loudness scale. The standard reference sound intensity, reckoned as 0 dB, has been fixed at 10^{-16} W/sq cm with the idea that that is the threshold of hearing at 1,000 c/s, but actually it is the nearest round number to it. The real threshold of hearing is, after all, only an average of rather tricky measurements made on human beings, who come and go.

But this is not all. Granted that zero loudness is where a sound just begins to be audible (or just ceases to be audible, if you are varying the intensity the other way), where should "1" come on the scale? How loud is unity loudness? Your guess

is as good as mine, but hardly likely to be the same. Then, supposing we agree to put "1" on the scale at an arbitrary increase in intensity above "0," where do we put "2"? When is a sound twice as loud? There is a little more to go on than in fixing "1," but still plenty of room for difference of opinion.

Quite a long time ago these difficulties were evaded by deciding to make the loudness scale for 1,000 c/s coincide with the intensity scale. The question then arose: what about sounds of other frequencies? Should the curves for all loudnesses be made the same shape as the zero-loudness curve of Fig. 3, by drawing them exactly parallel to it through the appropriate points on the 1,000 c/s scale?

It was soon found that if they were they certainly could not claim to be equal-loudness curves. For instance, a 50 c/s sound 60 dB above the 50 c/s threshold (i.e., at the 100 dB level) is far louder than a 1,000 c/s sound 60 dB above its threshold. The only reasonable way of drawing equal-loudness curves is so that they show the intensities that are heard equally loudly, even though it means employing the large gang of young hearers for a much longer time in order to arrive at an average of their views on how intense the sounds of different frequencies have to be in order to be as loud as the standard 1,000 c/s sounds. And that is not a thing that can be done quickly or easily, for people are not fitted with pointers that automatically show how loudly they are hearing, and the requisite

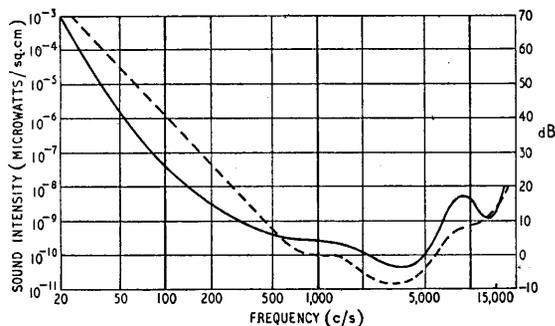
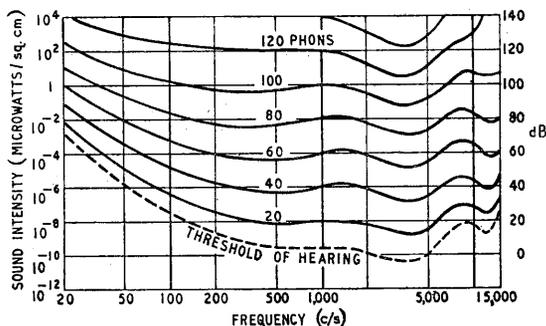


Fig. 3. "Threshold of hearing" curves. The dotted line is the well-known one by Fletcher and Munson; the full line is a more recent determination of the same thing by Robinson and Dadson.

Fig. 4. Robinson-Dadson equal-loudness contours.



*"Loudness, its Definition, Measurement and Calculation," H. Fletcher and W. A. Munson, *Jour. Acoust. Soc. Amer.*, Oct. 1933.

†"A Re-determination of the Equal-loudness Relations for Pure Tones," D. W. Robinson and R. S. Dadson, *Brit. Jour. Appl. Phys.* May 1956.

listening conditions are difficult to maintain over wide ranges of frequency and intensity.

The results of an extensive set of such observations are shown in Fig. 4, which is Fig. 3 with a superstructure of equal-loudness curves erected upon it. This kind of diagram is very familiar, but the exact shapes of the curves will be less so, for they are the recent ones by Robinson and Dadson instead of those by Fletcher and Munson that have been reproduced so many times during the last 24 years. The reason for their popularity is that a representation of the intensity/loudness relationship is one of the most important in the study of sound reproduction (and especially to Cathode Ray's modest contribution to the subject: the term "scale distortion").

In place of the Fletcher and Munson zero loudness curve, which was an observed threshold curve fiddled to pass through the 10^{-16} W/sq cm level at 1,000 c/s, Robinson and Dadson show their observed threshold as a dotted line which does not pass through this standard point. It therefore does not form a harmonious foundation for the other curves, which are retained at the Fletcher and Munson levels at 1,000c/s. Presumably this is because it would be inconvenient to alter the levels of the whole lot every time anybody came out with an improved set of observations. Perhaps even the average acuteness of hearing might drift slightly from generation to generation. Personally I would suggest retaining a "zero loudness" curve passing through 0 dB at 1,000 c/s, representing the threshold of an ideal hearer, who at the present time would be about 4 dB more acute than the average.

The curves in Fig. 4 show clearly, though to a less extent than the Fletcher-Munson set, that at low frequencies the divisions on the loudness scale are closer together—in terms of intensity—than at 1,000 c/s and above. So much so that at the 100 dB level sounds of all frequencies are heard almost equally loudly, in contrast to the threshold level. Even the arbitrary tying of the loudness scale to the intensity scale all the way up at 1,000 c/s cannot conceal the fact that these essentially different quantities—intensity and loudness—are in general not even approximately proportional to one another.

Overworking the Decibel

What can we say then of the authorities who reckon them both in the same units? As if the decibel were not already liable to be misunderstood by the weaker brethren, they chose it to be also a unit of loudness! They label the rather irregular curves, as well as the horizontal straight lines, "dB," so that the same diagram contains two lots of decibels, measuring two basically different quantities not related in any simple way! If a perverted genius had wanted to confuse the issue most completely he could not have hit on a more brilliant way of doing it.

In Europe this scheme of things could not be tolerated for long, and in 1935 (or thereabouts) loudness on this kind of diagram began to be scaled in *phons*. But this civilized custom does not seem even yet to have penetrated to all parts of America.

The next muddle was to draw parallel curves at intervals above the threshold curve—the ones we agreed couldn't possibly be called loudness curves—

and call them "sensation levels." In the first place, if this name suggests anything at all it suggests that they are a subjective quantity, which of course they are not. The other thing is that these sensation levels are scaled in—yes, you have guessed it!—decibels! Apollyon himself, the Prince of Darkness, could scarcely have thought of a diagram with three entirely different things all in decibels.

Even if we sensibly mark the Fig. 4 curves in phons and ignore "sensation levels" altogether, these curves are a fraud. There is no justification, except the convenience of dodging a difficulty, for making a loudness scale coincide with an intensity scale anywhere. However widely opinions may differ on relative loudnesses, no one in his senses, asked to double a 40-phon loudness by adjusting the intensity of a sound, would set it anywhere near 80 phons. He would be much more likely to make it 50. So persistent attempts have been made to find a genuine loudness scale.

Origin of the Sone

Having been so rude about the American fondness for measuring the most diverse things in decibels, I must acknowledge that as long ago as 1936 S. S. Stevens of that land originated the *sone*, which is belatedly being recognized as a loudness unit. More recently he has reviewed the subject fully†. And I gather that the sone is receiving official approval in this country.

The difficulty, as I have said, is to judge when a sound is twice (or half, or any other ratio) as loud as another. Quite a number of methods have been devised for presenting sounds for such judgment, and results differ somewhat according to the method; and even with any one method the ratios are largely a matter of opinion. However, the averages of large batches of such opinions agree well enough for there now to be general agreement that a loudness scale can be approximately represented on the basis that two-to-one loudness ratios are produced by ten-to-one (10 dB) intensity ratios at 1,000 c/s.

Incidentally, it is interesting to note that what is judged to be a doubling of loudness by increasing the intensity of sound at one ear is equivalent to what is produced by bringing the *same* intensity to bear on the second ear. In other words, equal sounds at two ears give double the loudness of the same sound at one ear only.

Although true loudness and intensity scales cannot be made to coincide like the phon and dB scales at 1,000 c/s, in order to define the loudness unit—the sone—they must be tied together at one point. For convenience the point chosen is 40 phons, which is reckoned as 1 sone. Not only is this a good round number representing a moderate intensity; it is the standard loudness for judging that other subjective quantity—pitch.

So to convert phons to sones it is necessary first to deduct 40. To get the proportionality right, the result is multiplied by 0.03 to make it equal to the logarithm of the number of sones:

$$\log_{10} S = 0.03 (P - 40)$$

where S is the number of sones equal to P phons. Fig. 5 is a curve calculated from this empirical equation.

†"The Measurement of Loudness," *Jour. Acoust. Soc. Amer.*, Sept. 1955.

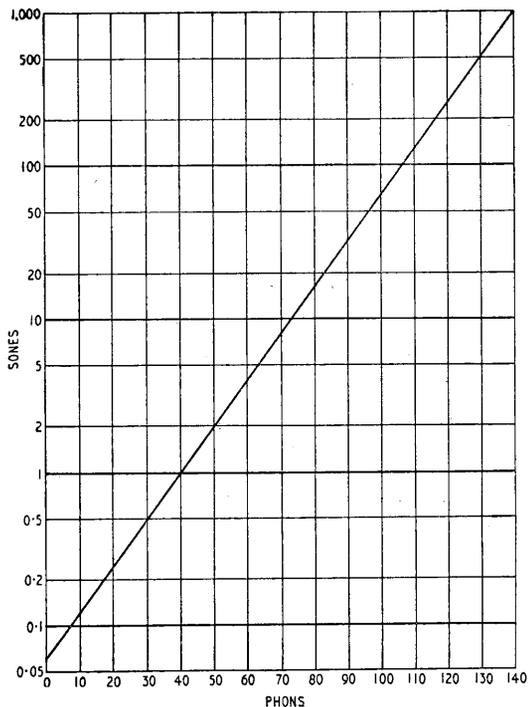


Fig. 5. Relationship between phons and sones, as calculated by an empirical formula.

Presumably in an attempt to keep themselves out of the phon fraud, writers on sound often refer to the curves in Fig. 4 as loudness level curves. It is, I suppose, something to be thankful for that any distinction at all is drawn between them and the approximation to true loudness curves, but if we were strict we might say that attaching the subjective word "loudness" to the phon curves was a form of the offence committed by using the term "sensation level," though admittedly a milder one seeing that the curves do at least mark equal-loudness intensities.

Acceptance of sones means rejection of what is called the Weber-Fechner law, as regards hearing at least. This "law" is the name given to the theory that our response to a physical stimulus is proportional to the logarithm of that stimulus. If it were true of hearing, then the phon scale at 1,000 c/s would be a true loudness scale, because phons at 1,000 c/s are equal to decibels, which are proportional to the logarithm of sound intensity. But no one would agree that loudness is anything like proportional to the number of phons. And even if it were, the "law" would break down at other frequencies, where the phon scale departs from the dB scale.

Switching from phons to sones does however seem to me to create an anomaly as regards the threshold of hearing. Using the logarithmic phon for loudness meant that there was a zero on the scale, corresponding nicely with the definition of threshold. But this threshold is 0.063 on the sone scale. That is admittedly a small loudness, but it is a loudness, which means it can be heard. So, too, is 0.01 sone, which theoretically can be heard. But it is far below the threshold of hearing, so it cannot be heard.

I don't know what the official answer is to this, but two possibilities occur to me.

The actual measured threshold of hearing depends very largely on the amount of background noise; in fact, on what might be called the signal/noise ratio. What is shown in diagrams as the threshold is supposed to be the just-audible intensity when there is no other sound than the "signal." But just as it is impossible to have an electrical signal with absolutely no noise, so with sound. Even if the room itself could be perfectly insulated from sound, the threshold of hearing cannot be determined without a hearer. And for the determination to be valid the hearer must be alive. And if he is alive his heart must be beating. I have read somewhere, too, that the aural counterpart of Johnson noise is not very far below the official threshold of hearing. Just as the threshold of hearing a pure tone can be raised to almost any sone level by the intrusion of a sufficiently loud "masking" noise, the official "silent" threshold (0.063 sone) may perhaps be regarded as the loudness that would be registered by a theoretical listener with normal hearing but no noise either outside or inside himself.

Of course this idea is rather unreal, because it is explaining away a difficulty that arises after real subjective observations have been replaced by an empirical formula devised to fit them as well as can be, but not necessarily (or even probably) perfectly at every point.

The other thought is that the infinitely large gap between 0.063 and zero sones belongs only to the logarithmic vertical scales in Figs. 3 and 4. The difference between 0.063 and zero on a linear scale going up to about a thousand is too small to show or to worry about. But does that mean one would use a linear scale for sones? Surely no, for the range of loudness between just audible (0.063 sone) and painfully audible (about 1,000 sones) is so vast that it can't all be shown clearly on a linear scale. So what does one do? One uses a log. scale, which brings one back to Fig. 4 with its phons! Does that mean that sones have been a waste of time? Again no, for the number of them gives a far better idea of the magnitude of loudness than the number of phons. So we should modify Fig. 4 by marking the curves with the numbers of sones instead of (or in addition to) the numbers of phons. Marking the 140-phon curve "1,000" shows what a vastly greater loudness it represents than the 80-phon curve, which is only 16 sones—but itself is very loud compared with 20 phons, which is only 0.25 sone.

New Induction Heater

COMPACTNESS is an outstanding feature of the new G.E.C. 18kW high-frequency generator, which occupies a floor space of less than 11 sq ft. The single oscillator valve is a BR1102 operating at approximately 500kc/s and power is supplied through six GU21 mercury vapour rectifiers. Forced air cooling is provided with filtering of the air supply, and electrical filters are fitted to prevent h.f. energy being fed back to the supply mains.

Either one or two work stations for surface hardening or brazing can be supplied and the water-cooled work coils are easily interchanged. There is a water-flow safety switch and interlocks on all panels and doors.

An ammeter current meter indicates power output and an hour meter serves as a check on valve life.

Bi-Directional F.M. Aerials

An Unconventional V.H.F. Receiving System

By H. B. DENT

WHEN Rowridge, Isle of Wight, commenced regular f.m. transmissions it was decided to make provision for receiving both the new station and Wrotham, which hitherto had been the mainstay of sound broadcasting at the writer's location on the south coast. Rowridge was the more favourably situated of the two and could reasonably be expected to provide a more reliable signal for most of the time. However, anomalous propagation on v.h.f. is not unknown, and it was thought desirable to have a second string available, especially as Wrotham's signals are reasonably strong if a two- or three-element aerial is used. Apart from this there were other reasons which made Wrotham a desirable station to have available at times.

Reception of both stations with a single aerial is complicated by the locations of the two stations; they lie very nearly in opposite directions from the receiving site and the obvious solution of separate aerials was not very attractive.

Fig. 1 is a plot of the true bearings of Rowridge and Wrotham taken from the receiving site and from these it will be seen that the two stations are not quite 180° apart, also that a bi-directional aerial having a polar diagram comparable to that of a simple horizontal dipole might be expected to serve for both stations. As the aerial cannot be orientated for optimum performance on both stations a compromise orientation must be found and, if possible, the expected efficiency of the aerial on both stations determined, so that the best type of aerial for the purpose can be chosen.

If now a transparency of Fig. 2(a) is prepared large enough to overlay Fig. 1, as shown in Fig. 4, the pattern can be moved around with its centre on the receiving site and a position found giving about equal efficiencies on both stations. Alternatively one or the other can be favoured and the expected performance on both deduced from the transparency. It will be seen that a position has been chosen which brings the bearings of the two stations just over 20° off the optimum line of the aerial, but in opposite directions. If all the data in Fig. 2 for the dipole is included on the transparency, as in Fig. 3, the expected efficiency of the aerial can be read off directly for either station. In this example it is 80% for both stations.

Allowing for equal efficiency in both directions,

Fig. 4 shows the optimum orientation of the aerial to achieve this performance. It reveals that if a dipole were used, or an aerial with a similar polar diagram and relative position of the elements, then the plane of the elements in this aerial must be on a line running from 145° to 325°. When laying out this bearing with a compass due allowance must be made for the magnetic deviation. At present this is 9° west at the site of the receiver, so that 9° must

Fig. 3. Pattern of a dipole's polar diagram to be prepared as a transparency.

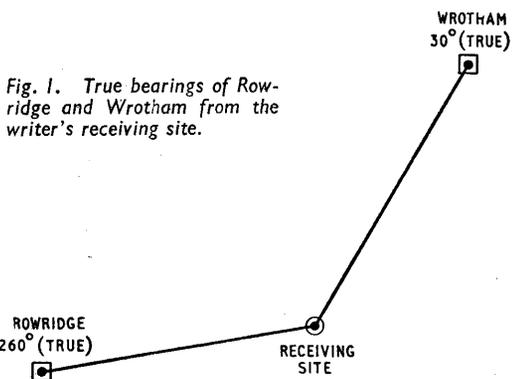


Fig. 1. True bearings of Rowridge and Wrotham from the writer's receiving site.

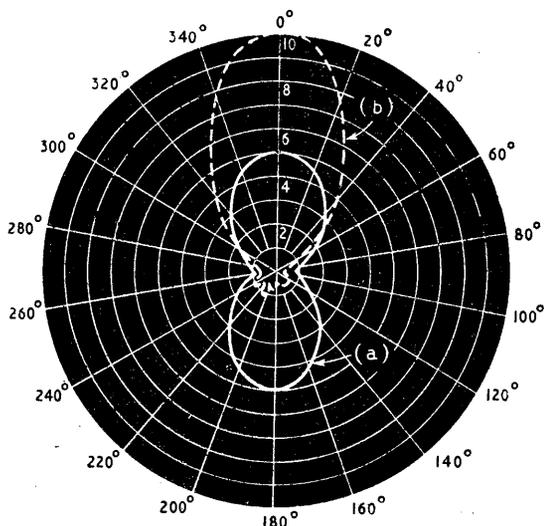
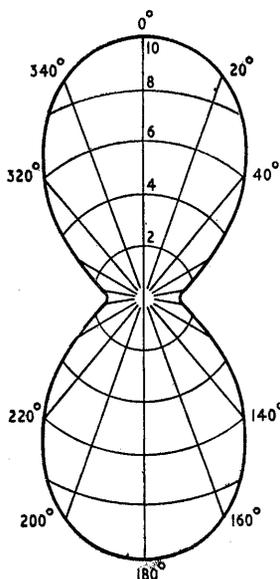


Fig. 2. Polar diagrams of (a) a halfwave dipole and (b) a 3-element Yagi.



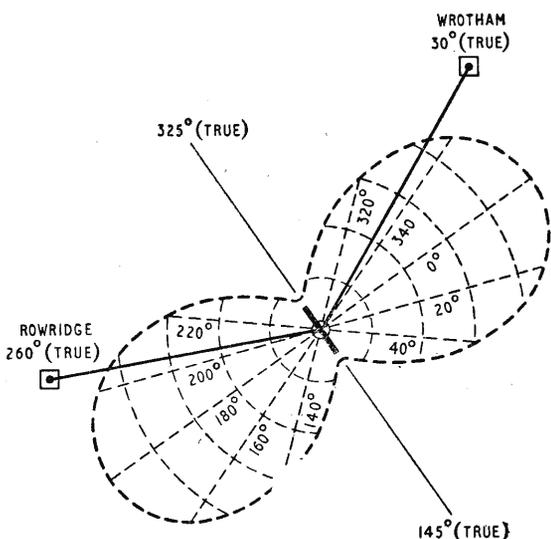


Fig. 4. The dipole's polar diagram superimposed on the plan, Fig. 1, as explained in the text.

be added making the bearing read by the compass 154° , or the reciprocal, 334° .

As a two-element aerial with a gain of about 4 dB over a plain dipole gave satisfactory reception of Wrotham, one of about 6 dB gain, but with bi-directional characteristics, should meet the new requirements. Included in Fig. 2 at (b), and plotted to the same scale, is the polar diagram of a three-element Yagi of the type often used in the fringe areas of f.m. stations. It is a uni-directional aerial of course and would not suit the present requirements, but as it can be seen to have a gain of about 6 dB, or twice the voltage gain of a plain dipole, an aerial with this order of gain, but having the polar diagram of the dipole, would serve the purpose. It now only remains to find a design of aerial having these characteristics.

There are several ways of imparting a bi-directional response to an aerial, but the one favoured by the writer for the present case is a vertical stack of half-wave horizontal dipoles. In order to obtain the required figure eight polar diagram in the horizontal plane and at right-angles to the plane in which the dipoles are stacked, all dipoles in the aerial must be connected for in-phase operation. This again can be achieved in several different ways and with a variety of spacings of the dipoles, but one that obviates the need for electrical measurement of any kind, and yet ensures the desired mode of operation, is to stack the dipoles a half wavelength apart, connect the feeder to the lower one and join all dipoles together by open-wire transmission lines, transposed at each level, as shown in Fig. 5.

Whilst Fig. 5 exemplifies the basic idea of a broadside aerial of this kind, it is not a very convenient practical arrangement, as with half-wave dipoles, split in the centre as shown, the terminating impedance, to which the feeder must match, is only about 25Ω ; this is much too low for the 75Ω type of coaxial feeder in general use. A matching section between the aerial and the feeder can be used, but it is inconvenient.

Folding a dipole steps up its impedance four times

if the tube or rod from which it is made is the same diameter throughout. Impedance multiplying factors greater or less than four can be obtained by making the two arms of a folded dipole unequal in diameter, but then the spacing begins to have a greater influence on the resulting impedance than when the diameter is the same throughout.

A stack of four half-wave folded dipoles, each fashioned from a single length of rod or tube, will give a close match to a 75Ω coaxial cable and yield a gain of about 7 dB in two directions. But for f.m. reception it would need a 15-ft pole to accommodate the elements alone, apart from that required to raise it above surrounding objects. As it is undesirable to fix guy wires to the pole above the lowest dipole, the supporting structure needs to be very sturdy indeed. Guys of non-conducting material, however, could be used and fixed to any part of the aerial system without affecting its performance; except, perhaps, to a small degree in very wet weather. The only material likely to withstand the very variable

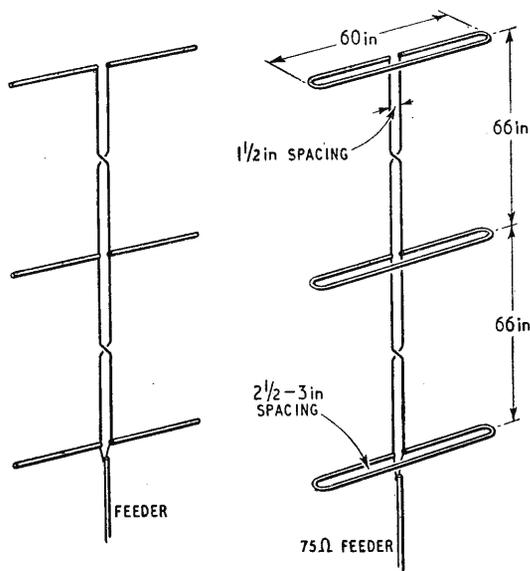


Fig. 5. Schematic arrangement of a stack of three half-wave dipoles.

Fig. 6. Practical broadside aerial using three stacked folded dipoles.

weather conditions prevailing in this country, without stretching or shrinking to an alarming extent, would be nylon rope, which is expensive.

Pruning the aerial to three folded dipoles, as shown in Fig. 6, brings the length of the aerial down to 11 ft, which is a far more practical size. Its terminating impedance becomes around 90Ω giving an acceptable impedance match to a 75Ω feeder. Any standing-wave ratio (or impedance ratio) of less than 2 to 1 is tolerable for most receiving purposes and with this aerial, and a 75Ω feeder, the impedance ratio is about 1.2 to 1.

Theoretically the feeder should be a twin-wire, or balanced, type and where a coaxial cable is employed there should be a balun (balanced-to-unbalanced connection) between it and the aerial. However, a balun is an additional complication hardly justified for f.m. reception and, moreover, unless properly designed can impair rather than

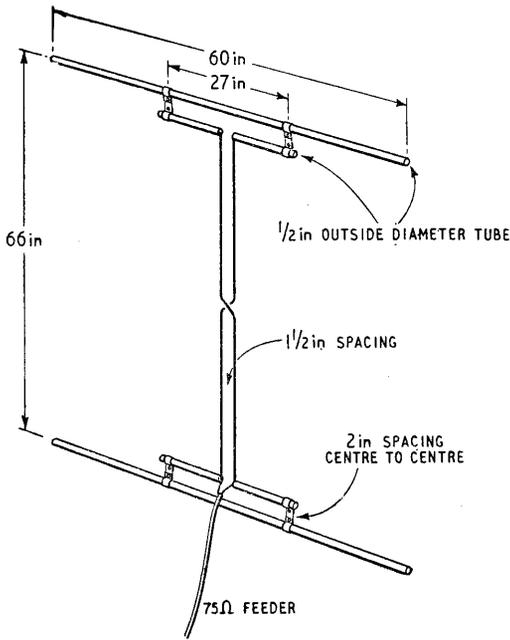


Fig. 7. Simple two-element stack using T-matched dipoles.

improve the performance of an aerial. By omitting the balun and connecting the coaxial feeder direct to the aerial, the only adverse effect so far noticed has been to introduce a little asymmetry in the front and back lobes of the polar diagram. The measured voltage gain of an aerial of this type is just over 5 dB compared to a single half-wave dipole.

Details are given in Fig. 7 of a simpler form of bi-directional aerial giving a gain of 4 dB. It has two stacked half-wave dipoles each with a T-matching section and it is only 5 ft 6 in high. The sacrifice of 1 to 1.5 dB in gain is more than compensated for by a 50% reduction in size and consequent convenience in mounting.

The T-match rods extend for 14 in each side of

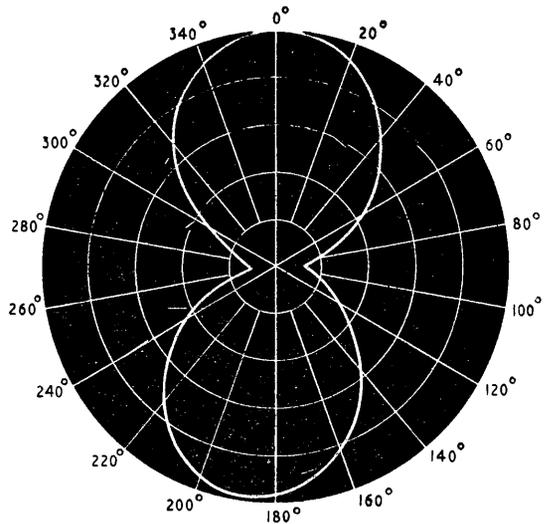
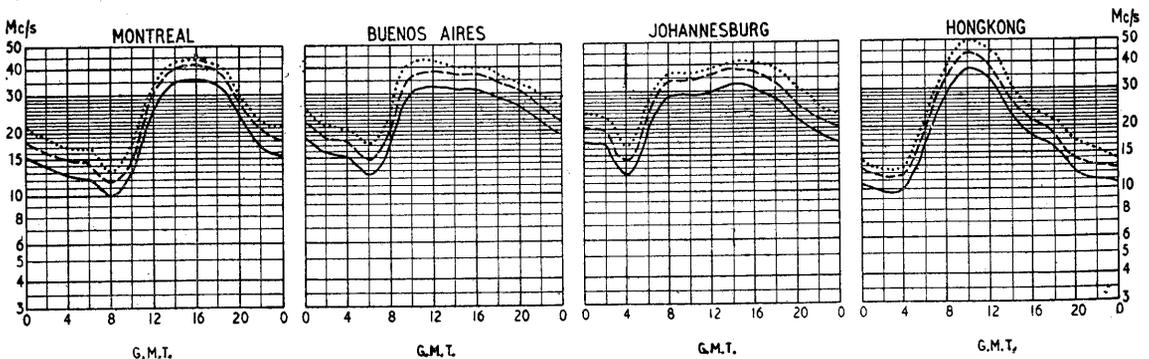


Fig. 8. Polar diagram of the two-element aerial shown in Fig. 7.

the centre insulator and their outer ends are fixed to the dipole by metal clamps. The T-match section of one dipole is joined to the T-match section of the other by an open-wire transposed transmission line and a coaxial cable is connected direct to the lower T-match unit. The polar diagram of this aerial is shown in Fig. 8 and the slight asymmetry in its two lobes, due to the omission of a balun, is only just apparent.

One advantage of using folded dipoles, or T-match dipoles, is that tests for electrical continuity can be made from the receiver end of the feeder, should it be suspected that a spell of poor reception might be due to a defect in the aerial system. Also aerials embodying either of these types of dipole are easily made reasonably safe to lightning by earthing the outer copper braiding of the feeder at, or near, ground level.

SHORT-WAVE CONDITIONS Prediction for November



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 November.

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

- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME
- PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY
- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

Recent Audio Developments

SOME NEW PRODUCTS SHOWN AT THE B.S.R.A. EXHIBITION

ALREADY this year we have reported progress in the field of high-quality sound recording and reproduction as exemplified by commercial products shown at the Audio Fair (April issue, p. 153) and the Radio Exhibition (October issue, p. 470). The rate of development in this field is rapid and at the recent exhibition organized by the British Sound Recording Association many new and interesting pieces of equipment were shown publicly for the first time.

Microphones. A ribbon microphone (type CRH) with a frequency response equivalent to that of the type RB has been developed by Reslo to provide a closer approach to uni-directional characteristics at a price much lower than is usually possible with this type of response. This has been achieved by the application of acoustic resistance and phase delay in the loading of the back of the ribbon without resort to organic absorbents such as wool and felt, and with the retention of the ease of ribbon replacement which is a feature of the original RB design. The front-to-back ratio of sensitivities is of the order of 10 dB.

Tape Recording Equipment. A professional stereophonic amplifier with the usual facilities of their type 21 single-channel model was shown by Leever-Rich. Monitoring on both channels is performed simultaneously and the ganged gain control is in balanced steps of $1\frac{1}{4}$ dB. A mixer for two pairs of stereophonic microphones is also available.

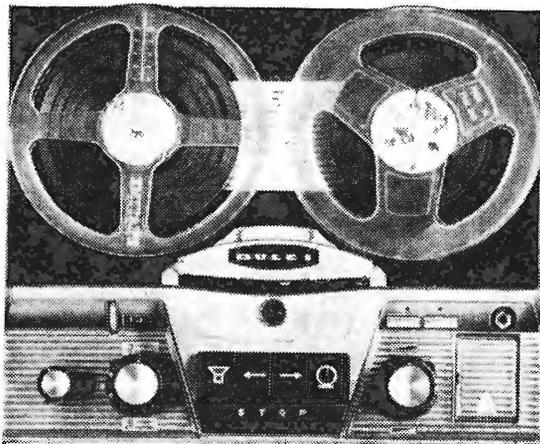
Completely separate record and replay heads and amplifiers are used in the Swiss Revox B36 tape recorder shown by Romagna Reproducers. Two inputs can be mixed with independent variation in their levels. A push-pull circuit is employed for the bias oscillator. It is interesting to note that this recorder dispenses with the use of pressure pads.

A two-speed tape recorder/reproducer with a 500 mV output designed to feed into a high-quality amplifier was shown by Dulci (Dulci-Harting). The bias level can be varied to compensate for different tape characteristics. A microphone input with a sensitivity of 1.5 mV for full output is provided.

Another two-speed tape recorder the German Harting HM6 shown by T.S.L., includes a 4-watt output stage which feeds a 9in x 6in bass speaker and 2 $\frac{1}{2}$ -in tweeter. The wow and flutter is stated to be better than 0.1%.

A new professional sprocket-driven recorder, suitable for use with 16mm film (6 or 17.5mm versions will be available later), was shown by Leever-Rich. The sprocket assembly, gearbox, spool motors, drive motor and head block are individual sub-units which can be removed and replaced after servicing without disturbing their alignment. The main sprocket which has a circumference of sixteen frames is driven by a worm gearbox, the drive shaft being extended to allow coupling to other machines.

Tuners. A number of f.m. (some in kit form) and a.m./f.m. tuners were shown by Jason, models with



Dulci-Harting tape unit

switched or continuous tuning on f.m. being available. One economical circuit seen in the Prefect switched tuner uses a pentode r.f. valve, a triode pentode as reactance valve (for a.f.c.) and self-oscillating mixer (pentode), followed by two pentodes providing i.f. amplification and limiting, and crystal diodes for the Foster-Seeley discriminator. The sensitivity is about $50\ \mu\text{V}$ for 20 dB quieting. In the Jason "AM/FM2" the f.m. circuitry includes a low-noise cascode r.f. stage, three i.f. stages, double diode and valve limiters, a Foster-Seeley discriminator and twin-neon tuning indicator. The a.f.c. can be reduced to avoid weak stations being overwhelmed by strong ones on adjacent frequencies. The sensitivity is $2\ \mu\text{V}$ for 20 dB quieting. R.f. amplification is also provided on medium waves and alternative bandwidths of $\pm 4\ \text{kc/s}$ and $\pm 8\ \text{kc/s}$ are available, the sensitivity being $10\ \mu\text{V}$. The ordinary "magic-eye" tuning indicator also indicates the signal strength on f.m. An adjustable cathode-follower output is provided.

Pre-amplifiers and Amplifiers. A maximum sensitivity of 10 mV for 10 watts output with 0.1% total harmonic distortion and a signal-to-noise ratio of 80 dB is obtainable from the CQ combined amplifier and pre-amplifier. The power response varies less than 1 dB between 25 and 60,000 c/s. Mains inputs of 115 or 230 V, 40 to 100 c/s are provided for, and the unit is fully tropicalized.

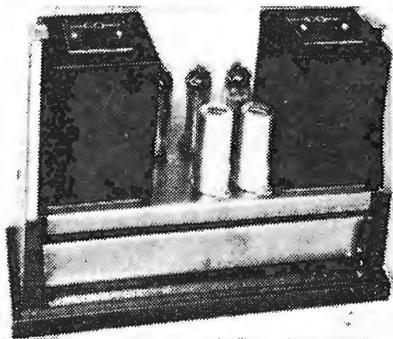


Audiomaster pre-amplifier.

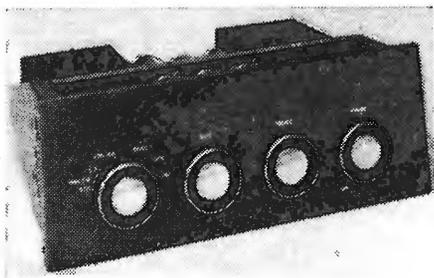
Another 10-watt combined amplifier and pre-amplifier shown by Jason has a maximum sensitivity of 1 mV, and is claimed to introduce less than 0.05% distortion.

Twenty watts output with an intermodulation distortion of 0.7% (40 c/s modulating 10 kc/s with a ratio of 4 to 1) and a signal-to-noise ratio of 89 dB (10 k Ω source resistance) is available from the "Audiomaster" amplifier shown by Musicraft. The power response varies less than 0.5 dB between 30 c/s and 20 kc/s at 20 watts. The damping factor is 50. The associated pre-amplifier includes four alternative record and two tape frequency compensation networks, and controls to give a treble-cut slope variable between 8 and 30 dB/octave from cut-off frequencies of 5, 7, 9 or 12 kc/s. The impedance at the pickup input is variable, the signal-to-noise ratio being 56 dB at the maximum sensitivity of 8 mV. A tape head input with a sensitivity of 1 mV and a signal-to-noise ratio of 45 dB is also available. The total harmonic distortion at 2 V output is less than 0.2% (240 mV gives 25 watts output from the main amplifier).

Two low-distortion amplifiers with output powers of 10 and 30 watts for 0.05 and 0.1 V inputs respectively were shown by Westrex. A 100-watt amplifier with a somewhat higher distortion (0.7%) at full output, reduced signal-to-noise ratio (65 dB), and narrower frequency response (3 dB down at 40 c/s) is also available. A transistor pre-amplifier to work between impedances of 600 ohms and with gain alternatives of 40, 55 or 65 dB can also be incorporated in these amplifiers. The frequency response is 30 c/s to 12 kc/s \pm 2 dB and the distortion 0.7% for 0.1 mW maximum output. The noise contribution from the three OC71 transistors is less than 10 dB up on the basic circuit noise. The pre-amplifier is

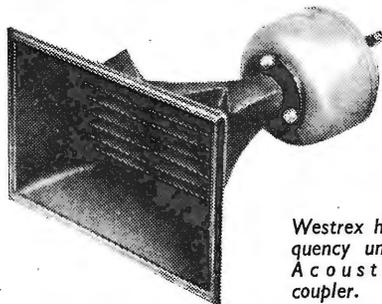


CQ amplifier showing (above) mains transformer and grain-oriented output transformer and (below) controls on the die-cast pre-amplifier panel.



temperature stabilized, and can operate up to 45°C.

Loudspeakers. There are some interesting design features in the Westrex "Acoustilens 20/80" loudspeaker system. Two speakers are used with a cross-over frequency of 700 c/s. The 15-in direct radiator bass speaker has a 3-in diameter voice coil of copper tape wound edgewise. This form of construction results in the large total flux linkage of 310,000 Maxwells, with a flux density of 13,200 gauss. The large diameter coil gives a more uniform effective drive



Westrex high-frequency unit with Acoustilens coupler.

over the whole cone surface, thus increasing the cone breakup frequency. The reduced distance between the driving point and the outer edge of the diaphragm increases the frequency at which a dip in the response generally occurs due to the sound transmitted through the cone and radiated from its edge being out of phase with that directly radiated from the centre. The proportion of the magnetic gap volume wasted is considerably reduced when the voice coil is wound with tape rather than with the usual cylindrical wire. The speaker is loaded by a 12 cu ft bass reflex enclosure with a low-Q resonance. The distortion for 20 watts input at 120 c/s is 0.8%. The treble unit also uses a 3-in diameter edgewound voice coil to drive a Duralumin dome. The sound from this dome passes through a phasing unit to a fibre-glass horn, incorporating a slotted acoustical lens to give a wide horizontal polar radiation pattern. The slots in this lens are arranged so that the radiation from the horizontal periphery travels a longer path than that from the centre. The central radiation is thus advanced in time over that at the side and a curved front is produced.

A similar acoustical lens will be available for the Mark II version of the Kelly ribbon loudspeaker shown by Romagna Reproducers. A substantially uniform distribution is obtained over an arc of 120° up to 18 kc/s. The matching transformer has a Ferrocube core and the distortion is less than 0.5% for 10-watts input at frequencies within the operating band (1 to 30 kc/s).

The speakers used in the CQ reproducer are now available for home constructors. These are 9in \times 5in and 4-in units whose cones have been specially treated with a non-setting viscous plastic to absorb unwanted reflections at the cone edge. In addition, damping pads are placed on the 9in \times 5in unit cones to reduce still further unwanted peaks in the frequency response characteristics. The speakers are individually tested.

A novel speaker mounting was seen in the TSL-Geruphon Omni-D Resonator. This consists of a cylinder only 15 $\frac{1}{2}$ in long and of 4 $\frac{1}{2}$ in diameter open at both ends, with a moving coil speaker mounted asymmetrically at a suitable point inside.

Calibrated D.C. Oscilloscope

A COMPACT, STABILIZED DESIGN

By B. PEARCE

THIS article describes the design and construction of a small portable workshop oscilloscope with a calibrated d.c. amplifier for Y-deflection. The oscilloscope was intended mainly for low frequency work and has a substantially flat response from d.c. to 20 kc/s. The maximum Y-sensitivity is 30 mV/cm. A linear time-base is incorporated, with facilities for free-running or single-sweep operation with internal or external triggering. The unit is mains-driven.

Some time ago the author was contemplating the building of a valve voltmeter to supplement the very inadequate range of test gear in his home workshop. The thought occurred that for the requirements in hand a far more useful instrument would be a calibrated oscilloscope which, with a slight sacrifice in accuracy and convenience, would incorporate the properties of a valve voltmeter and also have all the virtues of oscilloscopes. On perusing the specifications for one or two of the small commercially available instruments it was noticed that all deflection amplifiers were for a.c. signals only. Recollecting how such instruments had proved very exasperating on more than one occasion when a d.c. amplifier would have considerably eased the problem in hand, the author resolved to try to design an economical "scope" having a d.c. amplifier.

Although a 5-in cathode-ray tube was available, it was decided to use a 3-in ECR30 to keep the design simple and the bulk small. Reference to the manufacturers data showed that a final anode potential of 1,000 V was permissible, and that under these conditions the Y-deflection sensitivity would be 5.9 V/mm. Thus for a full screen deflection of 70 mm a voltage swing of $5.9 \times 70 = 413$ V is required. Using push-pull deflection this would mean a swing of 207 V per anode. To obtain reasonable linearity up to an out-

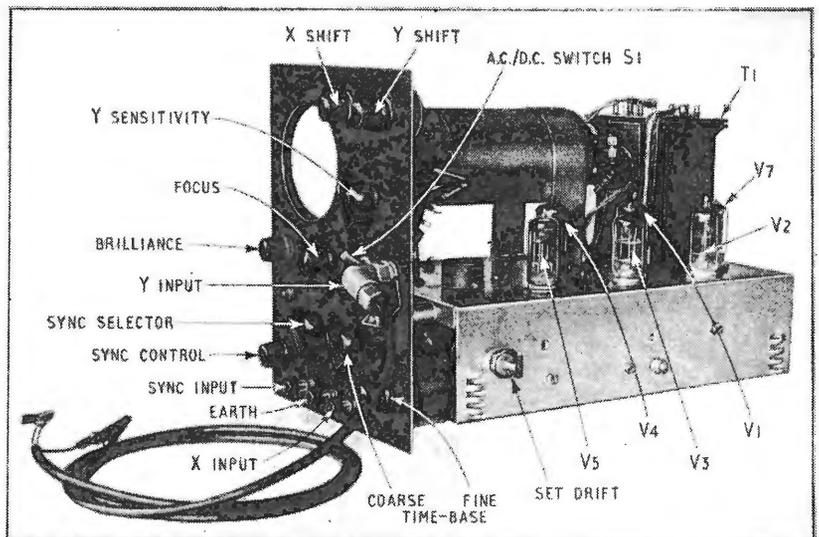
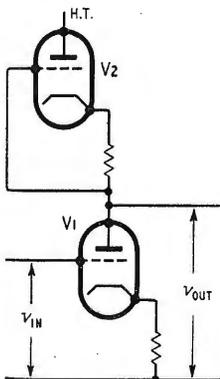
put of this order, an h.t. supply of at least 350 V would be needed for the deflection amplifier, and as in this case a Schmitt cathode-coupled stage was used, an h.t. supply of 400 V was required. It would, of course, have been possible to use a lower final anode voltage on the c.r.t., but as the author wished to incorporate a single-sweep time-base, a large final anode voltage was used in the interest of trace brightness.

The main problem in the design was the construction of a d.c. amplifier having sufficient long-term stability to warrant calibration. A phase-splitter was required if push-pull deflection were to be used and the Schmitt circuit proved ideal, having a second input for shift control. The output stage, being push-pull, is substantially unaffected by h.t. fluctuations, and thus the 400 V line was not stabilized. The grid potentials, however, being independent of one another, were ultimately derived from a stabilized supply in the interests of stability of the output.

Having decided on the output stage, a rapid calculation for a type ECC91 valve in this role showed that one more double triode stage would be adequate for present requirements so far as gain was concerned. Here, the question of long-term stability reared its head again, though by using a stabilized h.t. supply and high-stability resistors two sources of drift were eliminated. The principal remaining cause was variations in the valve heater voltage, which affect the mutual conductance and anode resistance of the valve. To reduce this effect the circuit of Fig. 1 was used. This consists of a triode voltage amplifier V1 whose normal anode load resistance has been replaced by an identical valve V2 with the same bias. It can be seen from the equivalent circuit (Fig. 2) that the load is now the anode impe-

Right: General view of oscilloscope showing principal components.

Fig. 1. Amplifier circuit to reduce effect of heater voltage variations.



dance r'_a of valve V2 in series with a generator μv_g and the internal impedance r_a of V1. Since the valves are identical and their heaters are fed from the same supply, changes in anode impedance due to heater supply variations will produce identical changes in r_a and r'_a , and the voltage output will remain constant.

In practice, even though a double triode with series heaters is used, slight manufacturing variations require that a certain amount of further compensation be included to make the gain of the stage

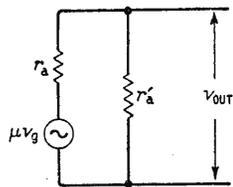


Fig. 2. Equivalent circuit of Fig. 1.

independent of heater fluctuations. This can be done by making one of the cathode bias resistors variable over a small range and adjusting this until the change in the anode voltage of V1 is a minimum when the heater voltage is varied (say) $\pm 10\%$. Unfortunately, this adjustment varies the anode voltage itself, so that this stage must be set up independently of the following stage, and if a coupling divider is used this must be "tailored" to bring the grid of the Schmitt stage valve to its correct level. This would involve some sacrifice in gain, and because of this the author preferred to dispense with

the divider and directly couple the anode to the following grid, although this involved adjustment of the Schmitt cathode resistor and shift grid potential before optimum conditions were obtained in this stage. As a rough guide, the aim is to adjust component values in the Schmitt stage until, when balanced and with equal anode loads, the anode voltages are about half way between cathode and h.t. At the same time it should be remembered that if the heater is "earthy," the heater-cathode voltage should not exceed the recommended maximum value, which for an ECC91 is 100 V. In the circuit diagram (Fig. 3) components which may require adjustment are underlined.

With the circuit as shown, a maximum sensitivity of about 30mV per centimetre was obtained using a direct anode to grid connection. With a divider coupling, a sensitivity of 50mV per centimetre can reasonably be expected. Calibration can be effected by adjustment of the divider resistance R_{13} . If the maximum sensitivity is required the first position of S2 can be used (connection shown dotted).

The rest of the design is fairly straightforward. The X-amplifier is a single Schmitt circuit with R-C coupling to the time-base and also to a front panel terminal. The dual-input feature of the Schmitt circuit enables an X-input to be applied at the same time as the time-base, and this could conceivably be

COMPONENTS TABLE

R ₁	See text (about 750k)
R ₂	510k 5%
R ₃	180k 5%
R ₄	51k 5%
R ₅	18k 5%
R ₆	5.1k 5%
R ₇	1.8k 5%
R ₈	510 5%
R ₉	220 5%
R ₁₀	220k
R ₁₁	3.9k 5% H.S.
R ₁₂	5.6k 5% H.S.
R ₁₃	See text (about 1.5m H.S.)
R ₁₄	1M 5% H.S.
R ₁₅	33k 5% H.S. 1.5W
R ₁₆	33k 5% H.S. 1.5W
R ₁₇	6.8k 5% H.S. (See text)
R ₁₈	470k 5% H.S.
R ₁₉	100k
R ₂₀	220k
R ₂₁	47k 5% H.S.
R ₂₂	22k 5% H.S.
R ₂₃	47k 5% H.S.
R ₂₄	220k
R ₂₅	220k
R ₂₆	470k
R ₂₇	33k 5% 1.5W
R ₂₈	33k 5% 1.5W
R ₂₉	6.8k 5% (See text)
R ₃₀	470k
R ₃₁	1M
R ₃₂	47k
R ₃₃	470k
R ₃₄	2.2k
R ₃₅	47k
R ₃₆	3.3k
R ₃₇	1M
R ₃₈	100k
R ₃₉	68k 0.5W
R ₄₀	100k
R ₄₁	68k
R ₄₂	680
R ₄₃	100k
R ₄₄	220k

R ₄₅	100k
R ₄₆	22k (See text)
R ₄₇	100k 0.5W
R ₄₈	100k 0.5W
R ₄₉	100k 0.5W
R ₅₀	100k 0.5W
R ₅₁	100k 0.5W
R ₅₂	100k 0.5W (See text)
R ₅₃	2.2M
R ₅₄	2.2M
R ₅₅	2.2M
R ₅₆	2.2M
R ₅₇	22k 3W

Note: All resistors $\frac{1}{4}$ W 20% carbon unless otherwise stated.

P ₁	2k wire wound linear
P ₂	250k carbon linear
P ₃	250k carbon linear
P ₄	250k carbon linear
P ₅	2M carbon linear
P ₆	50k carbon linear
P ₇	20k carbon linear
C ₁	0.25 μ 500V paper
C ₂	0.5 μ 150V "
C ₃	0.5 μ 150V "
C ₄	0.5 μ 150V "
C ₅	0.25 μ 350V "
C ₆	1.0 μ 150V "
C ₇	0.01 μ 350V "
C ₈	0.001 μ 350V "
C ₉	0.01 μ 350V "
C ₁₀	0.5 μ 350V "
C ₁₁	0.05 μ 350V "
C ₁₂	4700 p 350V
C ₁₃	470 p 350V
C ₁₄	47 p 350V
C ₁₅	8 μ 500V electrolytic
C ₁₆	0.5 μ 350V paper
C ₁₇	0.05 μ 350V "
C ₁₈	4700 p 350V
C ₁₉	470 p 350V
C ₂₀	47 p 350V
C ₂₁	8 μ 500V electrolytic
C ₂₂	10 μ 500V "

C ₂₃	0.5 μ 1000V paper
C ₂₄	1.0 μ 1000V "
V1	ECC83, 12AX7, CV492
V2	ECC91, 6J6
V3	ECC91, 6J6
V4	ECC83, 12AX7, CV492
V5	EF91, 6AM6, 6F12, 8D3, CV138
V6	ECR30
V7	QS150/15, CV287
T1	Mains transformer: Primary 0-210-230-250V, 50c/s. Secondary 350-0-350V, 60mA 6.3V, 2A, 4V, 1A
L1	Smoothing choke: 20 H, 30 mA
S1	Single pole, single throw toggle switch.
S2	Single pole, 9-way wafer switch.
S3	Two pole, 4-way wafer switch.
S4	Two pole, 6-way wafer switch.
S5	Single pole, single throw toggle switch.
MR1	Selenium rectifier stack consisting of two sections each having at least 25 plates 18 mm diameter (S.T.C.).
MR2	"Sentercel" Type K8/15
MR3	"Sentercel" Type K8/15
Front Panel Controls	
P2:	Y—Shift control.
P3:	X—Shift control.
P4:	Sync. amplitude and sense.
P5:	Time-base "Fine" control.
P6:	Focus control.
P7:	Brilliance control.
S1:	Input blocking capacitor switch.
S2:	Y—Sensitivity switch.
S3:	Sync. selector switch.
S4:	Time-base "Coarse" switch.
(Behind-panel control: P1)	

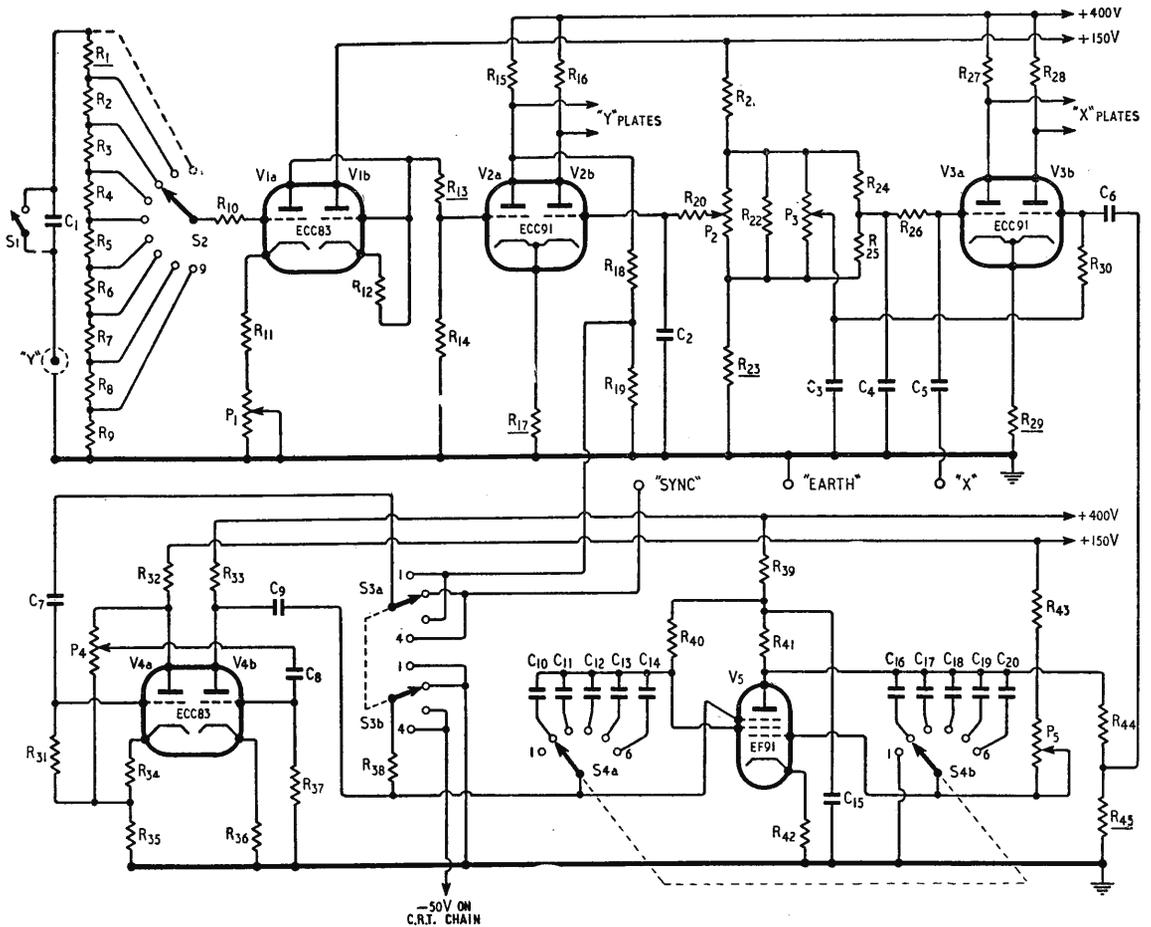


Fig. 3. Amplifier and time-base circuits.

used for time measurements. The comparatively poor response of this amplifier causes some non-linearity in the sweep on the higher ranges of the time-base. This was of no consequence in this design, though an improvement (short of using a cathode-follower buffer stage) could be effected by the use of smaller anode loads (say 22k or 15k) with a corresponding adjustment in supplies and cathode resistor to cope with the increased current drain.

The time-base also is conventional and its features need no special mention except that the suppressor can be either earthed via R_{38} or taken to a negative potential on the c.r.t. chain, dependent on whether free-running or single sweep operation is required. In the latter case, triggering is effected by V4 which comprises a phase splitter triode giving positive or negative "sync" from the potentiometer P_4 , followed by a single triode amplifier feeding the time-base suppressor grid. The "sync" selector switch enables either free-running or single-sweep operation to be used with either internal (i.e. from the Y-amplifier) or external synchronization.

The power supplies were originally built round a particular small mains transformer which the author happened to have handy, but in the design shown this has been altered to use a standard 350-0-350V, 60mA transformer having 4V, 1A and 6.3V, 2A heater windings. The c.r.t. heater should have its own

winding, and this should be insulated for at least 1000V. Most production transformers nowadays are tested to this voltage before leaving the factory, so that no trouble should be experienced here. It is important that the c.r.t. heater should be strapped to the cathode at one end. Metal rectifiers were used throughout, though there is no reason why valve rectifiers should not be used instead, if desired. It will be observed from the circuit diagram that the final anode of the c.r.t. derives its voltage from the four deflector plates via four 2.2M resistors. In this way the final anode voltage is kept at the mean value of the plate voltages, thus reducing trapezium distortion.

Mechanical details of the design are to some extent a matter of personal taste. The layout shown in the accompanying photographs was found satisfactory, although it will be seen that conditions under the chassis became a little cramped towards the end! A Mumetal screen round the c.r.t. is desirable, and the mounting of the mains transformer is fairly critical. It is best to build the oscilloscope with this transformer initially on long leads, and as soon as the stage is reached when a spot can be produced on the screen, to adjust the position of the transformer until the stray field produces a minimum deflection of the spot. This is usually when the axis of the transformer coils coincides with the c.r.t. axis.

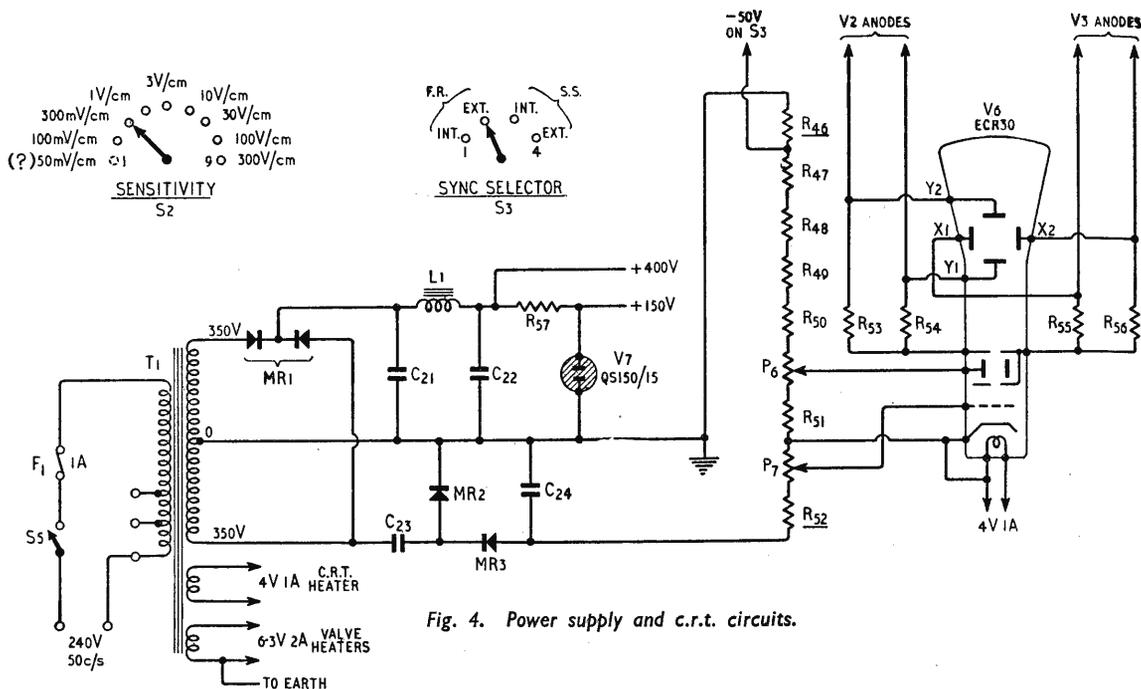


Fig. 4. Power supply and c.r.t. circuits.

The inclusion of a spare valve socket in the author's unit as shown in the photograph is of no significance.

A certain amount of initial setting-up is necessary before the instrument is ready for use. It is possible that the anode-cathode voltage of the c.r.t. may exceed the rated maximum of 1000V. A rough check of this should be made by measuring the anode voltages of V2 and V3 (which should all be about the same when balanced) and the current in the c.r.t. divider chain, from which the c.r.t. voltage can be calculated. If necessary R₅₂ can then be adjusted as required. Next V1 should be set up by adjustment of P₁ as described earlier. If the divider R₁₃, R₁₄ is used, R₁₃ should be adjusted until the c.r.t. spot is central with P₂ at mid-position. If the divider is dispensed with, V2's grids should be strapped together and connected via a 220k resistor to V1's output.

R₁₇ should then be adjusted until V2 anodes are at approximately 240V. Leaving the 220k resistor permanently between V1 and the grid of V2a, connect V2b grid back to the shift control and adjust R₂₃ until V2 is balanced with P₂ set mid-way. This will now have upset the bias on V3 and R₂₉ will probably need adjusting until V3 anodes are at about 240V. Having set up the amplifiers for balance, the input potential divider should be calibrated by injecting a known voltage into the Y-input and adjusting R₁ until the correct deflection is obtained. Due to adverse component tolerances it may be necessary to adjust the suppressor bias to V5 when the time-base is in the "single-sweep" condition. V4b grid should be earthed and R₄₆ increased until the time-base does not run on any range. The nearest standard value is sufficient for R₄₆. Setting-up should now be complete.

Books Received

An Introduction to the Cathode Ray Oscilloscope, by Harley Carter, A.M.I.E.E. Volume in the Philips Technical Library Popular series gives a simple treatment of c.r. tubes and their associated time base, deflection and power supply circuits, and of oscilloscope applications and measurements; and also includes data on standard c.r. tubes with details of four complete oscilloscope circuits. Pp. 100; Figs. 89. Price 12s 6d. Cleaver-Hume Press, Ltd., 31, Wrights Lane, London, W.8.

F.M. Radio Servicing Handbook by Gordon J. King, deals theoretically and practically with the stages in turn including the audio section, and with a.m./f.m. receivers. Pp. 188; Figs. 117. Price 25s. Odhams Press, Ltd., 96, Long Acre, London, W.C.2.

Cathode-Ray Oscillographs, by J. H. Reyner. Fifth edition covers c.r. tubes and associated deflection and

time base circuits, waveform characteristics, including those at r.f. and the possible modifying effects of c.r.t. circuits, frequency comparison and measurement, and circuit characteristic traces. Also includes special applications (e.g. at low frequencies) and techniques such as photography. Pp. 206; Figs. 141. Price 20s. Sir Isaac Pitman and Sons, Ltd., Parker Street, London, W.C.2.

Elektronenrohren by M. J. O. Strutt. Third volume in the Lehrbuch der drahtlosen Nachrichtentechnik series initially deals with theory of electrons in electric and magnetic fields, in solids, and in thermionic emission before discussing theories of (including noise in) diodes and other types of valves and also electron optical systems. Applications and data for many types of electron devices including transistors are given. Pp. 391; Figs. 455; Refs. 654. Price 58.50 DM. Springer-Verlag, Reich-bietschuerer 20, Berlin.

400-watt Audio Amplifier

USE OF SMALL OUTPUT VALVES IN PARALLEL PUSH-PULL

By G. R. WOODVILLE*

THERE are basically two alternative methods of generating high powers at audio frequencies using thermionic valves:

1. The use of two large valves in push-pull.
2. The use of several smaller valves in parallel push-pull.

The principal advantages of the second method are:

1. Low cost of valves. In the case of a valve failure the user is not faced with a large financial outlay.
2. High order of reliability. The failure of one or more valves does not result in a suspension of service. Valves may be removed or inserted without switching off (due to the comparatively low anode voltage used).
3. Low cost of the associated power supply, also due to the low voltage used.
4. If an "ultra-linear" circuit is used, the low output (and load) impedances simplify the output transformer design.
5. The high sensitivity permits a low-power driver stage.
6. The maximum available output is determined by the number of valves used.

This article describes an amplifier based on the second method which uses KT88 valves in the output stage. It was designed to give 400 watts output over a frequency range of 75 c/s to 25 kc/s, but the output is in fact well maintained up to 50 kc/s. It has been used for the operation of a vibrator, but is equally suitable for public address work.

The KT88s are used under somewhat conservative conditions; the anode plus screen dissipation for each valve does not exceed 35 watts (and may be as low as 20) during quiescent periods and is approximately 25 watts at full output. The operating conditions are similar to those given on page 4 of the KT88 Circuit Supplement†, but the anode voltage is lower (525 V). This reduces "cross-over" distortion at full output, because for a given dissipation the anode current can be increased and thus a smaller negative grid bias voltage used. The use of a common grid voltage control might otherwise increase the overall "cross-over" distortion because it prevents individual equalization of the cut-off voltages.

Circuit—This is shown in Fig. 1, the wiring

to only four valves being included. Each KT88 has its electrodes connected to bus-bars, as it were, and the individual cathodes are connected to earth through suitable meter shunts R_{18} of, say, 10 ohms, with series resistors R_{17} leading to the metering switch S_1 . A 200 μ A f.s.d. meter was used, arranged to read in milliamperes by suitable choice of R_{17} (i.e. about 10,000 ohms).

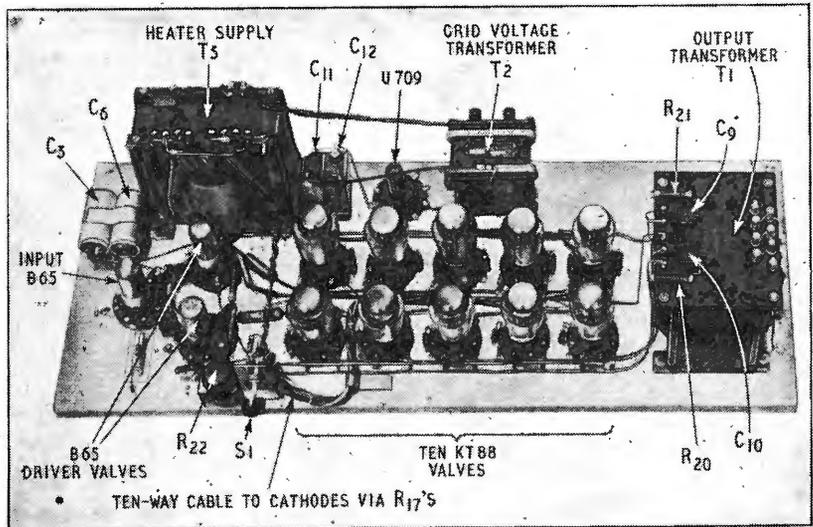
The two grid resistors R_{14} , R_{15} are returned to an adjustable (maximum value 90 to 100 V) grid voltage supply V_g , from R_{22} . It has been found that if the anode supply has a very good regulation a single grid voltage adjustment is satisfactory. This point will be discussed later.

An input of (55 + 55) V r.m.s. is required at the KT88 grids across the resistors R_{14} , R_{15} which are necessarily low in value. This voltage is obtained at a distortion of less than 2% from two B65 valves in an amplifier/cathode follower circuit. This stage is, in its turn, driven by a third B65 operating as an amplifier/phase splitter. For full output an input of 0.25 V r.m.s. is needed. The resistance values in the two B65 stages though not critical are somewhat inter-dependent.

Output transformer—This would, for the usual industrial service, have a ratio of 5:1 or 6:1. Screen-grid tapplings are provided including 25% to 50% of the total turns on each half-primary to enable the "ultra-linear" (UL) circuit to be used. The 40% tap was used in this amplifier. It is vitally

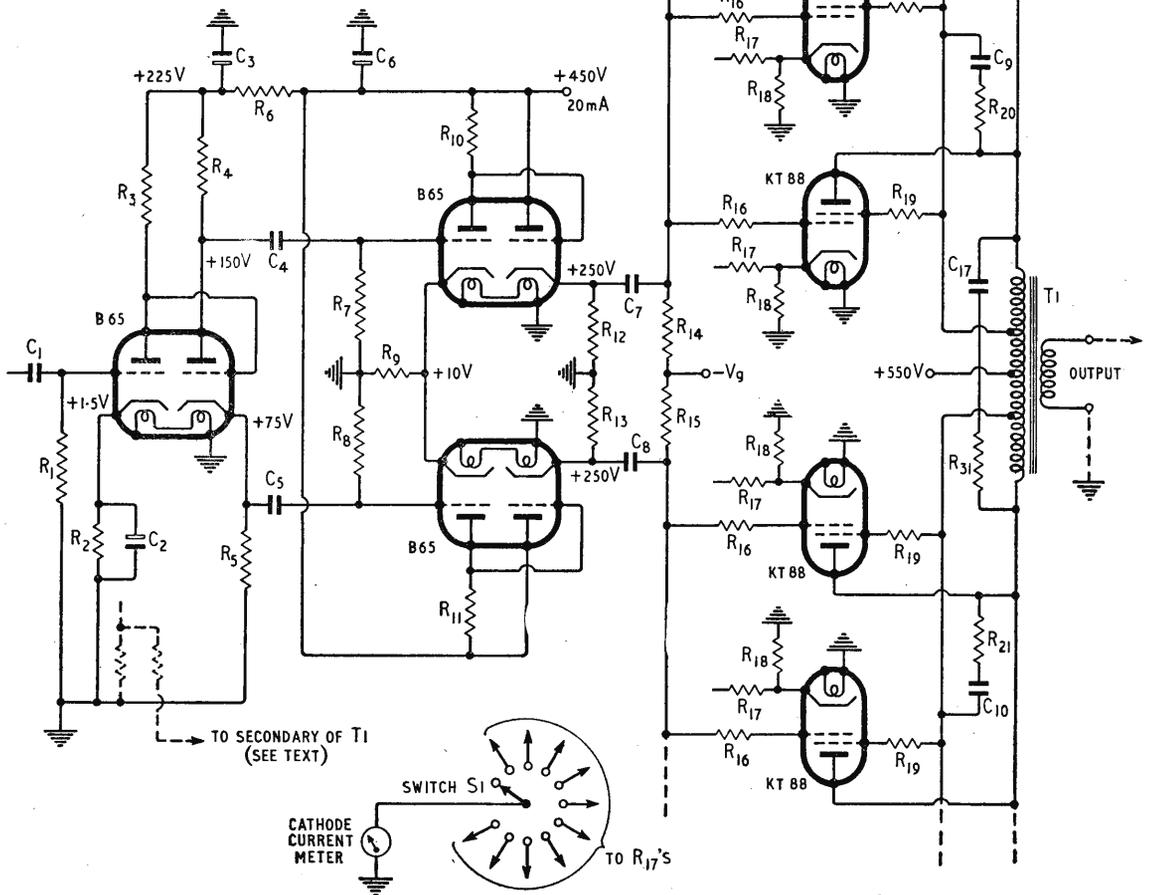
* M-O Valve Co., Ltd.

† Issued by The G.E.C. Ltd. (November 1956).



Prototype 400-watt amplifier with grid and 6.3 V heater supply components.

Fig. 1. Circuit for 400-watt amplifier using ten KT88s in parallel push-pull.



Resistors

No.	Value	Tolerance %	Rating (watts)
R ₁	1 M	20	1/4
R ₂	1 k	20	1/4
R ₃	100 k	20	1/2
R _{4,5}	15 k	20	1/2
Matched pair			
R ₆	33 k	20	1/2
R _{7,8}	1 M	20	1/4
R ₉	4.7 k	10	1/2
R _{10,11}	220 k	20	1
Matched pair			
R _{12,13}	47 k	10	1
Matched pair			
R _{14,15}	47 k	10	1/2
R ₁₆	15 k	20	1/4
R ₁₇	Meter series resistors		
R ₁₈	Meter shunt resistors		
R ₁₉	220	20	1/4
R _{20,21}	1 k (see text)	20	1
R ₂₂	10 k (wirewound)	20	1
R _{23,24}	22 k	20	1
R ₂₅	1.5 k	20	1/4
R _{26,*} R _{27,*}	100 k	10	1/2
R _{28,*}	4.7 k	20	1
R _{29,30}	47 k	10	1
R ₃₁	(see text)		
*Optional—see text.			

Capacitors

No.	Value	Rating
C ₁	0.01	350 V (pk.)
C ₂	50 (electrolytic)	12 V
C ₃	8 (electrolytic)	450 V
C _{4,5}	0.01	450 V (pk.)
C _{6,*}	8 (electrolytic)	450 V
C _{7,8}	0.25	450 V (pk.)
C _{9,10}	0.001 (see text)	350 V a.c. (pk.)
C _{11,12}	2	250 V (pk.)
C _{13,14}	300 (100+200, electrolytic)	350 V
C _{15,*} C _{16,*}	32 (electrolytic)	350 V

C ₁₇	(see text)
C _{18,19}	0.05 700 V

Smoothing Choke

L₁ 2 H 1.2 A.
(Haynes Radio Ltd., LUM 24/31 used)

Transformers

- T1 Output transformer
Savage Transformers Ltd., 4T35
- T2 Heater and grid supply
300 V C/T; 6.3 V, 20 A.
- T3 Anode supply
700 V, 1.2 A, 10 V tappings on primary
- T4 Rectifier filament supply 4 × 2.5 V, 5 A

Valves

- 3 B65 or 6SN7GT
- 10 KT88
- 4 GXU1 or 3B28
- 1 U709 or U78/6X4

important that the transformer has a low leakage inductance between (1) primary (P) and secondary (S); (2) The two half-primaries and (3) each half primary and its UL tapping.

The transformer used in the prototype amplifier was a type 4T35, made by Savage Transformers Ltd., and has the following characteristics:—

Primary inductance, 4 H.

Leakage inductance, P to S, 0.75 mH

Leakage inductance $\frac{1}{2}$ P to $\frac{1}{2}$ P, 0.75 mH.

Leakage inductance $\frac{1}{2}$ P to UL tap, 1.5 mH.

The secondary is composed of four sections, each giving 25 volts at full output.

Components R_{20} , R_{21} and C_9 , C_{10} may be required to stabilize the amplifier and prevent oscillation at an ultrasonic frequency. Typical values would be 1,000 Ω and 0.001 μ F.

Power supply—It is essential to design the power supply to give a good regulation, in order to reduce cross-over distortion. An anode supply of bad regulation would call for a low quiescent anode current (i.e. high value of negative grid bias) to keep the dissipation within the rated value at zero output when the anode voltage would be higher than from a well regulated supply.

The power supply used suffered only a 10% change in voltage as the current increased from 400 mA to 1,200 mA, with the result that the output stage would accept a fairly wide variation in valve cut-off voltages without undue cross-over distortion at full output. The four rectifiers are GXU1s, xenon filled valves equivalent to the American 3B28. In this circuit they are very considerably under-run, the peak inverse voltage across each being below 1 kV whereas the rated maximum is 10 kV. They have been chosen due to the excellent regulation obtained. A delay switch is recommended which will not apply the anode voltage until at least ten seconds after the heaters are switched on, in order to allow the filaments time to attain the correct working temperature. This switch can be operated from the grid voltage supply and would then also act as a protective interlock.

The anode supply transformer T3 has primary and secondary resistances of 2 and 12 Ω respectively. The choke L_1 has a d.c. resistance of 18 Ω and an inductance of 2H at its rating of 1A, this current being somewhat exceeded at full output. As the heater current from T5 amounts to approximately 20A, an adequate gauge of connecting wire is required.

The resistor R_{25} not only reduces the peak current through the U709 rectifier, but also serves to adjust the grid potential to the recommended value of

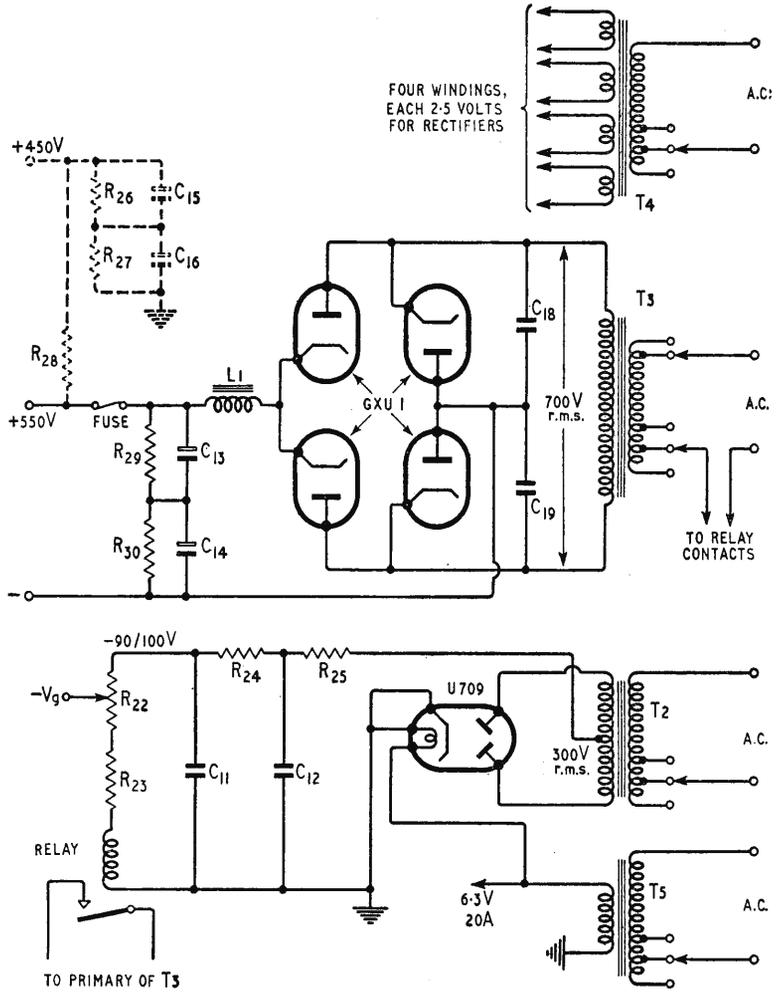


Fig. 2. Power supplies for 400-watt amplifier.

90 to 100 V. Capacitors C_{18} , C_{19} prevent the radiation to nearby receivers of mains interference generated by the xenon rectifiers.

The B65s require 15 to 20mA at 450 volts. This could be obtained from the KT88 supply, as shown in Fig. 2, by the use of a series resistor R_{25} , in which case the capacitor C_6 should be replaced by C_{15} , C_{18} to give both a higher capacitance and working voltage. A separate 450-volt source may be more convenient if other low level stages are to be used.

Operating conditions and performance

	Quiescent	Full Output
Line voltage	570	530 V
Anode voltage	565	525 V
Anode current (per valve)	35-60	100-125 mA
" " (total)	450	1200 mA
Control grid voltage, approx.	-75	— V
Anode-to-Anode load impedance	—	1000 Ω
Output impedance	—	1200 Ω
Power output	—	400 W
Distortion	—	5 to 7%
Input, grid to grid, r.m.s.	—	55+55 V
Input to first stage, Fig. 1	—	0.25 V
Anode dissipation per valve, approx.	35	25 W

Some of the above data will vary with the individual valves used. If any of them give widely differing figures they should be replaced—they will still be quite suitable for use in normal two valve amplifiers. The behaviour with different values of anode load is shown in Fig. 3. The minimum distortion will be obtained when the combined quiescent anode currents for each side (and thus their mean operating points) are equalized by interchanging valves.

The prototype amplifier will reproduce, at 80 to 90% of full power, a 5,000 c/s square wave. A resistor and capacitor R_{31} and C_{17} connected across the primary of the output transformer enable the overshoot to be controlled. The values required will be dependent on the transformer characteristics, but were $1000\ \Omega$ and $0.0035\ \mu\text{F}$ with the transformer used in the prototype. In Fig. 4 is shown a reproduction of the excellent waveform which can be obtained, a single overshoot of about 15% appearing.

The performance may be improved if required by the addition of feedback. A 22-ohm resistor should be inserted at the earthy end of R_2 and C_2 and a

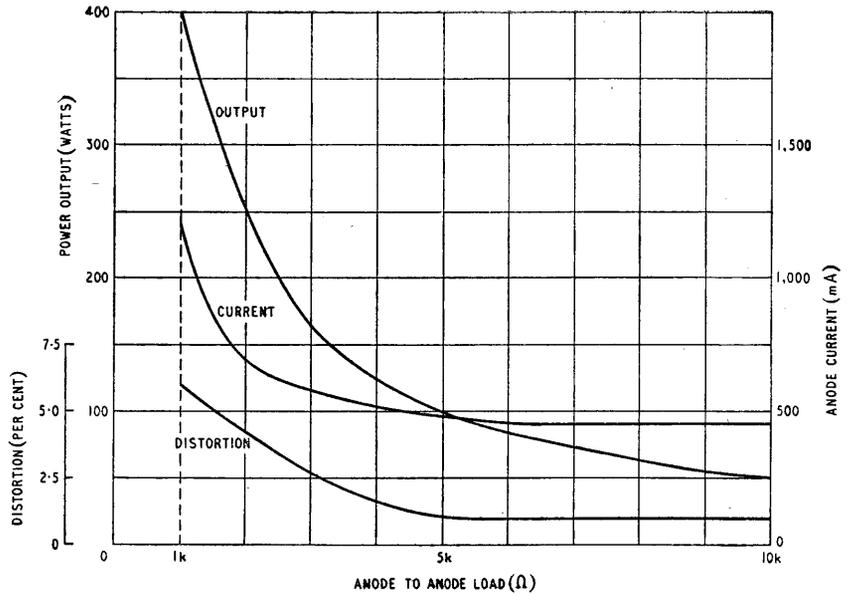


Fig. 3. Performance of amplifier for various anode loads.

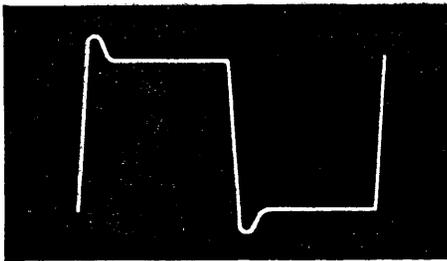


Fig. 4. Output for 5,000 c/s square wave input.

second resistor taken to one side of the secondary of the output transformer, the other side being earthed. The correct value for the second resistor will depend on the feedback required and the load impedance in use, but for 10 dB and 25 ohms, the correct value is 5,600 ohms. The connections are shown in Fig. 1 by dotted lines. With 10 dB feedback the distortion falls to 2%, and the residual hum is reduced to a negligible figure.

Layout—To reduce any tendency to instability some care should be taken with the layout. The prototype amplifier had the output valves placed in two parallel lines $3\frac{1}{2}$ inches apart, the valves on each side having a 3-inch spacing. The valveholders on each side were displaced axially to bring pins 6 and 7 opposite each other thus permitting a balanced layout, as in Fig. 5, to be obtained.

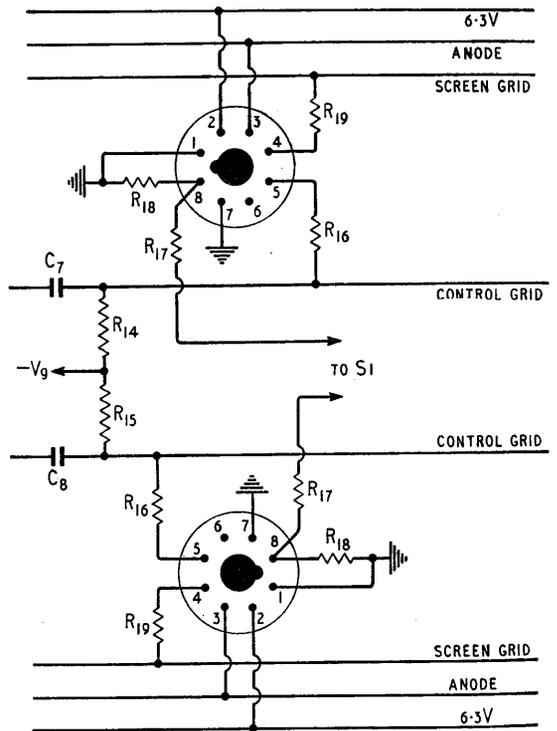
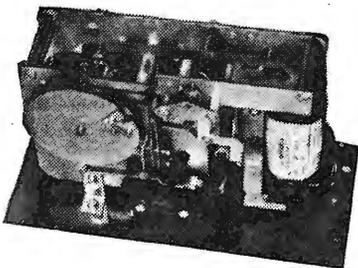


Fig. 5. Preferred layout for output stages.

If this layout is used with a rack-mounted amplifier care must be taken to ensure adequate ventilation for the rear row of valves. It is probable that a 2-inch slot, extending horizontally along the panel, would allow sufficient air to be drawn in. In case of doubt tests should be made with "Tempilac" temperature sensitive paint.

Variable-Velocity Scanning in television has already been suggested as a means of obtaining bandwidth compression—the idea being that the scanning rate is slowed down over picture areas of fine detail and speeded up over areas of coarse detail, so that a more even (and on the average lower) rate of transmission of information is achieved. With magnetic scanning, the difficulty is that a sudden change of voltage across the deflector coils is needed to obtain a sudden change of velocity, but the stray capacitance across the coils sets a limit to the rate of this voltage change. A variable-velocity scanning circuit in which the speed of response is improved by negative feedback is discussed by M. P. Beddoes in I.E.E. Monograph No. 241R, of June 1957. The negative feedback is obtained from a monitor coil which is coupled to the deflector coils and gives an output proportional to the rate of change of useful flux-producing deflection current. This output is integrated in a Miller integrator to give a signal proportional to the current itself, which is applied as negative feedback to the scanning output amplifier. The circuit will operate at scanning frequencies up to 10kc/s, with a maximum displacement error (during velocity changes) of no more than 0.2%.

Valve Protection Timer produced by Venner's is basically a delay relay for ensuring that h.t. is not connected until the heaters or filaments have warmed up—but it has a difference. Normally with these devices, if there is a short interruption in the power



supply the relay resets immediately and then there is a delay before the h.t. is restored. This, however, is not really necessary if the supply interruption is of shorter duration than the normal warming-up time. It is avoided in the Venner device by an arrangement whereby the relay only resets after a certain delay, which is determined by the timer running back to zero at a chosen rate under the control of an escapement mechanism. The reset time can therefore be manually set according to the cooling characteristic of the equipment. An additional feature is that the reset timer can be made inoperative for very brief supply

Technical Notebook

interruptions of less than, say, 10 seconds' duration, coming into action only when the relay is de-energized for longer than this period.

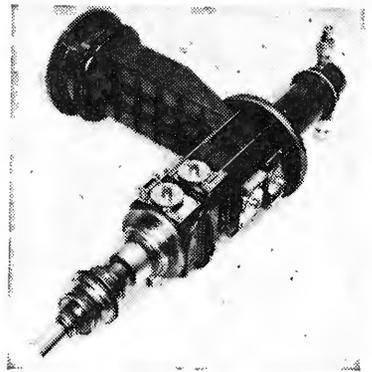
Circular Waveguide Coupling for laboratory use, described by P. J. Allen in D.S.I.R. unpublished report PB116623, permits connected waveguides to be oriented relative to each other about their axes, and allows polarization adjustment of components with precise axial alignment.

Electronic Photo Printer.—The American LogEtronics equipment mentioned in our July, 1957, issue (p. 332) has now been demonstrated by E.M.I. Electronics, who are handling and further developing it in Britain. As already explained, the system effectively reduces the overall contrast range of the negative to suit the printing paper. This particular machine, however, as distinct from others previously reported, does not use a television type of raster on the cathode-ray tube light source. It has a rectangular form of Lissajous figure generated by applying triangular waves of slightly different frequencies to the X and Y deflection systems. The difference in frequencies causes the rectangles to widen and narrow in a cycle of about once per second along two diagonal axes across the scanning area. This is said to give a more complete and even illumination than the television-type raster, where one has the problem of gaps between the lines to contend with. In addition to the photocell in the feedback system, a second photocell is used in a light integrating arrangement which automatically controls the length of exposure according to the density of the negative being printed. This arrangement, which can be set to view either a part or the whole of the printing area, does not require adjustment, and widely different negatives can be made to give prints of uniform density.

Superconductive Storage Element, similar to the "cryotron" described in our May, 1957, issue (p. 232) but much faster in switching time, has been developed by International Business Machines in America. According to *Electronic News* for 2nd September, 1957, the device

utilizes a miniature printed circuit of metallic lead on a glass base, and is therefore less expensive to manufacture than previously reported elements using tantalum and niobium. It is said to have a switching time comparable with that of thermionic valves.

High Power Klystron amplifier giving some 10kW of c.w. output power is one of the latest valves to be produced by Varian Associates of California, U.S.A. Using internal resonant cavity circuits, it is capable of



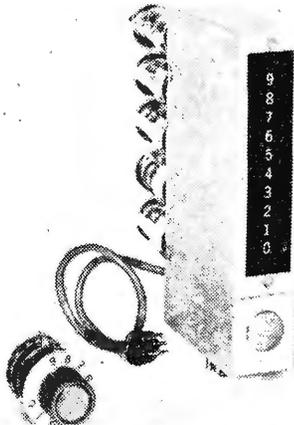
tuning over the wide frequency range of 1,700Mc/s to 2,400Mc/s. Less than 1 watt of r.f. drive power is said to be required for the 10-kW output. The valve is intended for use in forward scatter communication systems, and the makers say it will provide sufficient bandwidth for one or two television channels or hundreds of telephone or teleprinter channels.

Mechanical Damping Constants of materials can be measured conveniently by a new electronic equipment in order to test their internal structure for non-homogeneities, flaws and so on. Developed by A. E. Caw-kell, it centres around a test bench on which the material under investigation has vibrations applied to it by an oscillator and transducer. A second transducer picks up the vibrations and converts them back into an electrical signal which is fed to a Dekatron counter. When the driving oscillator is cut off, there is a decaying oscillatory voltage at the pick-up transducer resulting from

the mechanical damping in the material. The cycles of this voltage are counted between two pre-determined levels set by a gate system, and from the count the logarithmic decrement and "Q" of the material can be easily calculated.

Universal Computer Code to provide a "common language" for different types of high-speed digital computing machines is being investigated as a possibility by the U.S. Army. In D.S.I.R. unpublished report PB121055, S. Gorn presents the results of an experiment with a simplified semi-automatic coding system run on both the EDVAC and ORDVAC computers.

Remote Pre-set Counter.—A new decade counting unit produced by the American firm Computer Measurements Corporation has the useful facility that it can be remotely preset to count up to a selected number and then emit an output pulse. Each decade, of course, only



allows the selection of a digit between 0 and 9, but several of the devices can be connected in cascade to count units, tens, hundreds, thousands, etc., and the same method of pre-selection is applied to them all. A rotary switch at the end of a five-wire cable is used for the remote pre-setting of each decade.

Liquid Valves? Now that we have successfully utilized the flow of electrons in gases (thermionic valves) and in solids (transistors), the next logical step seems to be to try liquids. According to physicists at the U.S. Naval Ordnance Laboratory, quoted by *Control Engineering* for August 1957, this possibility is not far off, and they think it may lead to smaller, simpler and less expensive equipments than with valves and transistors. The first stage has been the development of a new electrochemical transducer utilizing the flow of ions between

electrodes in an iodine solution. A low-voltage dry battery provides the current, and in the transducer this is said to be sustained and varied by outside factors, such as temperature, pressure and light. An application at present under test is a personal "sound exposure meter" for protecting Air Force personnel against the low-frequency sound of aircraft jet engines, which can cause deafness.

Improved Mercury Switch recently introduced by Engel and Gibbs has a plastic coating on the glass container for the mercury. This is intended to protect the switch from damage by accidental blows. If a really severe blow shatters the glass, the mercury is held inside the protective coating—an important safeguard in equipment which can be damaged by mercury. The coating is about 0.04in thick and is normally translucent so that the switch can be seen in operation, though an alternative coating available for tropical environments is opaque.

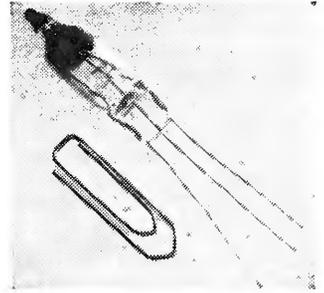
Transistor E.H.T. Supply has been developed by the U.S. Atomic Energy Commission to provide 900 volts at 25 μ A for Geiger-Müller and scintillation counters. Described by G. E. Driver in D.S.I.R. unpublished report AECHW30602, it is based on an alternate-firing transistor blocking oscillator. It is powered by a 9-V mercury-cell battery, weighs 4.5oz and occupies less than 5 cubic inches.

Radar on Television—A special tube for transforming radar images of the usual p.p.i. type into television pictures on 625 lines is used at Brussels Airport to allow controllers to follow directly the course of air-



craft in the vicinity. The television picture (see illustration) is a good deal brighter than the original radar image, so the room lighting does not have to be lowered.

Subminiature Trigger Tube of the cold-cathode type recently introduced by Ericsson is designed mainly for computing applications. Known as the GTR120W, it measures only



1.32in long and 0.39in in diameter. The electrical tolerances are slightly wider than those normally met in cold-cathode tubes, but the makers say this is offset by the long life, reliability and low cost of the tube. The anode hold-off voltage is 310V, while the trigger striking voltage is 170V. The operating current limits are 3mA to 9mA, and at 4.5mA the anode-cathode voltage lies between 95V and 140V.

Torsional-Wave Delay Lines have advantages over lines propagating longitudinal acoustic waves because they introduce less distortion in the signal and give approximately double the delay for a given length of material. A torsional-wave line using steel wire and giving a 5-millisecond delay at 1.5Mc/s has been constructed by G. Bradfield at the N.P.L. The velocity of the waves can be decreased still further by loading the delay wire or rod with equally spaced discs so that it is composed of alternate large- and small-diameter sections. It then becomes in effect a low-pass filter whose cut-off frequency decreases with increasing diameter, thickness or spacing of the discs. Thus, to obtain high cut-off frequencies small dimensions are necessary. On the other hand, the delay for a given length increases roughly as the square of the ratio between the diameters, so large delays at reasonable frequencies require small-diameter rods and precise machining. Two delay lines of this type machined from solid brass rods have been constructed by P. Andreatch and R. N. Thurston at Bell Telephone Laboratories in the U.S.A.—one having diameters of 0.180in and 0.045in (4 to 1) and the other 0.220in and 0.044in (5 to 1). Transducers made from barium-lead-calcium titanate were soldered on to the ends of the lines. At 32kc/s the 4-to-1 line (with 0.020-in discs and spaces) gave a delay of 43 μ sec per centimetre with an insertion loss of 1.7dB. The bandwidth was 4.6kc/s. The delay in the 5-to-1 line (with 0.015-in discs and spaces) was 114 μ sec per centimetre, the insertion loss about 1dB, and the bandwidth 6.3kc/s. The cut-off frequency for both lines was about 50kc/s.

it was shifted 90° when measuring phase angles. This was omitted on the model in the interests of simplicity. A further refinement is to replace R_1 and R_2 by two further diodes (connected in a series ring); this increases the sensitivity of the instrument. Meter overload is cared for by limiting the possible output from V_2 , and no damage will occur when a component under test is removed from the test terminals.

The usable range with the model tested was from about 100 Ω to over 100 M Ω , and from 100 pF to over 12 μ F. for an error of well under 10% of the meter reading. The limit of the low-impedance end is determined by the output current it is possible to take from the transformer without lowering its voltage. A standard is built into the instrument for setting up the gain control. It is most important that the voltage to the component bridge is very accurately centre tapped.

Apart from checking the tolerance on components, it is possible to use the instrument for any impedance measurement, such as measuring the output impedance of a stabilized power supply, or the mutual conductance of a valve by measuring the output impedance of it as a cathode follower, and many similar applications.

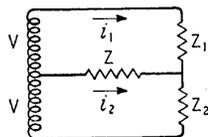


Fig. 2. Basic circuit of the comparator.

APPENDIX

Applying Kirchhoff's Law to Fig. 2:—

$$V = Z_1 i_1 + Z_3 (i_1 - i_2) = Z_2 i_2 + Z_3 (i_2 - i_1)$$

$$\text{From which we get } i_1 = \frac{Z_2 + 2Z_3}{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1} V$$

$$\text{and } i_2 = \frac{Z_1 + 2Z_3}{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1} V$$

Hence detector voltage is

$$V_0 = \frac{(Z_2 - Z_1) Z_3}{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1} V$$

$$\text{if } Z_3 \text{ were } \infty V_0 \text{ would be } \frac{Z_2 - Z_1}{Z_1 + Z_2} V$$

\therefore The voltage error is

$$\frac{Z_1 Z_2 (Z_2 - Z_1)}{(Z_1 + Z_2)(Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1)} V$$

$$\text{and the percentage error } \frac{100 Z_1 Z_2}{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1} V$$

and if E is the permissible percentage error,

$$Z_3 \text{ must be greater than } \frac{Z_1 Z_2 (100 - E)}{E (Z_1 + Z_2)}$$

In practice Z_1 and Z_2 are very nearly equal

$$\text{which gives } Z_3 = \frac{Z_1 (100 - E)}{2E}$$

$$\therefore \text{ For } \begin{array}{l} 1\% \text{ accuracy } Z_3 = 50Z_1 \\ 5\% \quad \quad \quad \text{,, } Z_3 = 9.5Z_1 \\ 10\% \quad \quad \quad \text{,, } Z_3 = 4.5Z_1 \end{array}$$

Servicing Printed Circuits

AN AMERICAN SERVICEMAN RECORDS SOME (PRINTABLE) COMMENTS

By JACK DARR*

ONE of the latest of the many inventions to come boiling out of the brains of the design engineers is the Printed Circuit. Nowadays, when the TV technician removes the back from a receiver, he is confronted with something that looks rather like a nest of intoxicated snakes which had unwisely decided to take a nap in front of a road-roller! Attached here and there to this maze are a few parts which look vaguely familiar: valves, transformers, resistors, condensers, etc. This is intended to replace the old homely jumble of wiring inside the chassis, in which he felt quite at home, to tell the truth. At least, colours here and there guided his probing instruments to a small degree.

Gone forever, apparently, is even that slight aid and comfort; instead of the old faithful "blue for anode, red for h.t., green for grids, etc.," to guide him, he is expected to trace circuits and wiring on a brownish "board," looking something like a metallic jigsaw puzzle. To trace a given wire, he locates one of the aforementioned serpents, by a bewildering process of turning the board rapidly back and forth, finding the given tube or part on one side,

then attempting to turn the board over quickly enough to remember where the part in question was! Some setmakers give him the cold comfort of telling him that he can shine a flashlight through the board, thus silhouetting the parts on the other side, enabling him to orientate himself "with ease." The quotes are from them, not me!

Having thus found either head or tail of said reptile, he proceeds to follow its meanderings over the surface, often covering the entire board, more or less, only to find himself back within an inch or two of where he began. This wandering is made necessary by the obvious impossibility of crossing two of these "wires." By this time he has usually forgotten just which circuit he was tracing, and the whole process must be repeated.

Now, having located the offending component, or what he suspects is one, he proceeds to apply some of the old reliable methods of testing. Chief among these, of course, is that of disconnecting one end of a part to make accurate measurements on it. Complications immediately set in. Resistors and capacitors, of course, are mounted by poking the ends of the leads through holes in the board, and soldering them there, to either head or tail of

* Ouachita Radio-TV Service, Mena, Arkansas.

a snake. Now arises the problem of getting one end of the thing loose without disrupting the whole assembly. He cautiously applies his regular soldering iron to the joint, only to discover that the bit is so big that half of the board is melting away before his horrified eyes. So, he renders the tool unfit for normal service by filing it down to an extremely sharp point. Now, it doesn't apply too much heat to the joint, causing damage to the wiring: in fact, it doesn't apply enough!

This brings on some very picturesque remarks in Urdu, Swahili, or preferably German (the last language lends itself admirably to the invention of long and complicated swear-words). Further experiment finally develops a sort of compromise point, and the suspected component is loosened and tested. Of course, by the perverse nature of things electronic, this is not the part he wanted. After a repetition of the process, the correct part is located and replaced.

This can also be quite a novel process. According to the "authorities," the accepted method of performing this act is to cut the part in two with a pair of diagonal cutters, then crush it between the jaws, leaving the wire leads firmly attached to the board. The ends of these leads are then formed into a small loop, and attached to the shortened leads of the new part. This joint is identical with those used to mend barbed-wire fences. There are only a few small difficulties inherent with this process, though. Have you ever tried to cut a 0.1 μ F condenser in two with a pair of 4-inch diagonals? Experimentation will prove that this is hardly a practicable way to make a living.

It does work, however, with such components as resistors (small) and condensers (mica or ceramic). They may be crushed, according to the book, and the loop formed. The worst headache attached to this is the revolting tendency of such joints to loosen in the board, due to the heat conducted down the wire itself as the loop is being soldered. Thus, the end comes out of the board just as you complete the joint, and the whole effort is brought to naught; one may as well remove the whole board in the first place. Incidentally, the object of this operation is to enable the harassed technician to remove and replace parts without removing the printed circuit board from its place on the chassis, or in the cabinet. (This is often a much bigger job than removing chassis, locating part, removing and replacing part, on the old familiar type of set!)

Thermal Rat-race

Having thus satisfactorily(?) dispensed with the replacement of small parts, we now arrive at the next category, the replacement of larger parts, such as valve-holders (tube-sockets, to us), transformers, filter condensers, and the like. These *objets d'art* have, as a rule, rather more connections than the small parts, with their two terminals, and hence may prove more difficult. (The preceding understatement is merely the opinion of the writer, and his colleagues.)

Referring once again to the maker's instructions, this jovial soul recommends that leads, lugs, etc., used to mount the part in place, be heated and loosened one at a time, until the part is free. This again is much easier said than done. Upon attempting the removal of such an item as, say, a

filter condenser block or can, a multiple unit, from its home on the board, the technician finds that he is expected to unsolder, more or less simultaneously, the three condenser terminals, and three more for the can itself, or a total of six. These protrude through eyelets in the board, rather resembling the eyelets in shoes or boots, and are firmly and immovably held in place by large gloops of solder. Said technician optimistically melts one of these, then goes to the next. While this is melting, No. 1 has firmly set again. Likewise, as No. 3 is heated, No. 2 and No. 1 set still firmer, and so on, *ad infinitum*. In only a short while, this has degenerated into a sort of thermal rat-race, as he dashes madly around and around the base, trying to get each one hot enough to stay more or less liquescent until the remainder are heated. This proving to be an utter impossibility, he is faced with one of two alternatives: either toss the whole assembly into a large furnace, thus bringing it to a temperature suitable for the method outlined, or finding a method whereby each of the joints can be loosened and kept loose until the rest can be loosened in turn.†

After some cogitation, he finally secures a small pick, or perhaps his wife's eyebrow-brush, and manages to pick and heat one of the joints until he has knocked off at least part of the surplus solder. This, of course, is only the surface solder; the part that does the actual holding, deep down inside the joint, is still setting its plumbic teeth and holding on with bulldog tenacity. In desperation, he attempts a drastic alternative: heating the joint well, and brushing like mad, the while flexing the board to an alarming degree, one of the joints is persuaded to let go. Keeping up the flexing until this joint has set, he finds that he has at last accumulated a wee bit of play, which aids in loosening the rest by the same drastic process. At this point, it is tea time, and he takes a well-deserved rest. After tea, with the base joints loose, the rest of the job is a breeze.

This breeze continues until he finds that in his entire stock he does not have a suitable replacement for the highly specialized filter condenser used in the original circuit! Electrical values, yes; these are common enough. But the special can-type mounting, with small pointed projections on the bottom instead of the standard husky lugs? No, never. Use instead, separate units to make up the required capacitance? One would be required to construct another chassis of equivalent size to hold the same capacity, if used in single units. The only hope is to secure the compact multiple block or can equivalent.

Well, how about using one of the standard "twist-lock" can types? These useful units have comparatively large lugs on the bottom of the can, which are inserted into slots in the chassis, and twisted. Can we file these down to fit into the tiny holes in the board, which are round?

After some filing and bending, it is found that the lugs might conceivably be made to fit the holes, but another disturbing factor enters here: while the can lugs now fit, after a fashion, the condenser connections won't! This unit having been rendered almost totally unfit for further service of any kind, unless it is secured to the chassis with a bit of

† Plessey in this country have solved the problem with spring tension connecting tags.—ED.

string, it is now laid aside, and other action contemplated. (At times, the first alternative considered is dropping the whole thing off the nearest cliff, and going back to raising turnips, re-entering the military, etc.) But now a ray of hope begins to show itself. On the shelf is a paper tubular condenser, almost the proper capacity, or near enough so that it won't matter, filters having a generous tolerance, thank goodness. This useful bit of apparatus is equipped with long flex leads, fastened to terminals. By clipping the leads off about an inch long, removing the insulation, and stiffening them with solder, they may be inserted through the holes in the board and soldered in place. The negative lead, which is usually on the other end, can be brought down the side of the can, and slipped into one of the holes which previously held the can in place. The stiffness of the leads will be ample to hold the light unit in place. If necessary the negative three holes may be joined with bits of scrap wire, to restore circuit continuity, and the job is done. As an average, it has consumed only enough time to make from three to five similar replacements on the older type sets, including two stops for tea: now the only thing remaining is to get the thing back into the cabinet and collect for it!

"Intermittents"

Now, albeit somewhat reluctantly, for we have never really relished the utterly gruesome type of tale, we arrive at the Ultimate Horror: the Intermittent Printed Circuit! This is the unit which, when jarred lightly, such a vibration as might be caused by a large housefly sneezing in the next room, gives off a deafening howl or stops playing altogether. The trouble is caused, of course, by one (or more) of the very delicate foil strips developing a fine crack. This cleavage may be caused by almost anything, apparently; defective solder joints, thermal expansion or contraction of the board, or, in most cases, sheer dislike of the electronics maintenance profession as a whole.

This defect, of course, is seldom of an obvious nature. The ends of the ribbon do not curl up and invite the eye, saying "Look, here I am!". No, indeed. They will hide themselves whenever possible, beneath the false façade of an apparently perfect, smooth solder surface, smiling happily up at the technician, saying, "Who, me? Bad joint? Never! Look at me, I'm as sound as a dollar! (Pound, lira, rouble, yen, mark, zloty, etc.; take one). Me make an intermittent connection? Never! Perish the thought!". In the weary course of investigating this phenomenon, the technician will discover that there are just certain ways in which the board may be flexed that will either aggravate or stop the trouble. The average noisy intermittent in printed wiring will be so sensitive that jarring the set anywhere will produce the same ear-splitting crack; this may also be brought forth by any form of disturbance. The horse chewing on a tough stem of grass in the back yard, or the barmaid at the local setting a glass down a bit hard, either will induce the symptom. This renders the job of locating the source quite simple: it is definitely within just this *one* set! But which section of the set? This may be found by applying some of the techniques previously used with older types: tapping parts, cursing, tapping more parts, cursing, disabling some circuits in order

to eliminate them from consideration (this becomes quite a problem in some sets, with their series filament circuits). Of course, a duplicate tube, with the anode pin clipped off, may be inserted to disable a given stage. This means that one must disable a full set of perfectly good tubes in order to make this test!

After finishing his peregrinations through the *terra incognita* of the remainder of the set, we will assume that our technician has been fortunate enough to locate the one single printed wiring board which holds the defect. Now arises the problem of locating, among this flattened nest of silvery serpents, the one lone defective joint. This one bit of helpful information can be passed along right at the beginning: it is utterly impossible to locate the thing by applied inductive reasoning, logic, tests or measurements of any kind! This is the correlated result of tests made by millions of servicemen. One American technical lecturer said quite recently, "Stop trying the physical method, and instead try the mental!", meaning that troubles could be found much more easily if technicians would stop and think out the problem, instead of aimlessly reading voltage, resistance, etc. We regret to state that this is an entirely impractical approach in these cases. Herewith a bit of advice from men who have spent a lifetime (in only a few short days) in hunting for troubles in these boards. Abandon the mental approach entirely, and concentrate on the physical! In other words, there is really only one practical way to solve the problem of an intermittent joint on a printed circuit board. Immediately upon beginning the job, fall to and resolder every blooming joint on the whole board! Some men have even resorted to a grease-pencil, or a black crayon filched from their youngest's colouring set, to mark off the board into sections, to make the job of counting joints easier. Usually, every single joint must be resoldered, to effect a cure!

So, for the inevitable reason, economy of manufacture, it seems as if we're stuck with the things for a long time to come. However, we will, as in the past, develop methods of coping with them, on both sides of the Atlantic, just as we have for all of the countless other difficult-to-service innovations which have come bursting forth in the past few years. One item which will definitely be added to our stock of gadgets will be a pair of very sharp needle-pointed test leads, for piercing the plastic coatings. Others will be worked out as needed, and we may even become resigned to them, after a while! For your information, the American technicians, although as a whole quite bitter about the things, have learned to cope quite well; I'm sure the rest of us will, too!

No Prizes Offered!

Do you know the limits of the v.h.f. band?
What is the formula for finding the Q of a coil?
How many turns of 26 s.w.g. (single silk covered) can be accommodated in an inch?
Where does one apply for a mobile radio licence?
Is there a colour code for fuses?
If you cannot readily answer all these questions then you should obtain a copy of the *Wireless World* Diary for 1958. In addition to the 80-page information section there are the usual diary pages of a week to an opening. It costs 6s 3d (leather) or 4s 6d (Rexine), including purchase tax. Overseas prices are, respectively, 5s 3d and 3s 9d, plus 4d postage.

Severe Ionospheric Storm

SOME NOTES ON THE DISTURBANCES OF AUGUST 29th TO SEPTEMBER 6th

ONE of the most intense ionospheric and magnetic disturbances of recent years occurred during the period August 29th to September 6th, 1957, when for certain prolonged intervals during this 9-day period, radio communications via the ionosphere, and especially those over high-latitude transmission paths, were widely disrupted. Though there were, on some of these days, periods between the disturbed intervals when conditions were more or less normal, it would, perhaps, be correct to regard the time between about 2030 GMT on August 29th and about 1200 GMT on September 6th as that of the lifetime of a single ionospheric storm.

It is interesting to note that, at the time of the occurrences leading up to the disturbance, there were two large sunspots near the sun's central meridian, both being due to cross it on August 31st.

The event which would appear to have initiated the disturbance occurred on September 28th, when, between 0913 and 1215 GMT an intense solar flare was observed on the sun, reaching maximum intensity at 0955 GMT. Simultaneously with this—at least between 0920 and 1200 GMT—a severe "sudden ionospheric disturbance" of the kind which causes a temporary fadeout of short-wave signals occurred. These two events are, most often, intimately connected, the fadeout being due to ionization in the D layer set up by ultra-violet radiation from the flare. But the corpuscular emission from the flare, which is assumed to cause the major ionospheric disturbance, does not arrive in the earth's orbit until many hours later, and, as has been pointed out in these pages, it sometimes does not appear to arrive at all, for the expected ionospheric storm sometimes fails to materialize. However, in this instance it certainly did.

At about 2030 GMT on August 29th propagation conditions over transatlantic paths began to deteriorate, and an hour later an ionospheric storm was evidently in progress, whilst, at the same time, the earth's magnetic field became disturbed. Assuming 2030 GMT to be the time of the storm's start the travel time of the corpuscles would thus have been about 35 hours. During the night the ionospheric disturbance intensified, but towards the evening of the 30th both ionosphere and magnetic conditions became undisturbed. The 31st was more or less normal so far as short-wave propagation was concerned, though towards evening the magnetic field was again disturbed. Soon after midnight propagation conditions again deteriorated and by 0200 GMT on September 1st a renewal of the ionospheric storm was apparent. On the afternoon of this day conditions, both magnetic and ionospheric, again became undisturbed, but the worst phase of the storm was yet to come. It started with a deterioration in propagation conditions at about 0600 GMT on 2nd. By 1200 GMT the ionospheric storm was again intense, and soon deepened in intensity, with the magnetic field becoming more disturbed as the day went on. Thereafter propagation conditions remained continuously disturbed until the end of the

storm, at about 1200 GMT on 6th. Magnetic conditions were also continuously disturbed except for the early part of the 4th.

There were further "sudden ionospheric disturbances" at 1306 GMT on August 31st and at 1024 and 1422 GMT on September 3rd, which may have indicated further eruptions on the sun from which corpuscular streams would be emitted, tending, perhaps, to prolong the major ionospheric storm.

So far as propagation conditions were concerned the most intense phases of the storm were 0900-1300 GMT on 3rd, 1800-2100 GMT on 4th and 0100-1130 GMT on 5th, when reception over high-latitude transatlantic paths was practically impossible. The ionospheric measurements made at the D.S.I.R. station at Slough also indicate the severity of the disturbance during the two latter of these phases, the F_2 layer critical frequencies being generally over 40% below normal. The magnetic disturbance on both 3rd and 4th reached the proportions of a Great Magnetic Storm, and was very severe on 2nd and 5th, the most intense phases being 1500-1800 GMT on 3rd and 1500-1800 GMT on 4th.

It is interesting to note that the aurora borealis, which is produced by the solar corpuscles when they enter the earth's atmosphere, was seen at numbers of places in Great Britain: on the nights 29th/30th, 31st/1st, 2nd/3rd, and 4th/5th, that on the first of these nights being seen as far south as Devon.

The solar and terrestrial events connected with this disturbance were, no doubt, comprehensively observed throughout the world, as part of the I.G.Y. programme, and interesting data as to the correlation between the solar and terrestrial happenings may thus become available.

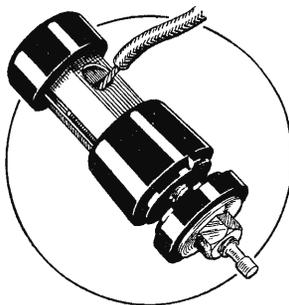
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Television Frame Pulse Separator

SINGLE-PULSE CIRCUIT FOR ACCURATE INTERLACING

By H. D. KITCHIN*

THE problem of achieving a good interlace in television receivers has formed the subject of much work in recent years. Although an accurate interlace has always been the ideal to aim at, many commercial receivers have fallen short of the ideal owing to the cost of the circuitry necessary to ensure a consistently accurate interlace in production. However, the trend towards larger tubes now makes the requirement of good interlace essential if the line structure of the existing 405-line picture is not to be too obvious.

The synchronizing pulse waveform in the British television system presents a difficulty to frame pulse

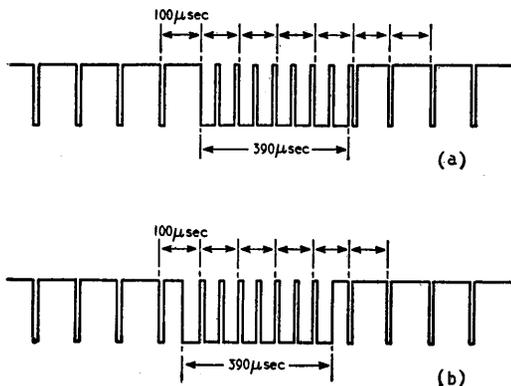


Fig. 1. The standard television synchronizing waveform, showing frame pulses at the end of (a) an even frame, and (b) an odd frame.

separation because of the differences between odd and even frames. The waveforms associated with the train of frame pulses for even and odd frames are shown in Figs. 1(a) and (b) respectively. It will be seen that on odd frames the frame pulses start only half a line after the preceding line pulse, this being necessary to achieve an interlaced scan. Also, the interval between the end of the last 40-μsec frame pulse and the following line sync pulse is only 10 μsec for an even frame against 60 μsec for an odd frame. The effect of these differences in differentiating and integrating circuits is to give rise to differing pulse shapes on odd and even frames. An examination of these defects formed the subject of an investigation by Patchett¹, where it was shown that the ideal pulse for frame timebase synchronizing is a single short pulse with a sharp leading edge. The last requirement precludes the use of integrating circuits, leaving only some form of differentiating circuit for frame pulse separation.

Previous methods of using differentiating circuits

have fallen into two categories, which are illustrated in Figs. 2 and 3.

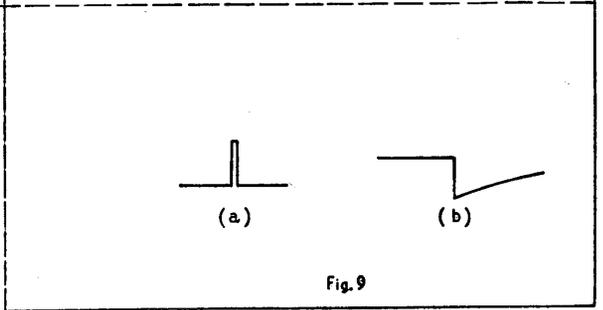
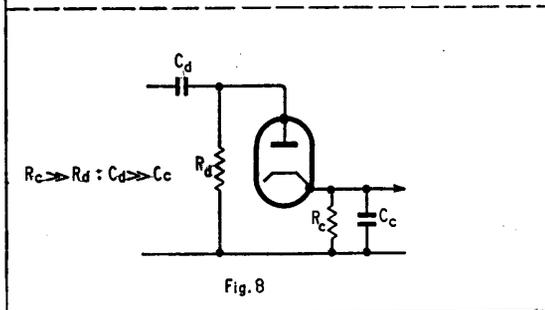
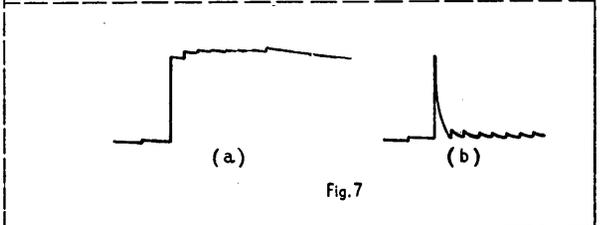
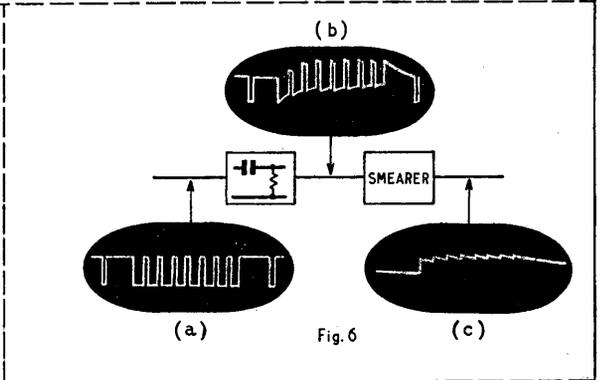
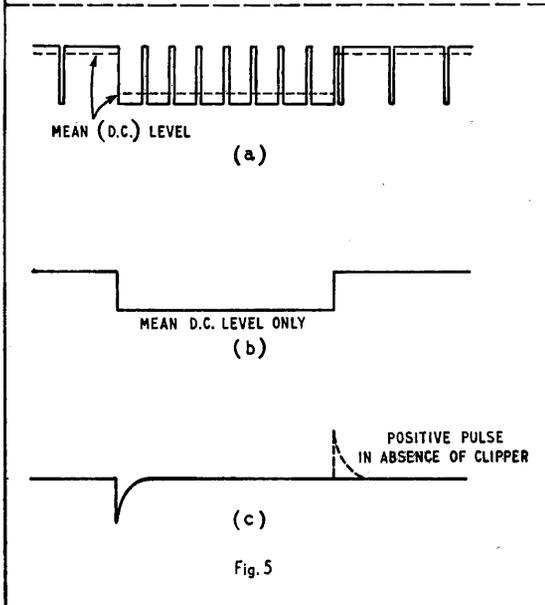
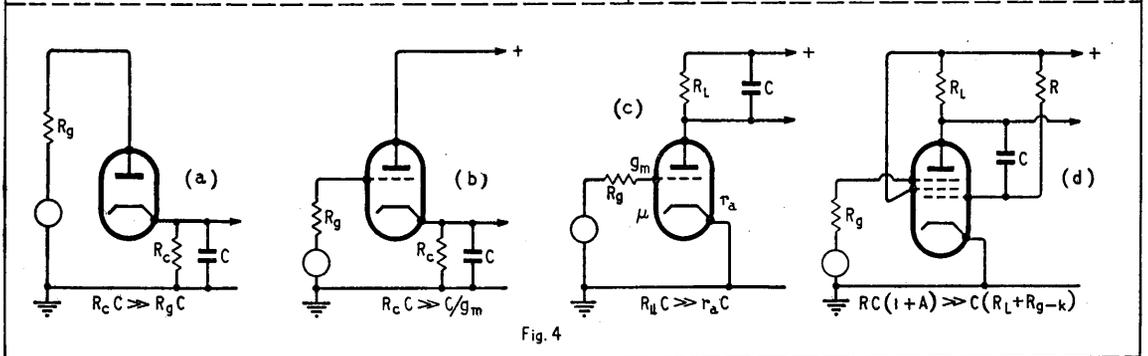
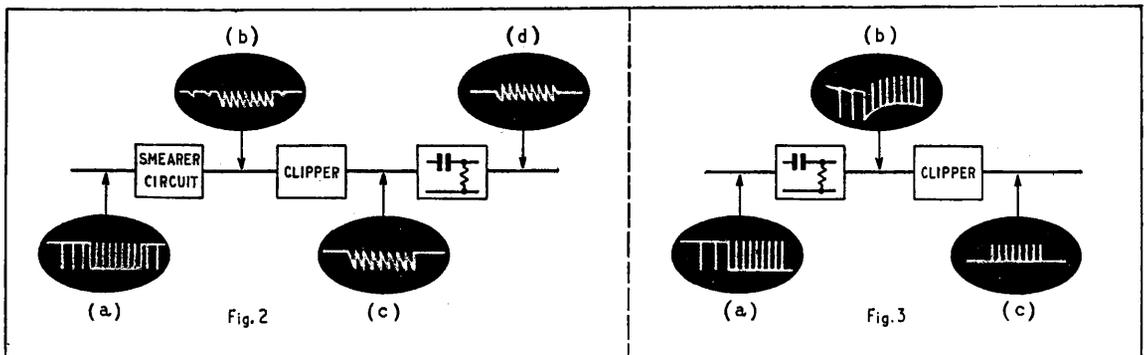
In Fig. 2 the composite synchronizing pulses, after removal of the video signal, are applied to a circuit having a much slower response to input excursions of one polarity than for excursions of the opposite polarity. Such a circuit has been termed a "smearer."² For an input waveform having negative-going line sync pulses, as in Fig. 2, suitable smearer circuits are shown in Figs. 4(a), (b) and (c). In these circuits a capacitor is charged through the low resistance of a valve and discharged through a high resistance leak, the valve being cut off. In the circuit of Fig. 4(d) the discharge of the capacitor takes the form of the well-known Miller run-down, the valve being conductive. Charging of the capacitor takes place through grid-cathode conduction and the anode load, anode current being cut off by the suppressor grid being negative. As the conduction and non-conduction periods of the valve are the reverse of those for the other circuits of Fig. 4, the input required must have positive-going line sync pulses.

Because a frame pulse is four times the duration of a line pulse, the potential of the capacitor during a frame pulse will be four times that during a line pulse, assuming a linear fall in potential. The output, shown as waveform (b) in Fig. 2, may then be clipped to remove the line pulses, giving a train of frame sync pulses identical on both frames. This clipped waveform, shown at (c), will give triggering on the sloping front of the first triangular pulse and can give variable interlace if the triggering level or pulse amplitude varies. This effect will obviously be inversely proportional to the slope of the leading edge, and could be much reduced by having a triggering pulse with a sharp leading edge. Simple short-time-constant differentiation of the clipped waveform will give such a sharp edge, of the opposite polarity to that of the sloping front, at the instant of each half line pulse, as shown at (d). This can be used to trigger the frame timebase, giving, theoretically, perfect interlace. Although the use of a differentiating circuit for final shaping may appear somewhat of a refinement, it should be noted that it is essential if the requirement of a sharp leading edge is to be satisfied.

Of the four types of smearer circuit in Fig. 4, only the diode type (a) has been used commercially—the interlace filter. The Miller circuit suggested by Patchett³ possesses certain advantages but, unfortunately, requires a pentode with a short suppressor-grid base, a type which is not in the current preferred ranges of valves for television. The clipper associated with this type of separator is invariably the diode type for economy.

We will now examine the method of frame pulse separation illustrated in Fig. 3. In this case differ-

* Formerly with Ambassador Radio & Television, Ltd.



entiation is the first operation, using a critical time-constant RC network. The use of such a network is well known and forms the basis of a large group of sync separators. For the British system the maximum difference obtainable between line and frame pulses is 47% of the line pulse amplitude, and is produced with a time constant of 21.6 μ sec.

The waveform obtained by such differentiation is shown in Fig. 3 waveform (b). By means of a suitable clipper the line pulses may be eliminated, leaving a train of short pulses, waveform (c), consisting of the half line pulses which occur between consecutive frame pulses. The first pulse of this train may be used to synchronize the frame timebase.

A difficulty with this method of separation is the presence of the large amplitude line pulses which make the clipper design critical with regard to operating potentials and the input signal. A considerable improvement is obtained by the use of grid leak bias in conjunction with a short grid-base valve, but if the input signal is reduced below a certain level then the line pulses start to appear in the output and may produce poor interlace.

If we return now to consideration of the original composite synchronizing waveform and the mechanism of timebase synchronizing it is apparent that:—

(a) Only the first frame sync pulse from the frame pulse separator is of any value in synchronizing the timebase. The remaining pulses serve no useful purpose and may upset the timebase during flyback, causing faulty interlace during scanning.

(b) During the frame pulses the mean d.c. level changes. This is illustrated in Fig. 5(a). It is this change which the popular integrator type of frame pulse separator responds to, and is also the reason for the displacement of the half line pulses with the critical time-constant RC differentiator.

Thus we see that if we could separate out the change in d.c. level whilst still maintaining a sharp transition, then by short time-constant differentiation we should obtain a single short pulse with sharp leading edge ideally suited for synchronizing the

frame timebase. This process is shown in Figs. 5(b) and (c).

It is now proposed to describe a frame sync separator which gives, virtually, such a short pulse with sharp leading edge and is not critical in regard to operating potentials and component tolerances.

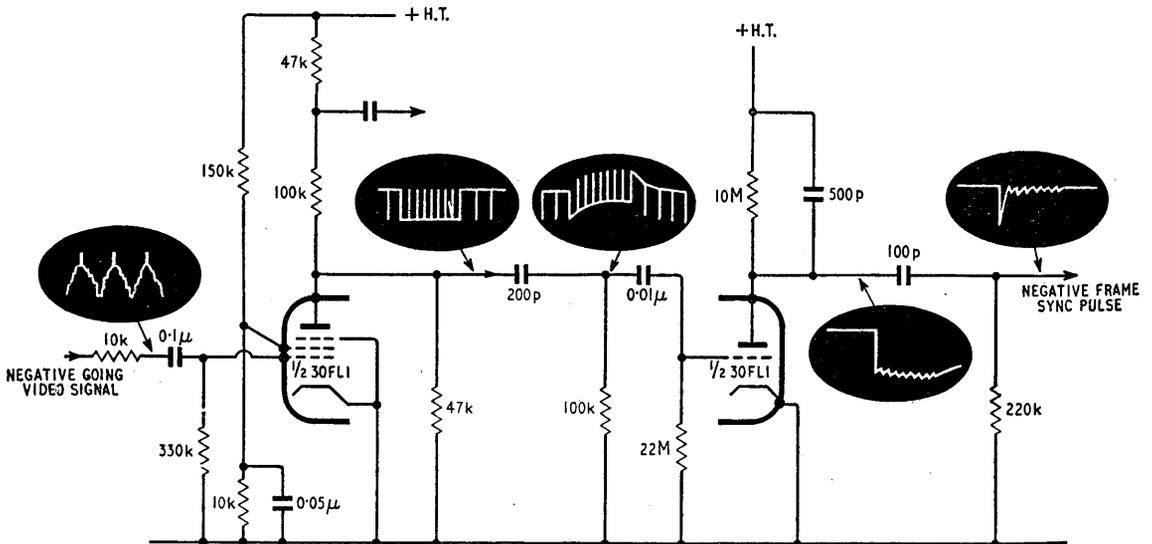
This is done by combining certain features from each of the previous methods of Figs. 2 and 3. The composite pulses are first differentiated using a critical time-constant network, and the resulting waveform passed to a smearer circuit with a long decay time-constant. This results in the waveforms illustrated in Fig. 6, where it is seen that the line pulses have been eliminated and the frame pulses are "smoothed," by the storage action of the capacitor, into a single frame pulse with a sharp leading edge. This eliminates the differences at the end of the train of frame pulses present in the input. By short time-constant differentiation of this "smeared" pulse a short pulse with a sharp leading edge is obtained, followed by much smaller short pulses as shown in Fig. 7(b). This pulse is very close to the ideal for synchronizing the frame timebase.

Any of the four smearer circuits shown in Fig. 4 are suitable, the choice depending on the polarity of the input available. The simplest and most obvious choice is the peak rectifier diode at (a). For satisfactory operation of this circuit it must either be fed from a low impedance source, for example, a cathode follower, or from a differentiator which has constants chosen in accordance with the conditions specified in Fig. 8, otherwise the circuit functions as a counter.⁴

The diode has the merit of simplicity, requires the normal negative-going line and frame sync pulse input, and gives a positive output pulse, which is suitable for triggering a blocking-oscillator or thyratron timebase. It suffers from the disadvantages of the output pulse being less than half of the peak-to-peak input voltage and of transfer of line pulses through the diode capacitance.

If the input signal is sufficiently large, the cathode-follower smearer of Fig. 4(b) may be used with a long

Fig. 10. Complete circuit diagram of the improved frame pulse separator, based on a double valve.



time-constant in the cathode, when the well-known inability of a cathode follower to follow large negative changes is exploited to advantage. In this case there is no limitation on the relative values of input and output circuit impedances, for provided no grid current flows, the charging current for the cathode circuit comes from the h.t. supply. The anode supply voltage should be just sufficient to prevent grid current flow in order to provide the shortest possible grid base. This type of circuit, in common with the diode, gives a positive output pulse, and requires negative-going line and frame sync pulses. However, the modern tendency towards a multi-vibrator as a sawtooth generator makes a negative pulse desirable, as it may be fed on to the "free" grid of the cathode-coupled type and also gives easier triggering with the cross-coupled type. The Miller integrator smearer of Fig. 4(d) is unsuitable as it, also, gives a positive-going output pulse and requires an input with positive-going line and frame pulses. This requirement necessitates an additional valve after the usual sync separator valve.

The earthed-cathode smearer of Fig. 4(c) will provide the required negative output pulse from the normal negative-going line and frame pulse input, as shown in Fig. 9(a) and (b). When the triode conducts the anode capacitor charges through the low impedance of the valve, giving a sharp drop in anode potential. When the valve is cut off discharge can only occur through the high resistance anode load, with a consequent slow rise in anode potential. A complete circuit using a triode as described above is shown in Fig. 10, the correct operating point is maintained by the use of grid leak bias. The fall of the leading edge is determined by the anode impedance at zero grid volts and anode capacitance, the rise of the trailing edge by the anode circuit time-constant. Suitable time-constants are between 0.5 and 5.0 μ sec for charge and 100 to 1,000 μ sec for discharge. A valve with low anode impedance and short grid base is desirable. The attainment of a short grid base is assisted by choosing an anode supply voltage only about 50% greater than the output pulse required for satisfactory synchronizing of the timebase.

The circuit has the advantage of not being critical in the component values required, owing to the break-through of line pulses being almost eliminated by the large discharge time-constant in the anode circuit. Care should be taken that the charging time-constant ($r_a C$) is not too long, otherwise a counting action takes place on the half line pulses and gives a step waveform. Also, it is essential to preserve the sharpness of the half line pulses during the eight frame sync pulses in any circuit using critical time-constant differentiation. This will usually necessitate feeding the differentiator directly from the usual sync separator limiter anode, with particular attention to minimizing stray anode-to-earth capacitance.

By the use of a triode-pentode, with the pentode acting as the normal video limiter as shown on the left of Fig. 10, a single valve sync separator is obtained having excellent interlace—provided, of course, that the normal precautions are observed to prevent stray line pick-up in the frame circuit and also to prevent transfer of line pulses back through the video limiter. This circuit has been employed in production receivers for over a year and found to be trouble-free and to give a consistently good

interlace. The noise susceptibility of this particular differentiator type of frame pulse separator has not proved to be any worse than the usual simple integrator type.

Finally, the author wishes to thank T. C. Isaac for much helpful discussion during the preparation of this article.

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APPENDIX I

For an exact analysis of the response of an RC differentiating network to a composite train of line and frame sync pulses it is necessary to know the effective capacitor charging voltage during a line pulse and during a frame pulse. This effective charging voltage will be equal to the amplitude of a line or frame pulse less the charge remaining on the capacitor from the previous pulse. As the first frame pulse follows a line period (at the end of an even frame in the British system*), the effective charging

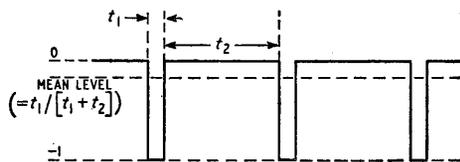


Fig. 1

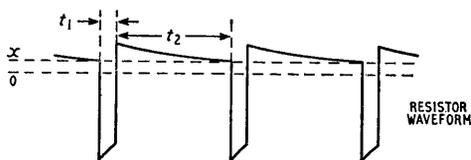


Fig. 2

voltage for the first frame pulse will be the same as that for a line pulse.

The response of an RC differentiating network will be examined for the steady state condition, and an expression derived for the charge remaining on the capacitor at the end of a line period.

Due to the series capacitor of such a network there can be no transmission of any d.c. component of the input wave. Thus the average charge on the capacitor will be that of the d.c. component. This requires the output waveform to have equal positive and negative areas about the zero level, which implies that the charge gained by the capacitor during any part of one complete line period must be equal to the charge lost during the rest of the period.

If it is assumed that the input pulses have unity amplitude as shown in Fig. 1, then the waveforms across the resistor and capacitor will be as shown in

* The first frame pulse will follow after only half a line period at the end of odd frames in the British system, and after a half line period on both frames in systems employing equalizing pulses.

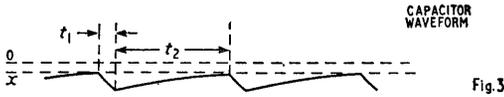


Fig. 3

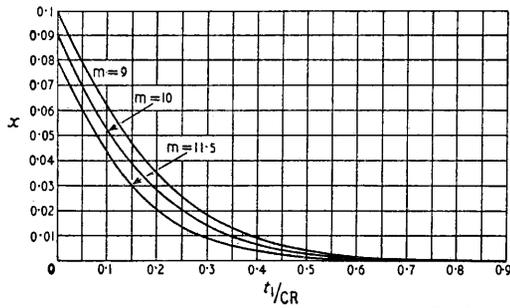


Fig. 4

Figs. 2 and 3 respectively. Referring to these figures, we will let the voltage on the capacitor at the end of the period t_2 be x , then the amplitude of the effective charging voltage during the line pulse t_1 will be $1 - x$, the capacitor charging up according to the relation

$$(1 - x)(1 - e^{-t_1/CR}).$$

The voltage on the capacitor at the end of a line pulse will be

$$(1 - x)(1 - e^{-t_1/CR}) + x$$

This is the initial voltage on the capacitor available for discharge during the period t_2 , the expression for this discharge being

$$[(1 - x)(1 - e^{-t_1/CR}) + x] e^{-t_2/CR}.$$

The voltage remaining on the capacitor at the end of the period t_2 will be

$$[(1 - x)(1 - e^{-t_1/CR}) + x] e^{-t_2/CR}$$

and is equal to x when equilibrium has been attained; hence we have as the equilibrium condition

$$[(1 - x)(1 - e^{-t_1/CR}) + x] e^{-t_2/CR} = x$$

simplifying and rearranging this gives

$$x = \frac{1 - e^{-t_1/CR}}{e^{-t_2/CR} - e^{-t_1/CR}}$$

If we put $t_2 = mt_1$ this becomes

$$x = \frac{1 - e^{-t_1/CR}}{e^{mt_1/CR} - e^{-t_1/CR}}$$

We may plot curves, according to the above equation, showing the variation of x with t_1/CR for various values of "m." This has been done for $m = 9, 11.5$ and 10 , representing the British, American and continental systems respectively, the curves being shown in Fig. 4. It will be seen from these curves that the voltage on the capacitor at the end of the period t_2 is not more than 1% of the peak-to-peak input voltage if the ratio of t_1/CR is greater than 0.4.

APPENDIX II

When a train of composite line and frame sync pulses are passed through an RC differentiating network, there is an exponential change of the average charge on the capacitor during frame pulses due to the different average level during these pulses to that prevailing during line pulses. The extent of this change will depend on the time-constant of the network in relation to the duration of the pulses. The general effect of the network on the frame pulses has been shown in Figs. 3(b) and 6(b) of the main

text. By varying the time-constant of the network we will vary the degree of the response of the circuit to such changes. If we make the time-constant sufficiently long then the level will not have time to change during the frame pulses and they will be transmitted with negligible shift in level. If we now shorten the time-constant the shift in level during the frame pulses will become apparent and the half line pulses between the frame pulses start to rise up above the level of the line pulses, as in the above-mentioned diagrams. This suggests its use as a frame-pulse separator, only a simple clipper being required to eliminate the line pulses and leave a train of half line pulses during the frame pulse period. (This simple method has disadvantages which have been dealt with elsewhere¹.) As can be seen in Fig. 1, another effect appears as the time-constant is shortened—that of differentiation of the line pulses, giving rise to an overshoot as they return to black level. This overshoot will subtract from the displacement of the half line pulses which occurs during the frame pulses, as any clipper will have to take the peak of this overshoot as a limit, in order to completely eliminate the line pulses.

As we further shorten the time constant the amplitude of this overshoot starts to increase faster than the displacement of the half line pulses until, with a very short time-constant, both tend to the peak-to-peak input amplitude. This condition is shown in Fig. 2, for an RC network of $1-2\mu\text{sec}$ time-constant. Between the two limiting cases of very long and very short time-constants, neither of which gives any difference in amplitude between the line and the half line pulses, we would expect some particular time-constant to give the maximum difference. This time-constant is termed the "critical" time-constant and its relationship to the pulse lengths of the input wave will now be examined.

In order to simplify the analysis it will be assumed that the charge remaining on the capacitor at the end of a line period is negligible, otherwise it would be necessary to take variation of this voltage with variation of the time-constant RC into account when differentiating with respect to RC. From the considerations in Appendix I this assumption is permissible if the ratio t_1/CR is not less than 0.4.

The output from the differentiating network at the end of a frame (in the British system, an even frame) will be of the form shown in Fig. 1. We

(Continued on page 559)

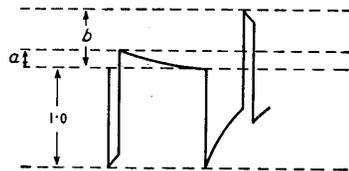


Fig. 1

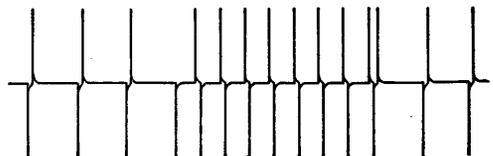


Fig. 2

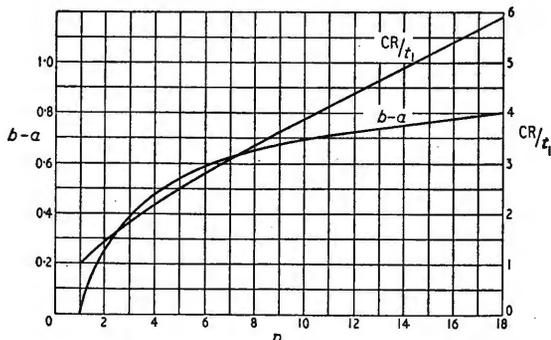


Fig. 3

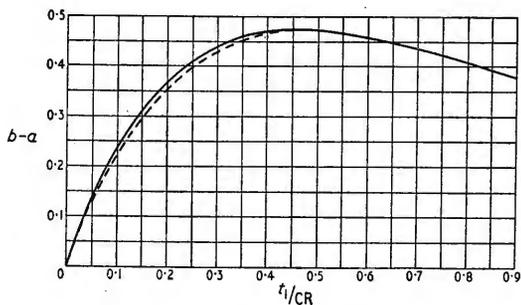


Fig. 4

require the maximum difference between the amplitude of the first half line pulse, b , and the amplitude of the overshoot of the line pulses, a , in order to give the greatest latitude in clipping level. The amplitudes a and b are given by the voltage rise on the capacitor during the intervals t_1 and t_3 , i.e.

$$a = 1 - e^{-t_1/CR}$$

$$\text{and } b = 1 - e^{-t_3/CR}$$

From these the difference $b - a$ becomes

$$b - a = e^{-t_1/CR} - e^{-t_3/CR} \dots \dots \dots 1$$

Differentiating this expression with respect to CR, we have

$$\frac{d(b - a)}{dCR} = \frac{1}{(CR)^2} (t_1 e^{-t_1/CR} - t_3 e^{-t_3/CR}).$$

Equating this to zero, the condition for the maximum value of $b - a$ is

$$\frac{t_3}{t_1} = \frac{e^{-t_1/CR}}{e^{-t_3/CR}}$$

putting $t_3 = nt_1$ this becomes

$$n = e^{t_1/CR(n-1)}$$

and giving, after rearrangement

$$\frac{CR}{t_1} = \frac{n - 1}{\log_e n} \dots \dots \dots 2$$

Substitution of equation 2 in equation 1 gives the maximum value of $b - a$ as

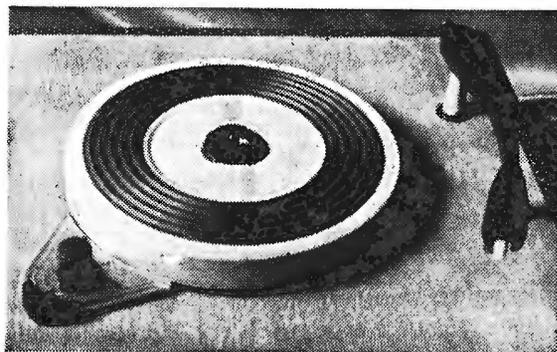
$$b - a = (1 - 1/n) e^{-\frac{\log_e n}{n-1}} \dots \dots \dots 3$$

Curves are plotted, in Fig. 3, of the above equations 2 and 3, showing the maximum value of $b - a$ for any value of n up to 20, and also giving the time-constant, expressed as the ratio CR/t_1 , necessary to realize this maximum value.

When circuits using a critical time-constant differentiating network are to be used in production equipment, it is desirable to know the manner in which the output ($b - a$) varies with the time-constant CR for a given value of n , in order to determine component tolerances. In Fig. 4 is shown a curve of $b - a$ against t_1/CR for the British television system, where $n = 4$, calculated from equation 1. It will be seen that a broad maximum occurs at $t_1/CR = 0.463$. If a 5% drop in the amplitude of $b - a$ can be tolerated, without affecting synchronizing, then, from Fig. 4, the limits of t_1/CR are 0.315 and 0.645, giving CR from $31.7 \mu\text{sec}$ to $15.5 \mu\text{sec}$ when $t_1 = 10 \mu\text{sec}$. Thus a nominal time-constant for CR of $22 \mu\text{sec}$ with a 10% tolerance on both C and R should be satisfactory. It should be remembered that the curve of Fig. 4 will be subject to an increasing inaccuracy as t_1/CR decreases below 0.4, due to the effect of the residual charge on C at the end of a line being neglected in the analysis. The result of taking this residual charge into account, according to the analysis in Appendix I, is shown by the dotted curve of Fig. 4. The divergency from the simplified treatment is negligible for practical purposes.

An additional consideration with the British television system is the difference between the start of the first frame pulse on odd and even frames, the odd frame pulses starting only half a line after the preceding line pulse. The effect of this is to start the first frame pulse on odd frames from a different level to that on the even frames, due to there being more residual charge on the capacitor. With a time-constant of $22 \mu\text{sec}$ this difference in level, which gives rise to a difference in amplitude of the first frame pulse between odd and even frames, amounts to about 1.4% of the peak-to-peak input. This represents 3% difference in the amplitude of $b - a$ between odd and even frames and will be unimportant if the triggering pulse for the timebase is sufficiently large, so that triggering does not occur during the top 10% of the frame pulse.

Four-speed Gramophone Turntable



The Birmingham Sound Reproducers Ltd. new TU9 four-speed turntable and pickup is fitted with a B.S.R. 'Ful-Fi' turnover crystal cartridge type TC8H. The 45 r.p.m. centre hole record adapter is permanently fitted to the turntable and can be raised or lowered as required. The separate pickup arm has a special mounting which virtually eliminates acoustic feedback. The address of the manufacturers is Monarch Works, Old Hill, Staffs.

News from the Industry

Mullard Research Expansion.—To meet the growing demands on the resources of the Mullard Research Laboratories at Salfords, Surrey, a new building with a total floor space of 28,000 square feet has recently been opened. As a matter of policy three main activities—fundamental research, development and advisory service on Mullard products, and Government contracts—are carried on simultaneously and with mutual benefit at Salfords, which can now claim to be among the largest laboratories in this country devoted to radio, electronics and allied subjects.

W. S. Electronics (Production), Ltd., Brunel Road, East Acton, London, W.3, which since its formation in 1945 has been largely concerned with producing under contract army h.f. communications equipment and mine detectors, has recently been manufacturing its own proprietary lines. Its D103 u.h.f. transmitter-receiver has now been ordered for the Navy and the R.A.F. It is a wholly-owned subsidiary of K. G. Holdings, Ltd., who also own Bonocord, Ltd., and Tellux, Ltd. G. C. Wheeler and J. Wolff have resigned their directorships of the company and Col. A. E. Tyler has been appointed general manager. He also becomes general manager of the associated W. S. Electronics (Extruder), Ltd.

B.C.C.—Mobile radio-telephone equipment is to be installed by British Communications Corporation at the railway marshalling yard at Newport, near Middlesbrough. Six locomotives and two signal boxes ("up" and "down") are being equipped A double-frequency simplex system is employed.

Telefunken tape recorders are now available from the Welmecc Corp., Ltd., of 147, Strand, London, W.C.2, who have been appointed sole distributors in the U.K.

"By Any Other Name . . ."—Because Collaro's trade name "Challenger" is inadmissible in America, to which they export a large quantity of record changers, they have re-named their changer "Conquest."

Rhoden Partners, Ltd., who provide a service for the design and development of specialized manufacturing equipment, have moved to 29, Park Crescent, London, W.1 (Tel.: Langham 7488). They are not manufacturers, but will undertake the design of manufacturing equipment or modifications to existing assembly lines.

Semiconductors, Ltd., recently formed jointly by the Plessey Co. and the Philco Corp., of Pennsylvania, to manufacture in this country transistors and other semi-conductors under Philco patents, are to build a factory on the Cheney Manor Estate, Swindon, Wilts. Production is expected to start during next year with the manufacture of h.f. surface barrier and Micro-Alloy transistors, now made by the Lansdale Tube Co., a division of Philco. Germanium Micro-Alloy diffused transistors for operation at 250 Mc/s will be available later in 1958. To assist manufacturers in the development of transistor equipment samples are being obtained from the U.S.A.

Adhesive copper foil known as "Plymaster," made by the Rubber & Asbestos Corp., of Bloomfield, New Jersey, U.S.A., to which we referred on page 296 of our June issue, can now be imported under open general licence, so that individual import licences are not required. The sole U.K. distributors of the foil, used for making "copper clad" tor printed circuits, are Omni (London), Ltd., 35, Dover Street, London, W.1.

Marconi's are to supply the equipment for the f.m. radio-telephone service for Southampton Harbour. The equipment includes five 25-watt v.h.f. transmitters and five receivers for the fixed stations, and three mobile transmitter-receivers. The fixed stations will be remotely controlled from a central site.

Decca Navigator is to be fitted in a further 44 tankers of the Shell Petroleum Co., making 66 in all.

CQ Audio, Ltd., is the new name adopted by RGA Sound Services, Ltd., who market CQ amplifiers. They have moved from Plymouth and are now at 2, Sarnesfield Road, Enfield, Middlesex. A. R. Neve, a director of the company, and Stanley Kelly have also floated a new company, Audio Amplifiers, Ltd., of the same address, to manufacture audio equipment.

OVERSEAS TRADE

Surveillance radar is to be supplied and installed by Marconi's at two air bases in Wellington, New Zealand—the civil airport at Rongotai and the N.Z. Air Force base at Ohakea. Both installations will include duplicate 500-kW sets (Type S264A). At Rongotai the scanner will be erected at the top of a 1,650-ft hill, from which the radar information will be fed by a microwave link to both the airport and the airways control centre in Wellington city, approximately four miles away.

Solartron's commercial director, Eric E. Jones, is visiting the United States. Whilst there he will make arrangements for the manufacture under licence in the U.S.A. of the Solartron electronic reading automaton (E.R.A.). The group has an American subsidiary, Solartron Incorporated, of Los Angeles, set up a year ago, and has agreements with Rheem Manufacturing Co., of New York, and the Consolidated Electrodynamic Corp., of Pasadena.

Tape Recorders.—Two production models of the recently introduced "Thoroughbred" tape recorder were flown by Winston Electronics, Ltd., to their North American distributors Mechtron Products, Ltd., for exhibition at the Canadian Institute of Radio Engineers show in Toronto (October 16th to 18th).

A £1M contract, calling for the complete reorganization of the long-wave broadcasting station at Ankara, Turkey, including the addition of a second 120-kW transmitter for parallel operation with the existing one, has been awarded to Marconi's.

S. W. Transmitter.—British Sarozal, Ltd., whose new address is 1-3, Marylebone Passage, Margaret Street, London, W.1, have supplied to the Radio Club of Cape Verde a 5-kW transmitter for broadcasting in the 19-, 41- and 75-metre bands. The transmitter gives an overall frequency response of ± 2 dB between 30 c/s and 15 kc/s with distortion below 4%.

Thorn Electrical Industries plan to invest more than £A2,000,000 on a development project in Victoria to provide facilities for the production of the complete range of the company's products in Australia.

Television Receivers.—There is at present no television service in Chile, but three stations using American 525-line standards are being operated experimentally by institutions. British manufacturers will have the opportunity of showing their television equipment at the technical exhibition at the Universidad Tecnica del Estado in Santiago in December. Details are obtainable from the Exhibitions and Fairs Branch of the Board of Trade.

Automation Exhibition.—The 4th International Automation Exposition and Congress will be held in New York Coliseum from June 9th and 13th next year. British firms interested in exhibiting or in visiting the Show should communicate with the organizers, Richard Rimbach Associates, 845, Ridge Avenue, Pittsburgh 12, Pa.

NOVEMBER MEETINGS

LONDON

1st. R.S.G.B.—“Microwave link equipment” by S. Korytko (S.T.C.) at 6.30 at the I.E.E., Savoy Place, W.C.2.

5th. I.E.E.—“The design of the control unit of an electronic digital computer” by Dr. M. V. Wilkes, W. Renwick and Dr. D. J. Wheeler; “A decimal adder using a stored addition table” by M. A. Maclean and D. Aspinall; and “An accurate electroluminescent graphical output unit for a digital computer” by Dr. T. Kilburn, Dr. G. R. Hoffman and R. E. Hayes at 5.30 at Savoy Place, W.C.2.

8th. Junior Institution of Engineers.—“Television” by T. M. C. Lance (Cinema-Television) at 7.0 at Pepys House, 14 Rochester Row, S.W.1.

12th. Institute of Physics (Electronics Group)—“Crossed field interaction in microwave valves” by W. E. Willshaw (G.E.C. Research Laboratory) at 5.30 at 47 Belgrave Square, S.W.1.

13th. I.E.E.—“Broad-band slot-coupled microstrip directional couplers”; “The application of printed circuit techniques to the design of microwave components”; and “Re-entrant transmission line filter using printed conductors” by J. M. C. Dukes at 5.30 at Savoy Place, W.C.2.

15th. Television Society.—“Industrial television” by I. M. Waters (Pye) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

15th. B.S.R.A.—“Some recent developments in loudspeaker enclosure design” by A. R. Neve, at 7.0 at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2.

25th. I.E.E.—“Problems of sound and television broadcasting coverage” by G. Millington at 5.30 at Savoy Place, W.C.2.

27th. Brit.I.R.E.—“Transmission standards and signal distortion in television and other communication systems” by Dr. A. van Weel at 7.15 at the London School of Hygiene & Tropical Medicine, Keppel Street, W.C.1.

29th. Television Society.—“Some aspects of waveguide technique” by J. C. Parr (Kelvin Hughes) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

29th. R.S.G.B.—“Some aspects of atmospheric radio noise” by F. Horner (D.S.I.R. Radio Research Station) at 6.30 at the I.E.E., Savoy Place, W.C.2.

BIRKENHEAD

22nd. Brit.I.R.E.—“Scatter propagation” by M. Telford at 7.0 at the Birkenhead Technical College.

BIRMINGHAM

25th. I.E.E.—“Magnetic materials” by Professor F. Brailsford at 6.0 at the James Watt Memorial Institute, Great Charles Street.

BRADFORD

12th. I.E.E.—Discussion on “The teaching of radio and TV servicing” opened by Dr. G. N. Patchett at 6.30 at the Technical College.

CAMBRIDGE

12th. I.E.E.—“Some radio aids for high-speed aircraft” by Dr. J. S. McPetrie at 8.0 at the Cavendish Laboratory, Free School Lane.

GLASGOW

21st. Brit.I.R.E.—“V.H.F./F.M. transmission” by H. V. Sims at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

IPSWICH

4th. I.E.E.—“Colour television” by

L. C. Jesty at 6.30 at the Crown and Anchor Hotel.

LIVERPOOL

18th. I.E.E.—“Some aspects of half-wave magnetic amplifiers” by G. M. Ettlinger at 6.30 at the Royal Institute, Colquitt Street.

MANCHESTER

6th. I.E.E.—“The importance of research in hearing and seeing to the future of telecommunication engineering” by Dr. E. C. Cherry at 6.45 at the Engineers' Club, 17 Albert Square.

14th. Brit.I.R.E.—“Some electronic techniques used in textile research” by K. B. Todd at 6.30 at Reynolds Hall, College of Technology, Sackville Street.

NEWCASTLE

4th. I.E.E.—“The importance of research in hearing and seeing to the future of telecommunication engineering” by Dr. E. C. Cherry at 6.15 at King's College.

11th. I.E.E.—“Cathodic protection” by L. B. Hobgen, K. A. Spencer and P. W. Heselgrave at 6.15 at the Neville Hall, Westgate Road.

13th. Brit.I.R.E.—“Electronic control of machine tools” by H. Ogden at 6.0 at Neville Hall, Westgate Road.

NORWICH

25th. I.E.E.—“Germanium and silicon power rectifiers” by T. H. Kinman, G. A. Garrick, R. G. Hibberd and A. J. Bullundell at 7.30 at the Assembly House.

READING

25th. I.E.E.—“Cathodic protection” by J. H. Gosden at 7.15 at the George Hotel, King Street.

RUGBY

26th. I.E.E.—“Transistor circuits and applications” by L. P. Morgan at 6.30 at the College of Technology.

SHEFFIELD

20th. Institute of Physics.—“The velocity of light” by Dr. L. Essen (N.P.L.) at 5.0 in the Physics Department, University of Sheffield.

SOUTHAMPTON

6th. I.E.E.—“Frequency-modulated v.h.f. transmitter technique” by A. C. Beck, F. T. Norbury and J. L. Storr-Best at 7.0 at Southampton University.

WEYMOUTH

29th. I.E.E.—“Equivalent circuits of transistors and their application” by L. E. Jansson at 6.30 at the South Dorset Technical College.

WOLVERHAMPTON

13th. Brit.I.R.E.—“Cold cathode switching techniques” by J. Beesley at 7.15 at the Technical College, Wulfruna Street.

LATE-OCTOBER MEETINGS

21st. British Computer Society.—“The machine's-eye view” by Professor D. R. Hartree at 6.15 in the William Beveridge Hall, Senate House, Malet Street, London, W.C.1. (Applications for admission to the secretary, 29 Bury Street, London, S.W.1.)

30th. Brit.I.R.E.—“Tropospheric scatter system evaluation” by M. Telford at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.



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RANDOM RADIATIONS

By "DIALLIST"

Hi-Fi and V.H.F.

WRITING from St. Peter Port in Guernsey a reader, who is a hi-fi enthusiast tells me that, though he can receive in the right conditions North Hessary Tor, Rowridge, Norwich and Wrotham, he always makes use of the last of these when possible owing to the much superior quality of reproduction obtainable from any of its transmissions which originate in or near London. He makes the suggestion that I should let this be known for the benefit of other followers of the hi-fi cult—and this I willingly do. Wrotham, as you may recall, was started as an experimental v.h.f. station some years before work was begun on the f.m. network. It is served by a very special cable from London and its modulation band of a.f.'s seems to be considerably wider than that of most, if not all, of the B.B.C.'s other Band II stations. What exactly is its upper limit is rather a mystery. When, in 1956, filters restricting the upper limit to 10 kc/s were installed readers wrote to *Wireless World* complaining about the fall in quality. The filters were subsequently removed. In two I.E.E. papers 15 kc/s has been given as the upper limit but this is by no means certain. I can, however, testify to the quality of the reproduction obtainable from Wrotham.

Comparisons Are Instructive

For some little time during the experimental transmissions from Wrotham—I was then living in Hertfordshire—I had on loan one of the f.m. receivers, which were made for the B.B.C. by Ambassador and cost, I believe, not far short of £100 apiece. At the same time I had a good medium- and long-wave broadcast receiver and a television set which did full justice to the sound part of the TV transmissions. The v.h.f. set had a muting switch and I fixed up similar contrivances for the others. It was thus possible to turn instantly from one set to another. It seldom happened, of course, that the TV and sound programmes were the same; but quite often concerts (though not always the same ones) were being broadcast on the medium waves and Bands I and II. Com-

parison was easy to make and it showed how infinitely superior was Wrotham's transmission of music. The TV sound was a good long way behind as second and there was no doubt that the medium-wave transmissions from London—or, rather, Brookmans Park—were badly beaten into third place by the necessarily high selectivity of the i.f. circuits in the receiver. I notice that several people in the part of East Anglia where I now live have their Band II aerials directed on Wrotham instead of Norwich. Some even have aerials for both stations and musical folk tell me that they use Wrotham when it's receivable.

Who's Responsible?

UNDER the heading "Mechanical Engineering is Key to Reliability," the American weekly *Electronic News* published a report on the second symposium on reliability held in June by what was then known as the Radio-Electronic-Television Manufacturers' Association. The title has since been tidied up and is now simply Electronic Industries Association. Representatives of several countries took part in the symposium. One of them, R. E. Clark, of the Royal Naval Scientific Service, is reported to have said that reliability in electronic equipment is not so much a matter of electronics

as of mechanical engineering. I agree heartedly up to a point. But hasn't this always been so? It's hard to think of a fault in sound radio or television equipment, for example, which is purely electronic in origin and nature. And there are a tidy few of electro-chemical origin. If the emission of a valve or a cathode-ray tube becomes low, the common causes are a cathode faultily made in the first instance, or poisoned by the electro-chemical action of residual gases which are present because the pumping was not good enough, or blocked by the formation of an interface (electro-chemical action again) between the metal part and the emissive coating. Common purely mechanical faults are disconnections, poor contacts and short circuits. Resistors or capacitors may break down if such a fault subjects them to loads a good deal beyond what they are designed and rated to carry. Composite resistors not infrequently "go high," or "go low," owing, I suppose, to electro-chemical effects. It seems, then, that the electronic engineer, the chemist and the mechanical engineer concerned with the design and production of receivers and components have all their parts to play in improving reliability and that their responsibilities are very closely inter-related. You can't blame the mechanical engineer if his products are misused



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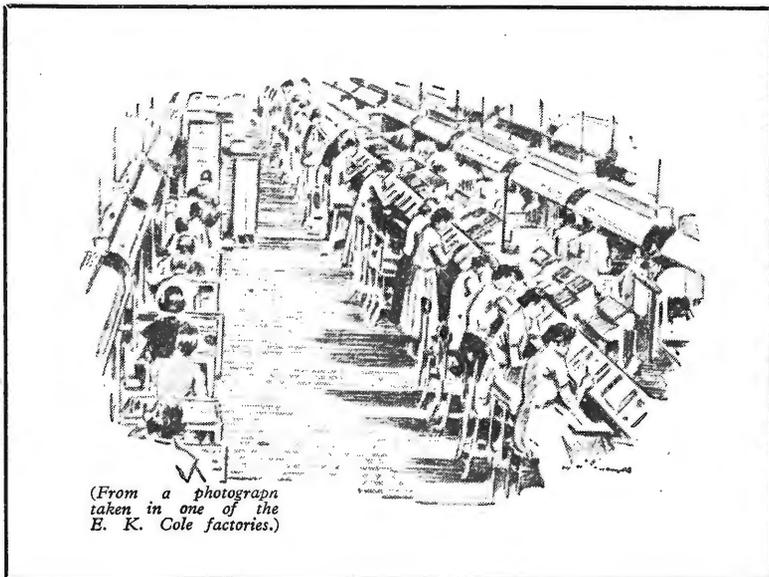
or grossly overloaded by accident, it is the job of the electronic engineer to devise means of ensuring that such things don't happen. The chemist (and the metallurgist too) have big parts to play in the selection of suitable materials.

Dust

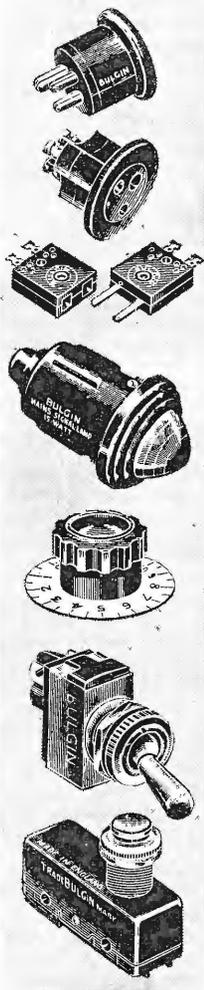
ONE feature I'm glad to notice in some of this year's television receivers is the protective mask easily detachable from the front. The seal between the mask and the big end of the cathode-ray tube isn't always as dust-tight as it should be. However clean the room in which a TV set is used there's always sure to be a good deal of fire dust in the air. This is sucked in through the louvres and moves, when the set is warmed up, at a fairly high speed about the "works" inside the cabinet. If the aforesaid seal is poor, dust gradually collects on the glass over the screen, forming unsightly patches. It's annoying for the knowledgeable viewer to have to remove the chassis from the cabinet in order to clean it off. And it's still more annoying for the unskilled viewer who has to summon his dealer every so often and to pay for his services. May we, please, beg manufacturers to give us really dust-tight seals, or masks which can be quickly removed from the front?

"Tweediness"

IN the Norwich area, where the TV transmitter is still working on low power, though the v.h.f. sound service is going full out, what people call "tweedy" patterning is very much in evidence, particularly in or near the television fringe areas. Both transmissions are horizontally polarized, so it's perhaps not altogether surprising. Fortunately, the patterning can be virtually eliminated by the use of a filter designed for the purpose—though it's a bit surprising to find how many people to whom the cost of a filter would be neither here nor there regard the interference as just one of those things and do nothing about it. A more serious nuisance, because no filter can cope with it, is interference from the Belgian television transmitter at Liège. Luckily, it's not always in evidence; though when it is it pretty well ruins the picture. Things should be better before the end of the year, for I hear that the B.B.C., the G.P.O. and the Belgian authorities have worked out between them a means of minimizing the trouble.



(From a photograph taken in one of the B. K. Cole factories.)



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The Torso Two

I WONDER if you happened to read with as much interest as I did, the account given by "Diallist" (Sept. issue) of how a stone-deaf man was made to hear by sticking one end of the secondary of an audio transformer into his auditory nerve and the other end into a muscle. The secondary was placed under the skin by plastic surgery and the primary was outside the body over the area of the subcutaneous secondary.

The reason for my special interest is this. I have long had the idea of developing a portable receiver which was self-contained within the human body or, in other words, a personal receiver in the literal sense of the word. The great snag has always been to turn the a.f. electrical impulses into sound without the use of loudspeaker or headphones external to the body; now this problem has been solved.

Briefly my idea is to get a plastic surgeon to embed under my skin, at strategic points, a number of transistors and other components of Lilliputian dimensions; probably I shall start on a modest scale and call my initial effort the Torso Two.

These components will be connected in circuit not by having wiring put under my skin. I intend to use the modern technique of a "printed" circuit formed by tattooing. The "ink" used by a tattoo artist is not a good conductor, as I found when I made tests on a seaman's chest in a waterfront pub with a Megger, but by a simple addition it can be made so.

Thus it would be possible to tattoo many turns of "wire" around each of a man's legs. The turns would

be tattooed on each leg in the opposite sense so that by varying the distance between the legs the same tuning effect would occur as we used in our old variometers years ago. No variable capacitor would be required.

There are one or two problems to be solved before my idea is ready for commercial exploitation. One question is that of self-contained battery power, for even transistors need a few volts. However, it must not be forgotten that the blood and other bodily secretions, such as serum and sweat, are salty solutions having some of the characteristics of the electrolyte of a Leclanché cell. It should surely not be impossible to embed a carbon and a zinc rod somewhere. If any of you have any ideas on the matter please let me know.

Worthless Wireless Facts

RECENTLY I had a letter from a reader asking me if the oscillating crystal technique about which *W.W.* published a good deal of information in the early 'twenties was the forerunner of transistors. The question surprised me for *W.W.* has several times stated that this was so.

I don't think many readers realize how old oscillating crystal technique really is. I find from my scrapbook of worthless wireless facts, which I have been painfully putting together for many years past, that oscillating crystals date back to Edwardian days. They were demonstrated in action before the Physical Society of London by Dr. W. H. Eccles in May 1910; and when that month began King Edward VII was still on the throne.

This really means that the oscillating crystal preceded the oscillating valve, for although the triode was with us long before 1910 the principle of regeneration was not introduced until 1912. As for the transistor, it is my belief that by the time *W.W.* celebrates its jubilee in 1961, it will have almost completely displaced the valve in our receivers, and I thought the cartoon of the imperious transistor showing the door to the lachrymose valve, displayed on Pye's stand at the Radio Show, to be highly prophetic.

As I have already told you I have a mania for collecting in my scrapbook wireless facts which are not usually to be found elsewhere. Most of these facts are quite worthless but I

am always glad to receive any of them. Maybe if you send me enough of them I will try to get a book published under the title of "Free Grid's Book of Worthless Wireless Facts."

Lament for the Past

AS I mentioned some months ago there was a time when every reader of *W.W.* was familiar with the succinct abbreviation I-V-2 as an adequate description of a certain type of receiver. The magic figures 1 and 2 together with the V formed the vital statistics of the set which conveyed as much information to the wireless fan of 1925 as the vital statistics of Marilyn Monroe do to the film fan of to-day.

Another long-forgotten thing known only to us "old contemporaries" of radio is the expression "tuning indicator." We used to put a simple milliammeter in the anode circuit of the detector to serve as an indicator of what was going on. In later days manufacturers gave us a thermionic tuning indicator and we used to refer to it as such, or as a cathode-ray indicator. Nowadays we use this device also as a recording-level indicator in our tape machines.

Unfortunately, however, the thermionic indicator had not long appeared when some manufacturer's publicity pundit evolved the comic-strip expression "magic eye" which instantly caught on and is now used by the most learned technologists. Such men would balk at referring to the c.r.t. of their TV sets as a "magic mirror" or to a valve as an "Aladdin's lamp" although there is every bit as much justification for doing so.

However, by far the most astonishing instance of once-familiar things being lost in oblivion is the push-button set of the type with which we were all familiar a few years ago. At the show this year there were push-button sets in plenty but I found only one of them used the buttons for tuning-in stations; this particular one went the whole hog and housed the buttons in a remote-control unit. Maybe there were other sets using push-buttons for tuning which I missed and if so I should be glad to hear from their manufacturers. On the other sets I saw the buttons performed only the function of a wave-change switch.

What impressed me most, however, was that push-button tuning not only seemed to have disappeared but to have been forgotten. At the stand of a famous manufacturer where I enquired for a push-button tuned set I not only drew a blank but a look of blank surprise as well. The young man of whom I enquired had never heard of them but he did think the whole thing an excellent idea to pass to his firm's designers as a novelty for next year's show.



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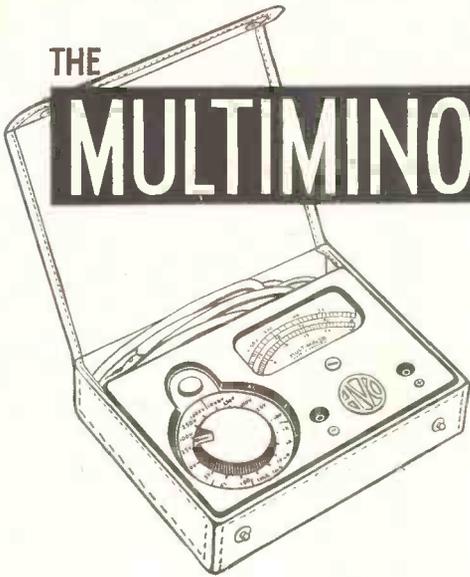
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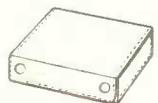
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0 — 250 V.	
0 — 1000 V.	
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VOLTAGE	±150V	±150V to ±180V	±250V or ±300V	±250V or ±300V	±250V or ±300V	±250V or ±300V	±250V or ±300V
CURRENT	0-40ma	0-200ma	0-50ma	10-100ma	0-150ma or 50-200ma at 250V. 100-200ma at 300V.	0-500ma	0-1A
A.C. OUTPUTS	6.3V 4A C.T. 6.3V 1A	6.3V 4A C.T. 6.3V 4A C.T. 6.3V 1A C.T.	6.3V 4A C.T. 6.3V 1A	6.3V 4A C.T. 6.3V 2A C.T. 6.3V 1A	6.3V 4A C.T. 6.3V 4A C.T. 6.3V 1A	6.3V 5A C.T. 6.3V 5A C.T.	6.3V 10A C.T.
D.C. SOURCE IMPEDANCE	<2Ω	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω	<1Ω
STABILISATION FACTOR BETTER THAN	400:1	400:1	400:1	400:1	300:1	400:1	400:1
A.C. SOURCE IMPEDANCE 40c/s—100kc/s	<2Ω	<2Ω	<0.25Ω	<0.25Ω	<0.5Ω	<0.5Ω	<0.5Ω
RIPPLE AND NOISE CONTENT	<350μV	<300μV	<250μV	<300μV	<1mV	<300μV	<300μV
DIMENSIONS	9½" × 6½" × 6½" high	10" × 10" × 6½" high	9½" × 6½" × 6½" high	9½" × 7½" × 6½" high	9½" × 9½" × 6½" high	19" × 12½" × 10½" high	19" × 19" × 10½" high
WEIGHT	14½ lbs	21½ lbs	14½ lbs	20½ lbs	21½ lbs	80 lbs	approx 150 lbs

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

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



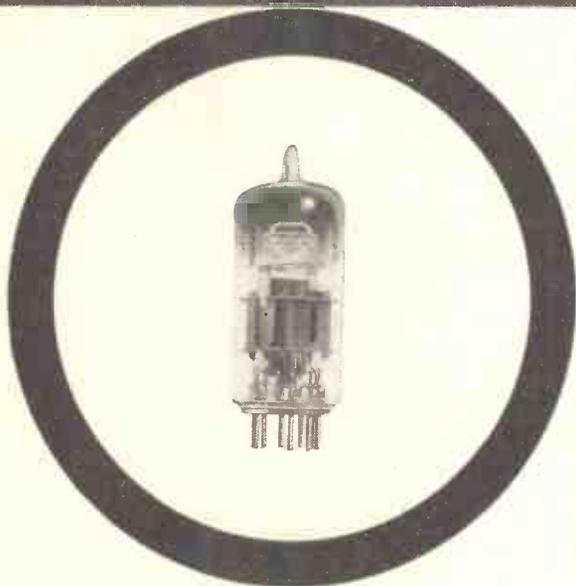
Notable features are

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

Power Supply Sub-units

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

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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.

E88CC

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

ABRIDGED DATA

$V_h = 6.3V$ $I_h = 300mA$

Computer operation

$V_a(b)$	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 $I_a = 100\mu A$)	$< -2.0V$

Cascode amplifier

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

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complete answer with their
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Every item which we list below is a normal stock item which we are prepared to pack and despatch to you in any part of the world. Each item is chosen because we believe it to be a "Quality" product and unless it measures up to our standards we do not stock it.

In Gt. Britain and N. Ireland full hire purchase and credit sale terms are available with our confidential system and prompt despatch. Credit sale agreements must be cleared in nine months—all articles advertised can be purchased on 6 months credit—no extra charge.

SECTION	Item No.	Make	Model No.	Delivery	Cash Price	Terms C.S.		Terms H.P.		Export Price	
						Deposit	Payments	Deposit	Payments		
GRAMOPHONE MOTORS. ALL MAKES IN STOCK											
SECTION I	Garrard		R.C.88	Ex/stock	£ 17 18 8	£ 2 18 8	9 of 39/-	£ 9 0 0	12 of 14/9	£ 12 18 0	
	Garrard		R.C.98	Ex/stock	£ 19 17 8	£ 2 4 0	9 of 44/-	10 0 0	12 of 20/-	14 6 0	
SECTION II	PICK-UPS		Leak	Mark II	Ex/stock	£ 13 16 5	£ 2 16 5	9 of 29/-	7 0 0	12 of 14/8	10 5 0
	Connoisseur		Mark II	Ex/stock	£ 12 9 10	£ 2 9 10	9 of 27/-	6 5 5	12 of 11/8	8 11 0	
SECTION III	TUNER UNITS		Ortofon	Type "A"	Ex/stock	£ 17 18 1	£ 2 18 1	9 of 28/-	8 19 6	12 of 10/1	13 0 0
	Leak		Mark II FM	Ex/stock	£ 35 10 0	£ 3 17 9	9 of 77/4	17 15 4	12 of 33/3	25 0 0	
SECTION IV	Rogers		Mark I FM	6-12 weeks	£ 30 9 0	£ 3 7 4	9 of 66/10	15 5 1	12 of 28/6	21 0 0	
	Quads		FM Unit	Ex/stock	£ 24 17 0	£ 2 14 8	9 of 54/8	12 9 2	12 of 23/3	18 0 0	
SECTION V	AMPLIFIERS		Armstrong	FM 61	Ex/stock	£ 22 1 0	£ 2 8 6	9 of 48/6	11 0 6	12 of 20/8	17 10 0
	Armstrong		A10	Ex/stock	£ 32 10 0	£ 3 11 6	9 of 71/6	16 5 8	12 of 30/5	32 10 0	
SECTION VI	Rogers		Junior	Ex/stock	£ 26 0 0	£ 2 17 2	9 of 57/2	13 0 6	12 of 24/4	26 0 0	
	Leak		TL.12A	Ex/stock	£ 32 11 0	£ 3 11 7	9 of 71/7	16 5 8	12 of 30/6	32 11 0	
SECTION VII	LOUDSPEAKER UNITS		Leak	TL.25A	Ex/stock	£ 43 2 0	£ 4 14 9	9 of 94/9	21 11 9	12 of 40/4	43 2 0
	Wharfedale		Super 3	Ex/stock	£ 6 19 6	—	—	—	—	5 0 0	
SECTION VIII	Wharfedale		Super 8	Ex/stock	£ 6 19 6	—	—	—	—	5 0 0	
	Wharfedale		Super	Ex/stock	£ 17 10 0	£ 1 18 6	9 of 33/6	8 15 11	12 of 16/4	17 10 0	
SECTION IX	Wharfedale		W.15 ES	Ex/stock	£ 17 10 0	£ 1 18 6	9 of 38/6	8 15 11	12 of 16/4	17 10 0	
	Goodmans		Trebox	Ex/stock	£ 5 9 3	—	—	—	—	5 9 3	
COMPLETE LOUDSPEAKER ASSEMBLIES											
SECTION X	Goodmans		Midax	Ex/stock	£ 11 16 0	—	—	—	—	11 16 0	
	Lowther		Acoustica	Ex/stock	£ 37 16 0	£ 4 3 1	9 of 83/1	18 18 0	12 of 35/5	37 16 0	
SECTION XI	Lowther		T.P.1	Ex/stock	£ 96 0 0	£ 10 11 1	9 of 211/1	48 0 0	12 of 90/-	96 0 0	
	Tannoy		Canterbury	Ex/stock	£ 57 15 0	£ 6 7 0	9 of 127/-	28 17 6	12 of 54/1	57 15 0	
SECTION XII	Tannoy		York	Ex/stock	£ 75 0 0	£ 8 5 0	9 of 165/-	37 10 9	12 of 70/3	75 0 0	
	Tannoy		G.R.F	Ex/stock	£ 122 0 0	£ 13 8 4	9 of 268/4	61 0 6	12 of 114/4	122 0 0	
SECTION XIII	Tannoy		Autograph	6/8 weeks	£ 165 0 0	£ 18 3 0	9 of 363/-	82 10 3	12 of 154/8	165 0 0	
	Westrex			Ex/stock	£ 169 0 0	£ 18 11 9	9 of 371/9	84 10 9	12 of 159/10	169 0 0	
TAPE DECKS, ETC.											
SECTION XIV	Truvox		Mark I'	Ex/stock	£ 23 2 0	£ 2 10 9	9 of 50/-	11 11 9	12 of 21/7	23 2 0	
	Wearite		Stereo	Ex/works	£ 47 10 0	£ 5 4 6	9 of 104/6	23 15 0	12 of 44/7	47 10 0	
SECTION XV	Collaro		Mark III	Ex/stock	£ 23 2 0	£ 2 10 9	9 of 50/9	11 11 9	12 of 21/7	23 1 0	
	Wearite		Model 2A	Ex/stock	£ 35 0 0	£ 3 17 0	9 of 77/-	17 10 9	12 of 32/9	35 0 0	
SECTION XVI	Wearite		Model 2B	Ex/stock	£ 40 0 0	£ 4 8 0	9 of 88/-	20 0 0	12 of 37/6	40 0 0	
	Wearite		Model 2C	Ex/stock	£ 45 0 0	£ 4 19 0	9 of 99/-	22 10 3	12 of 42/2	45 0 0	
SECTION XVII	E.M.I.		Stereo Deck	Ex/stock	£ 122 17 0	£ 13 10 3	9 of 270/3	61 8 6	12 of 115/2	122 17 0	
	COMPLETE TAPE RECORDERS										
SECTION XVIII	Elizabethan		'56	Ex/stock	£ 54 12 0	£ 6 0 1	9 of 120/1	27 6 2	12 of 51/2	54 12 0	
	Elizabethan		'57	Ex/stock	£ 68 5 0	£ 7 10 1	9 of 150/1	34 3 0	12 of 63/1	68 5 0	
SECTION XIX	Grundig		TK5	Ex/stock	£ 54 12 0	£ 6 0 1	9 of 130/1	27 6 2	12 of 51/2	54 12 0	
	Grundig		TK8	Ex/stock	£ 75 12 0	£ 8 6 3	9 of 166/3	37 16 5	12 of 70/10	75 12 0	
SECTION XX	Grundig		TK320	Ex/stock	£ 99 15 0	£ 10 19 5	9 of 219/5	49 17 5	12 of 93/6	99 15 0	
	Ferrograph		3/AN	4/6 weeks	£ 79 16 0	£ 8 15 6	9 of 175/6	39 18 9	12 of 74/9	79 16 0	
SECTION XXI	Ferrograph		3/AN/H	4/6 weeks	£ 94 10 0	£ 10 7 10	9 of 207/10	47 5 2	12 of 88/7	94 10 0	
	CABINETS										
SECTION XXII	Heals		Console	Ex/stock	£ 30 0 0	£ 3 6 0	9 of 66/-	15 0 0	12 of 28/6	30 0 0	
	Leak		Contemporary	4/6 weeks	£ 22 15 0	£ 2 10 0	9 of 50/-	11 7 6	12 of 22/3	22 15 0	
SECTION XXIII	Classic		Functional	Ex/stock	£ 14 14 0	£ 1 12 4	9 of 32/4	7 7 0	12 of 15/-	14 14 0	
	Classic		Contemporary S/U	Ex/stock	£ 18 18 0	£ 2 1 6	9 of 41/6	9 9 0	12 of 19/3	18 18 0	
SECTION XXIV	Classic		Contemporary D/U	Ex/stock	£ 28 7 0	£ 3 2 0	9 of 62/-	14 4 6	12 of 27/-	28 7 0	

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KLYSTRON POWER UNIT TYPE 698B



THE Power Unit Type 698B which is now available for immediate delivery, is designed to provide H.T. and L.T. supplies for high voltage Klystron valves. All the H.T. supplies are stabilised, the output being less than 0.5 per cent of the input voltage changes. Internal Oscillators provide square wave and saw-tooth wave modulation and switching enables either the internal modulation or modulation from an external source, to be applied to the grid or reflector voltages. A switch position is also provided for operation under C.W. conditions.

STABILISED H.T. OUTPUTS

Cathode Volts	Cathode Current	Grid Volts		Reflector Volts	
		Max.	Min.	Max.	Min.
-2.4 kV (Max.)	18mA	-220V	0	-500V	0
-1 kV (Min.)	10mA	-100V	0	-280V	0

Stabilisation: Output change of less than ± 200 mV for input change of 210—250V.

Ripple Voltage: Not greater than 20mV R.M.S.

Regulation: Output Impedance less than 500 ohms at 10mA

L.F. OUTPUTS

Rating: 4.0V D.C. at 1.4A.
Ripple: Less than 150mA R.M.S.

Write for full details of this or any other Airmec instrument which will be forwarded gladly upon request.

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V.H.F. radio telephones

Radio links with type RL equipment are a practical, economic and reliable alternative to landlines.

V.H.F. Radio telephones are particularly suitable where contact is to be maintained between isolated communities and individual subscribers remote from main trunk routes.

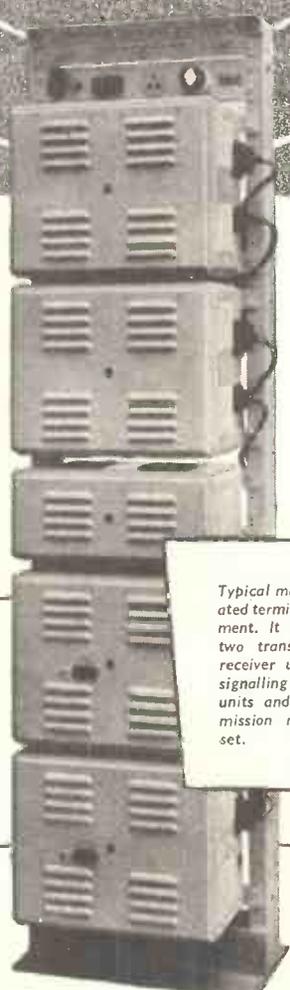
A.T.E. single-channel v.h.f. equipment type RL is designed for a variety of applications where an easily installed and simply maintained system is required. Over any type of terrain it provides normal point to point communication or, alternatively, it can be linked in with existing telephone circuits without modification of equipment.

***The equipment has the following characteristics**

MAINS OR BATTERY OPERATED • AMPLITUDE OR FREQUENCY MODULATED • OPERATES IN RANGE

54-186Mc/s • TRANSMITTED POWER 0.6W-10W

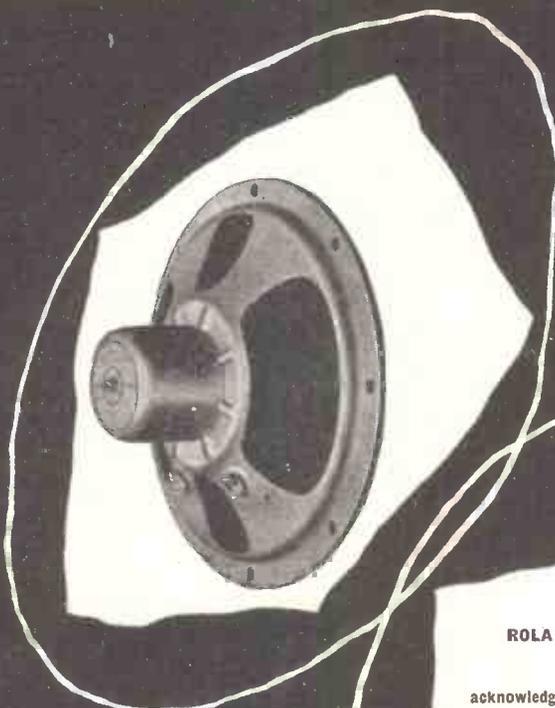
Typical mains operated terminal equipment. It comprises two transmitter / receiver units, two signalling / power units and a transmission measuring set.



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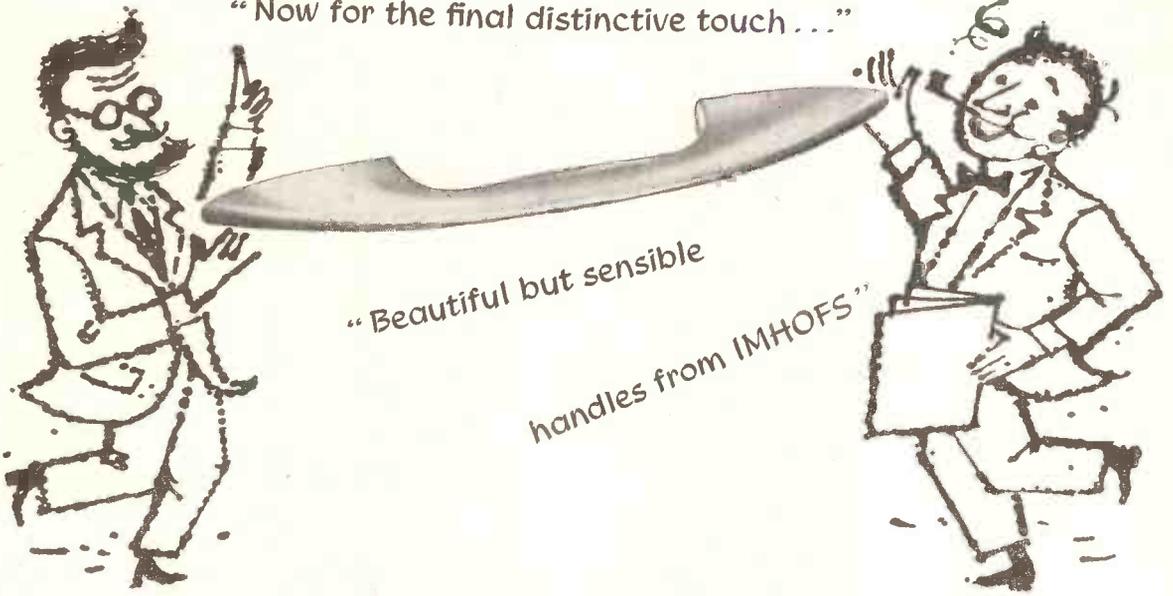
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FOR ALL
PURPOSES**

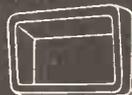
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Telephone: EMBerbrook 3402

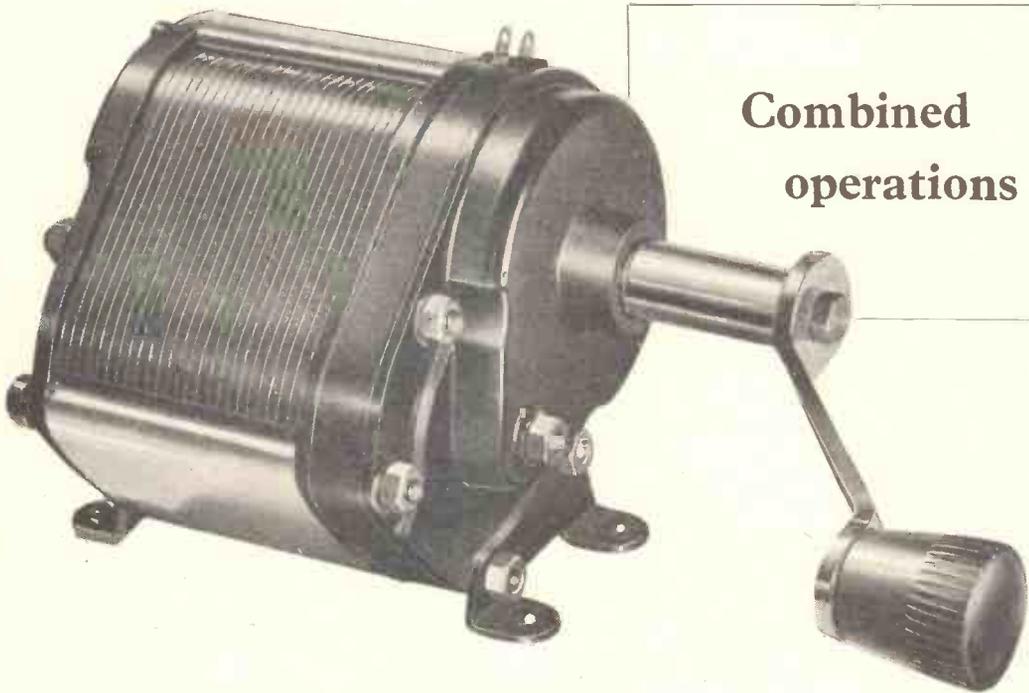
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 21A					 24A
 35B					 18
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 37					 10A
 20B					 19

In a single application, Araldite epoxy resins combine such diverse functions as bonding, impregnating, insulating and providing surface finishes of remarkable protective value. This rotating magnet generator, made by Ericsson Telephones Limited for telecommunication equipment, has a greater output than other generators of the same drive torque. It incorporates heavy-gauge iron sheet laminations bolted between diecast alloy end cheeks, and the coil is separately wound on to a moulded bobin which, when assembled, forms an integral part of the lamination structure. Dimensional accuracy between the end cheeks must be combined with a relatively large dimensional tolerance on the thickness of the laminations, and Araldite Surface Coating Resins have proved indispensable for impregnating the coil, locking the laminations, and imparting an excellent surface finish to equipment which also conforms to tropical specifications.



Combined operations

Araldite epoxy resins are used

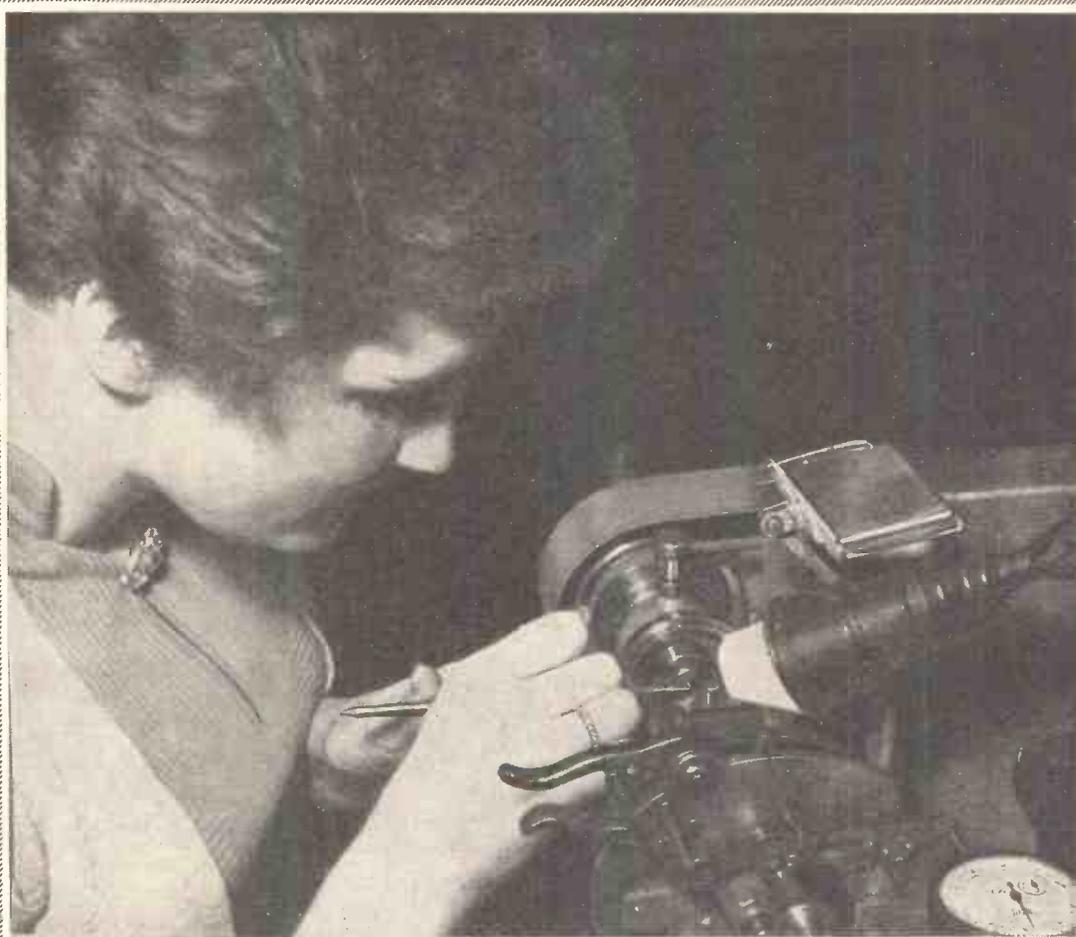
- * for bonding metals, porcelain, glass, etc.
- * for casting high grade solid electrical insulation
- * for impregnating, potting or sealing electrical windings and components
- * for producing glass fibre laminates
- * for making patterns, models, jigs and tools
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- * as protective coatings for metal, wood and ceramic surfaces

Araldite epoxy resins

Araldite is a registered trade name

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AP 321



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"Why  is best" series No. 8

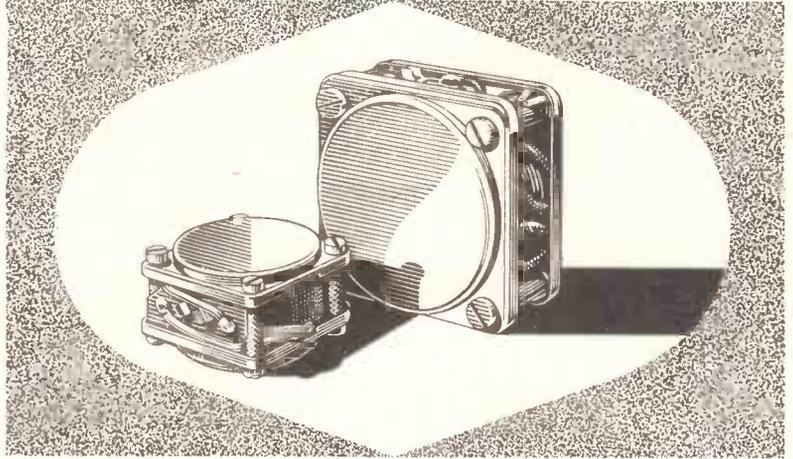
EXTREME accuracy and delicacy of touch is required by the skilled operator in mounting the sapphire stylus point in the metal shank. The illustration above shows an operator at the Garrard factory inserting a sapphire, which is twenty-thousandths of an inch diameter, into the metal shank and burnishing its end to hold the sapphire in position. Specially designed machines are in everyday use in the Garrard factory to perform the many intricate operations necessary to produce the world's finest record playing equipment. One more reason why Garrard units are the finest in the world.

Garrard AUDIO
PERFECTION

THE GARRARD ENGINEERING AND MANUFACTURING CO. LTD SWINDON · WILTS

THESE HIGH Q COILS

are now even easier to install



Designers of communications equipment, will welcome the new mounting and terminating arrangements of the Mullard 25mm and 36mm pot cores.

Unique design features that make installation easier than ever, include positions for tag boards on three sides and a new system of fixing, which eliminates the need for additional mounting plates.

Combining constructional advantages with sound technical performance, these 25mm and 36mm pot cores take full advantage of the low loss of Ferroxcube to produce inductances of up to 30 henries, together with high Q values over a wide frequency range. As an additional service these pot cores can be supplied wound to individual specifications, if required.

Write now for full details of the comprehensive range of Mullard pot cores currently available.

Outstanding features

- * Controllable air gap, facilitating inductance adjustment
- * Self screening
- * Controllable temperature coefficient
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- * Ease of winding, and assembly

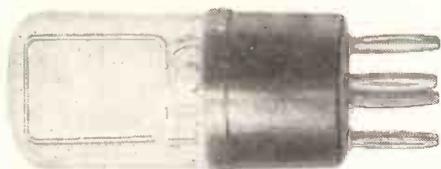
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'Ticonal' permanent magnets
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Mullard Ltd., Component Division, Mullard House, Torrington Place, W.C.1

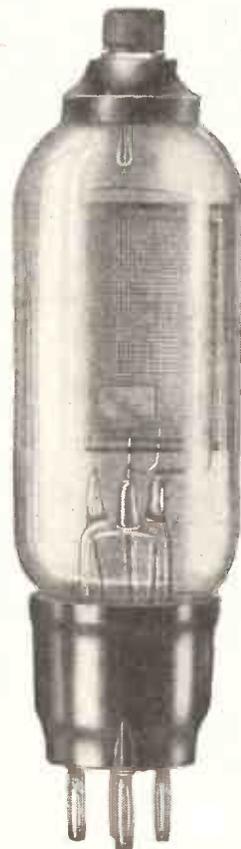
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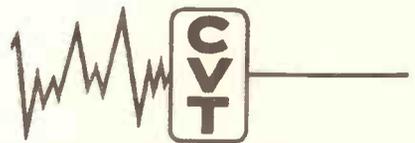
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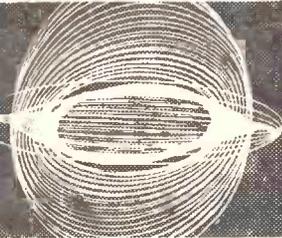
Whenever soldering is discussed, *ENTHOVEN* enters the argument. It's a name that represents 150 years' experience in non-ferrous metals, and an incomparable record in research and development.



ENTHOVEN SOLDER PRODUCTS

Champion

High-Fidelity unit equipment for the home



**Model 853
Power Amplifier**



The complete power amplifier for use with either of the 2 other models (853A or 854). It is supplied in a beautifully finished polished wood cabinet which can be placed on a side table or bookshelf and will blend harmoniously in any room.

TECHNICAL DETAILS

The amplifier is based on a circuit developed by Mullards incorporating an ultra linear output-stage and contains a Power Supply for a Pre-amplifier and F.M. Tuner.

Maximum power output 11 watts. Frequency Response 1 watt within 1 db. 10 c/s — 20,000 c/s—at 10 watts within 1 db. 30 c/s — 15,000 c/s.

Output impedance (Speech Coil): 15 ohm or 3.75 ohm. Mains Supply: 200-250 volts 50-60 c/s A.C. or 100-130 volts 50-60 c/s A.C.

**22 gns.
NO TAX**

Champion proudly introduce the latest developments in HI-FI unit equipment

**Model 853A
Pre-Amplifier
Control Unit**



The Pre-Amplifier comprises a low noise, low distortion amplifier with tone controls and low pass filters. The first stage gives balanced compensation for five recording characteristics used by the leading recording companies in England and the U.S.A. This is effected by the use of frequency selective negative feedback. The tone control circuits give continuously variable control of both bass and treble frequencies.

TECHNICAL DETAILS

- Input selector.
 (1) Tape/Radio Replay.
 (2) R.I.A.A.
 (3) A.E.S. and R.C.A. ORTHO.
 (4) Col. L.P. and F.F.R.R.
 (5) N.A.R.T.B. and H.M.V. L.P.
 (6) British 78 R.P.M.
 (7) Microphone.
 Treble and Bass Control.
 Volume Control.
 Low Pass Filter. Switched 10 K c/s. 7 K c/s. 5 K c/s level. Dimensions 15" x 4 1/2" x 4 1/2".

**18 gns.
NO TAX**

**Model 854
Pre-Amplifier and
F. M. Tuner**



The Master Control comprises a low noise, low distortion tone control pre-amplifier and a sensitive VHF/FM tuner covering the frequency range 88-95 Mc/s, housed in a handsome polished wood cabinet matching the Main Amplifier Model 853.

TECHNICAL DETAILS

- Input Selector.
 (1) Mains OFF Switches off mains to Power Supplies in Model 853.
 (2) FM Tuner.
 (3) L.P. Records,
 (4) 78 Records,
 (5) Tape/Radio Replay,
 (6) Microphone,
 Volume Control.
 Treble and Bass Controls.
 Tuning Control.
 Tuning Indicator,
 Magic Eye. Mullard EM 81. Dimensions 15" x 8 1/2" x 9 1/2".
 £25.0.4 + £9.12.8 P.T.

**33 gns.
INC. TAX**

Model 875 "Golden Concerto"
 High Fidelity Record reproducer. Separately constructed acoustical chamber using three speakers—one 12in. and two 5in. P.M. speakers. 10-watt Hi-Fi output. Separate Bass and Treble control. Latest 4-speed mixer changer. Socket for VHF Tuner, microphone or tape recorder. The record storage is an additional advantage making the "Golden Concerto" one of the finest and most compact Record reproducers on the market.

69 gns. INC. TAX



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***With the Champion High-Fidelity you will become aware of a new excitement in music; suprised and delighted to hear with extraordinary realism your favourite works, which before lacked clarity.**

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RCA engineering combines quality and long-range economy

Because there's more to radio equipment than its initial cost, economy minded broadcasters prefer RCA equipment...their best insurance for safeguarding their investments and building profits. They realize that many RCA broadcast transmitters with more than 25-years of service are operating today because RCA has engineered and manufactured its broadcast equipment to meet the highest standards.

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- RCA uses the highest quality circuits and components — gives you a wide safety margin of operations, minimizes costly, time-consuming replacement.
- Superior specifications include superlative wiring — for longer service without re-wiring.
- Long tube life in RCA Broadcast Equipment often saves more money in the long run than the initial cost of less carefully engineered equipment.
- Higher trade-in value for RCA equipment.

FROM THE STATION LOGS

Here are a few of the many station reports from all over the world, describing long tube life in RCA Broadcast Equipment. When these reports were received, the tubes were still going strong:

- 94,613 hours:** RCA final amplifier triode in RCA 10 KW medium wave transmitter, at KPOJ, Portland Oregon.
- 62,000 hours:** RCA final power triode, in RCA 50 KW medium wave transmitter at KDKA, Pittsburgh, Pennsylvania.
- 46,115 hours:** RCA final power triode in RCA 1 KW short wave AM transmitter at DZMB, Manila, Philippines.
- 33,738 hours:** RCA mercury-vapor rectifier, in RCA 50 KW short wave transmitter at Canadian Broadcasting Corporation.

RCA offers a complete line of Broadcast Transmitters ranging from 250 watts to 250 kilowatts. Consult your RCA Distributor or write Dept. BE-49-K at the address below for complete information.



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RADIO CORPORATION OF AMERICA
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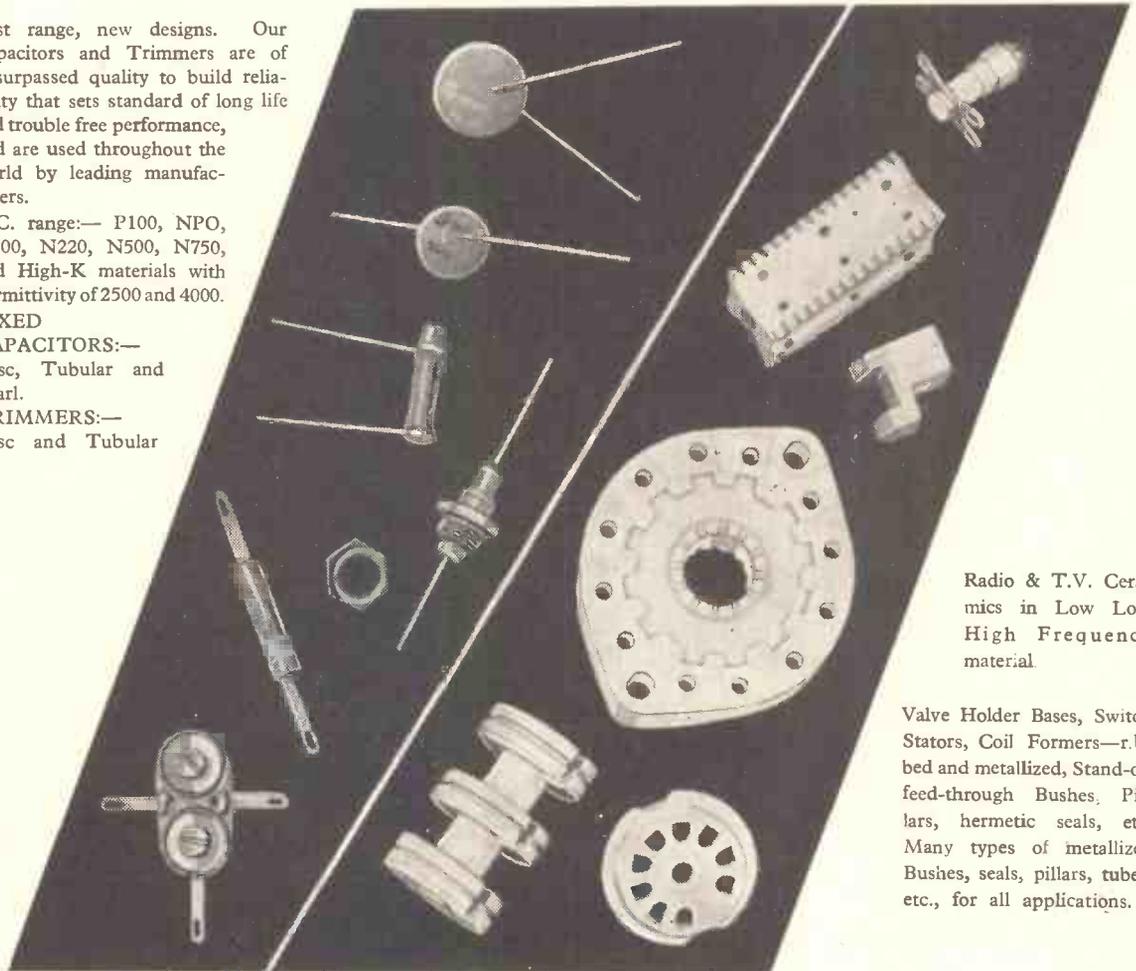
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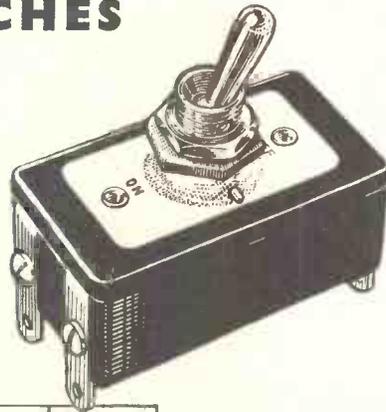
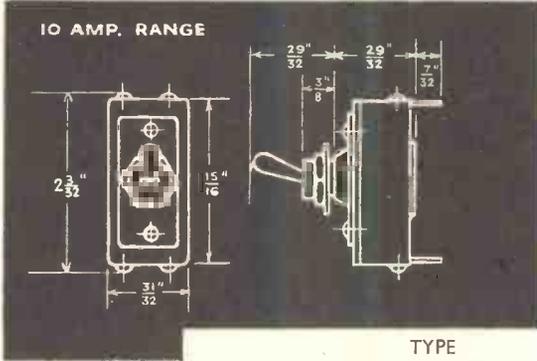
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Telephone: EDGBASTON 5381/2.
Telegraphic Address: "STEATITE-BIRMINGHAM, 15"



By Appointment to the Professional Engineer

TOGGLE SWITCHES



TYPE	CAT. No.
SINGLE POLE CHANGE OVER OPERATION.	501056
DOUBLE POLE ON/OFF OPERATION.	500705
As 500705, but fitted for two-hole mounting by 4 B.A. bushes on 1 3/16" fixing centres.	501089
DOUBLE POLE ON/OFF. Dimensions and finish of bush and lever to conform to current RCL 151.	501402

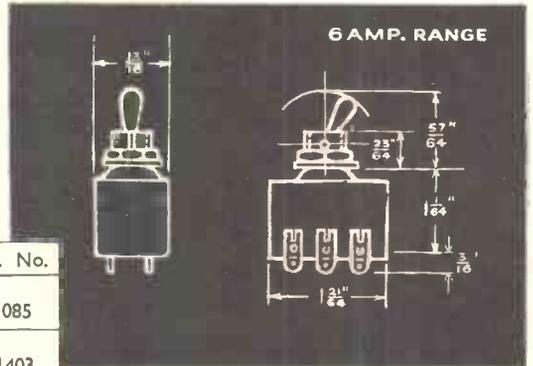
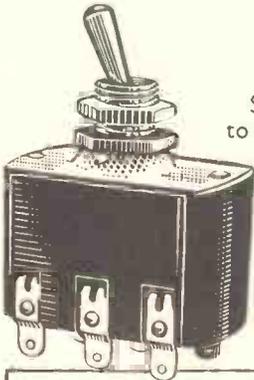
10 AMP

SWITCH RATINGS:
10 amps. at 250 volts AC/DC
AVERAGE INTERNAL RESISTANCE:
Less than .002 ohm.
CONTACTS AND TERMINALS:
Silver clad phosphor bronze.

6 AMP

The Painton 6 Amp. Toggle Switches are designed to conform to the performance requirements of appropriate R.C.S.C. Specification.

SWITCH RATINGS:
6 amps. at 250 volts AC/DC
AVERAGE INTERNAL RESISTANCE:
Less than .002 ohm.
CONTACTS AND TERMINALS:
Silver clad phosphor bronze.



TYPE	CAT. No.
DOUBLE POLE CHANGE OVER. Dimensions shown in line drawing. Heavy duty chrome finish.	501085
DOUBLE POLE CHANGE OVER. Dimensions and finish of Bush and Lever to conform to current RCL 151.	501403
DOUBLE POLE CHANGE OVER. Bush and Lever Dimensions to conform to current RCL 151 but with chrome finish.	501521

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Northampton England

CATHODEON



Quartz Crystal Units

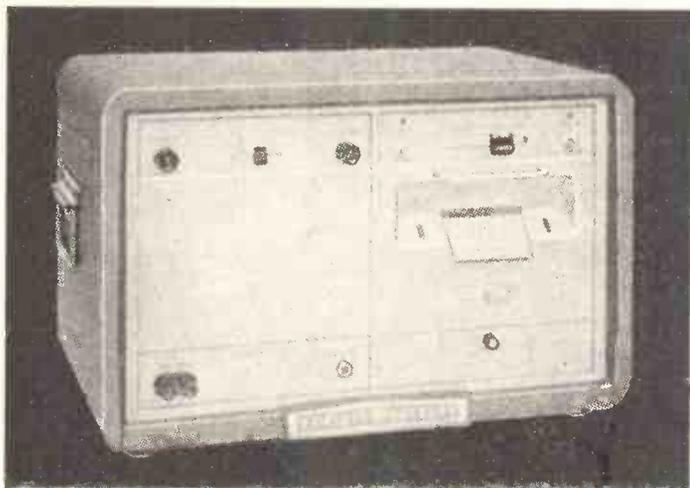
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new -hp- 560A DIGITAL RECORDER

**Continuous digital record
for your frequency counter!**

**Prints 11-digit information
at 5 lines per second**

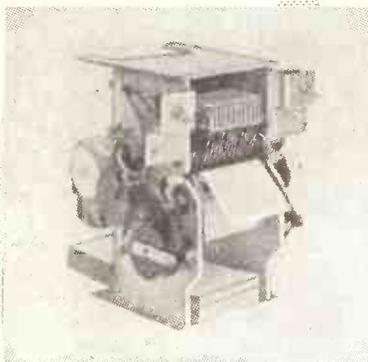
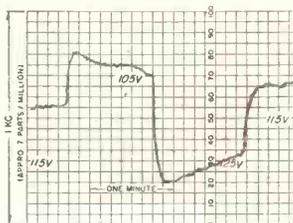
**Controlled by electronic or
mechanical devices**

**Direct print-out from
all -hp- counters**

**Analog output for strip-chart
recorder**

**Expanded scale; full scale can
represent 1/107**

Frequency stability vs. line
voltage; 150 MC oscillator



SPECIFICATION

Accuracy: Identical to that of basic counter; used.

Printing Rate: Controlled by counter, 5 lines/sec. max.

Digit Capacity: 11 digits per line.

Driving Source: Parallel entry staircase voltages derived from standard digital frequency counters such as Hewlett-Packard types. Staircase descends from +135 v. to +55 v. as the count progresses from 0 to 9. Internal impedance of staircase source should be approximately 700,000 ohms.

Print Command Signal: 1 μ sec. or greater, positive or negative pulse, 15 volts p-p or greater.

Paper Required: Standard 3in. roll or folded paper.

Line Spacing: Single or double, adjustable.

Analog Signal: Any three consecutive digits may be selected by selector switch. Output is function of selected digits. For example, if consecutive digits were 3, 8 and 6, output voltage would be 38.6 millivolts or 0.386 ma.

Output Available: 1 milliamp for galvanometer strip-chart recorders. 100 millivolts for potentiometer strip-chart recorders.

Power: 105/125 volts, 60 cycles, 250 watts.

Dimensions: Cabinet Mount: 20½ in. wide, 12½ in. high, 18½ in. deep. (Rack Mount available.)

Weight: Net 60lb. Shipping 100lb.

Accessories Available: 1052-24, 3in. folded paper, 487carton.

Price: Price on request.

Data subject to change without notice

Price f.o.b. factory

Model 560A is a new kind of continuous duty instrument designed from the chassis up for digital recording of frequency counter output and similar information. It is specifically useful in recording time functions, telemetered data, information to be monitored, tabulated and plotted and system drift phenomena. It is also a convenient digital/analog converter for strip-chart production.

Frequency counter accuracy

Since -hp- 560A is a slave to its information source, accuracy is that of the counter or other source. The instrument's motor-driven print mechanism comprises 11 number wheels and associated mixing-comparator circuits. The print mechanism is controlled by a staircase voltage and external print command pulse. The availability of 11-digit lines means secondary or coding data may be printed on the same line as primary data.

Complete details from your -hp- representative, or write direct.

HEWLETT-PACKARD COMPANY

Represented by:

LIVINGSTON LABORATORIES

RET CAR STREET · LONDON, N.19, ENGLAND

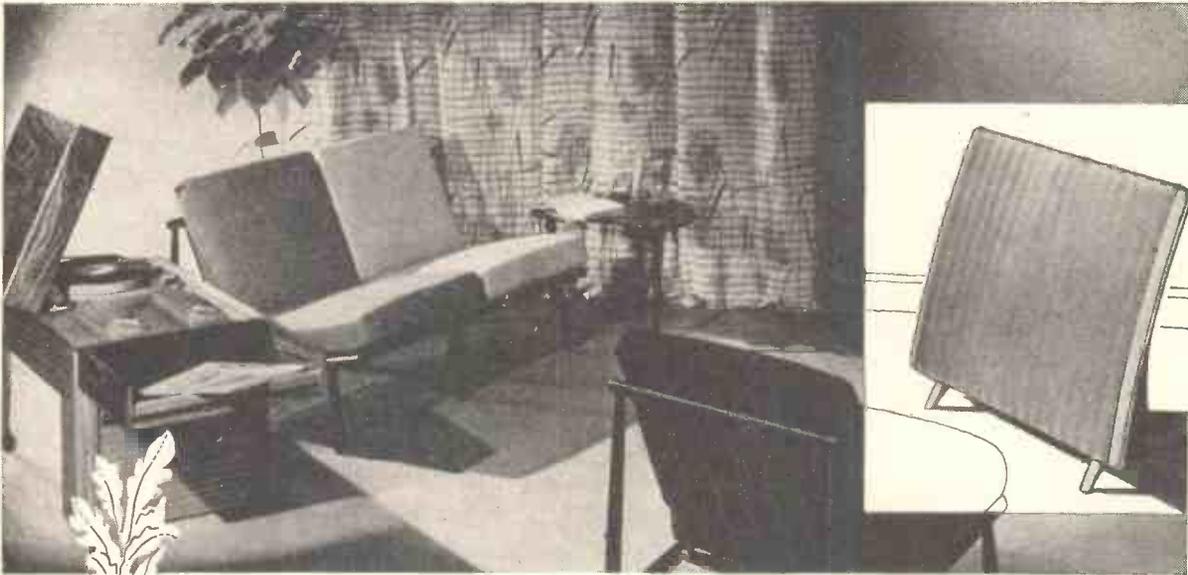
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speed, convenience, accuracy, value

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THE QUAD ELECTROSTATIC LOUDSPEAKER



To those who are awaiting the availability of this loudspeaker, we are very pleased to say that it is now in production and that orders are being accepted through our usual channels. It is likely that demand will exceed supply for some time — in waiting for your delivery please remember that we are allocating supplies as fairly as we can.

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The new brochure published by English Electric Valve Co. Ltd., gives data of the widest range of valves for industry, communications, radar and broadcasting made in Great Britain. A copy of this publication will be sent on request.



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- Klystrons*
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Telephone: Chelmsford 3491

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POWER-POINT

A revolutionary miniature *ceramic* record player cartridge with two sapphire tips.

POWER POINT is a proved sales success—over 3,000,000 have already been sold abroad!

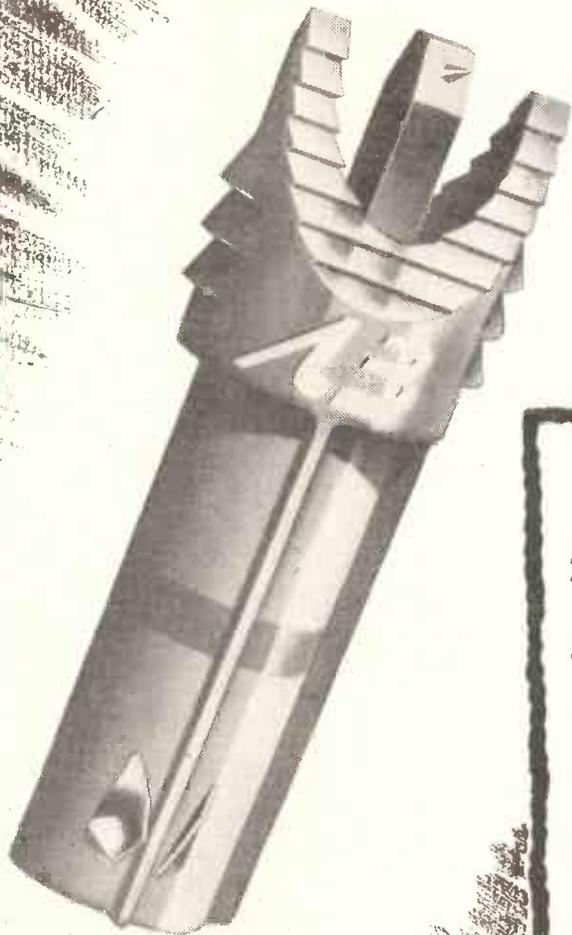
POWER POINT can be fitted to all popular pick-up arms.

POWER POINT is so easy to handle and so quick to replace—it solves your stylus replacement problems!

POWER POINT gives higher fidelity, longer life, and reduces record wear to a minimum.

OVER 3,000,000 **POWER-POINTS**

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

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

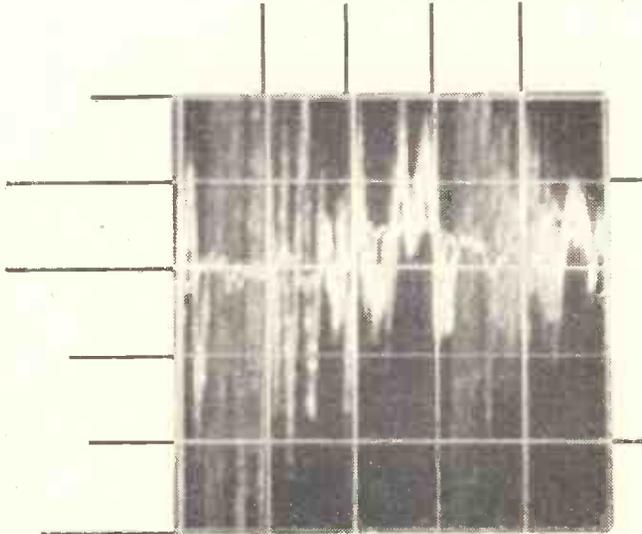
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A EUROPEAN TOUR
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Wholesalers and Retailers!**

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

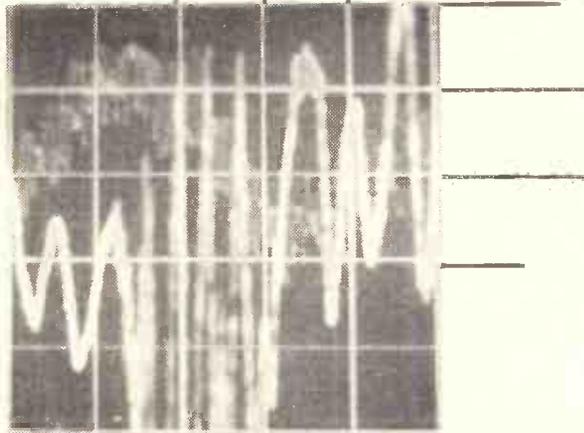
**You can profit from
POWER POINT!**

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

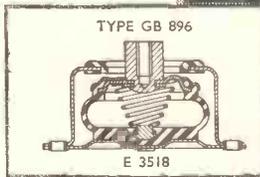
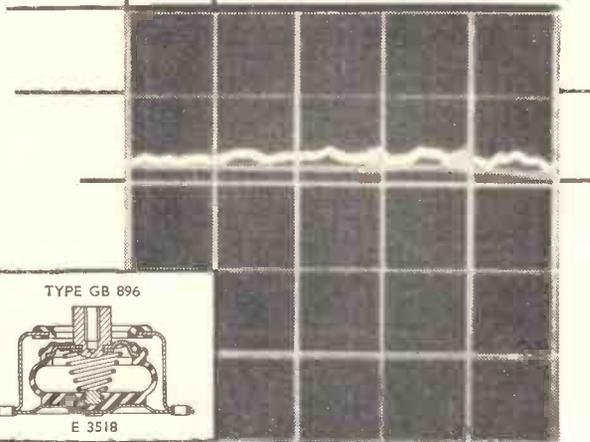
ARE ALREADY IN USE ABROAD!



Isolator "A" with some damping, but snubbing at resonance (15 c.p.s.). Metal to metal impact. Transmitted acceleration approx. 12 g. for sinusoidal input of ± 0.028 ". Envelope contains transients as high as 10,000 c.p.s.



Isolator "B" with little damping, but with rubber buffers to reduce shock at resonance (15 c.p.s.). High frequency transients reduced but transmitted acceleration still approx. 12 g. for same input.



"BARRYMOUNT" Isolator. Non-linear, air-damped. No snubbing at resonance (8 c.p.s.). Transmitted acceleration for slightly increased input (± 0.030 ") is 0.62 g. Note sinusoidal waveform of equipment.

Nett Gain < 1?

Where airborne application of instrumentation is concerned, it is all too easy to find "progress" has resulted in the substitution of one element of chance, not necessarily human, for another and the nett gain can actually be well below unity.

The new enemy is vibration. The more complex and sensitive the equipment, the more potent is the enemy, and protection against vibration becomes part of the design problem. Attempts to achieve isolation have often magnified the problem, for it is obvious that if a major component of the offending vibration happens to be at the resonant frequency of the isolator employed, danger is increased by the isolator itself.

To keep the resonant frequency of the isolator low is not a complete answer. In fact there is, as yet, no complete answer. But by far the nearest approach is today provided by "BARRYMOUNT"

Isolators, the principle of which is the complementary performance of non-linear springing and air-damping. Even at resonance "BARRYMOUNT" Isolators offer quite spectacular freedom from vibration, as the accompanying un-retouched oscillographs of transmitted acceleration show.

We shall be happy to tell you all you want to know about "BARRYMOUNT" Isolators. We shall be even happier to mount your "problem unit", in your presence, and give it "the works".

Your equipment rides safely on the



"BARRYMOUNT" and "BARRY B MOUNT" are Registered Trade Marks CEMENTATION (MUFFELITE) LTD. 20 ALBERT EMBANKMENT, LONDON, S.E. 11 TELEPHONE RELIANCE 6556

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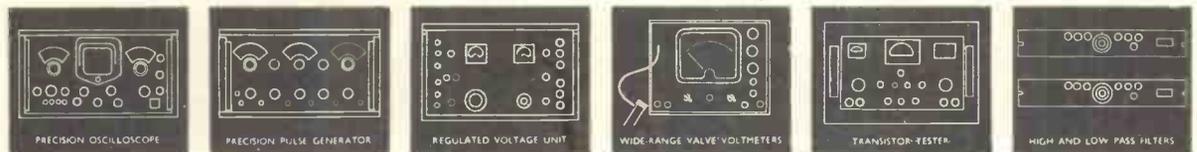
leading technicians
throughout the world
use the
Mullard
Dual Trace Oscilloscope

**The DUAL TRACE OSCILLOSCOPE
TYPE L101 MARK 2 as used by**

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Scientists and technicians throughout the world recognise that the quick, easy and accurate way to measure and compare waveforms is to use the Mullard Dual Trace Oscilloscope L.101 Mk. 2. Many hundreds of these oscilloscopes are now helping to speed production and research.

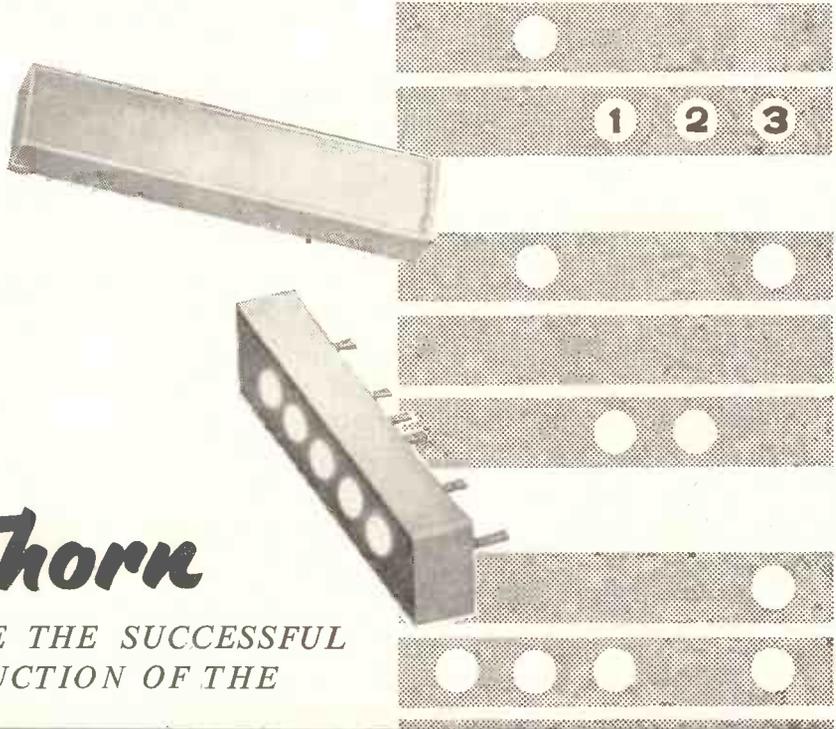
Here are some of the advanced design features that have brought this instrument international recognition: Two signals can be locked steady on the graticule for comparison and measurement by the turn of a knob. Two amplifiers preserve their frequency response on all gain settings—each has a 4Mc/s bandwidth (0.1 μ s rise time) irrespective of sensitivity, and a maximum sensitivity of 20mV pk/pk-cm. There is no interaction between channels. Free running or triggered, the time base has sweep speeds from 0.1 μ s/cm to 10ms/cm and the trace may be expanded five times. Both voltage ($\pm 5\%$) and time ($\pm 10\%$) are measured by the null method and calibration accuracy is preserved by a well regulated power supply.



Manufacturers and design engineers are invited to write for full details of the Oscilloscope L.101 Mk. 2 and other instruments in the Mullard range.

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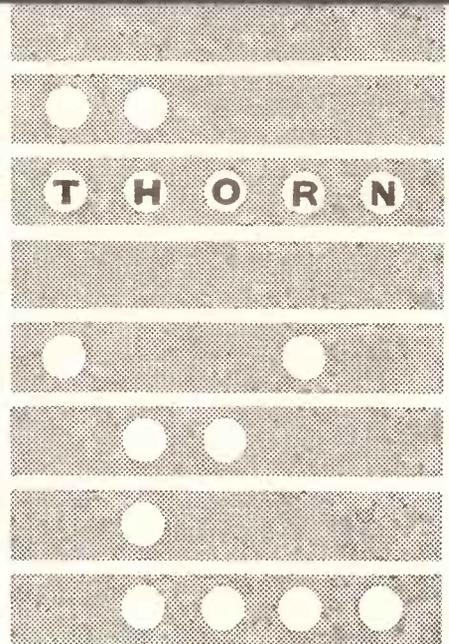
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**The essential component for
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For those planning assemblies requiring banks or panels of illuminated indicators, here is the ultimate in simplification, space-saving and economy. The newly developed Thorn Electro-luminescent block which has overall dimensions of only $2\frac{3}{16}'' \times \frac{1}{2}'' \times \frac{5}{16}''$ contains five electro-luminescent areas each with its separate contacts. These blocks can be assembled in great numbers and only occupy a fraction of the present space utilised by lamp indicators.

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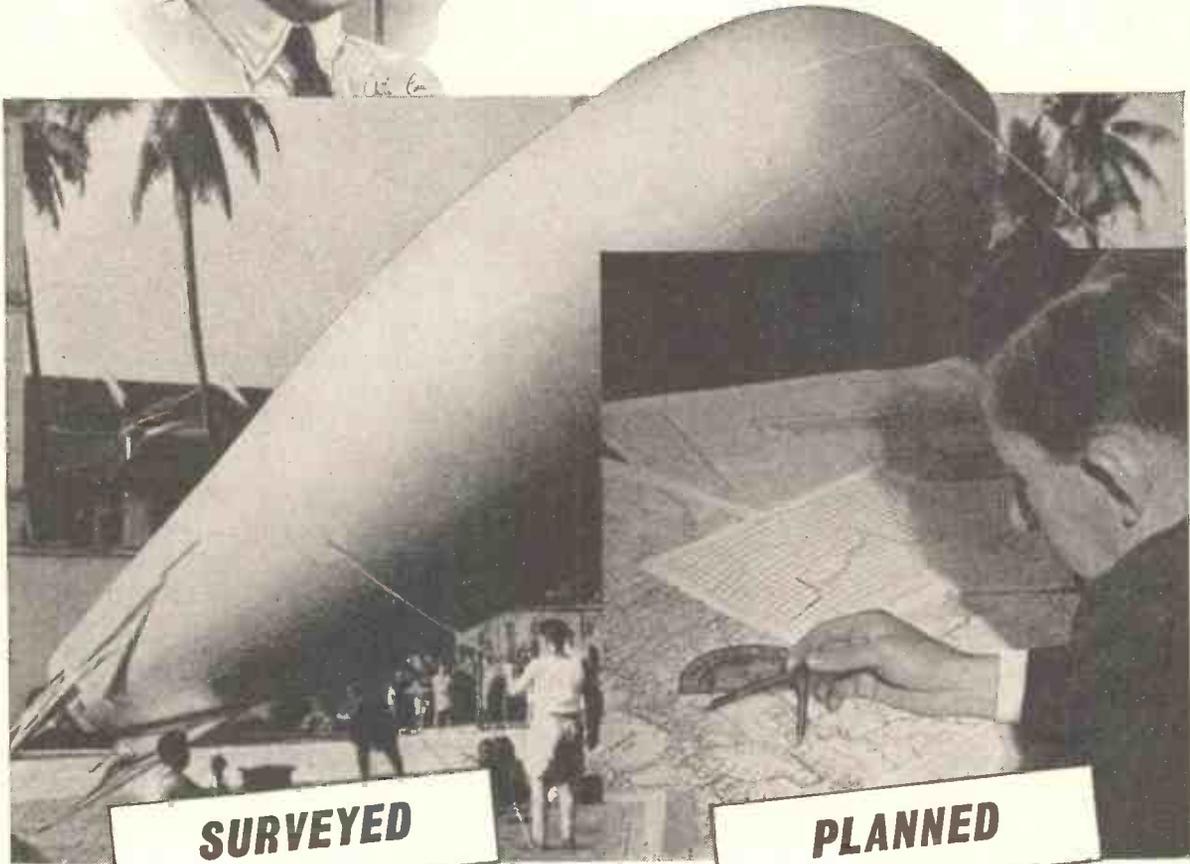
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MULTI-CHANNEL SYSTEMS VHF radio telephony was welcomed in its early days as an economic means of providing communication over inhospitable or undeveloped terrain. Today, such is the flexibility and reliability of multichannel radio equipment, that radio links carrying up to 600 telephone channels or a colour television programme are recognised as being preferable to the use of line or cable systems in many instances on grounds of performance as well as installation cost.

COMPLETE COMMUNICATION SYSTEMS — *all the world over*



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MARCONI'S & A.T.E. Co-operation between Marconi's and Automatic Telephone and Electric Co. Ltd., now brings together an unrivalled wealth of knowledge and experience for the benefit of all whose work lies in the field of telecommunications.

The Lifeline of Communication is in experienced hands

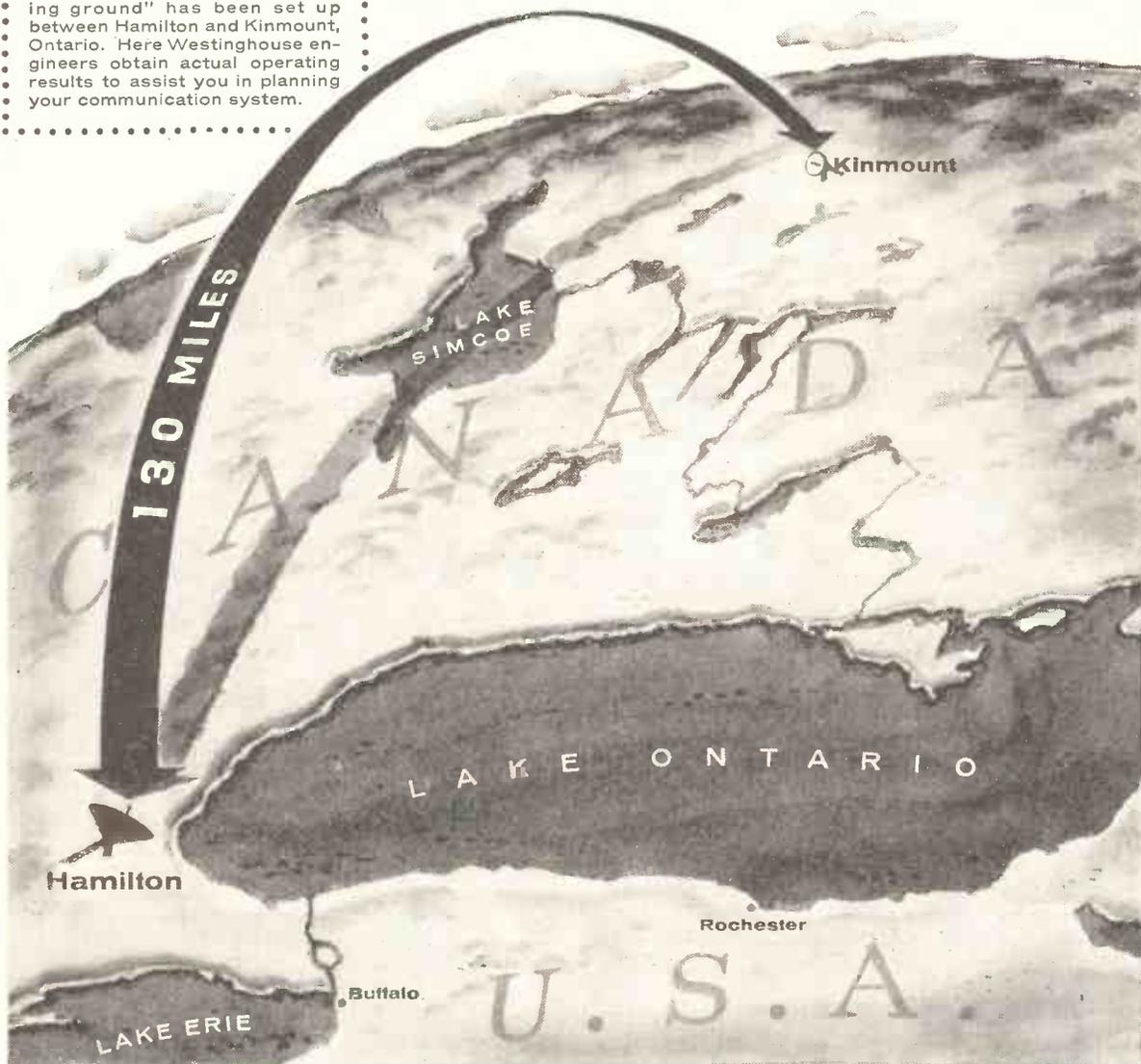


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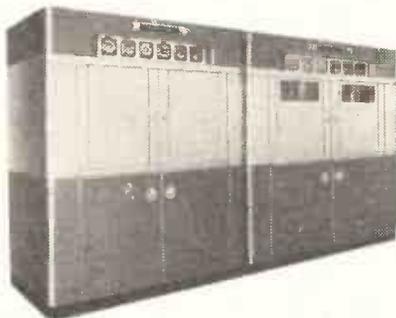
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 • A 130-mile Westinghouse "proving ground" has been set up between Hamilton and Kinmount, Ontario. Here Westinghouse engineers obtain actual operating results to assist you in planning your communication system.
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57-B-745R

SHF "Scatter" Transmission



New Westinghouse 4400-5000 mc. Transmitting and Receiving Equipment is compactly and durably designed for truck mounting or fixed installation for either commercial or military application.

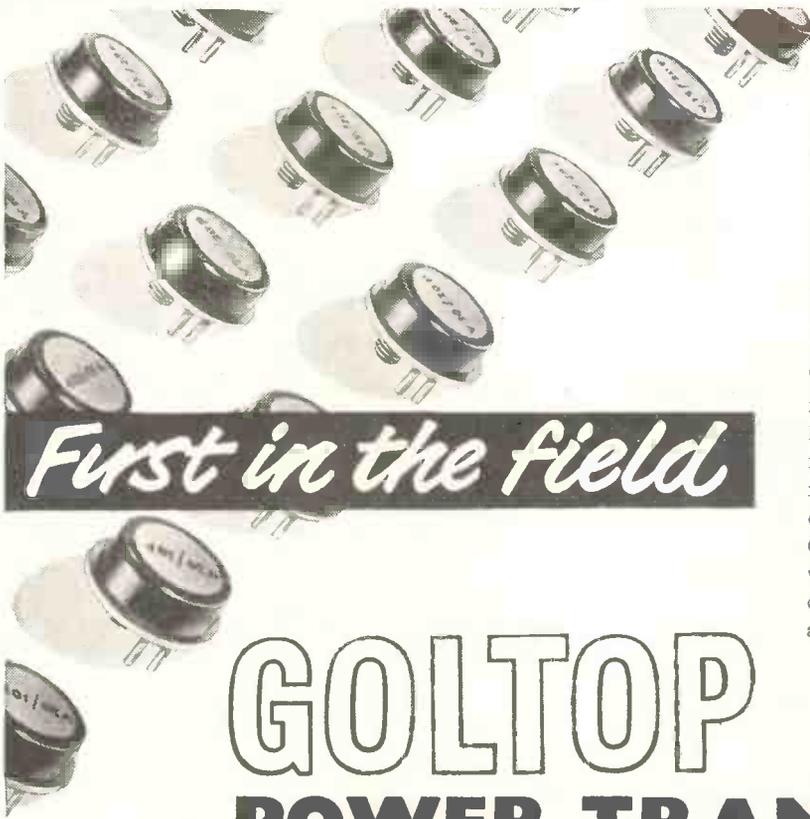
• Now for the first time in the communications field, scatter equipment for super-high frequency transmission for fixed or transportable operation has been introduced by Canadian Westinghouse.

• The new Westinghouse "Scatter" communications equipment is designed for high quality, high-reliability transmission of voice, teletype, telemetering, facsimile, television and data signals over hops of 100 to 200 miles. Voice capacity for multi-channel operation extends to 120-150 channels.

• Contact your local Westinghouse Sales Office for Descriptive Bulletin H83-100 or write Canadian Westinghouse Company Limited, Electronics Division, Hamilton, Canada.

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First in the field

These have been in regular quantity production for the past two years, and have proved themselves reliable and stable in a *variety* of applications. They are admirably suitable for all forms of DC to DC or DC to AC Converters, High Power portable Amplifiers and Public Address Equipment. "GOLTOP" Power Transistors are the first to be offered for immediate delivery in quantity. Representing the latest developments in semi-conductor technique for power applications, these entirely British-made p-n-p Germanium Junction Transistors will open up entirely new fields to designers of industrial, commercial and military equipment.

GOLTOP POWER TRANSISTORS

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Available in 6 TYPES, all for 10-watts power dissipation:

V15/10P. V15/20P. V15/30P. for 15 volts max.
V30/10P. V30/20P. V30/30P. for 30 volts max.

Maximum Collector Power Dissipation (DC or Mean) for all types	$t_{amb}=25^{\circ}C$	$t_{amb} > 25^{\circ}C$ Reduction/ $^{\circ}C$
(1) Clamped directly on to 50 sq. in. of 16 S.W.G. aluminium	10W	200mW
(2) Clamped directly on to 9 sq. in. of 16 S.W.G. aluminium	4W	80mW
(3) As (2) but with 2 mil mica washer between heat sink and transistor	2W	40mW
(4) Transistor only in free air	1W	20mW

- * High power rating—up to 10W at audio and supersonic frequencies.
- * High current ratings up to 3A DC.
- * Long life.
- * Excellent resistance to mechanical shock.
- * Hermetic sealing and rigorous manufacturing control ensure uniformity and stability of a high order.



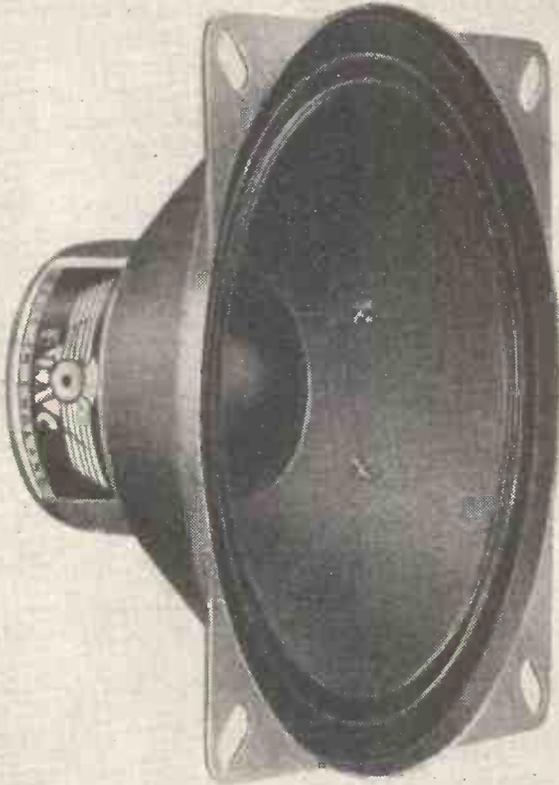
British Design, Materials and Craftsmanship

Data sheets gladly forwarded on request

All trade enquiries to: **Newmarket Transistor Co. Ltd.**
Exning Road, Newmarket. Telephone: Newmarket 3381/4

EX 10715

The latest in the Hi-Fi range



The Elac 4 inch Tweeter

A further addition to the "Elmag" High Fidelity range, this 4in. cone type Tweeter is the finest of its class yet produced. Response to transients is exceptionally good and the absence of undesirable peaks results in clear and smooth reproduction.

For best results it should be used with a suitable cross-over filter in conjunction with 1 or 2 larger units.

Frequency response within 5 dB from 5,000-17,000 cps, only 7½ dB down at 20,000 cps.

OVERALL SIZE : 4in. DIA. x 2½in. DEEP.

POWER HANDLING : 2 W. Peak A.C. INPUT.

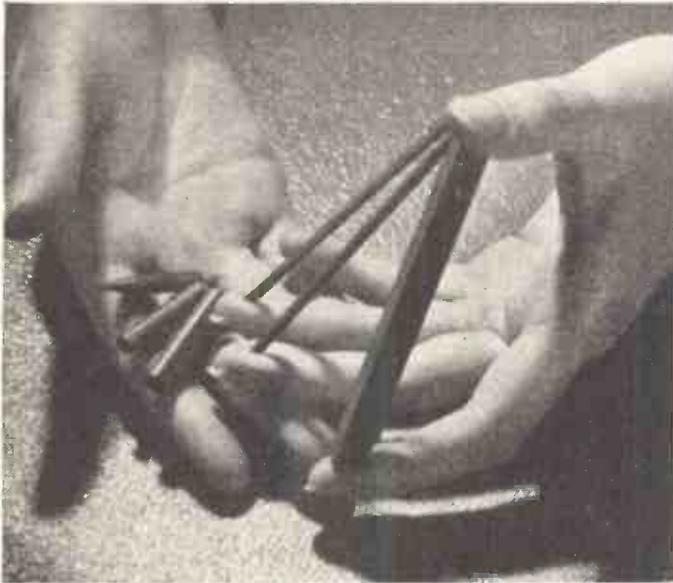
VOICE-COIL IMPEDANCE : 6 ohms at 5,000 cps.

PRICE : 29/10 inc. P.T.
Trade Terms 33⅓%.

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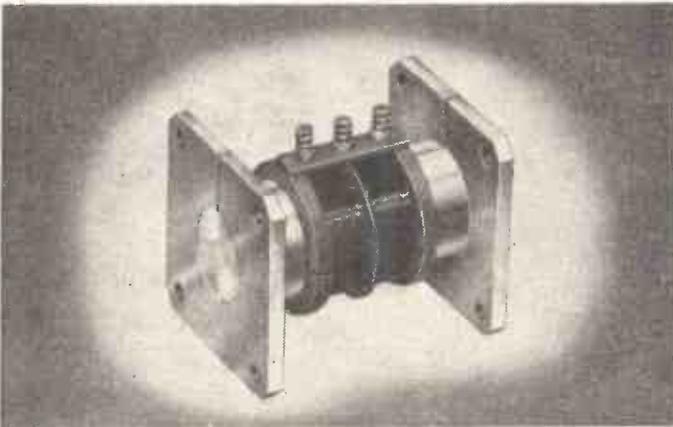
FERRANTI FERRITES



MICROWAVE FERRITE TYPE F5X

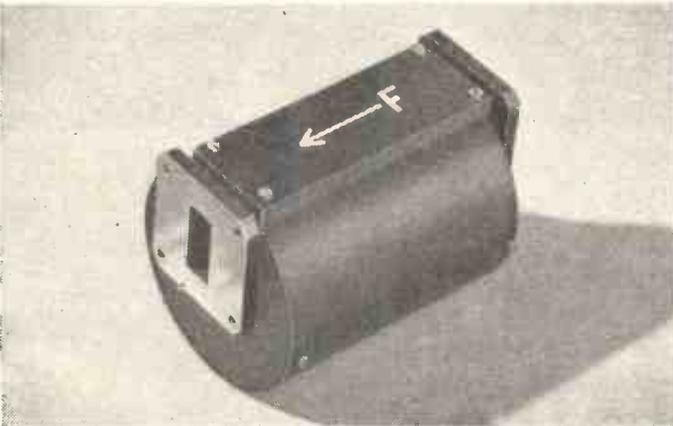
- Available in rod or slab form.
- Suitable for X-Band frequencies and above.
- Specific rotation $30^\circ/\text{cm}$.
- Figure of merit $330^\circ/\text{db}$.
- Permittivity 12 approx.

Microwave measurements carried out at 9,750 Mc/s. on a 0.2" diameter rod supported in 0.7" diameter waveguide. The permittivity of the supporting material was virtually unity.



FERRITE SWITCH

- Minimum frequency band 9,600 to 9,800 Mc/s.
- Insertion loss 0.5 db max.
- Peak attenuation 30 db min.
- Power handling capacity 30 Watts mean.
- Dimensions $1\frac{1}{8}" \times 1\frac{1}{8}" \times 2"$ long.
- Total weight 3 ozs.



FERRITE ISOLATOR

Designed for operation up to a peak incident power level of 75 kW or a mean incident level of 75 Watts. The reverse attenuation is greater than 20 db over any 10% frequency band between 8,500 and 10,000 Mc/s with forward attenuation less than 0.8 db, V.S.W.R. less than 1.2 over the frequency band.

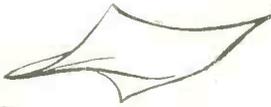


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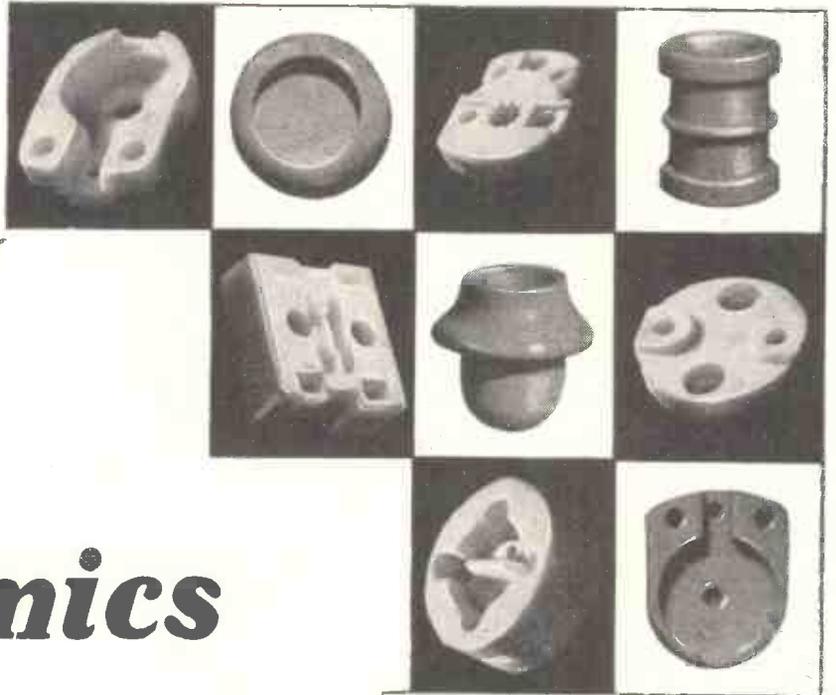
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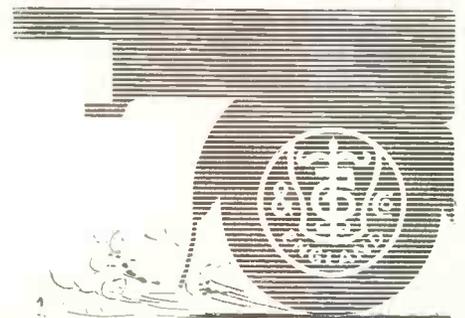
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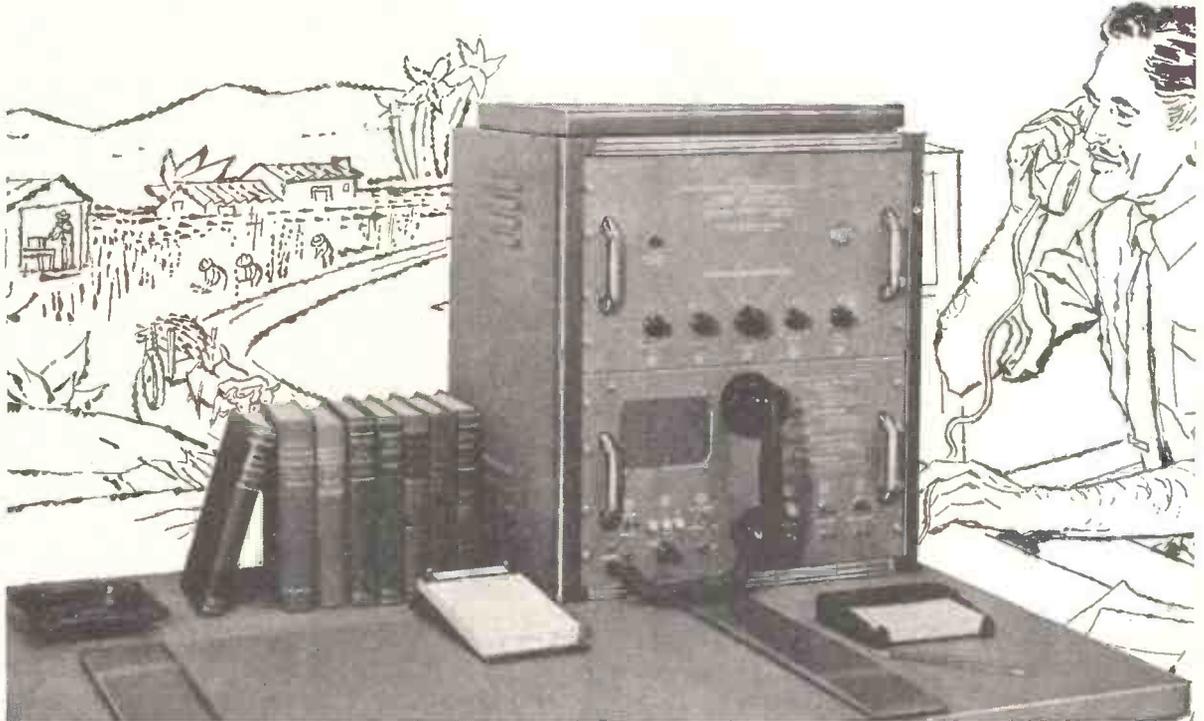
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- *Costs Less To Own, Less To Operate*
- *8 Times More Effective—60 Watt SSB-1 equivalent to 500 Watt AM Transmitter*
- *Saves Power—emission only takes place during actual transmission*
- *Easy To Operate—simple switch selects any of four pretuned channels*
- *50% Less Noise And Interference—less distortion*
- *Greater Privacy than conventional AM Transmission*
- *Spectrum Conservation—frequency space about 2.8 Kc*

The SSB-1 meets the needs of private and governmental organizations that require high quality economical radio and telegraph communications.

RCA SSB-1 Single-Sideband Transmitters installed in commercial and governmental operation are providing users with trouble-free dependable service over many hundreds of kilometers under the most adverse

climatic and operational conditions. Installation is simple—merely connect it to the antenna and suitable power supply. Operation is simple—non-technical personnel can change to any of four frequencies by turning selector switch. Easy-access chassis permits quick channel tuning and replacement of tubes.

SSB-1 telegraph signals can be received by stations equipped for high-frequency CW. Its telephone signals can be heard by AM receivers equipped with a beat-frequency oscillator. The transmitter's special "Carrier-On" switch permits compatible operation with conventional AM receivers, when necessary. In turn, SSB-1 can receive most high-frequency telegraph and AM telephone signals.

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Specifications—Model SV-5

RANGE	12 Channels and IF.
SWEEP WIDTH	Approx. 25 mc. adj.
OUTPUT	1 volt into 75 ohms.
IMPEDANCE	75 ohms.
FLATNESS	5% over each channel. 10% overall.
ATTENTION	Atten. #1 20, 20, 10, 6, 3 db. } Plus vernier
MARKERS	Atten. #1 20, 20, 10, 6, 3 db. } atten. 0-10-db.
SIZE	Pulse type on video and audio carriers.
	10" × 12" × 9½".

(One 75 to 300 ohm balun is supplied—extra baluns are available.)

TELONIC SWEEP and MARKER GENERATORS 0-2400 mc

Hundreds of standard models—send for catalogue

Telonic VHF Sweep Generators—"Standard of the TV Mfg. Industry"

This 13-position sweep generator uses a separate crystal on each channel to produce 2 pulse markers, one on the video and one on the audio carrier frequencies. A special circuit forms pulses with much greater accuracy and stability than the usual multi-vibrator method.

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Dual attenuators permit instantaneous comparison of unit under test to a standard unit by use of an electronic switch and also permit production set-ups involving permanent connection to an IF input without disconnecting the RF input.

An extra marker can be supplied on the I.F. channel at extra cost.

SV-5 —American standards.

SV-5F—Frequency and power may be specified to meet other requirements.

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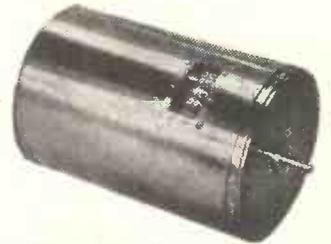
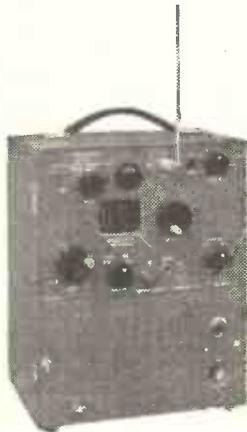
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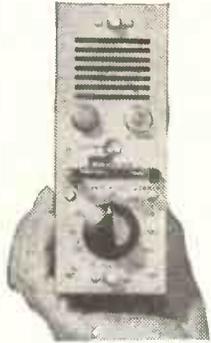
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DRIFT FREE
DC μ V
AMPLIFIER



The **KIN TEL MODEL III** amplifier provides the lowest drift of any commercially available broad-band d-c amplifier. The unique circuit incorporates **KIN TEL'S** proven chopper amplifier system to provide unsurpassed dynamic performance—unaffected by load or gain changes. Available in a single-unit cabinet or a six-amplifier rack-mountable module only 19in. wide, the **Model III** is ideal for data reduction facilities, or as a strain gauge amplifier, recorder driven amplifier, or general purpose laboratory amplifier.

SPECIFICATIONS

- $\pm 2\mu$ v equivalent input drift
- Integral power supply
- ± 35 V, ± 40 ma output
- 100,000 Ω input impedance
- 0 to 1 000 gain in ten steps
- $\pm 1\%$ gain accuracy
- 5 μ v peak equivalent input noise
- Price (Single) Amplifier \$550.

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UNIVERSAL METER
microvolts to kilovolts

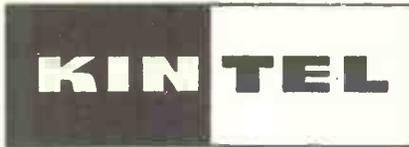


This new microvolt-am-meter-amplifier will measure as little as 10 μ v or 10 μ ma with accuracy. It may also be used as a DC amplifier with up to 80 db gain and only 10 μ v drift. A zero-centre mirrored scale provides instant polarity indication. Utilization of **KIN TEL'S** chopper stabilized circuit provides versatility, accuracy, and stability that is unobtainable with conventional VTVM's. The **Model 203** is the ideal general purpose laboratory meter, production test set, or null meter.

SPECIFICATIONS

- 100 μ v to 1,000 v fs.
- 100 μ ma to 100 ma fs.
- 25 ranges.
- 100 megohms input impedance.
- 80 db gain as amplifier.
- 10 μ v equivalent input drift
- 1 volt output into 1k Ω .
- Price \$550.

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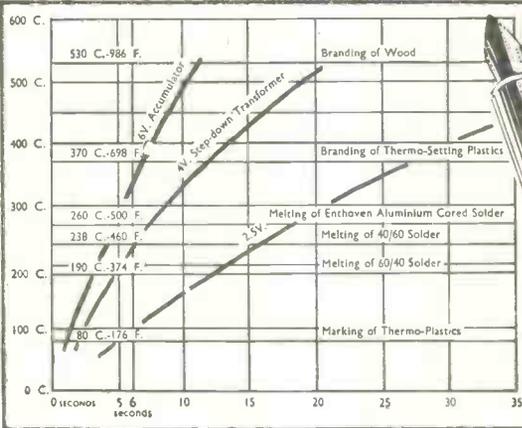
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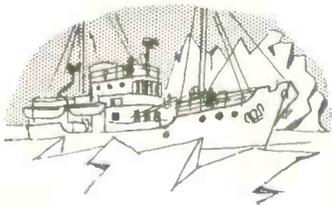
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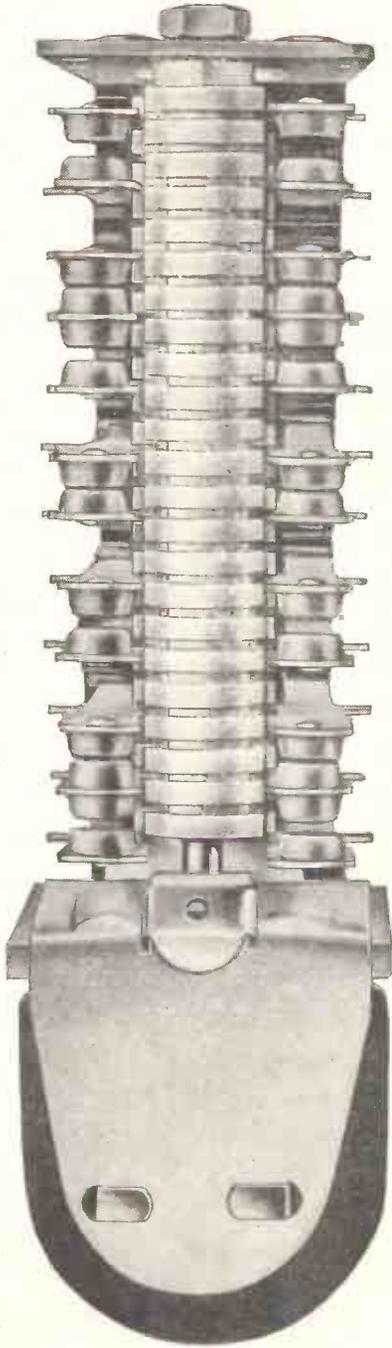
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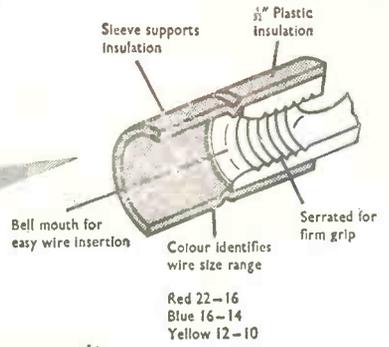
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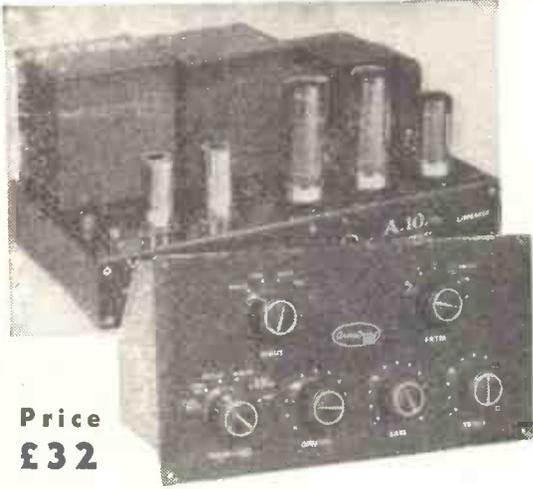


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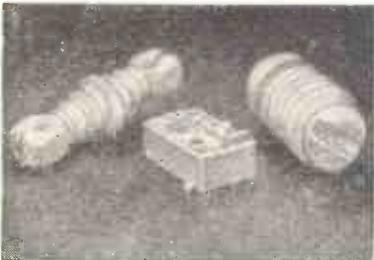
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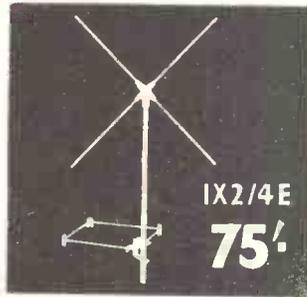
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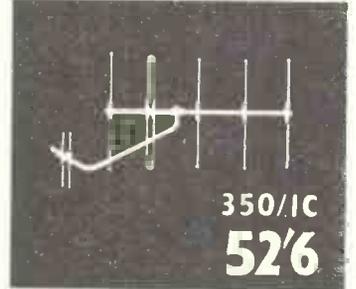
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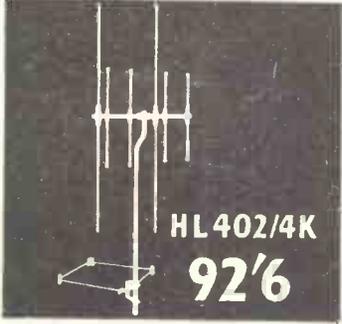
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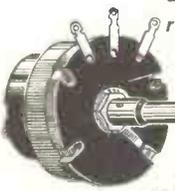
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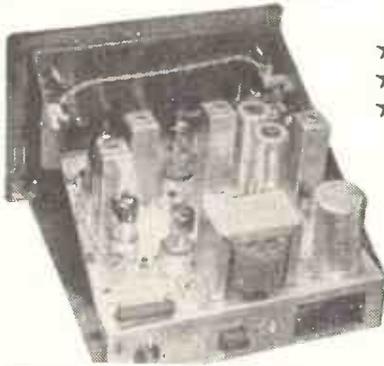
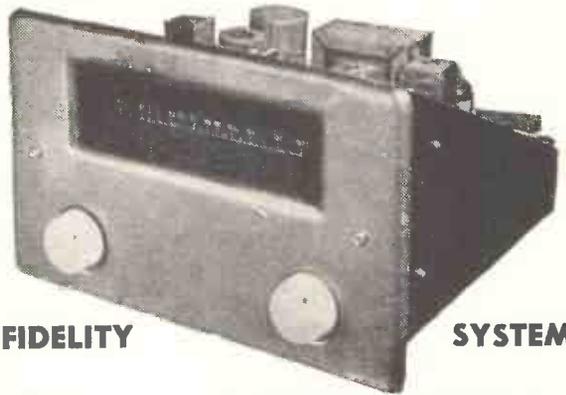
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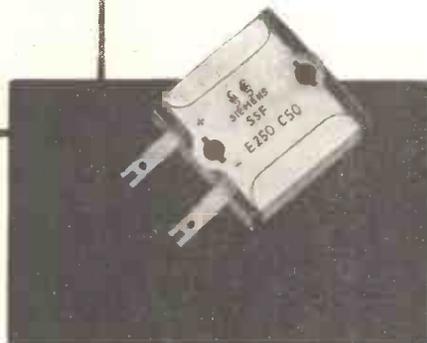
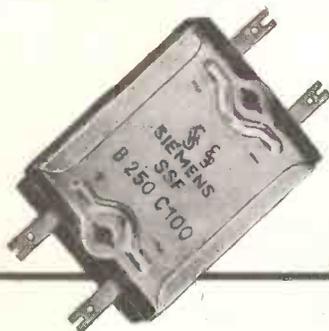


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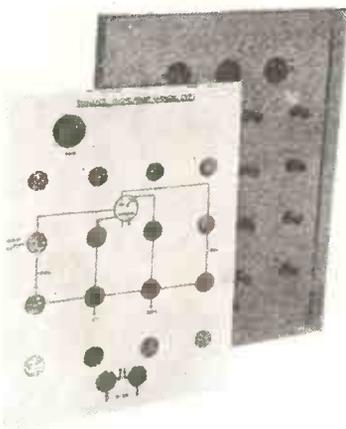


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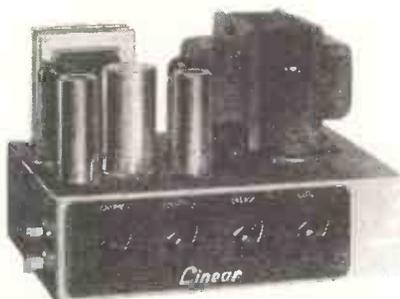
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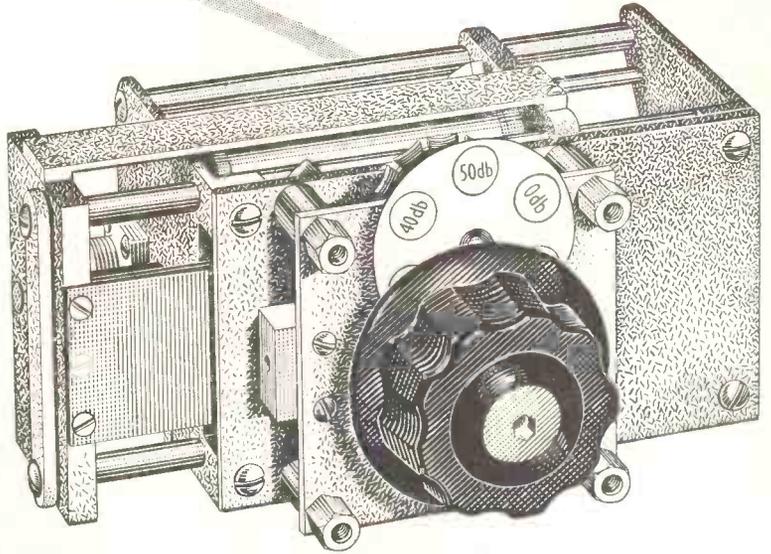
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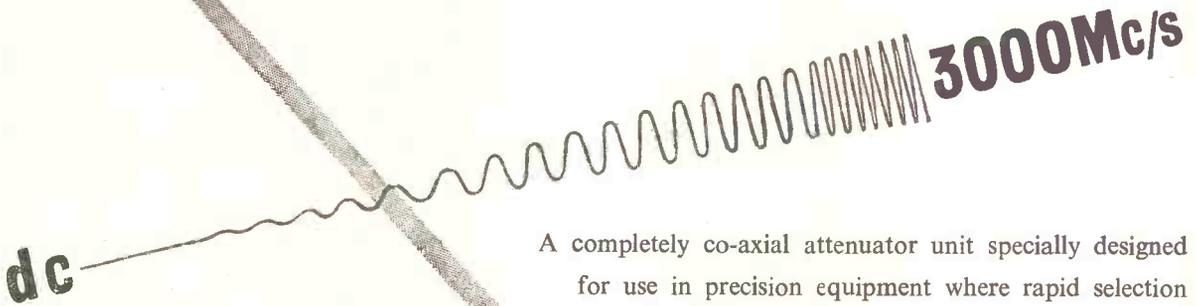
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		V	mA										
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XFY14	A.F. O/P. Pentode ...	1.25	50	67.5	67.5	-6.5	3.1	0.95	0.65	0.02	65	5672	2238
XFY15	A.F. O/P. Pentode ...	1.25	20	67.5	67.5	-6.5	3.1	0.95	0.65	0.02	65	5672	2238
XFY54	A.F. O/P. Tetrode ...	1.25	10	22.5	22.5	-2.0	0.34	0.08	0.28	0.03	2.75		
XFRI*	R.F. Amp. Pentode ...	1.25	100	45	45	0	3.0	0.9	2.0			IAD4	2237
XFR2*	R.F. Amp. Pentode ...	1.25	50	67.5	67.5	0	1.8	0.5	1.1			5678	2254
XFR3	R.F. Osc. Triode ...	1.25	120	135		-5.0	4.0		1.65			5676	2239
XR4	R.F. Power Amp. ...	1.25 2.5	125 62.5	125	125	-7.5	7.0	1.1	1.95			6397	
XFR5	R.F. Amp. Pentode ...	1.25	20	67.5	67.5	0	1.8	0.5	1.1			5678	2254

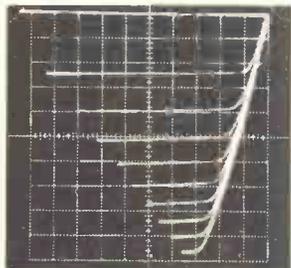
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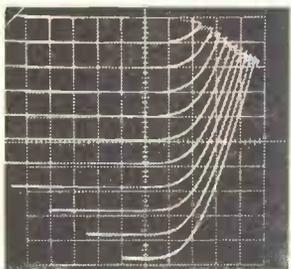
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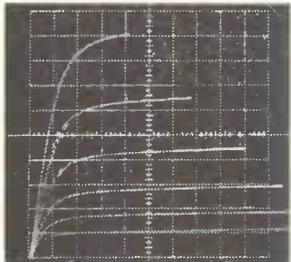
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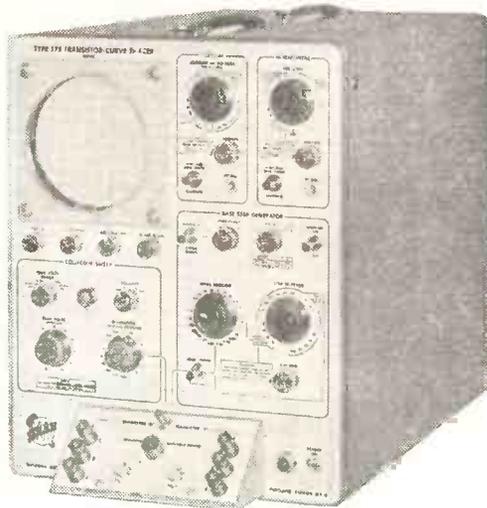
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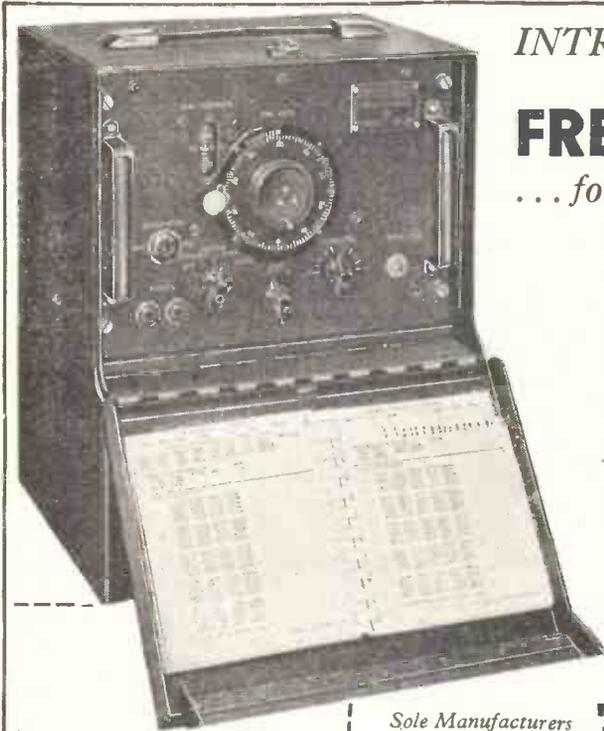
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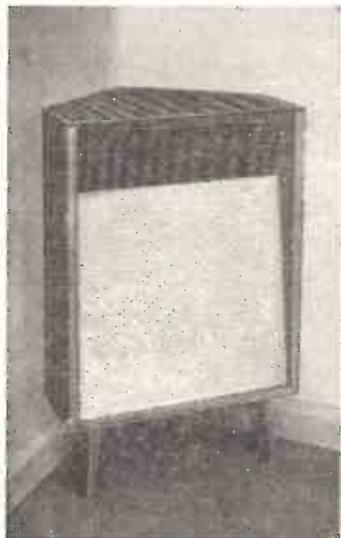
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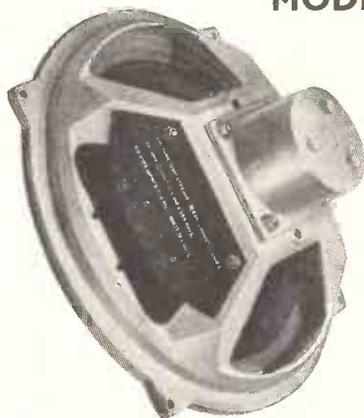
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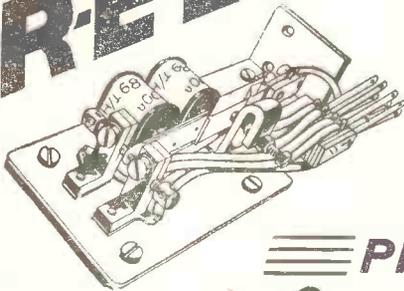
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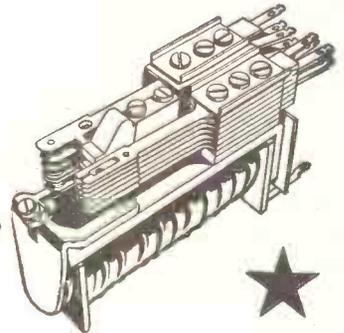
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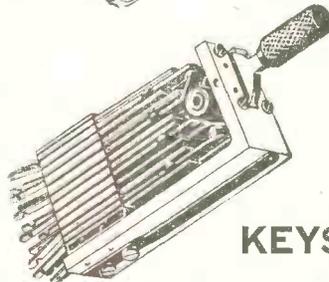
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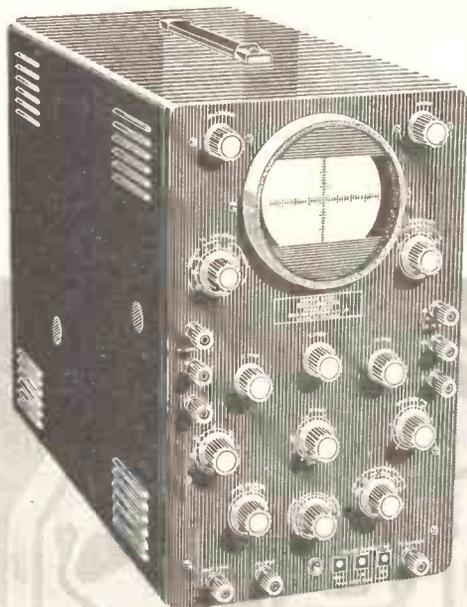
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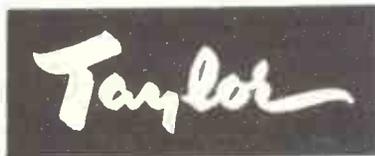
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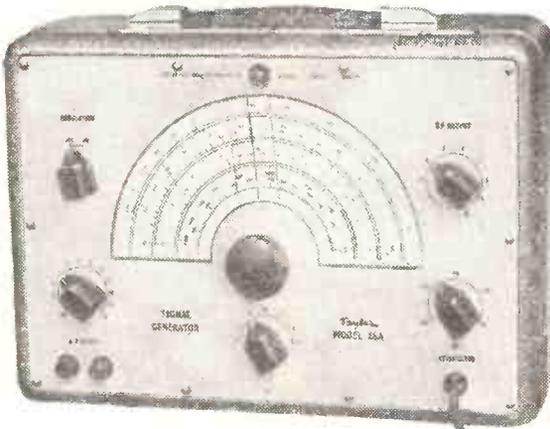
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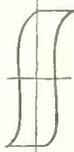
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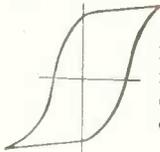
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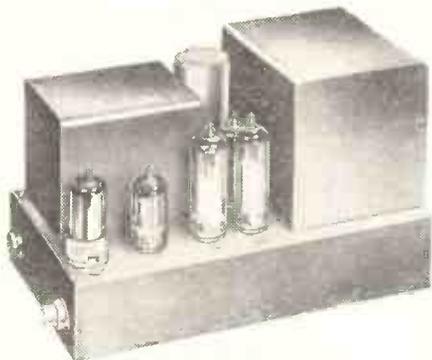
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RR Series 102

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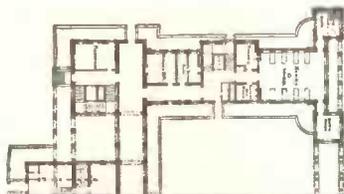
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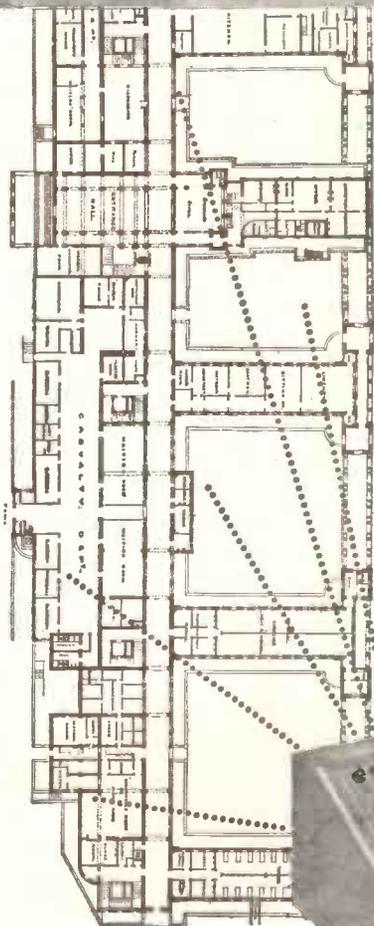
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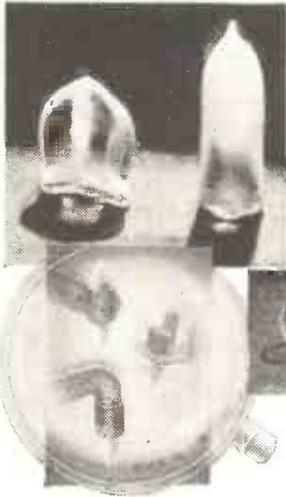
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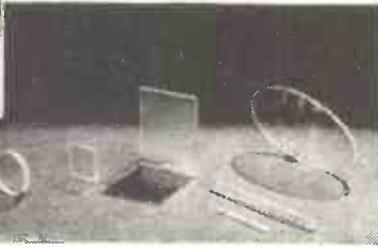


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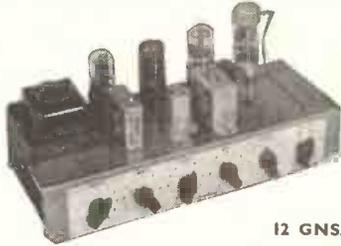
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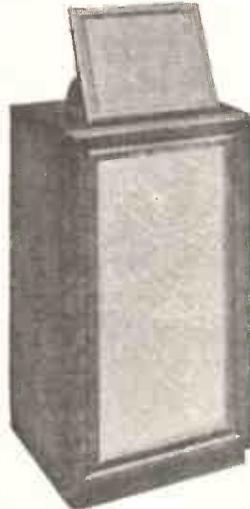
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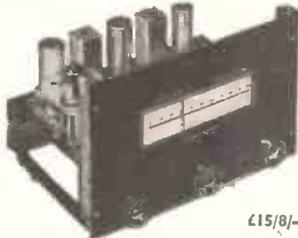
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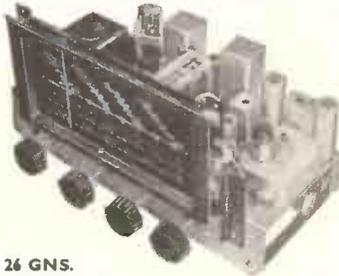
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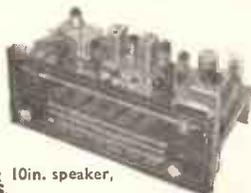
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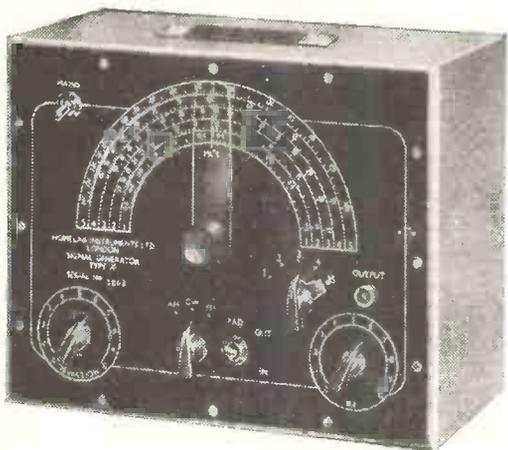
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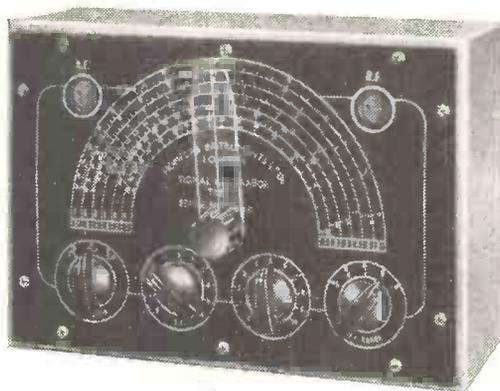
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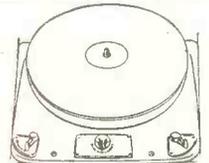


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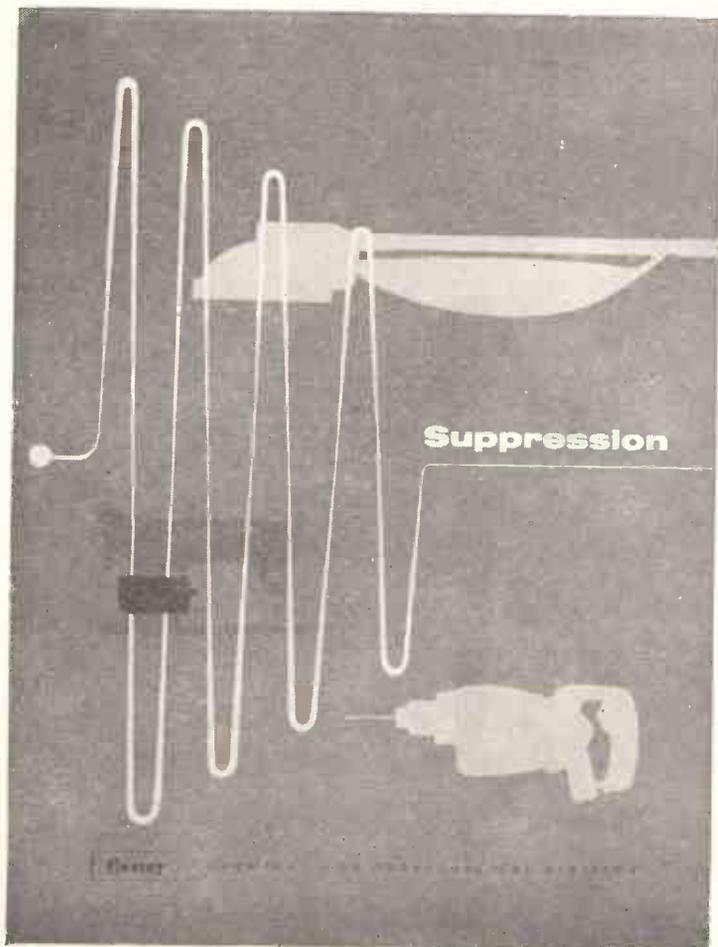
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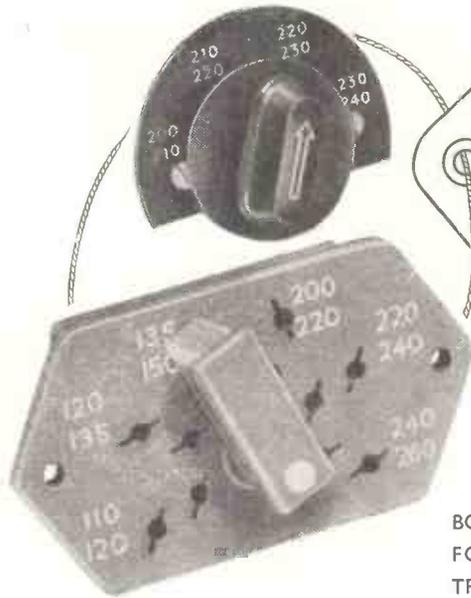
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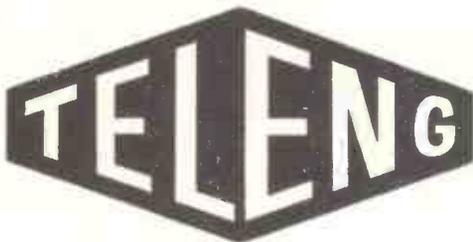
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JSP/MV57



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Mark III—40 to 220 mc/s (covering ALL Bands 1, 2 and 3) Gain 20 db \pm 2 db. 75 ohms in and out. Rack Mounting.
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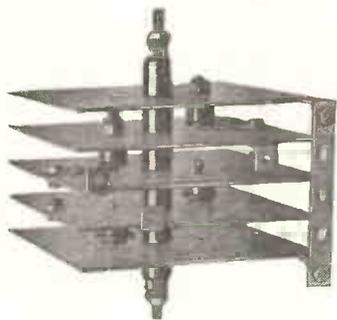
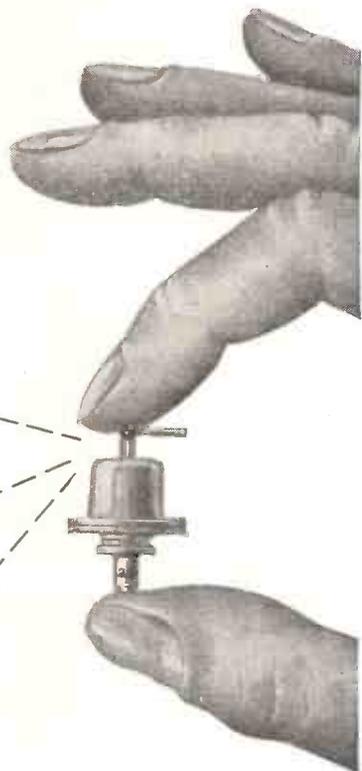


'GEX 541' germanium power rectifier available in finned and unfinned stacks

The basic element in all stacks is the GEX 541 diode, standard ranges being available in both finned and unfinned stacks. Whether a finned or unfinned stack is used for a specific application will depend upon monetary and space considerations.

Using series and parallel diode connections, power requirements of up to 30 kVA are economically handled by finned units. With derating, operation is still possible up to a maximum ambient temperature of 55°C. Each stack illustrated uses four diodes.

Rectifier units constructed with this diode show remarkable improvements over those previously available.



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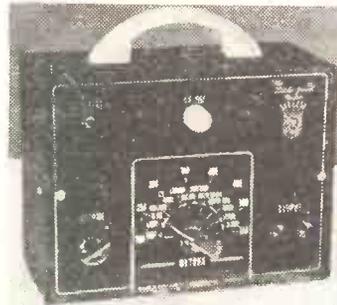
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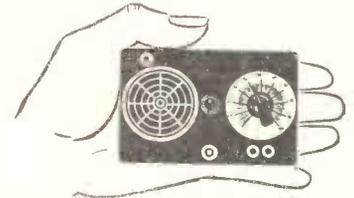
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FOR ONLY
37'6

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47'6

Build this exceptionally sensitive double triode radio. Uses unique assembly system and can be built by anyone without any radio knowledge whatever in 45 minutes. Handsome black-crackle steel case with specially made black and gold dial with stations printed. Size of radio only 6½in. x 5in. x 3in. Covers all Medium and Long waves—uses only one all-dry battery. H.T. consumption only 1 to 1.5 mA. Uses personal phone. Ideal for Bedroom, Garden, Holiday, etc. Many unsolicited testimonials. Mr. Norton of Oxted writes: Yesterday evening on the Medium waveband, I counted 32 separate stations; I am very pleased with the set, which is well worth the money. **BUILD THE "SKYROMA" NOW!** Total building cost—everything down to last nut and bolt—**47/6** (Postage, etc. 2/-. C.O.D. 2/- extra).—with full set of clear, easy-to-follow plans. (Parts sold separately. Priced Parts Lists, etc., 1/6).



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Outstanding performance in TWO functional groups

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The low hole storage and high current of this new junction diode particularly recommend it for this group of applications. The peak forward current is 1 amp at less than 1 volt drop, and its hole storage specification approaches that of a good point contact diode.

The OA10 can be very successfully employed as a coupling element in junction transistor circuits, particularly for computing applications. In addition, its high current characteristics suit it for ferrite magnetic memory circuits in computing and shifting registers.

Applied as a ring modulation diode, the sharp forward discontinuity and the stability of that characteristic are outstanding.

In transistor power supplies

The small size and low forward losses of the OA10 fit it for use as a general purpose mains rectifier for transistor power supplies. A single diode in a half-wave rectifier circuit will deliver up to 100mA d.c. at 6 volts. A bridge circuit will deliver up to 200mA at 12 volts.

In addition, the OA10 can be used as a non-linear temperature coefficient compensating device in germanium transistor circuits. It also finds application as a voltage stabiliser in its forward current direction where the voltage drop across it (about 0.4 volt) is relatively independent of current.

* Full data on the OA10 and other diodes and transistors in the Mullard range are available from the address below.

		At 25°C amb. temp.	At 60°C amb. temp.
Max. reverse voltage, d.c. or peak	(V)	30	30
Max. forward current:			
Peak (5 μ sec. max.)	(A)	1	1
Average (50msec. averaging time)	(mA)	100	100
Average Characteristics			
Forward voltage (at 0.3mA)	(V)	0.2	0.13
" " (at 100mA)	(V)	0.5	0.44
Reverse leakage current (at -20V)	(μ A)	1.5	10
Hole storage recovery time*	(μ sec.)	0.35	0.35
Capacitance (at -10V)	(pF)	4.0	4.0

* For test conditions see published data



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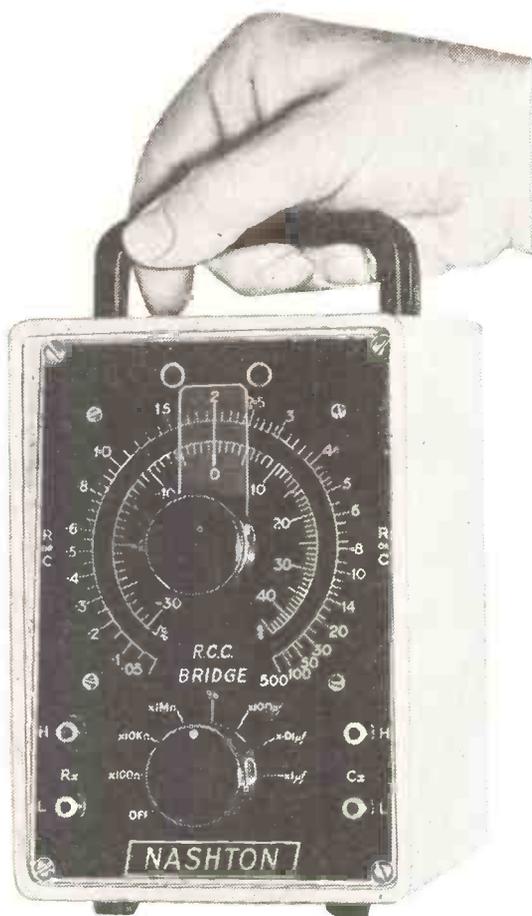
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2 $\frac{1}{2}$ % from 20 Ω to 20M Ω)

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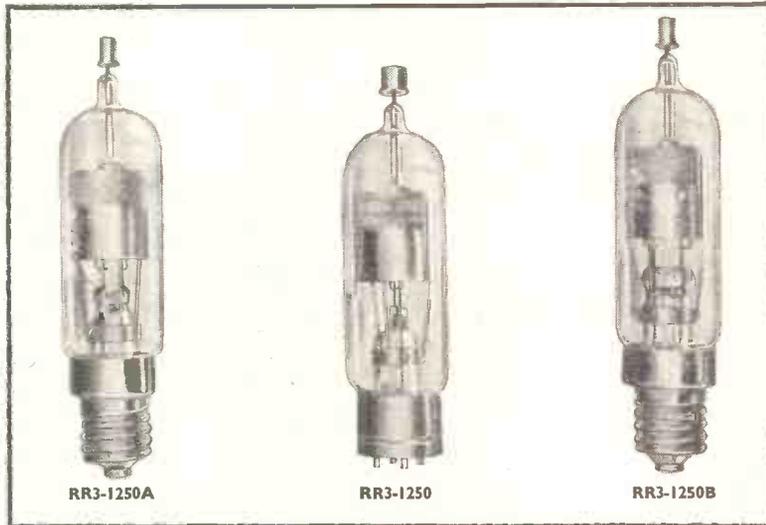
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3 new high voltage xenon rectifiers



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

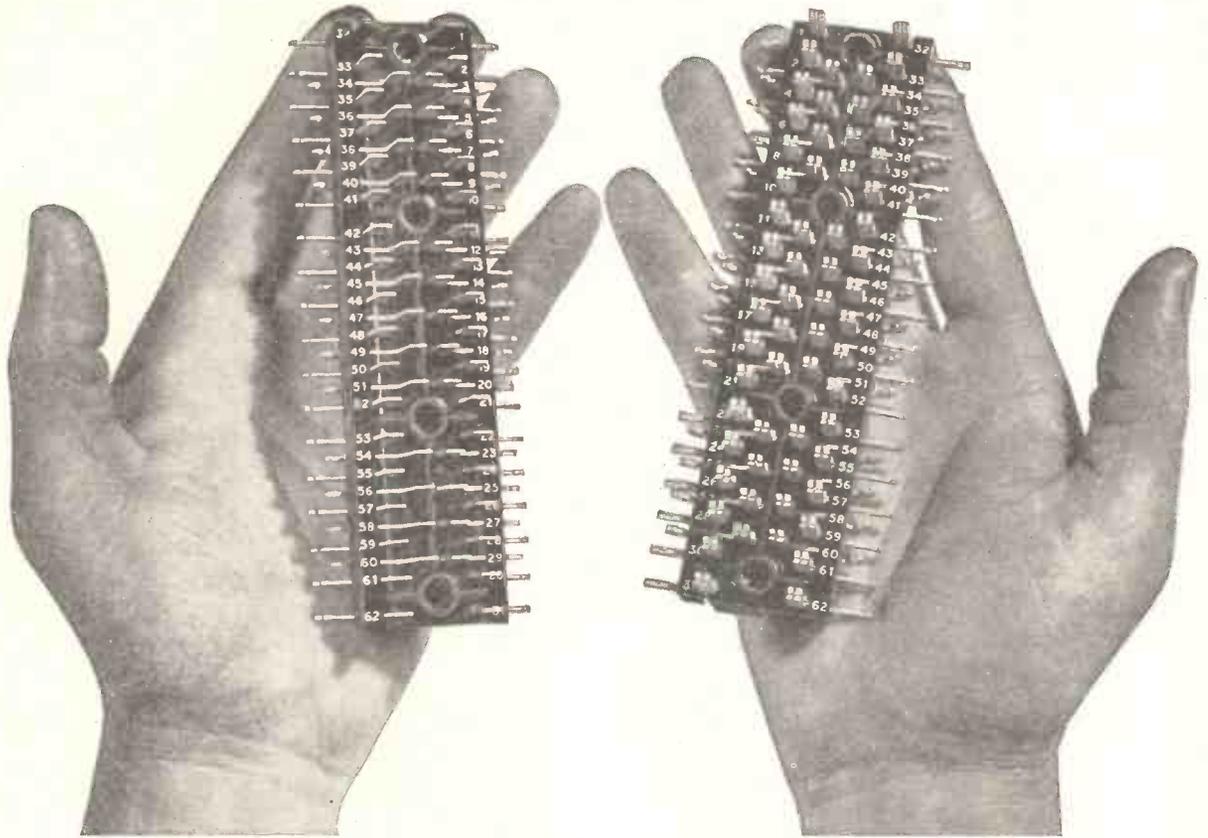
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MVT 330a



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SPECIFICATION

Contact Resistance:	less than 3 milli-ohms
Insulation:	2kV. between contacts
Voltage rating:	750V. r.m.s. working
Current rating:	10A. max. per single contact
Insertion pressure:	30 lbs.
Withdrawal pressure:	13 lbs.

31-way connector also available with identical specification except insertion and withdrawal pressures are 20 lbs. and 9 lbs. respectively.



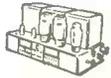
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The RCA "VICE PRESIDENT" High Fidelity phonograph (illustrated right) is a beautifully styled record reproducer with a quality of reproduction never before associated with instruments of its size. Panoramic triple speaker system; 10 watts peak power from push-pull amplifier with frequency range 40-20,000 cycles; triple control system; 4-speed changer.

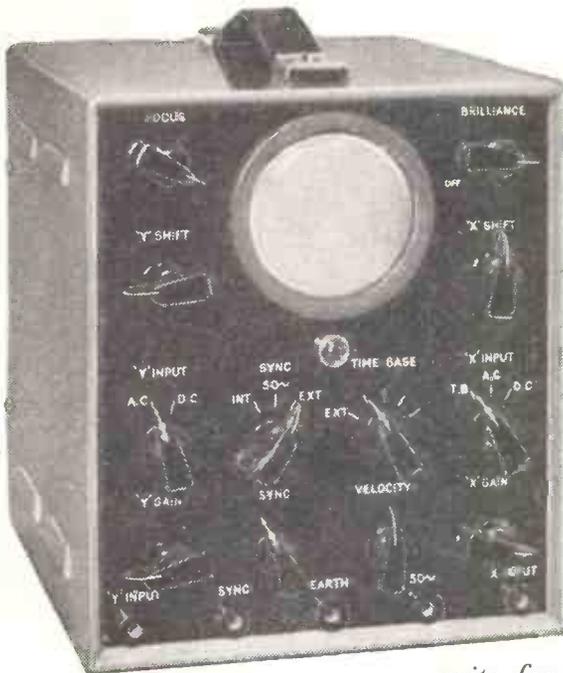
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(tax paid)



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Tube 3in. diam.

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Sensitivity 50mV/cm. C.R
Tube 3in. diam.
Dims: 7½x4½x7½ ins.



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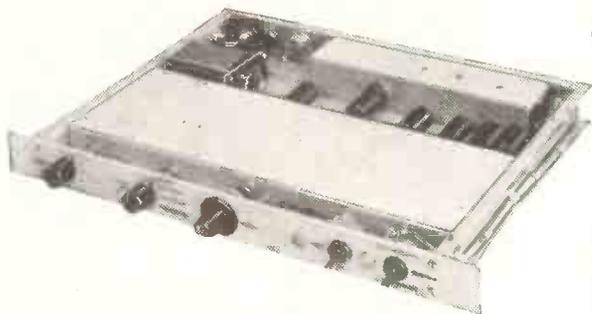
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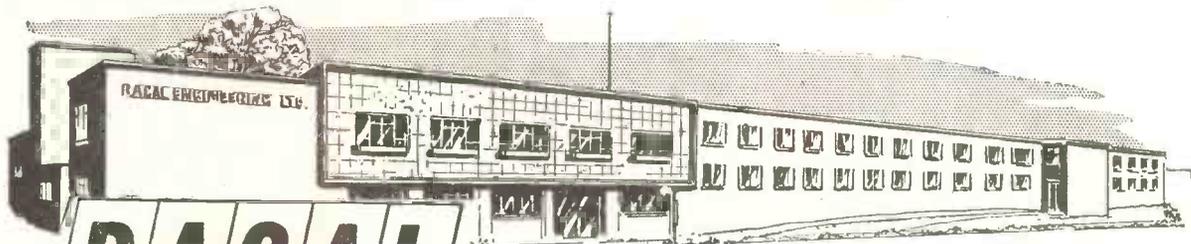


0.5 to 30 Mc/s
without
bandswitching



Already in service with the Royal Navy, the Ministry of Supply, the B.B.C., the G.P.O., the Canadian Government and various press agencies, the R.A. 17 Receiver has aroused wide interest wherever communicative equipment is used. In standard form, it represents an outstanding advance in design and performance, as the summary of features below will confirm. The addition of the R.A. 37 L.F. converter (available either as a separate unit for rack mounting, or included in the same cabinet as the R.A. 17) adds further versatility where required.

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- ★ Band changing without switches or turrets.
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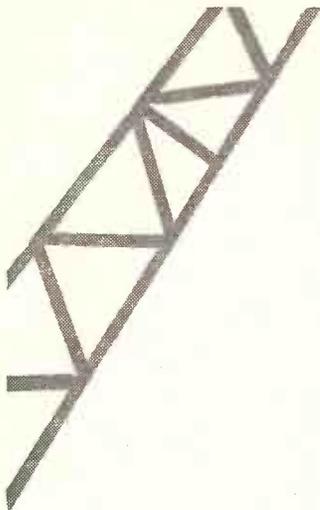
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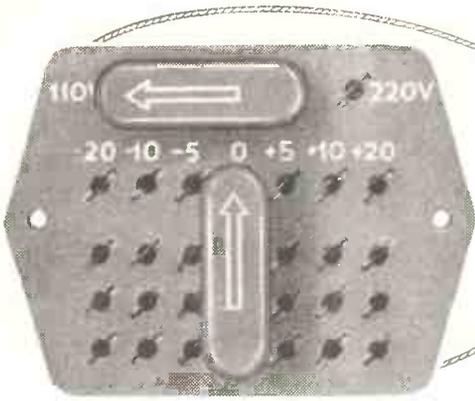
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CENTRIFUGAL AIR BLOWERS. Exceptional offer of brand new 216 units by Leach Electrical, powered with capacitor/induction motor, 230/240 v. 50 c., 1 ph. Rated output 35 c. ft./min. Overall length 8 in. Max. dia. 4½ in. Intake 2½ in. dia., outlet 1½ in. dia. Weight 6½ lb. An excellent quiet running unit for extraction or blowing. 24/17/6 (des. 2/6).

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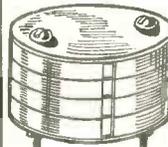
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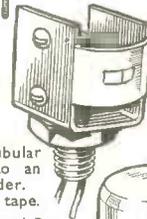
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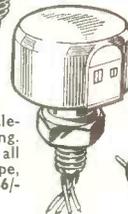


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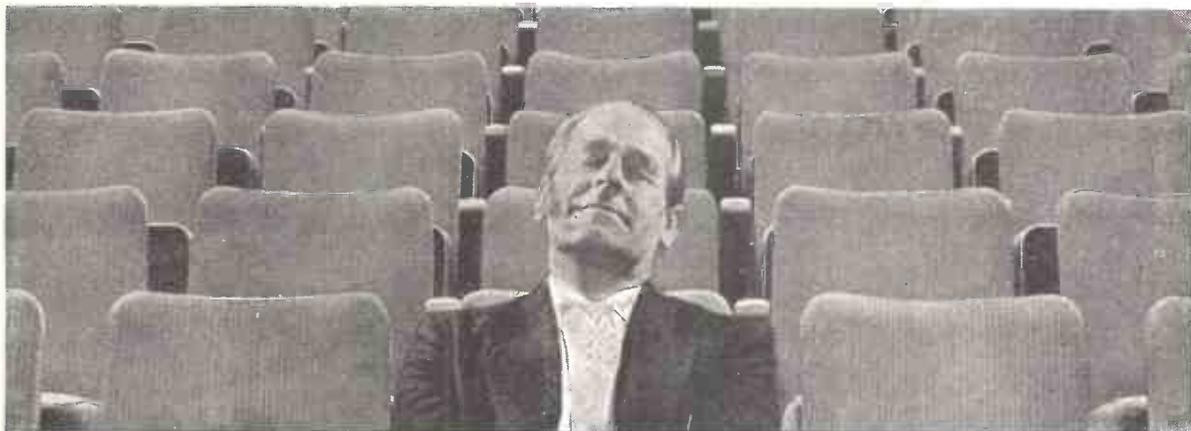
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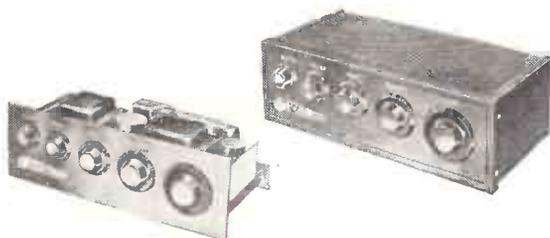
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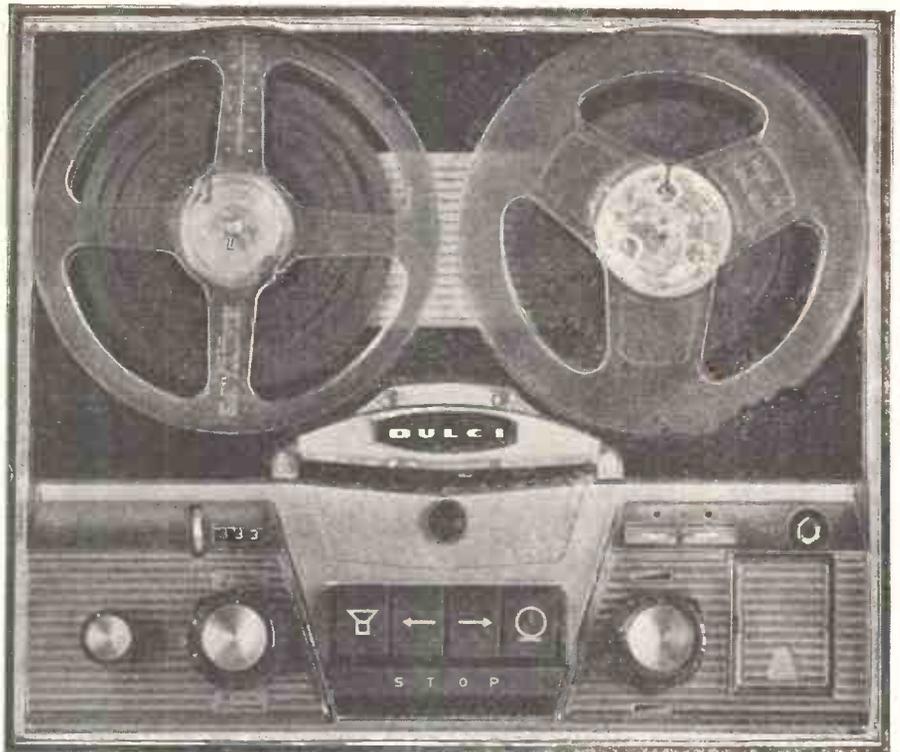
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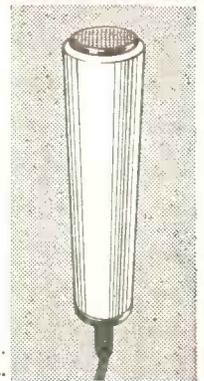
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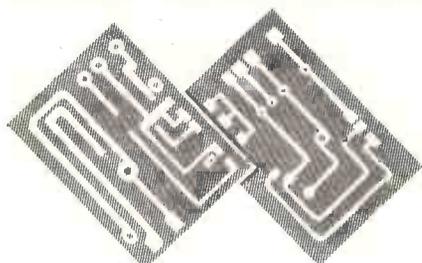
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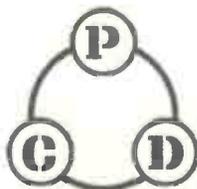
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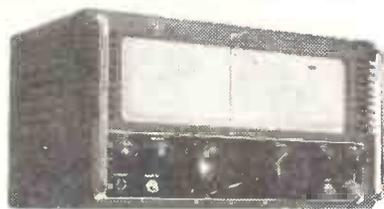
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FM85

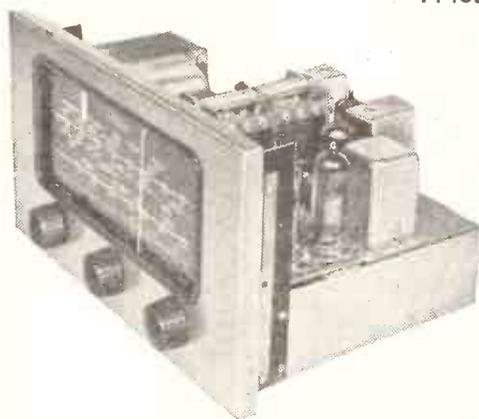
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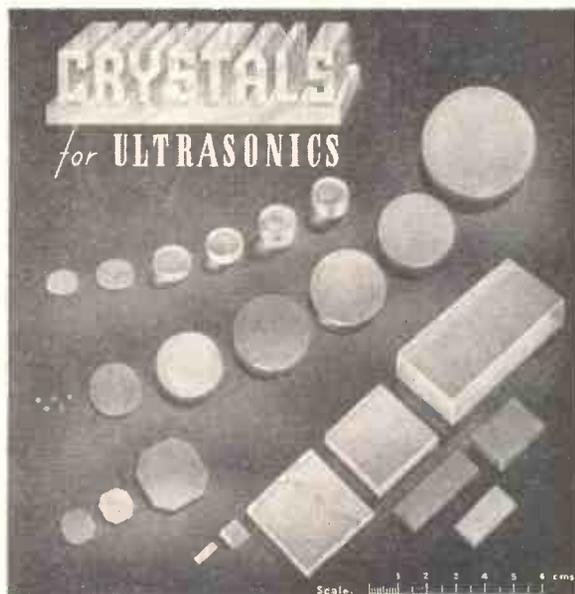
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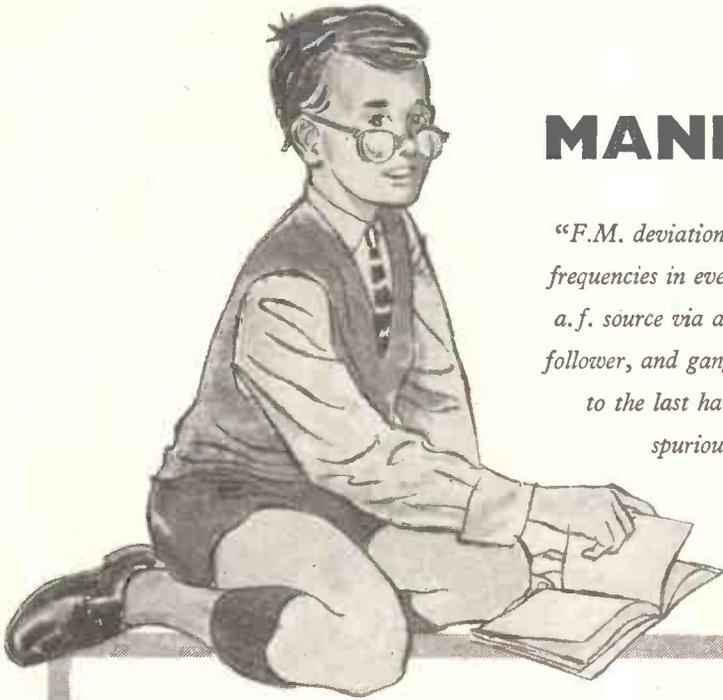
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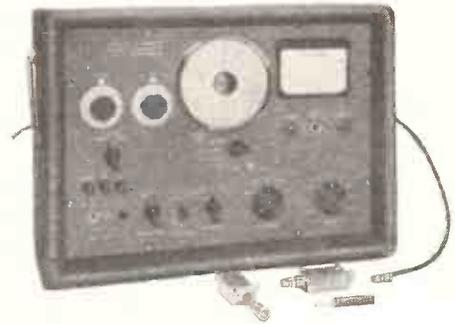
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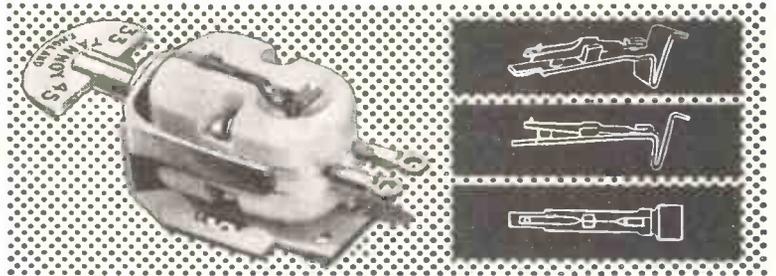
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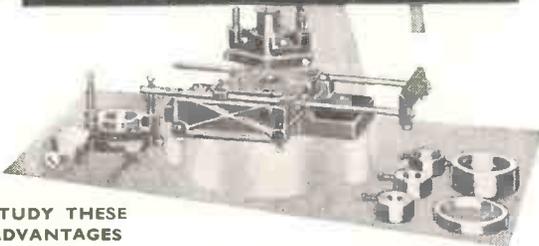


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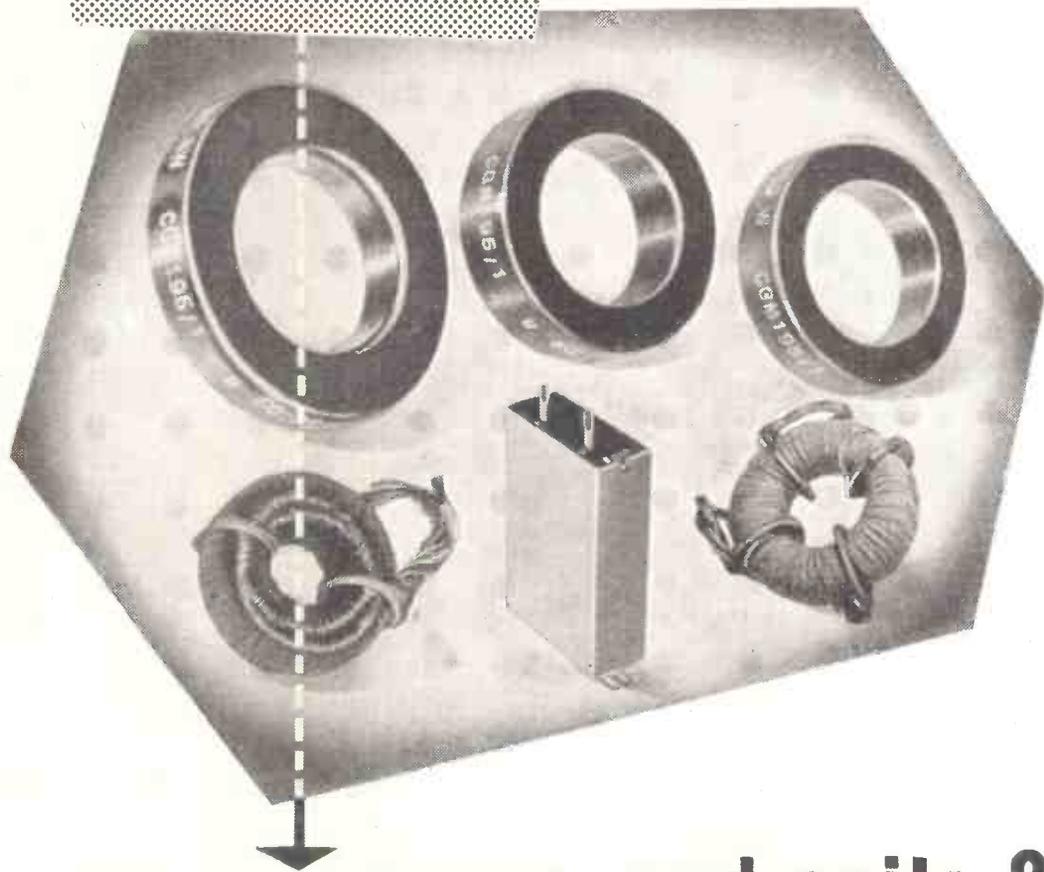
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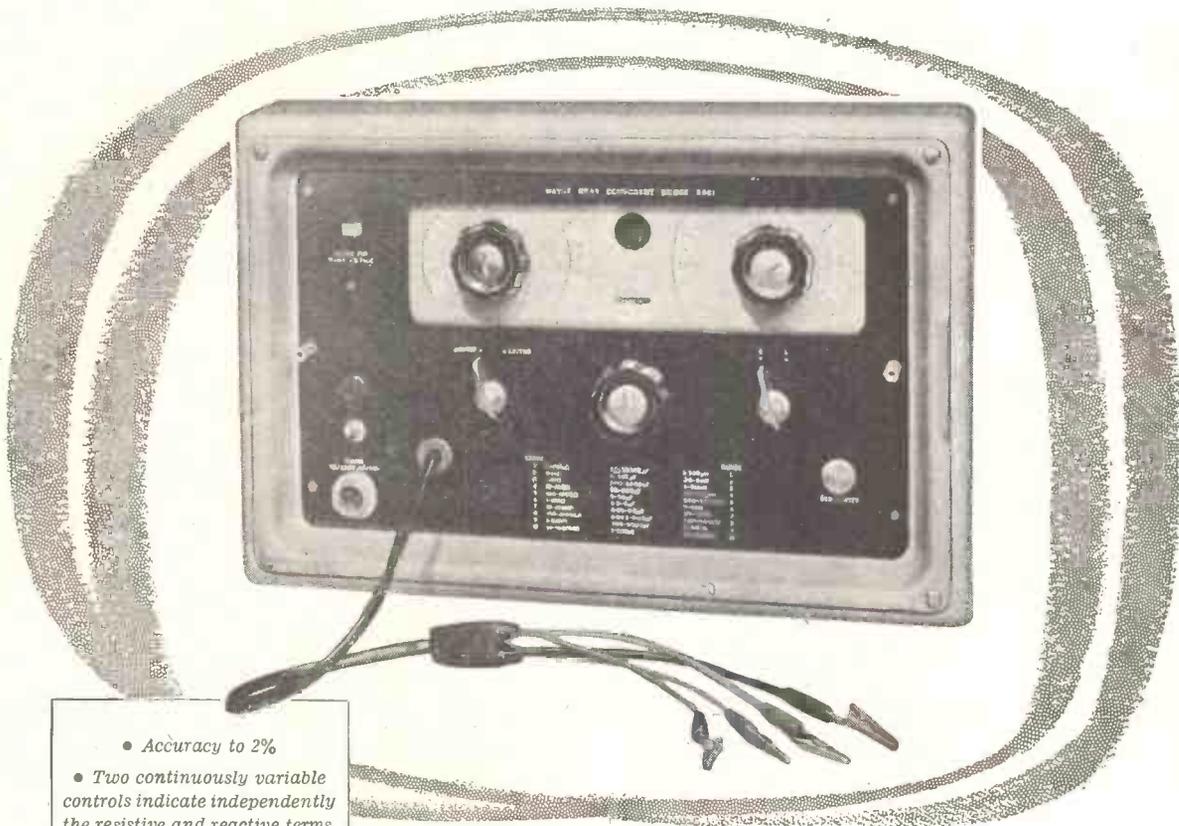
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- Two continuously variable controls indicate independently the resistive and reactive terms.
- Two, three or four-terminal measurements over an extremely wide range.

Specification
 Capacitance: 1 pF to 5F.
 Inductance: 1 μH to 0.5 MH.
 Resistance: 1 m Ω to 1000 M Ω.
 Accuracy 2%
 Power Supply: 110/125 and 200/250v.
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Operating at mains frequency, the B.521 has an effective ratio of $10^{12}:1$ and is intended for the rapid and direct measurement of virtually all components and networks likely to be encountered in electronic apparatus, whether in the laboratory or the service workshop.

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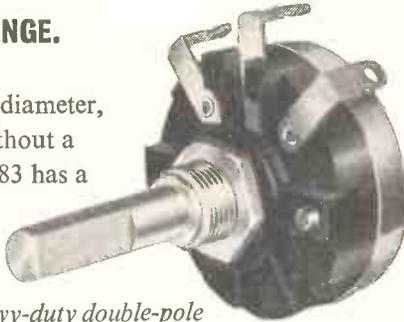
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Measuring 1¼" diameter, Type 181 is without a switch. Type 183 has a double-pole Q.M.B. switch and Type 243 a heavy-duty double-pole Q.M.B. switch specially designed for Television. These controls are available with tappings at 33%, 50% or 60% of slider rotation, also with terminations suitable for printed circuits.



NEW WIRE-WOUND PRE-SET for group assembly

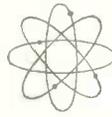
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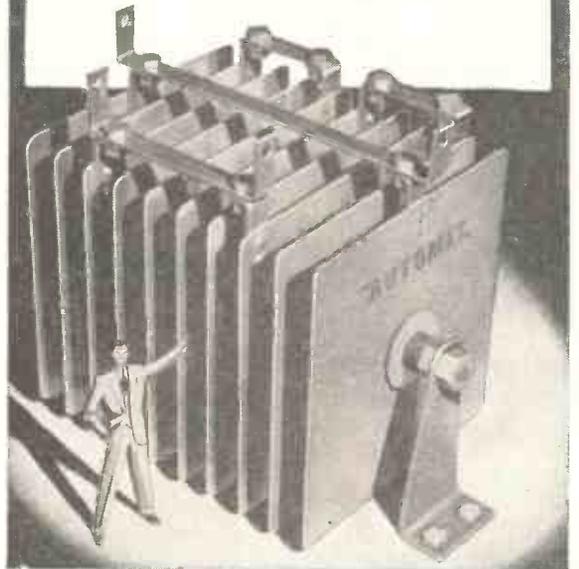
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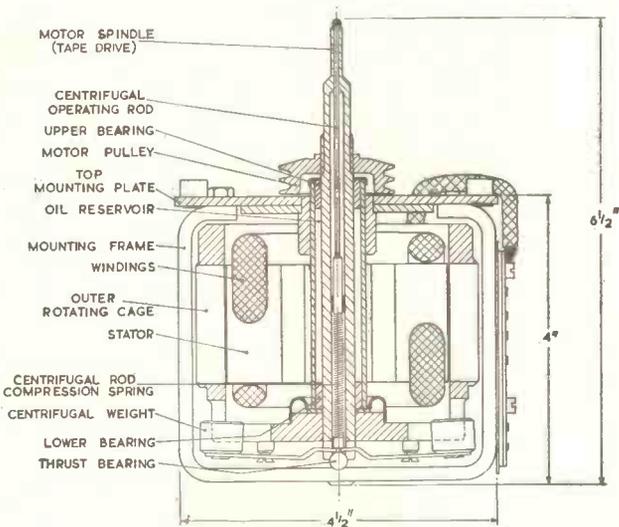
WHAT MAKES A GOOD TAPE RECORDER

Three against one - IS IT FAIR?

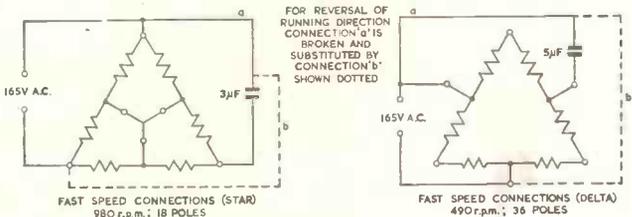
The answer—if you're talking about three motors as opposed to one in a quality tape recorder—is yes. Yes, if you've got design resources and a research set-up big enough to produce the right motor. After all, the advantage of employing three motors is mainly that it makes life easier for the designer. It is not necessarily better for the tape recorder.

Concentrating all your effort into one motor on the other hand may give you plenty of research headaches initially but finally enables you to achieve a much stricter specification, with more additional features, added reliability and a very high power reserve under *all* conditions. Especially if you decide to eliminate the mechanical complications associated with single motor drive by causing the motor to carry out those functions *electrically* (i.e., speed change, alteration of running directions, quick starting).

THE GRUNDIG TAPE RECORDER MOTOR



The motor is of the Outer Rotating Cage Split Phase Induction Type. From the description and from the accompanying diagrams it will be noted that the *outer* part of the motor *rotates* and the conventional rotor, carrying the windings, *stands still*. This in effect gives a very good fly wheel action, obviating the necessity for an additional fly wheel to achieve a constant motor speed. The hollow motor spindle contains a rod which is operated by centrifugal force when the motor is in rotation and the movement of this rod is utilised to operate a number of contacts, which for its starting operation, feed the motor from 260 volts A.C. As soon as the motor has attained its correct running speed (after approximately 0.4 seconds) the "centrifugal force operated rod" will cause the motor to be fed from 165 volts A.C., its correct operating voltage. The stator of the motor is wound for 36 poles which, for fast speed operation (usually 7.5"/sec. tape speed), are connected so that two poles are always in parallel, all windings being connected in 'Star' fashion. For operation at the slow speed (usually 3.75"/sec) all 36 poles are used in series and the windings are connected in 'Delta' fashion. The third phase required for the operation of the motor is obtained by means of a metallised paper condenser of 3 or 5 Mfd capacity. The exact amount of capacity required will vary between motors of different types used in Grundig Tape Recorders, but their capacity is usually in the range stated. For fast speed operation the capacity required will be lower than that for slow speed operation. It is usual, therefore, to use one of two smaller capacitors, which are then connected in parallel for slow speed operation.



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.)
 GS 49

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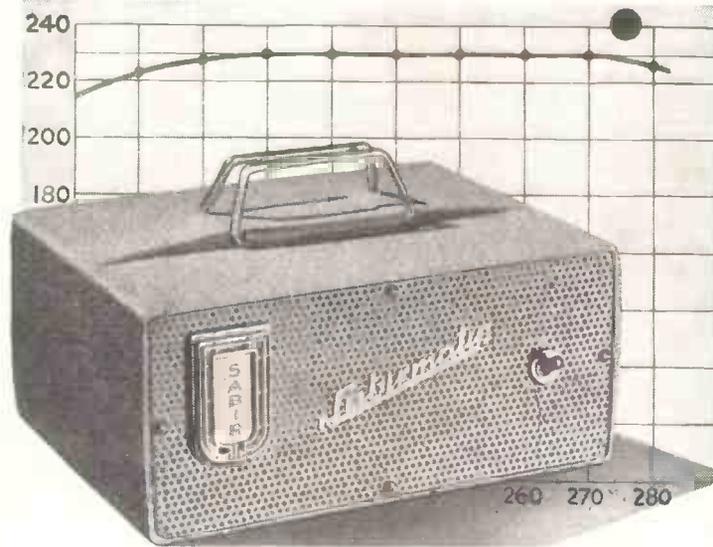
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AUTOMATIC AC VOLTAGE REGULATOR**

VOLTAGES: 110-110V; 110-230V; 230-230V.
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RATING: 200 VA nominal. (Load limits 25 VA-250 VA.)

RESPONSE TIME: .01 sec.
EFFICIENCY: 83% approx. at rated load.
FITTINGS: On-off switch, illuminated escutcheon.

The benefits of complete protection from the disturbing effects of varying mains—available for the first time at a moderate outlay. In a size, presentation and finish that make the **SABIR** ideal for:—Instruments, Test Equipment, Television and Broadcast Receivers, Appliances, and Experimental Work.

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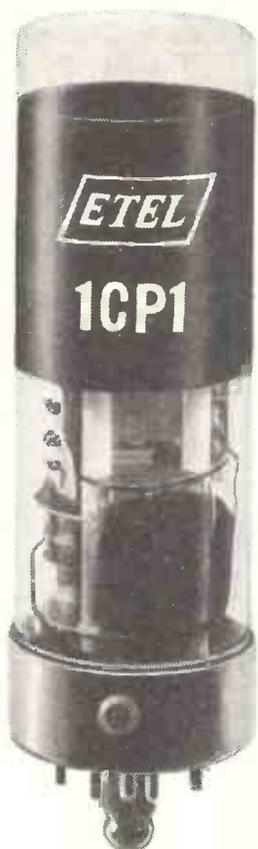
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$V_{h-k} (pk) = \pm 250V \text{ max.}$

$V_{al+a3} = 350V \text{ min.}$

$S_x = \frac{95}{V_{a3}} \text{ mm/V}$

$S_y = \frac{110}{V_{a3}} \text{ mm/V}$

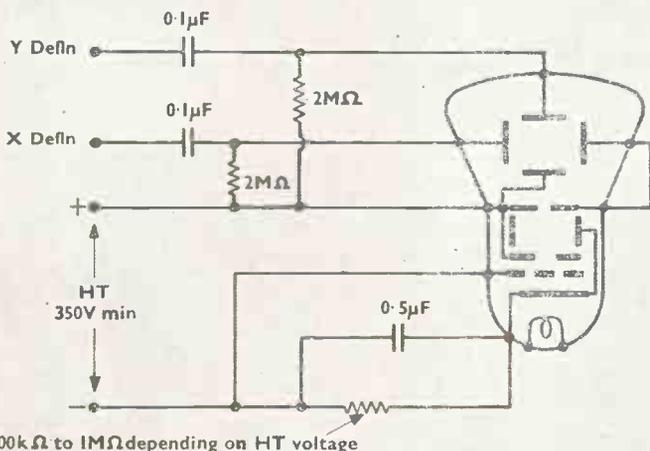
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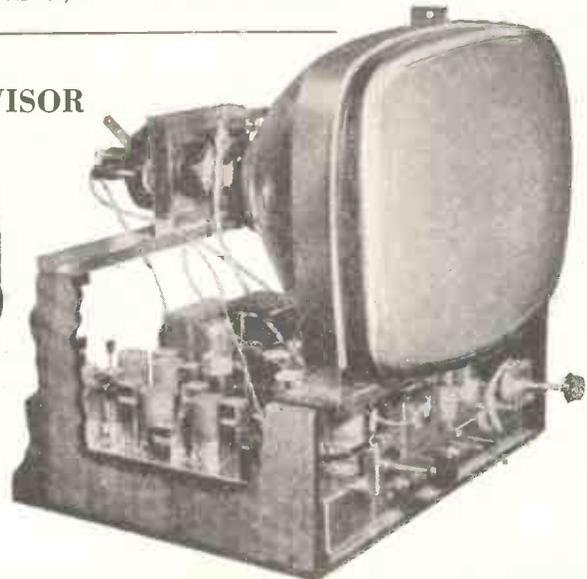
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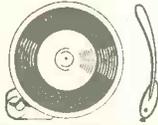
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 Grey Lizard Rexine covered . . . 45/-
 Overall dimensions 15 in. x 13½ in. x 6½ in. Clearance under lid when closed 3 in.



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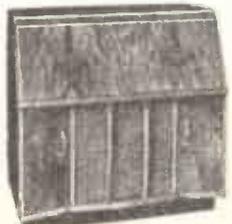


Dark Piano finished with gold and black styling, overall size 39 in. long, 32½ in. high, 16 in. deep. Two sliding doors, concealing on the left a black panel 18½ in. x 20½ in. finished in medium mahogany, and on the

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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.



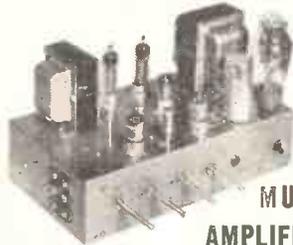
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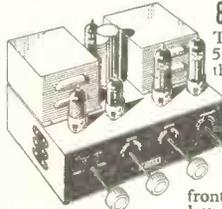
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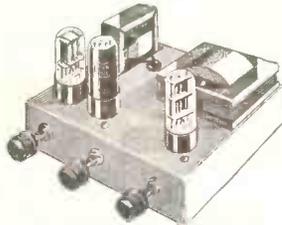
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8 WATT AMPLIFIER

This design includes 5 miniature valves of the latest types, an Ultralinear Output Transformer suitable for Speakers of 3 and 15 ohms, and a very attractive perspex front panel with gold lettering, complete set

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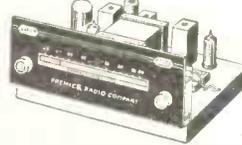
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Power requirements HT 230 v. 50 mA., LT 6.3 v. 1.5A. Dial size 3½ in. x 1½ in., overall size 11½ in. long, 5½ in. deep, 4½ in. high.

★ IT WILL PAY YOU TO VISIT OUR NEW HI-FI DEMONSTRATION ROOM



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6 Valves including Magic Eye and Power Supply using the latest type Gorler permeability Unit complete with first audio stage and preset output volume control. Maximum radiation less than 10 microvolts per metre. Sensitivity better than .5 microvolts. Cash price £17/10/- (inclusive) or Credit Terms: Deposit £2/3/9 and 8 monthly payments of £2/3/4. Postage and packing 5/- extra.

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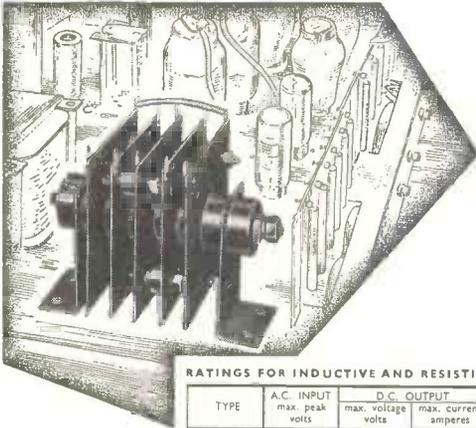
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	GA61-A	106	94	2.0 at 60°C	3½
	GA52-A	340	303	2.0 at 40°C	5
	GA62-A	170	151	2.0 at 60°C	5
THREE-PHASE	GB31-A	140	188	3.0 at 35°C	4½
	GB41-A	53	71	3.0 at 55°C	4½
	GB51-A	210	283	3.0 at 35°C	4½
	GB61-A	106	143	3.0 at 55°C	4½
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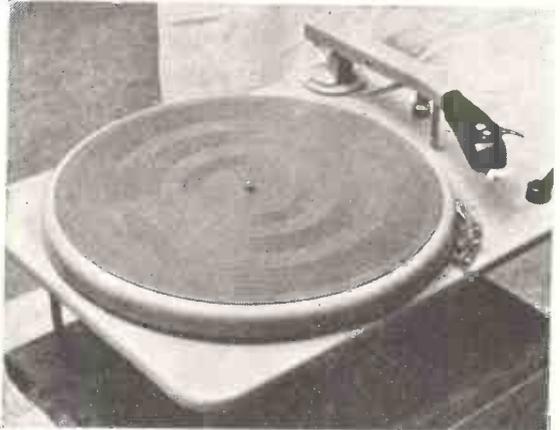
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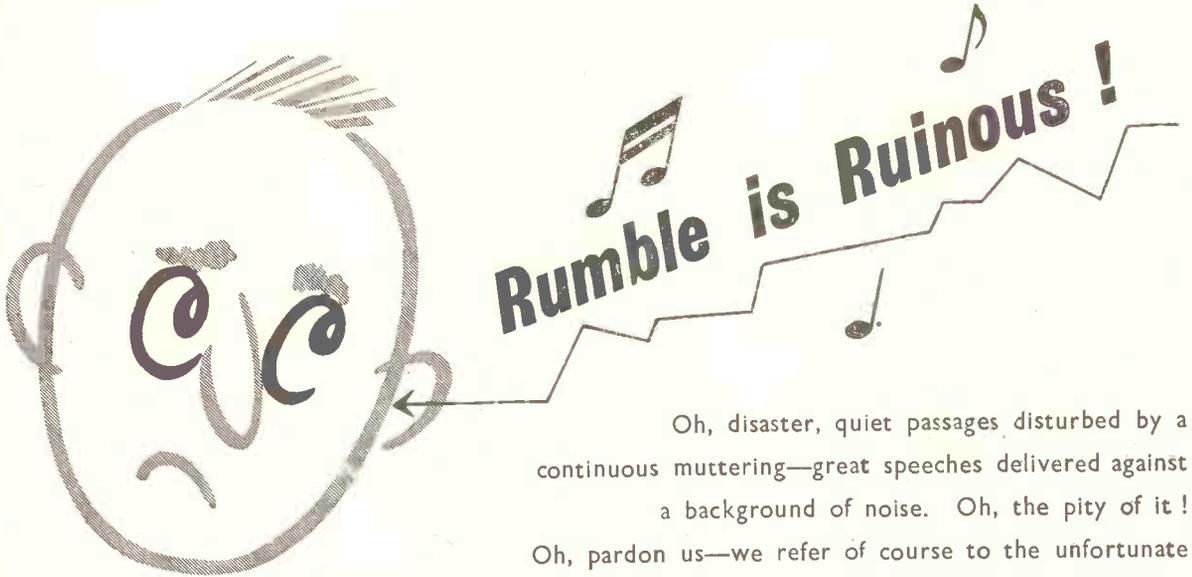
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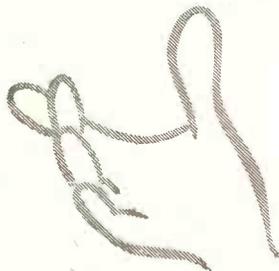
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NOVEMBER 1957

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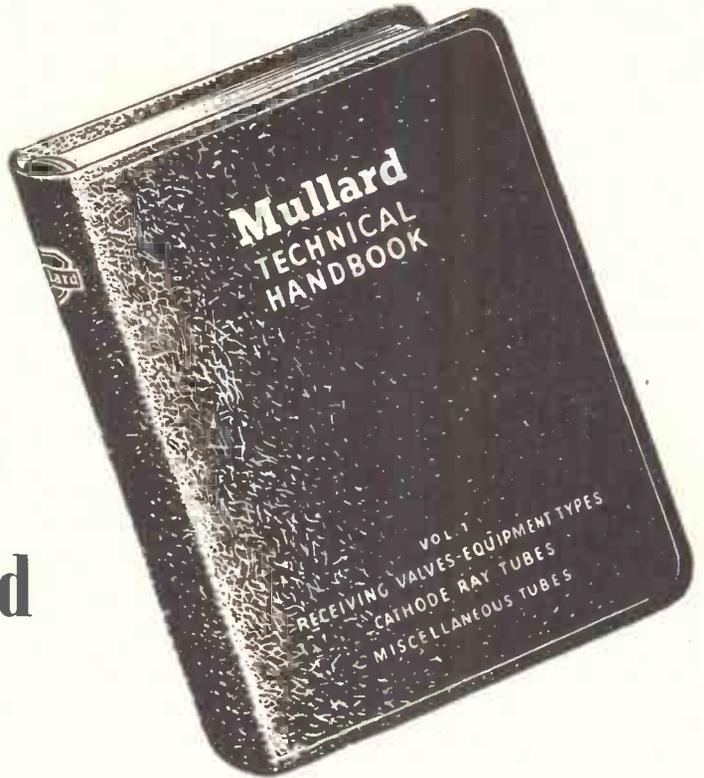
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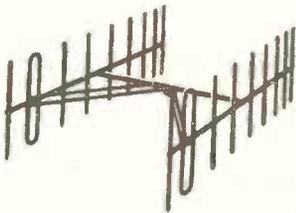
× 500 styli in slip-in fittings, and they play in league with practically every well-known make of gramophone. Forward fellows, these Acos 65.

* Outputs: Type 65-1, 0.15 V; Type 65-3, 1.0 V, at 1 cm/sec velocity, 1,000 c/s

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"BELLING LEE" NOTES

Just back from a tour of South Wales and the West, specifically taking in the towns of Cardiff, Swansea, Bristol, Taunton and Exeter, we would like to confirm our thoughts as written in the last issue. The aerial used for the test transmitter looks considerably smaller 400ft. up the mast, than it did outside our office door. As so often happens in such cases, those situated closest to the transmitter are worse served in the early stages, Cardiff, Swansea, Port Talbot and Neath being in the shadow of the plateau, whilst places farther afield such as Cinderford 45 miles, Chepstow 25 miles are getting a fair signal, Newport and Bristol being patchy. We were surprised to find a few reports from outlying districts in both Taunton and Exeter.



The "Belling-Lee" 99A/10 array

It must be remembered that the Hessary Tor transmitter was created because the signal from Wenvoe was so poor in Plymouth and Exeter. Yet the Exeter dealers and their customers seem optimistic that they will be able to receive a St. Hilary programme of entertainment value. We feel sure that this will only be possible with a really efficient double nine-array, and when on the subject of such aerials let us claim here and now that the "Belling-Lee" 99A/10 is the most efficient high gain aerial of its kind available in this country. The arrays may be attached to a wide variety of fittings and masts up to 14ft. in height.

Advertisement of
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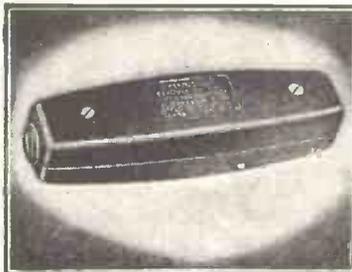
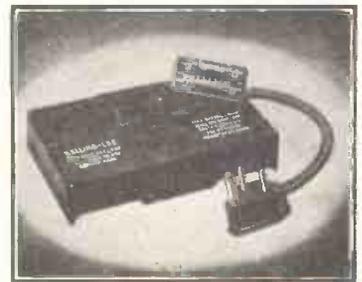
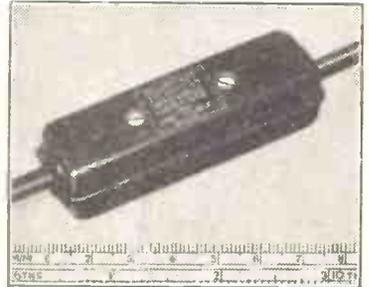
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L.1314 For 2-core cables 2 amp. 250 v. a.c./d.c.

L.300/3 All wave Mains Filter, 1 amp.

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L.1308 5 amp. 3-pole Mains suppressor plug 200-250 v. a.c./d.c.

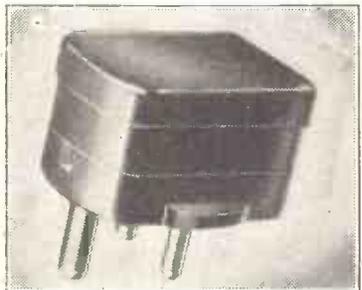
Where an appliance is suspected of or known to be creating electrical interference on the long and medium wavebands, the interference can usually be filtered or reduced by the insertion of this mains plug. This is designed for fitting to the free end of the flex lead, replacing the normal type of 5 amp 3-pole plug generally used.

Appliances likely to cause mains-conducted interference are hair dryers, refrigerators, washing machines, food mixers, fans, small motors, small drills, grinders, lathes, etc., actuated by commutator motors.

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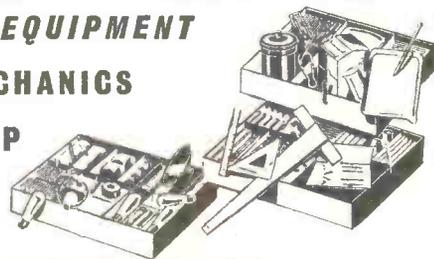
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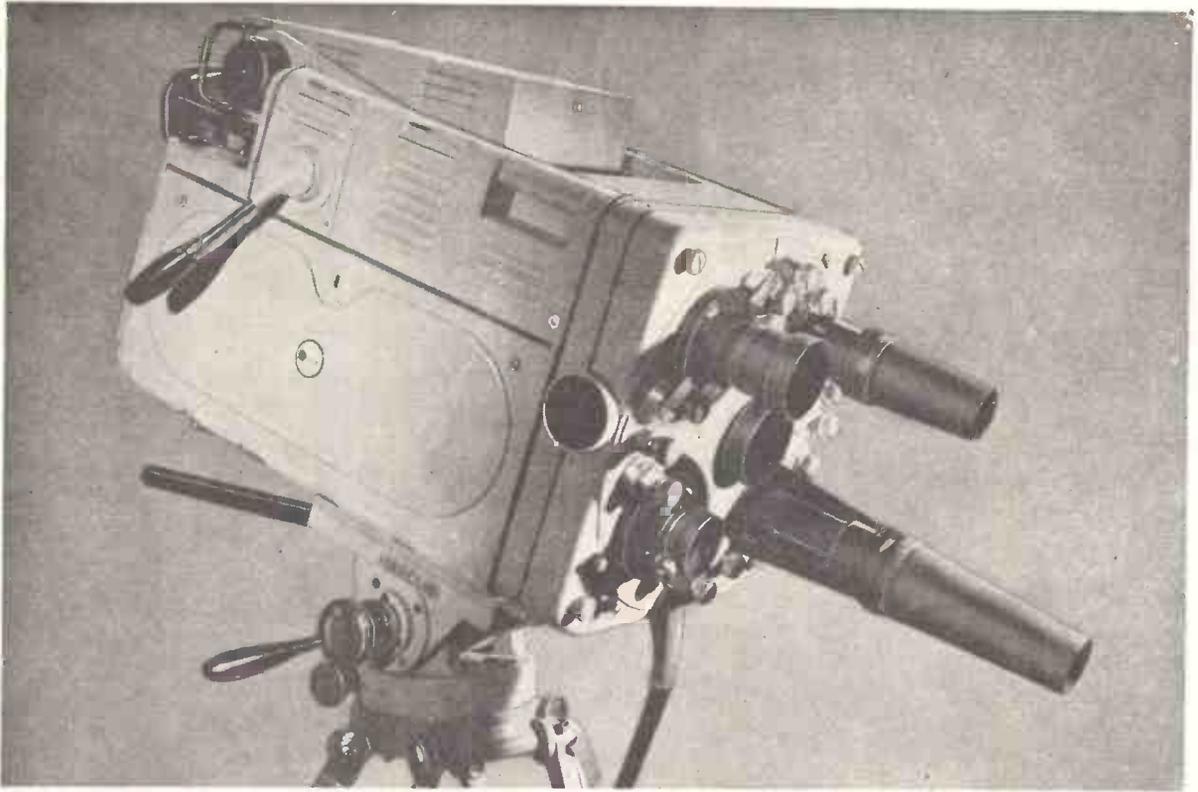
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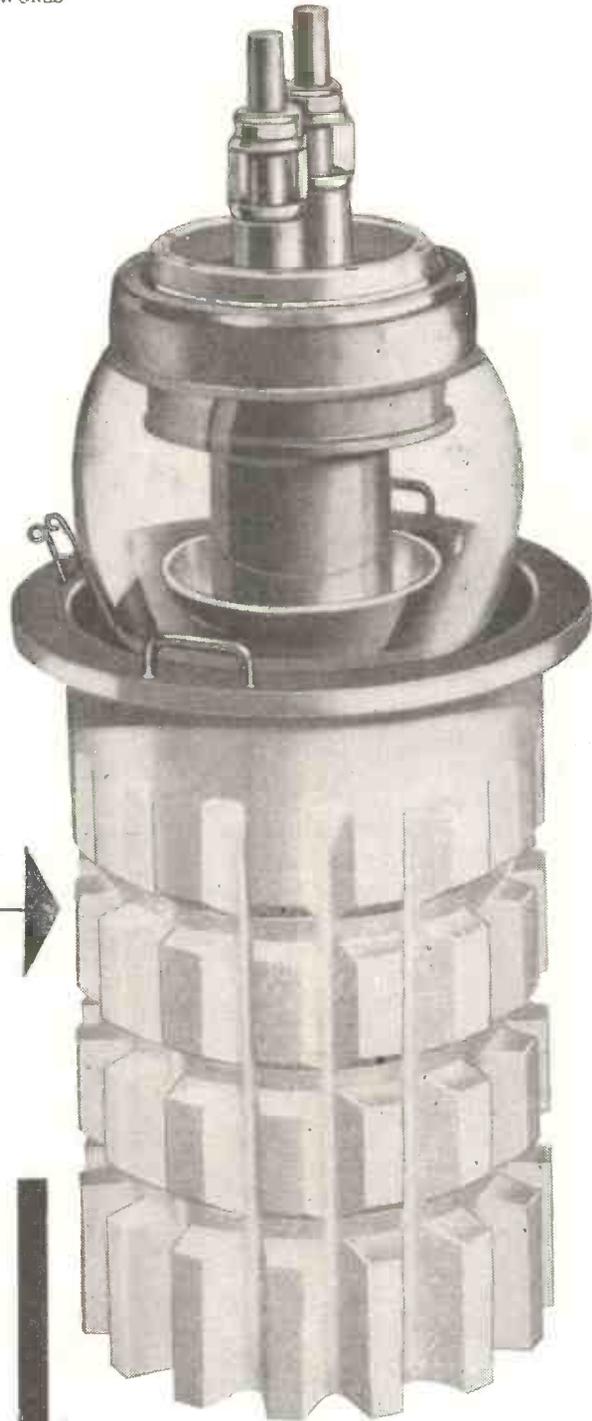
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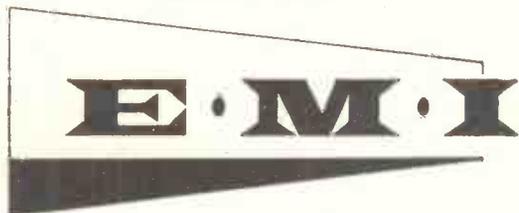
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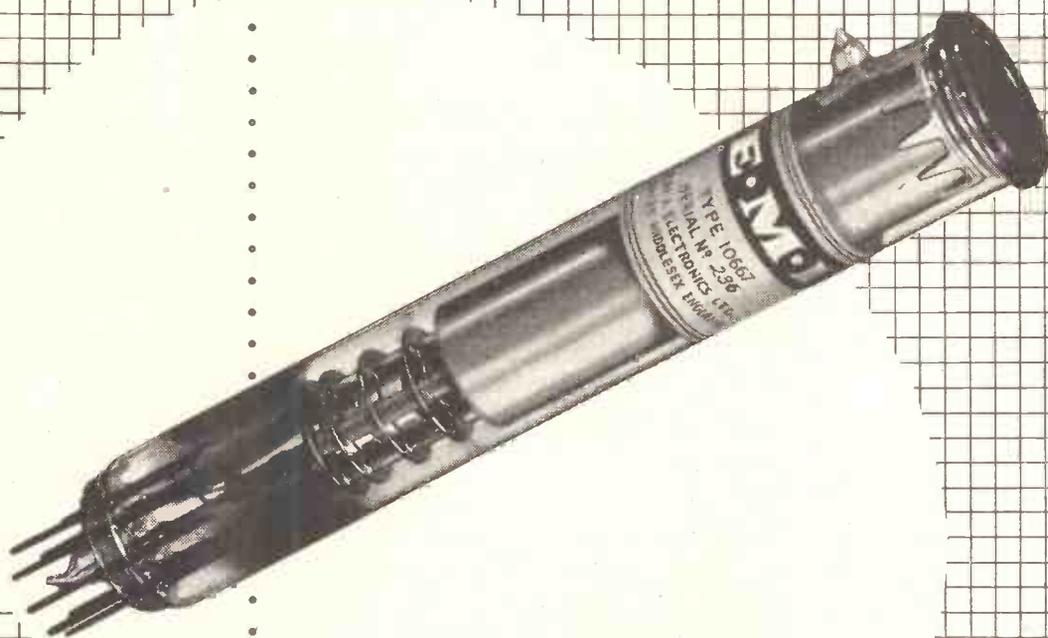
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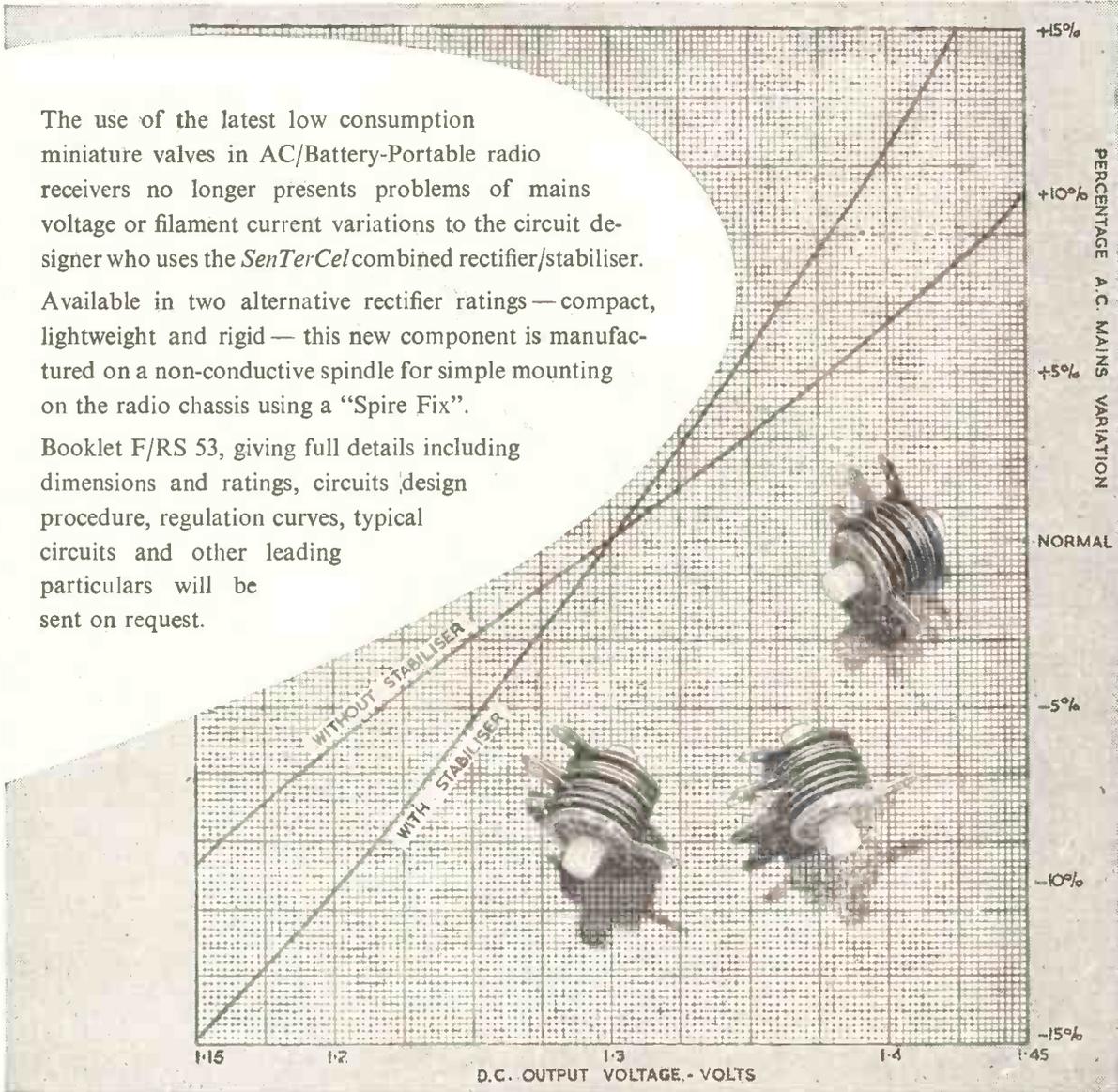
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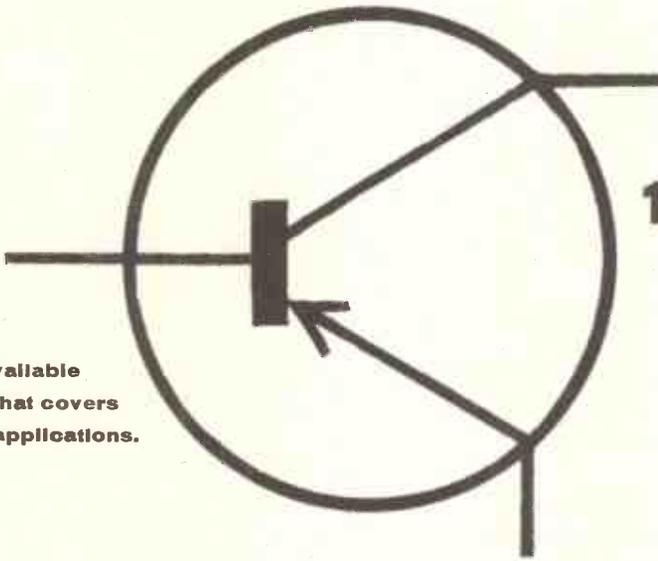


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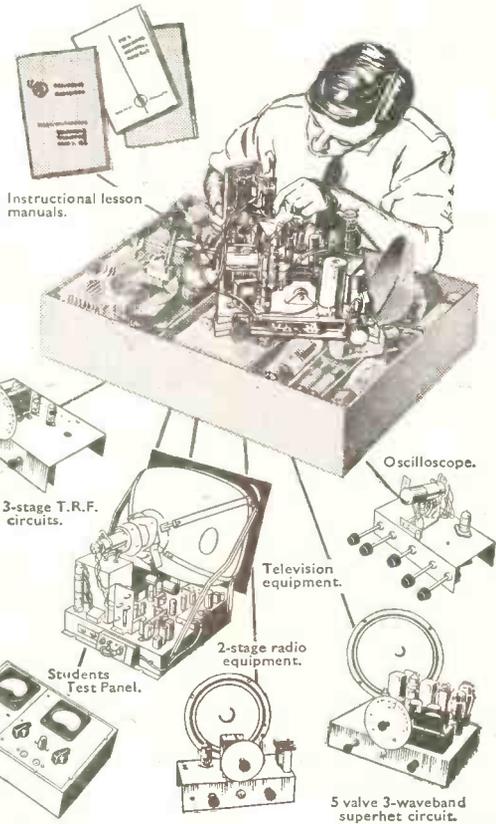
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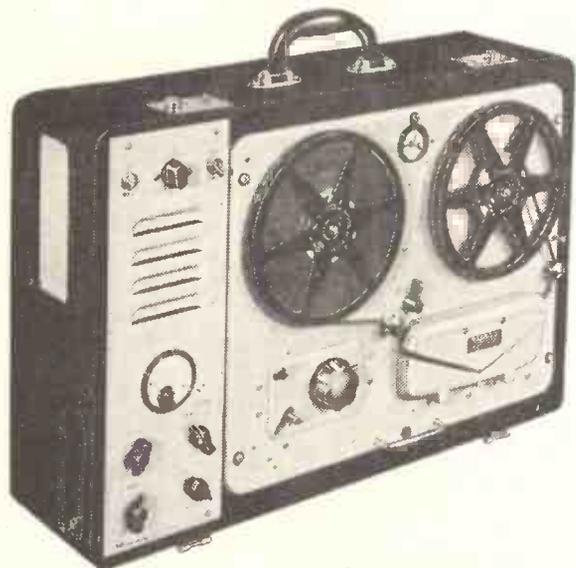
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Vortexion



The above recorder uses a synchronous capstan motor and for use on 12 volt car battery a 50 c/s \pm 1 cycle 230 v., 120 w. power supply unit is available as detailed below.

T.R.G.10 MINIATURE AMPLIFIER AND VERSATILE PRE-AMPLIFIER. A modern miniature amplifier, measuring only 4½ x 5 in. over front panel and projecting 10½ in. 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.

POWER SUPPLY UNIT for operation with Tape Recorder or similar equipment on 12V. car battery.

This D.C. to A.C. supply unit has been specially manufactured to provide 1% accurate 50 cycle A.C. power for 50 c/s synchronous motors and amplifiers sensitive to mains noise. The output from the 50 cycle is well filtered to reduce harmonics and give approximately the same degree of quietness as normal 50 cycle mains. The efficiency is over 80% at wattages over 50. Terminals for a remote control switch are fitted to prevent carrying the heavy low voltage L.T. cables any distance from the battery. The unit can then be fitted at the point closest to the battery to prevent voltage drop on leads and the A.C. satisfactorily extended to any required position.

The unit is fitted in an 18 gauge steel case to give screening, but it should not be placed close to tape heads in case the field causes slight hum.

The case measures 9 in. x 6 in. x 9 in.

Full details and prices of the above on request

VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3

Telegrams: "Vortexion, Wimble, London."

TAPE RECORDERS and AMPLIFIERS

★ The total hum and noise at 7½ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer, is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

★ The 0.5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

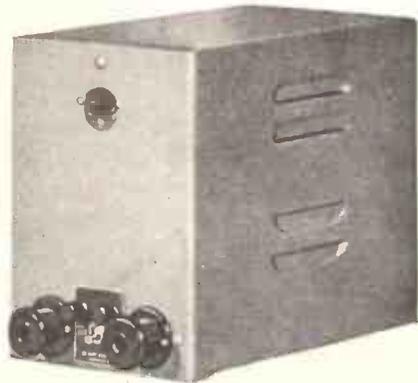
★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ 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.





**WESTON
PORTABLE
INSTRUMENTS**

Weston Portable Instruments include D.C. moving coil, A.C. rectifier and H.F. thermocouple types, and instruments of the A.C./D.C. moving iron type; high grade dynamometer models are also available.

Illustrated above is the Model S.82—a permanent magnet, moving coil instrument in the Portable range. This is primarily a Precision Grade instrument but can also be supplied with Industrial Grade accuracy. Details of this Model, together with others in this series, are available on request.

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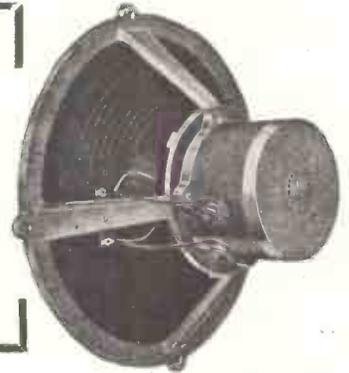
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Now, Plastic Foam Suspension (FS) gives this superior Wharfedale production even smoother performance than before. The high flux density gives excellent transient response and sensitivity over the whole frequency range. Alcomax III Magnet; flux density

17,000 gauss, 1 3/4 in. diameter centre pole; total flux 190,000 lines; speech coil 12/15 ohms; cone resonance 30-38 c/s. Price £17/10/- tax free.

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We have devoted over 22 years entirely to the design and manufacture of audio equipment and we are proud of our position as leaders in this field. We were the first firm in the world to design and market Amplifiers having a total distortion content as low as 0.1%; a claim which was received with incredulity in 1945, but which was subsequently confirmed by the National Physical Laboratory and has become an accepted world-wide standard.

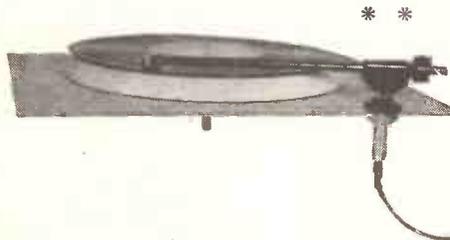
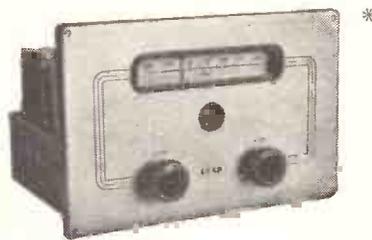
High engineering ideals have guided our efforts, and Leak Amplifiers have been the choice of the B.B.C., Commonwealth and foreign broadcasting authorities and Recording Studios. This acceptance by professional audio engineers has led to a demand for Leak equipment from music lovers throughout the world.

On the important question of prices it is appropriate to mention one of the basic principles of Leak design. From long experience and by extreme attention to design details during development work on the pre-production models, we enable our craftsmen to achieve a high output per man-hour. The labour costs thus saved offset the increased cost incurred for high-grade materials, components and finishes, and this, together with quantity production (made possible only by a world-wide market), explains how quality products may be sold at reasonable prices.

An important Test Report . . .

Independent laboratory tests of the Garrard 301 transcription turntable were recently carried out by Audio Instrument Company Inc., New York, U.S.A., under the direction of Mr. C. J. Lebel (Chairman of one of the groups which prepared the NARTB Standards). It was necessary that the pick-up and amplifier system should conform to the RIAA-New AES-new NARTB response curve within ± 1 db, and in the tests of this excellent transcription unit the components selected for use as complying with this requirement were a Leak tone arm fitted with Leak cartridge and a complete Leak pre-amplifier and power amplifier Model TL10.

The full test report appeared in the February, 1957 issue of "Wireless World," pages 22 and 23.



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INDUSTRIAL OVERHEAD HEATER



This overhead heater warms only the area within its radiant rays, and so effects a considerable saving of fuel. Its benefits are felt immediately, there is no warming-up period. It is essentially a personal type of heater, having controls within easy reach of the operative. The controls give four variations of heat and "Off." At maximum heat the unit consumes 1kW.

- The Infray Major is of particular use:—
- (a) In large rooms, warehouses, lofts, machine shops, etc., where the cost of heating the whole room to a comfortable level would be too great.
 - (b) In rooms which in the main have to be kept cool, e.g., food storage chambers, beer cellars, etc.
 - (c) In any situation where local heating is required quickly.
Price is £7/10/-, carriage paid.

8FT. UNBREAKABLE MAINS LEAD.

This is the type of lead which is fitted to electric razors and similar appliances, makes fine lead for test-meters and any other devices where the flex is subject to continuous bending and kinking. Twin figure eight construction, soft cream P.V.C. covered. Normally costs 2/- per yard—we offer three leads for 3/- post free; special quotes for large quantities.

ANOTHER SNIP

Heavy duty castors—ideal for fitting to T.V. instrument trolley. Current value 12/6—special snip price 7/6 set of four, plus 1/- post



W.D. CIRCUIT DETAILS

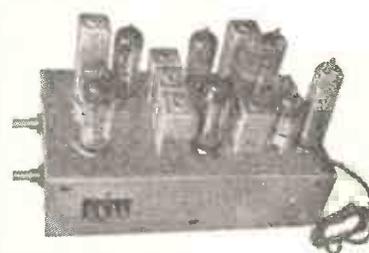
Diagrams and other information extracted from official manuals. All 1/6 per copy, 12 for 15/-.

American Service Sheets	R.109 78 receiver
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R.103A	RA-1B
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RA-1B	AN/APA-1
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R-1132A/R-1481	CAY-46-AAM-
R-1147	RADAR
R-1224A	A.S.B.-3.
R-1082	Indicator 62A
R-1355	Indicator A.S.B.3
B.C.1206-A/B	Indicator 62
B-455-A (or-B)	Indicator 6K
B-454-A (or-B)	R.F. unit 24
B-453-A (or-B)	R.F. unit 26
Transmitter T1154/	R.F. unit 25
B.D.J.N.	R.P. unit 27
Fifty-eight walkie-talkie	Wireless set No. 19
Frequency meter	Demobbed valves
B.C.221.	

TELEVISION UNITS

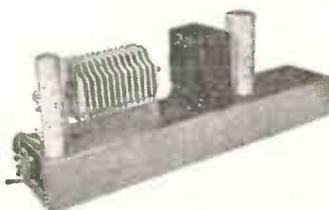
The I.F. UNIT

Employs 8 miniature valves, sound and vision are at 34/36 and 37.5 Mc/s respectively. Output just over one watt sound. Employs variable peak white clipper to reduce vision interference and sound interference. The unit which can be driven by any standard 24/37 Mc/s turret or other tuner is beautifully made and contained on a chassis size approx. 8in. x 4½in. x 2in.



The unit with valves made up, aligned and ready to work is available price £9/12/6.

The POWER UNIT



venience and symmetry. The size of the unit is 15½in. x 3in. x 2in. It is all wired up and ready to work. Price £3/5/-.

A.C./D.C. working for 3 amp valves. Rectification is by metal rectifier; smoothing is by a 3 Henry choke and large electrolytic condensers.

Ballast Register has tapings for HT and heater current, also fuse and a thermistor to protect the circuit against current surges

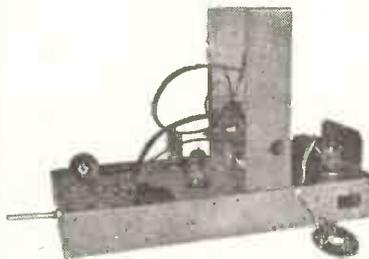
A double pole switched volume control which, although not part of the power unit, is included for the sake of convenience.

The TIME BASE CHASSIS

This uses 6 valves and includes the sync. separator, the focus magnet, scanning coils and ion trap.

The whole unit measures 15½in. x 6½in. x 2in. and the metal work includes tube support for chassis mounting a 14in tube, but up to 21in. tube can be scanned but will require separate mounting.

Price for unit with valves ready made up and tested is £12/15/-.



NOTE

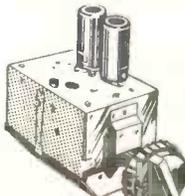
These three units, although quite separate and useable separately may also be joined together and then comprise a complete T.V. less only tuner unit and speaker (available if required). Demonstrations at all branches—circuit diagrams, etc., 3/6.

TAPE DECK—Made by the famous Truvox Company. This contains exactly the same essentials as the current model. Only the styling is different. It also takes the stereophonic head.

Specification: 3 B.T.H. shaded pole motors with silent friction drive eliminating wow and flutter. Push-button controls, electrically and mechanically interlocked. Patented electric type push-button controlled brake. Tape loading on the drop-in principle, accommodation for reels of 7in. diameter. Tracking sense to British and American standards. Playing times: up to 3 hours with L.P. Tape or 2 hours with S.P. Tape or 2 hours with Standard Tapes. Two tracks side by side with safety gap. Positive Azimuth adjustment of Record/Player head. High Impedance Heads. Overall size 14½in. x 12½in. x 5in. approx. 120 only of these fine decks offered at non-repeatable price of £17/10/- or £3/10/- down and eight monthly payments of £3. Non-callers add 10/- carriage and insurance.

TURRET TUNER

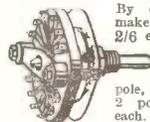
Brand new stock, not surplus, with coils for Band I and III, complete with valves PCC84 and PCF80—I.F. Output 33/38 Mc/s with instructions and circuit diagram 79/6. With knobs 3/6 extra, post and ins. 2/6.



ELECTRIC BLANKET WIRE

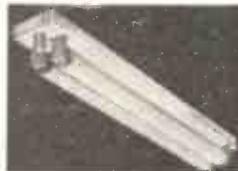
Waterproof P.V.C. covered, so blanket washable, 16½ ohms per foot—1/6 per yard. 14 yards, ideal for average blanket. £1 post free.

CERAMIC SWITCHES



By one of our best makers, 3 pole, 3 way, 2/6 each, also standard type switches 12 pole, 2 way, 1/3 each, 6 pole, 3 way, 1/3 each, 2 pole, 6 way 1/8 each.

FLUORESCENT LIGHTS



These are complete fluorescent lighting fittings. Built-in ballast and starters—stove enamelled white and ready to work. Ideal for the kitchen, over the work-bench and in similar locations. Single 40. 4ft. 3in long, uses a 40 watt tube. Twin 20. Uses 2 20-watt standard tubes. Price 39/6 each, with tubes. Carriage and ins. up to 150 miles 5/6, up to 250 miles 7/6.

VACUUM RELAY



American made type No. C61610, this is a relay completely sealed in a glass envelope. It will close in a strong magnetic field or by a coil placed close to or round one of its arms. Price 49/6. Operating coils 25/- each.

400 WATT MERCURY LIGHTING UNIT



This is a suspended unit which gives a terrific light and in addition to ordinary lighting, can be used to supplement daylight when growing plants during autumn and winter months. It is self-contained with glass enclosed ballast thus it can be fitted directly in place of an ordinary lighting fitting, no additional wiring is necessary. Few only available. Complete and ready to work, sale price £4/10/-, non-callers add 7/6 carriage and ins.

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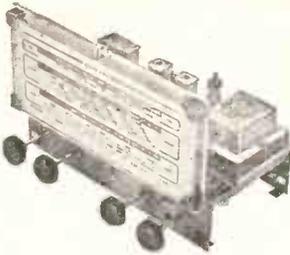
Fits into the pocket. Size only 4½ x 3 x 1½in. Wt. only 10 ozs. Works anywhere. Uses leaf aid or ordinary earpiece. Ferrite rod aerial. No external aerial required. Uses 2 transistors. Self-contained batteries. 1/- battery lasts months. All parts including data but not battery, case or earpiece, £2/17/6. Case now available. Price 2/6.



VARIABLE RHEOSTAT



This is a heavy duty slider resistor rated at 25 amps, but easily capable of twice this load. Basic resistance is 4 ohms but by the removal of one wire this becomes 8 ohms, alternatively it can be revised to suit individual requirements. Adjustment is by rotating a Bakelite knob which couples to a heavy duty slider, ideal for dimmer circuit. Price 5/6, post and ins. 3/6.



THE ORGANTONE

5-Valve 3-wave band superhet covering long, medium and short wave. Oram miniature valves are employed and low loss iron cored coils account for an excellent signal-to-noise ratio. Full A.V.C. is applied to both frequency changer and I.F. stages. The output stage utilises variable negative feedback. A gram. position is provided and reproduction of records is particularly good. Chassis size is 12 x 7 x 7in.—scale size is 10 1/2 x 4 1/2in. This receiver has been tested in particularly difficult areas and its stability and noise rejection have produced exceptional results. Price £11/10/- carriage, etc., 7/6. Or £2 deposit and seven monthly payments of £1/10/-, Carr., etc., 7/6.

DON'T BE CAUGHT LIKE THIS



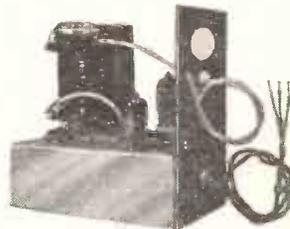
CAR STARTER CHARGER KIT

All parts to build 6- and 12-volt charger which can be connected to a "flat" battery and will enable the car to be started instantly. Kit comprising the following.

Mains transformer	22/6
5-amp. rectifier	17/6
Regulator Stud Switch	3/6
Resistance Wire	2/-
Resistance Former	2/6
Mains on/off Switch	2/6
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Construction Data	1/6

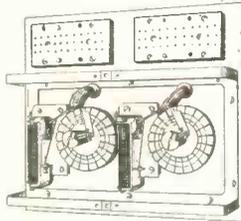
or if bought all together price is 52/6, plus 2/6 post and packing.

E.H.T. GENERATOR



This is a made-up unit, power consumption (6.3 volt 8 amp. filament and approx. 59 mA. H.T.). Contains three BVA valves. Output from 6 kV to 9 kV rectified with normal H.T. rail input but somewhat higher outputs can be obtained with higher H.T. supply. Dimensions are 6 1/2 x 4 1/2 x 7 1/2. Price 69/6, post, packing, etc., 5/-.

TOWARDS AUTOMATION

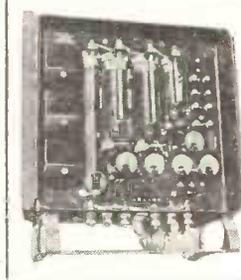


Rotary switch—Ministry Ref. No. AP57579, this is a motor-driven switch, the driving motor being a synchronous type for working on 110 volts 50 cycles. The two switches have 20 positions each and are enclosed by a Perspex fronted lid, separately operated relays providing interlocks. Sale price 27/6 each. Carr. 3/6.

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 2 amps. Price, unused and perfect, £3/17/6 each.



THIS MONTH'S SNIP
CHARGING SWITCHBOARD

Feed this Switchboard, through a Mains Transformer and Rectifier giving 24 volt D.C. up to 50 amps, and you have an excellent multi-circuit charger for simultaneously charging several batteries of different currents. This is an ex-Government switchboard rated at 550 watts 18 volts fitted into steel cases with doors. It contains three reverse current relays, one voltmeter, one main ammeter, two secondary ammeters and three variable resistors for controlling circuits. These are original cases. Price £2/15/-, Carr 10/-.

THE "CRISPIAN" BATTERY PORTABLE

A 4-valve truly portable battery set with very many good features as follows:—

- Ferrite Rod Aerial.
- Low consumption valves (DK96 range).
- Superhet circuit with A.V.C.
- Ready built and aligned chassis if required.
- Beautiful two-tone cabinet.
- Guaranteed results on long and medium waves anywhere.

All parts, including speaker and cabinet, are available separately or if all ordered together the price is £7/15/- complete. £1/15/- deposit and seven monthly payments of £1. Post and insurance 3/6. Ready built chassis 30/- extra. Instruction booklet free with parts or available separately 1/6.



SAVE £2 10s.



The Cleveland Band 3 converter is one of the best on the market and literally thousands are in use all over Britain. Original price £7/10/-. Sale price £4/19/6, carriage and ins. 5/-.

Yours for £1.10.0 Down



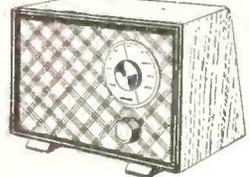
The latest most up-to-date Record Player made by the famous B.S.E. company. Using Hi-Fi Crystal Pick Up and fitted with every modern device. Definitely a record changer which will give years of trouble-free music. Not surplus but the current model. Price £3/10/- or £1/10/- deposit and 3 monthly payments of £1, carriage and insurance 5/-.

AUTOMATIC MOTOR STARTER



For remote control of D.C. motor between 1 and 3 kw., adjustment for 100v. or 230v. Unused and in first-class condition, complete with metal and wired glass cover. Price £10, carriage 5/-.

OUR 19/6 COLUMN



THE SKYSEARCHER

This is a 2-valve plus-metal receiver set useful as an educational set for beginners, also makes a fine second set for the bedroom, workshop etc. All parts, less cabinet, chassis and speaker, 19/6. Post and ins. 2/6. Data free with parts or available separately 1/6. 3-valve battery version also available at the same price.

ALL-MAINS AMPLIFIER



Powerful three-valve Mains amplifier ideal for dances, parties, etc. Complete less chassis, cabinet and speaker (available if required)—data 1/6 (free with parts). Price 19/6, plus 2/6 post and insurance.

"CHIMELITE" 19/6



It is a hall light, as well as a double chime and you can make it in a couple of evenings for the total cost of only 19/6 including instructions, post 2/- data available separately price 2/-

Simplex Transistor Kit



Makes ideal bedroom radio, uses one transistor and one crystal diode. Complete less case 19/6, case 5/- extra, post and ins. 1/6.

A.C./D.C. Multimeter Kit

Measures A.C./D.C. volts and ohms. All the essential parts including 2in. moving coil meter, selected resistors, wire for shunt, range selector, switches, calibrated scale and full instructions, price 19/6 plus 1/9 post and insurance.



BAND III CONVERTER

Suitable London, Midlands, North, Scotland etc. All the parts including 2 valves, coils, fine tuner, contrast control, condensers and resistors. (Metal case available as an extra.) Price 19/6, plus 2/6 post and insurance. Data free with parts or available separately 1/6.

ELECTRONIC PRECISION EQUIPMENT LTD.

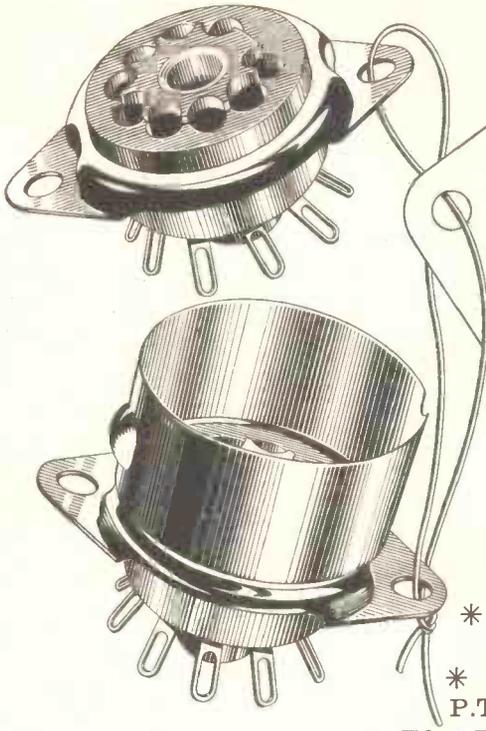
266 London Road, Croydon. Phone: CRO 6558. Half-day Wednesday.

42-46 Windmill Hill, Ruislip, Middlesex. Phone: RUISLIP 5780. Half-day Wednesday.

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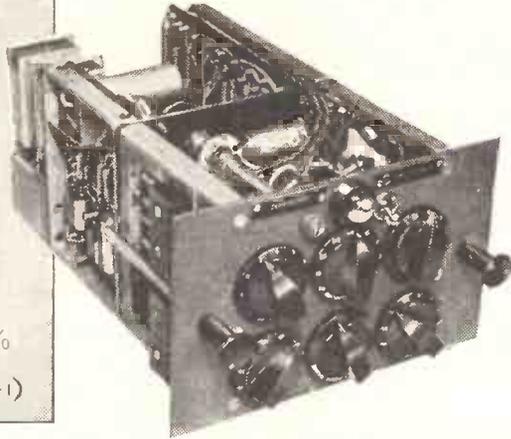
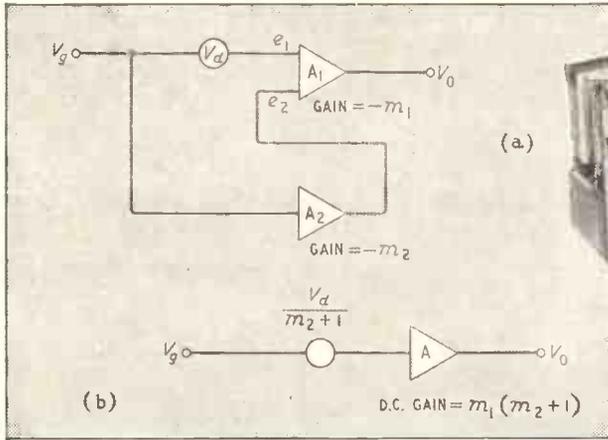
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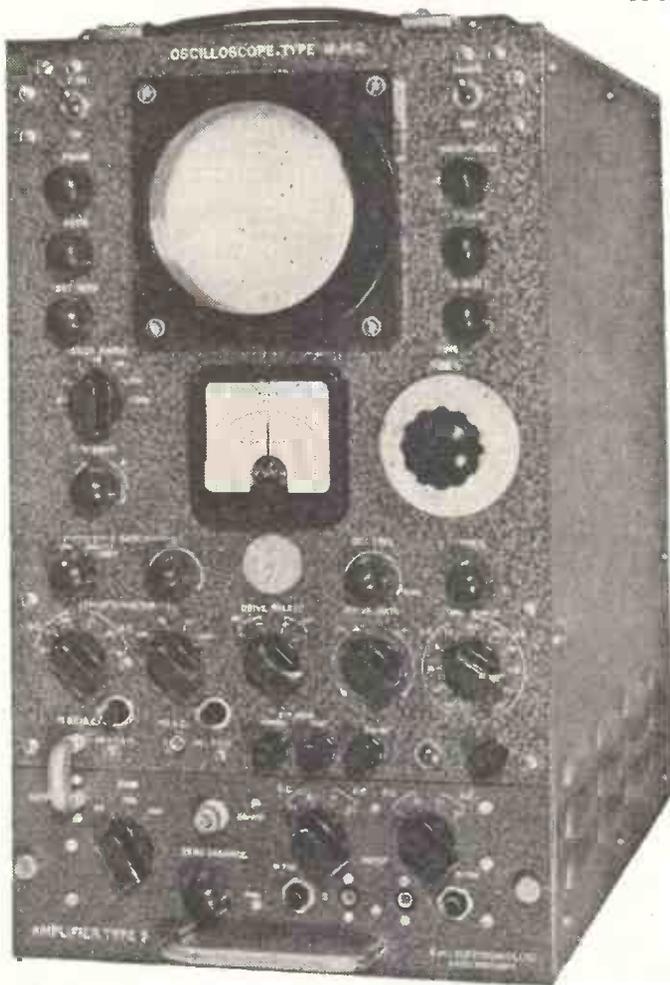
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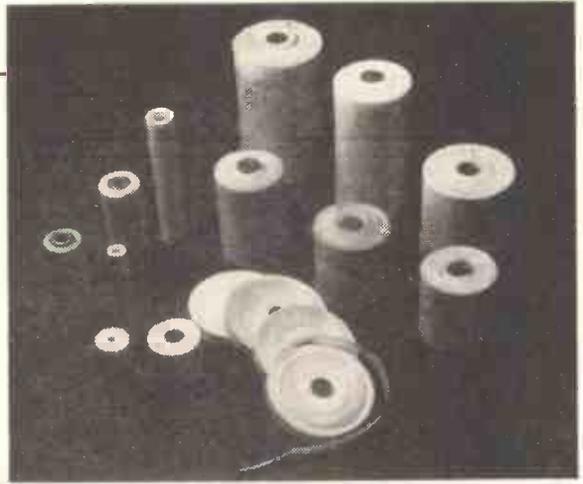
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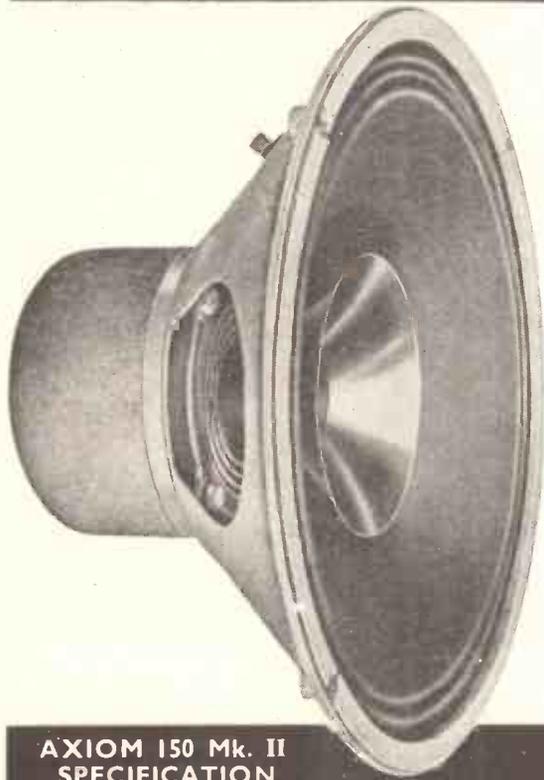
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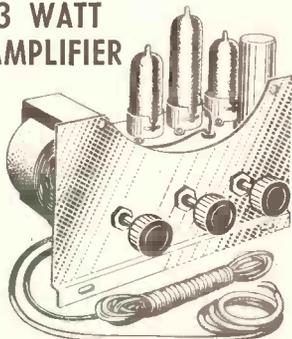
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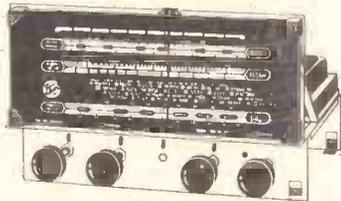
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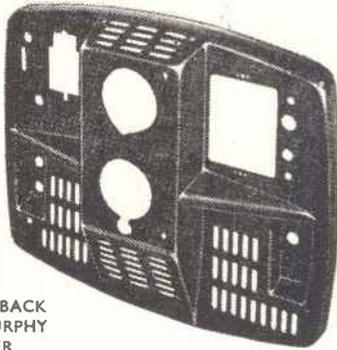
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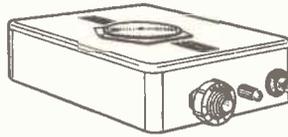
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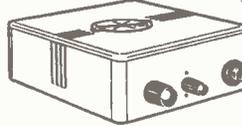
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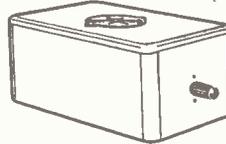
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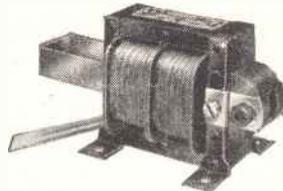
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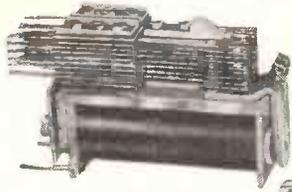
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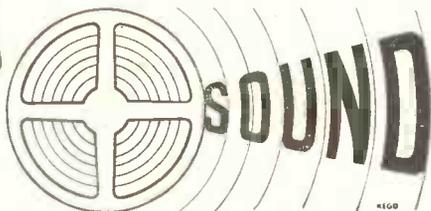
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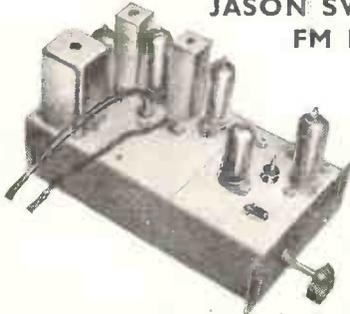
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This excellent unit enables the selection of Home, Light or Third programme at the touch of a switch. Complete freedom from drift is ensured by the incorporation of Automatic Frequency Control. Valve line-up: 4-EP80, 1-ECF50. Front end completely fabricated. 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 itemised price list 2/- post free or the complete Kit £9/19/6, plus P. & P. 2/6.

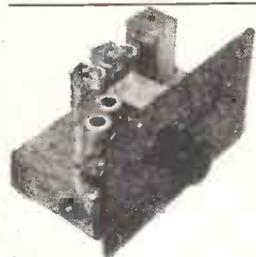
DULCI F.3.A.M. RADIOGRAM CHASSIS. We are very fortunate in being able to offer a further limited quantity of this very popular and efficient chassis at a greatly reduced price. Specification: Three wavebands, Long Medium and Short. Valve line-up: X79, 6BA6, 6AT6, 6L84, 6X4 (or equiv.). Four controls: Tone, ON/OFF. Volume. Wave-change. 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. 1 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. & P. Terms available.

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THE JASON FM TUNER

Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in Mc/s., and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 8in. x 8in. Chassis 7in. x 4 1/2in. x 1 1/2in. Complete standard kit £6/15/- plus 2/6 P. & P. Fringe area kit £7/15/- plus P. & P.



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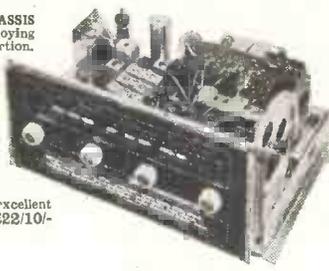
We can now supply complete kit for power pack suitable for the above F.M. tuner or any other similar type. Price for the complete kit is 37/6 only or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X4 and built on chassis size only 6 x 4 x 1 1/2in. Optional extra for power pack. Bulgin Octal Plug 2/3.

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 6 1/2" Dual Concentric Cone Loudspeakers, 3-5 ohm speech coil. This is a quality unit at only 35/- each brand new.

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A new style AM/FM Chassis employing a printed circuit F.M. Tuner section. Valve line-up: 8 valves: EC885, 6B86, 12AH8, 6BA6, 6AL5, 6AT6, 6L84, 5Y3. 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): 13 x 9 x 6in. Frequency coverage (four wavebands): 1,000-2,000 m., 200-550 m., 15-50 m., 88-100 Mc/s. This is an excellent and very efficient chassis. Price £22/10/- plus 5/- P. & P.



RCS. FM.

By leading manufacturer. AM/FM chassis. Seven valves—EC885, EC881, EP85, EAB80, EL84, E280, EM81. Covers long, medium, and F.M. bands. Separate bass and treble controls, illuminated volume control on extended lead. Attractive easily read edge lit dial. Incorporates Mullard F.M. tuner section. Overall dimensions: 12" L. x 10" W. x 10" D. Brand new and fully guaranteed. Whilst stocks last only £18/10/6 plus 5/- P. & P. H.P. or Credit Sale Terms available.

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CONSTRUCTORS NOTE !!

RADIO DATA BOOKS AVAILABLE, i.e. Valve guide, Colour code, etc. Send stamp for list.

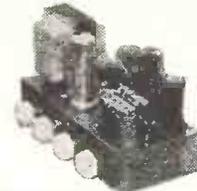
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Introducing the JASON AM/FM Kit for medium waves and F.M. This is a very high quality chassis incorporating 8 of the latest miniature valves, plus DM70 magic eye. Kits are available for chassis complete with output stage at £15/5/-. Also less output stage but with own built-in power pack at £13/19/6 only. These are high fidelity units and exceptional value at these prices which include all required component quality when used in conjunction with a good aerial. Fully illustrated Data Booklet with full construction details, plus individually priced component list, available per return of post 2/- post free. Both plus 3/6 P. & P.

THE R.C. 3/4 WATT AMPLIFIER KIT.

Compare the advantages. Treble, base AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250 v. Valve line-up: 6V6GT, 6X6GT metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. 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 24/5/- only, plus 2/6 packing and post or instruction Book fully illustrated for 1/-. Post free. This amplifier can be supplied assembled, tested, and ready for use at £5/5/- plus P. & P. Hearing is believing.



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 control quality when used in conjunction with a good aerial and earth. Incorporating PNP Transistor and Germanium Diode. For headphone reception. Included with the kit of parts is a handsome plastic case in black and white, measuring 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. & P.** Lightweight high resistance headphones can be supplied separately at 15/- pair. If, however, the kit is purchased complete with headphones this will be supplied at a **SPECIAL INCLUSIVE PRICE OF 37/6** plus 1/6 P. & P. Optional extra. 100ft. coil single 7/36 coloured P.V.C. covered wire, suitable for both aerial and earth. 2/6 only.



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 order; under £1. Cash with order or C.O.D. (charges extra).

Open: Tottenham Court Road: 9 a.m. to 6 p.m. Mon to Fri., Sat. 1 p.m. Holloway Road: 9 a.m. to 6 p.m. daily except Thurs., when we close at 1 p.m.

THE FIRST AND STILL THE BEST !!

THE "SUPERIOR FOUR" KIT

Our superior four-valve receiver A.C. mains, 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6X07, 6 6X50T and 6 6V6GT. Chassis is ready drilled. Cabinet size 10 1/2 in. x 10 in. wide. Maximum depth at base 6 in, tapering to 3 1/2 in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and selected prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at 1/6 post free. Our price for complete kit, £29/9/6. Please add 2/6 P. & C. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wave-change switch; dial, pointer, drum pulleys drive spindle, drive spring and knobs, at 45/-, plus 2/6 P. & C. N.B.—Our kits are even supplied with sufficient solder for the job



THE R.E.P. 1-Valve RECEIVER. All dry battery operation, for use with head phones, the complete kit is available at 42/-, less batteries plus 2/- P. & P. or full instructions at 9d. post free.

VALVES. We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list of brand new imported valve types, fully guaranteed. P.T. paid. Also all surplus types available such as 6V6GT, etc.

THE R.C. RAMBLER ALL-DRY PORTABLE KIT Full assembly details with practical 3rd theoretical diagrams, 1/8 post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. Cream plastic top panel, with dial engraved in red and green adds to the very imposing appearance of this model which is housed in attractive cream and grey leatherette covered attach-case type cabinet, measuring only 9 in. x 7 in. x 5 1/2 in. Weight less batteries 4 1/2 lb., with batteries 6 1/2 lb. This set really has everything. Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5 in. speaker. Valve line-up 3V4, 1B5, 1B5 174. The required components, exactly as specified, including cabinet can be supplied from stock at the special inclusive price of £27/7/- plus 2/6 p. and p. (less batteries). Uses Ever-Ready 90 v. H.T. type B120 at 10/-. Also L.T. 1.5 v. A.D. 55 at 1/6.



RAMBLER MAINS UNIT. For using our popular all-dry "Rambler" on A.C. Mains. Complete kit, when assembled fits snugly into battery compartment, supplied at 47/6 plus 1/6 packing and postage. Includes all required components, and full assembly instructions. N.B.—This unit is completely self-contained in a metal box measuring 7 in. x 2 1/2 in. x 1 1/2 in. and is ideally suitable for many all-dry battery portables requiring 90 v. H.T. and 1.5 L.T.

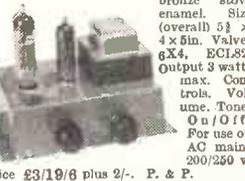
IMPORTANT ANNOUNCEMENT. IT HAS BEEN BROUGHT TO OUR ATTENTION THAT THE WORDING OF OUR ADVERTISEMENT ON THE RAMBLER MAINS UNIT IS INCORRECT. THIS UNINTENTIONAL ERROR HAS NOW BEEN CORRECTED AND WE TRUST OUR APOLOGIES WILL BE ACCEPTED FOR ANY MISUNDERSTANDING CAUSED.

N.B.—All our T.R.F. Kit circuits include specially wound Denon "Max Q" coils on polytron formers, improved performance. Price remains the same.

THE R.C. 2 AMP. BATTERY CHARGER KIT Includes handsome well-ventilated black stove-enamelled steel box, size: 7 1/2 in. x 3 1/2 in. x 3 1/2 in. Fully shrouded first quality transformer, brand new G.E.C. rectifier. Mains fuse, etc. for charging 6 or 12 v. batteries at 2 amp. Absolutely complete kit with full practical and theoretical instructions. Price 36/6 plus 2/6 P. & P. Can be supplied assembled and tested at 45/- plus 2/6 P. & P. Heavy duty crocodile clips suitable for car battery lugs, optional extra at 1/6 per pair.

RC2.A. Small Portable Gram Amplifier. This Little Amplifier is built around a Printed Circuit and employs the very latest highly efficient valve type ECL82. It is ideal for use where space is limited. Although of such small size 7 in. x 5 1/2 in. x 2 in. (overall) with a control panel 3 1/2 in. x 1 1/2 in. reproduction is excellent. A wide range tone control is provided. Output approx. 3 watts max. For use on A.C. Mains 200/250 v. NOTE THE PRICE 59/6, plus 2/- P. & P.

RC1.A. AMPLIFIER. A small high quality gramophone amplifier employing the latest circuitry and highly efficient miniature valves. Very neat chassis finished in bronze stove enamel. Size (overall) 5 1/2 x 4 x 5 in. Valves 6X4, ECL82. Output 3 watts max. Controls. Volume, Tone/On/Off. For use on A.C. mains and 200/250 v.



Price £23/19/6 plus 2/- P. & P.

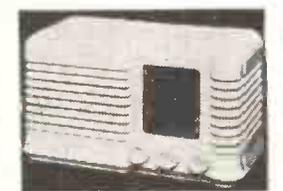
RC3.A. Small 3-Valve Portable Gram Amplifier. An excellent little amplifier for portable gram, giving high quality output. Separate Bass and Treble controls, 2-3 watts output. Valve line-up: E90, EL84, EC93. Provision for mounting 6 in. loudspeaker. Fully isolated from mains 200/250 v. A.C. Overall size: 6 1/2 in. L. x 5 1/2 in. H. x 2 1/2 in. D. PRICE £23/19/6 (less Speaker and Output Transformers), plus 2/6 P. & P.

RC4.A. (STALLION). This is supplied complete with high flux 8 in. P.M. Speaker and Baffle. Incorporating three octal type valves 607, 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 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. & P. 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.

RECORD PLAYER CABINETS—to suit all types of single record and autochanger units. Priced from 45/-. Send stamp for fully illustrated list.

THE "ECONOMY FOUR" T.R.F. KIT. A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and

bolt. Valve line-up 6K7, 6J7 and 6V6. Chassis rigidly drilled. Cabinet size 12 in. long by 6 in. high by 5 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 £5/10/- complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at 1/5 post free. This is allowed if kit is purchased later. Plus 2/6 packing and carriage for complete kit.



GRAMPHONE MOTORS are in SHORT SUPPLY!

COLLARO AC 8/554: Three speed, single player for A.C. 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 £2/19/6 plus 3/6 p. and p.

FOUR-SPEED CHANGERS
Collaro RC456 Mixer Auto-Changer in cream with Studio "O" insert. £9/15/-. B.S.E. Monarch Mixer Auto-Changer, in cream and gold. £8/15/-. Both plus 3/6 p. and p. H.P. Terms available. Stocks rapidly diminishing.



THE STAAR "GALAXY"
Four speed Mixer Auto-Changer. Finger-tilt stop, start and speed change control. Modern two-tone finish. Beautifully made and moderately sized to fit almost any cabinet. For A.C. mains operation 110-250 v. Price £12/16/3 inc. plus 3/6 C. & P. Also available ready mounted on playing desk. For A.C. mains operation 200-250 v. Price £14/9/11 inc. plus 3/6 C. & P. Both brand new, boxed and fully guaranteed.

RECORDER AMPLIFIER
(Well known manufacturer's surplus.) This is a brand new amplifier designed for use with a famous wire recorder. A simple modification is all that is required to make this unit ideal for use with any Tape Deck. Specifications: Valve line-up 7C5, 2AU7 6BR7, 6BR7, 6X4. Neon Record Level Indicator. Controls: Volume/Record Level, Tone Control, Record/Playback Switch. High and Low level inputs for Mike and Radio. External Speaker Socket. Built-in 5 in. Loudspeaker with High Flux magnet. Separate Power Pack. Dimensions: Amplifier 8 1/2 in. H. x 11 in. W. x 2 1/2 in. D. Power Pack: 6 in. x 6 in. x 5 in. High (overall). Full modification details are supplied. Price £23/19/6. P & P 3/6.



SURPLUS BARGAINS—METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 4 in.	M.C.	Rectangular	11/0-
50 microamp	D.C. 3 1/2 in.	M.C.	F.R.	95/-
100 microamp	D.C. 2 1/2 in.	M.C.	F.R.	45/-
200 microamp	D.C. 3 1/2 in.	M.C.	F.R.	65/-
500 microamp	D.C. 2 in.	M.C.	F.R.	18/6
750 microamp	D.C. 2 1/2 in.	M.C.	R.P. (scaled 0-100)	15/-
1 mA.	D.C. 2 in.	M.C.	F. Sq.	22/6
1 mA.	D.C. 2 in.	M.C.	F. Sq. (1954 by Elliott)	25/-
1 mA.	D.C. 2 1/2 in.	M.C.	Desk Type	30/-
100 mA.	D.C. 2 1/2 in.	M.C.	F.R.	10/6
.5 amp.	R.F. 2 in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2 1/2 in.	M.C.	F.R.	10/-
120-0-120 amp.	D.C. 2 in.	M.C.	F. Sq. (shunt required)	15/-
150 amp.	A.C. 4 in.	M.I.	E.P.	45/-
1 amp.	R.F. 2 1/2 in.	Thermo	F. Sq.	7/6
3 amp.	R.F. 2 in.	Thermo	F. Sq.	6/-
20 amp.	D.C. 2 in.	—	R.P. (with shunt)	10/6
30 amp.	D.C. 2 1/2 in.	M.I.	F.R.	12/6
15 volt.	A.C. 2 1/2 in.	M.I.	F.R.	10/-
15-0-15 volt	D.C. 2 1/2 in.	M.C.	F.R.	17/6
200 volt	D.C. 3 1/2 in.	M.C.	F. Rd.	35/-
300 volt	A.C. 2 1/2 in.	M.C.	F.R.	10/6
300 volt	A.C. 3 1/2 in.	M.I.	F. Rd.	30/-

SPECIAL U.S. 0-1 mA. 2 1/2 in. taken from equipment but perfect, 22/6 each. R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.

MEPHER RECTIFIERS. 1 mA. by G.E.C. at 6/6, also 5 mA. by G.E.C. at 8/6.

10 in. CABINET SPEAKER. Ideal for P.A. etc. Comprises solid wood cabinet complete with carrying handle. Painted dark brown, with built-in good quality 10 in. P.M. speaker. 3 ohm speech coil, complete with lead and Irganic Jack plug. Brand new. Price only 45/- plus 3/6 P. & P.

VALRADIO I/V TUNER. Limited stocks of this well-known unit available at much reduced price. An ideal prefabricated front end for any superhet T.V. receiver with 18 mc/s. i.f. Continuously variable tuning covering ALL bands from 40-100 mc/s and 170-225 mc/s. Valve line-up: PC684 PCF80 (series heaters). Whistl stocks last only £3/19/6, plus 2/- P. & P.

RETURN OF A WINNER!!!
(Exclusive)

We have been most fortunate in obtaining further limited supply of this fine and popular cabinet. Instantly recognised as being of leading High Quality manufacturers stock, this trolley-type cabinet is finished in polished dark solid walnut. Can easily be adapted to accommodate tape recorder, amplifier, radio-gram etc., etc. External measurements: 24 in. x 16 in. x 29 in. The whole is mounted upon "easy run" castors. Unrepeatable at this price £5/19/6, plus 15/- C. & P.



GLYNE RADIO LTD.

18, Tottenham Court Road, London, W.1
And at
162, Holloway Road, London, N.7.

SELENIUM RECTIFIERS BATTERY CHARGING EQUIPMENT

L.T. Types

2/6 v. 1/2 a.h.w.	1/9
6/12 v. 1/2 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.	22/9
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

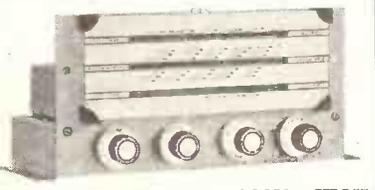
BATTERY CHARGER KIT
Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and ammeter. Only 49/9. Post 3/-

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 47/9 Carr. 3/6.

All for A.C. Mains 200-250v., 50 c/s. Guaranteed 12 months
Assembled 6v. or 12v. 4 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. **75/-**
Ready for use with mains and output leads. Carr. 3/9. Or Deposit 13/9 and five monthly payments 13/9.



AM/FM RADIOGRAM CHASSIS. 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. 1/4 in., 8d. yard. Twin screened feeder 11d. yard.

DIAL BULBS. M.E.S., 8 v. 0.2 a. 6/9 doz. 6.5 v. 0.3 a., 5/9 doz. 2.5 v. 0.3 a., 3/9 doz.

ELECTROLYTICS (current production). Not Ex Govt.

Tubular Types	Can Types
8 mfd. 450 v.	1/9
8 mfd. 500 v.	2/6
16µF 350 v.	1/11
16µF 450 v.	2/9
16µF 500 v.	3/9
8-16µF 500 v.	4/11
25µF 25 v.	1/3
50µF 12 v.	3/1
50 mfd. 25 v.	1/9
50µF 50 v.	1/9
100 mfd. 12 v.	1/9
100 mfd. 25 v.	2/3
3,000 mfd. 6 v.	3/9
6,000 mfd. 6 v.	3/11
16µF 450 v.	2/9
16 mfd. 500 v.	3/9
32µF 350 v.	2/11
32 mfd. 450 v.	4/9
100 mfd. 450 v.	4/9
8-8µF 450 v.	2/11
8-16µF 450 v.	3/11
16-16µF 450 v.	3/11
32-32µF 350 v.	4/9
32-32µF 450 v.	5/9
100-100 mfd. 350 v.	5/9
64-120 mfd. 350 v.	5/9
100-200 mfd.	7/6
275 v.	6/11

Many others in stock

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

EX GOVT. STEP UP/STEP DOWN TRANSFORMERS. Double wound 80/100 watts. 10-0-100-200-220-240 v. to 5-0-75-115-125-135 v. or Reverse. Only 11/9, plus 2/9 post. 10-0-100-200-220-240 v. to 9-0-110-122-136-148 v. or Reverse. 200 watts, 35/9, plus 7/6 carr.

EX GOVT. METAL BLOCK PAPER CONDENSERS

4 mfd. 500 v.	2/3
8 mfd. 500 v.	4/6
4 mfd. 1,000 v.	3/9
10 mfd. 500 v.	3/9

OIL FILLED BLOCK CONDENSERS
Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.



THE SKY FOUR T.R.F. RECEIVER
A design of a 3 valve 200-250 v. A.C. Mains L. & M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type.

It employs valves 6K7, SP61, 6F6G and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

5 CORE FLEX. Henleys circular rubber 14/36. Each lead colour coded. 1/6 yard.

EX GOVT. MAINS TRANSFORMERS
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 1/2-3 1/2 in.	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.	13/9
12.5 v. 3 a., 5 v. 3 a.	12/9

EX GOVT. VIBRATOR UNITS. 12 v. input 280 v. output. Suitable for car radio, etc. 16/6.

MANUFACTURERS' SURPLUS TRANSFORMERS. Primary 200-240-250 v. Drop through type 250-0-250 v. 70 mA. 6.3 v. 3 a., 11/9. Postage 2/9.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5 1/2 x 4 1/2 x 2 in. 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.



Type BM2. Size 8 x 5 1/2 x 2 1/2 in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions, 49/9, or ready for use, 59/6.

JUNCTION TRANSISTORS for Audio stages. Only 7/6. For R.F. 17/6.

MINIATURE MOTORS. 24/28 v. D.C. or A.C. Size only 2 1/2 x 1 1/2 in. Spindle 1 1/2 in. long. 1/2 in. diam. Made by Hoover Ltd., Canada. Price only 9/9.

M.E. SPEAKERS. 2-3 ohms R.A. 8 in. Field 600 ohms, 11/9.

R.S.C. TRANSFORMERS

FULLY GUARANTEED. INTERLEAVED AND IMPREGNATED.

MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a.	17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	19/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion.	31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
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
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.	22/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.	5/9	6.3 v. 3 a.	8/11
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/6
0-4-6-3 v. 2 a.	7/9	12 v. 3 a. or 12 v. 1 a.	7/9
25 v. 1.5 a.	17/6		

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 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.

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s.

120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v. 250 mA.	9/11

OUTPUT TRANSFORMERS
Midget Battery Pentode 66:1 for 3S4, etc. 3/6
Small Pentode 5,000Ω to 3Ω 3/9
Standard Pentode, 5,000Ω to 3Ω 4/9
Standard Pentode, 8,000Ω to 3Ω 4/9
Push-pull 8 watts 6V6 to 5 ohms 8/9
Push-pull 10-12 watts 6V6 to 3Ω or 15Ω 15/9
Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω 16/9
Push-pull EL84 to 3 or 15 ohms 16/9
Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms 21/9
Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω 47/9

SMOOTHING CHOKES

250 mA., 5 H., 100 ohms	11/9
150 mA., 7-10 H., 250 ohms	11/9
100 mA., 10 H., 200 ohms	8/9
80 mA., 10 H., 350 ohms	5/6
60 mA., 10 H., 400 ohms	4/11
1 amp. 0.5 ohm. L.T. type	6/6

VIBRATORS. Oak and Wearite Synchronous 7 pin 2 v. 7/9; 6 v. 8/9.

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

NEW 1957 DESIGN, HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams.



Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B., 30-20,000 c/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 9 in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 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.

Cover as illustrated **10 GNS.** car. 10/-
18/9 extra. Only 12 months' guarantee
Or Factory built with 12 months' guarantee **£12/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 35/9 and 9 monthly payments of 28/11.**

LT/45 HIGH QUALITY TAPE DECK AMPLIFIER

COMPLETE with POWER PACK and OSC. STAGE. Suitable for Collaro, Lane, Truvox, Aspdien, Brennel, etc., etc. State make of Deck when ordering. Chassis size 12-7-3in. Overall size 12-7-6in. For 200-250 v. 50 c/s. A.C. mains. Output for standard 2-3 ohm speaker. Only 16 millivolts input required for full recording. Only 2 millivolts minimum input required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Negative feedback equalisation. Linear frequency response ± 3 D.B. 50-11,000 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. Valves type ECC83, ECC83, EL84, EZ80, RM34. Output 4 watts. Unit supplied with maker's 12 months' guarantee. We know of no other make which represents the same exceptional value. We can supply Decks and microphones with above at a special inclusive price. Leaflet 6d.



LINEAR LG3 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 2 1/2 in. Fitted vol. (with mains switch) and Tone Control. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohms speaker. Guaranteed 12 months. Only 49/9, carr. 3/6.

R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/-, or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.



R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only £3/15/-, carr. 3/6 or factory built 22/6 extra. Or Deposit 18/6 and five monthly payments of 18/6 for assembled unit. P.M. Speakers 3 ohm recommended for use with A7, A5, LG3 or L45 amplifier. Plessey 12in., 29/11, 6in. Celestion and Goodmans with high flux density magnet 19/9. 10 x 6in. Goodmans Elliptical 27/6.

COLLARO RC457 4 SPEED AUTO-CHANGERS

With studio pick-up with turnover head. BRAND NEW. Cartoned, latest model. For 200-250 v. 50 c.p.s. A.C. mains. Very limited number at only £8/19/6. Carr. 5/6.

COLLARO RC54 3 SPEED AUTO-CHANGER

As above unit but for normal 3 speed requirements. Brand new cartoned but for 110 v. 60 c.p.s. A.C. mains. So that the unit can be operated from normal 200-250 v. A.C. mains we are supplying free with every changer a suitable auto-transformer with input and output voltages clearly marked. Limited number only. 7 gns. Carr. 5/6.

PORTABLE CABINETS. Exceptionally attractive design.

Finished in 2 tone revere. Provision for speaker and amplifier. Inside dimensions 17 1/2 x 12 1/2 in. 59/6. Depth 7in. plus lid 1 1/2 in. Carriage 5/-. SPECIAL OFFER. Above cabinet LG3 Amplifier 6in. speaker, and RC457 changer 15 GNS. Carr. 8/6.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER.

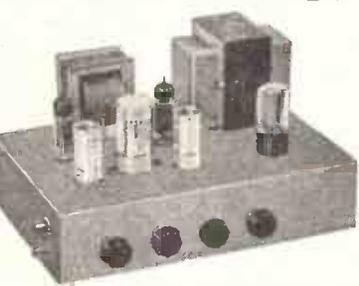
Suitable for use with Garrard, B.S.R. or any other record playing unit, and most microphones. Total negative feedback 12 db. Separate Bass and Treble Controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves used. Size only 6 x 5 x 5 1/2 in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only £5/19/6. Or Deposit 22/- and five monthly payments of 22/- Send S.A.E. for leaflet.



PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms) consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our All or any similar amplifier. Rating is 10 watts. Price only £5/17/6. Or Deposit 13/- and nine monthly payments of 13/-.

R.S.C. ULTRA LINEAR 12-14 WATT AMPLIFIER



NEW 1957 MODEL A11 HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL PRE-AMP. STAGES

Two input sockets with associated controls allow mixing of "mike" and gram as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer, specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. INDIVIDUAL CONTROL 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 makes and types of pick-ups and microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. FOR MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx. 12-9-7in. For A.C. mains 200-230-250 v. 50 c/s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Despite improved performance due to use of latest miniature valves price remains as previous model but extra input now standard.

Only 8 GNS. or factory built 45/- extra. Carr. 10/-. If required louvered metal cover with 2 carrying handles can be applied for 18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 25/6 and nine monthly payments of 25/6.

LINEAR "DIATONIC" 10-WATT HIGH FIDELITY AMPLIFIER. Incorporating pre-amp. For A.C. mains input 200-230-250 v. 50 c.p.s. A compact attractively finished unit with two separately controlled inputs, and outputs for 3 and 15 ohms speakers. Separate Bass and Treble controls. Five latest type miniature Mullard valves. Only 12 Gns. Send S.A.E. for leaflet and credit terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.

P.M. SPEAKERS. 2-3 ohm 6in. Goodmans 17/8. 7 x 4in. Elliptical, 19/9. 6in. Rola, 19/9. 8in. Rola, 19/9. 10in R.A., 28/9. 12in. Plessey 3 ohms, 10 watts, 59/6.

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch., and Vol. Output will load most Amplifiers requiring 500 mV. input depending on Ae. location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-point wiring diagrams and instructions, 2/6.

RECORDING TAPE. 1,200 ft. Reels Puretone, Medium Coercivity, 15/9.

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS, 2.

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 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

WELDING TRANSFORMER. In-put 230 volts. Output 17.5 volts 35 amps. New, 72/6. P/P. 5/-.

A.C. MAINS POWER PACKS. Input 230 v. Output 250 v. 50 m/a. 6.3 v., 2 a. Fully smoothed, 5Z4 rectifier. Housed in metal box with other useful gear, including 2X EF50, VR137, EA50 and Y63 valves, 32/6 each. P/P. 3/-.

ADMIRALTY 12 VOLT D.C. MOBILE AMPLIFIERS. Separate mic. or gram. inputs. Output 10 watts, matched, 3, 15 or 600 ohms. Not new but all tested, £8/19/6 each. P/P. 5/-.

R.1155 SUPER SLOW MOTION DRIVES Improved version as fitted to Model L and N. Suitable for Model A, etc. Brand new, 12/6 each. P/P. 1/6.

AMERICAN SUPER LIGHT-WEIGHT HEADPHONES

Magnetic type, res. 50 ohms. Fitted with rubber earmoulds to fit inside the ear. Extremely good quality, ideal for communication receivers, etc., supplied brand new, 15/- pair. P/P. 1/-.

ROTARY CONVERTORS. Input 24 volts D.C. Output 230 volts, 50 cycles, 100 watts. Supplied unused, 92/6 each. P/P. 5/-.

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/-.

MIDGET RECORDER MOTORS Size only 1 1/2 x 1 x 2 1/2 in. Will operate from 4.5 to 24 volt D.C. Fitted with reduction gear. Supplied brand new, 12/6 each. P/P. 1/-.

TAPPED L.T. TRANSFORMER. Input 200/250 volts. Output tapped, 3, 6, 9, 12, 24 or 36 volts 5 amps., 35/- each. P/P. 3/-.

BARGAIN 6.3 VOLT FILAMENT TRANSFORMERS

Potted, hermetically sealed, ceramic terminations, all brand new. Made by famous manufacturer.

Type 1. 200/250 volt input. Outputs: 6.3 v. C.T. 5.6 amps., tapped 5 v.; 6.3 v. C.T. 4.8 amps., tapped 4 v.; 6.3 v. C.T. 1 amp., tapped 4 v., 19/6 each.

Type 2. 200/250 v. input. Output: 6.3 v. C.T. 3.3 amps., tapped 5 v.; 6.3 v. C.T. 1 amp., tapped 4 v.; 6.3 v. C.T. 9 amp.; 6.3 v. C.T. 6 amp., 15/6 each. Postage both types, 2/-.

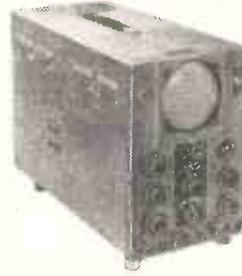
EDDYSTONE MAINS POWER PACK. Input 200/250 volts. Output 175 volts 65 m/a. 6.3 volts 3 amps. Fully smoothed, 5Z4 rectifier. For Eddystone 358 receiver, etc., 32/6 each. P/P. 3/-.

A.C. MAINS BLOWER MOTORS. 220/230 volts. 1 1/2 in. dia. outlet. Housed in metal box and fitted with dust filter pads. Supplied with 2 lengths of hose, brand new, £4/19/6 each. P/P. 1/6.

RGA. OUTPUT TRANSFORMERS

Completely potted. Centre tapped primary, 8,000 ohms. Secondary tapped, 3, 7.5, 15, 500 or 600 ohms. Separate feedback winding. 15 watts rating. Ideal for 6L6, KT66, EL84's etc. brand new, 27/6 each. P/P. 2/-.

A.R.88 WAVECHANGE SWITCHES. Ceramic, 8 bank, 6 position, complete with all screens. Brand new, 17/6 each. P/P. 2/6.



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. .8 v. rms. Supplied in good working order. £27/10/- each. P/P. £1.

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/-.

HALLIGRAFTER S. 36A. V.H.F. COMMUNICATION RECEIVERS. Improved version of S.27. Specification: Completely self contained except for headset or speaker. Operation 110/230 volt A.C. Superhet receiver, for A.M. or F.M. incorporating R.F. and 3 I.F. stages, A.V.C., noise limiter, and S meter. Frequency coverage 27.8 to 143 mc/s. Supplied brand new, £45 each. P/P. 15/-.

AMERICAN MINE DETECTORS. Type SCR-625C. Battery operated, portable and supplied complete with instruction book. Ideal for detecting all types of metals. £12/10/- each. P/P. 10/-.

SPECIAL OFFER

BRAND NEW AMERICAN/CANADIAN No. 19 MARK II TRANSMITTER-RECEIVERS. Complete with all valves. Frequency coverage 2 to 8 mc/s, 65/- each. P/P. 10/-.

Limited number available

HEAVY DUTY MAINS ISOLATING TRANSFORMERS. Specification:—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/-.

HEAVY DUTY "C" CORE TRANSFORMER. Input 230 volts. Outputs, 510/0/510 v 300 m/a., 375/0/375 v. 100 m/a., 6.3 v. 9 a., 2 x 6.3 v. 2 a., 2 x 6.3 v. 1 a., 6.3 v. 1.5 a., 6.3 v. .5 a., 5 v. 3 a. Brand new, 82/6 each. P/P. 5/-.

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 1S5 and 1 1R5), 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/-.

AMERICAN ROTARY TRANSFORMERS

Models available for either 6 or 12 volt D.C. input. Output 250 volts D.C. 80 mA. Ideal for car radios or razors, etc., brand new 22/6 each. P/P. 3/-.

EX-NAVY SOUND POWERED TELEPHONES

This type requires no batteries to operate and can be fitted in moments. Uses hand generator for calling, giving an extremely loud buzzing note, and also a neon indicator. Ideal for field activities, factories, office, etc. Only 45/- each. P/P. 4/6.

12 VOLT MIDGET ROTARY TRANSFORMERS

Type H.T.11, size 4 1/2" x 2 1/2". Output 310/360 volts at 30 m/a. Price 22/6, P/P. 1/6.

CHEAP TRANSISTORS
Red spot. A.F. 800 kc/s., 10/-;
3 for 22/6. Blue spot, 1.5 mc/s., 15/-;
Yellow/red, 8 mc/s., 21/-.

TRANSISTOR TRANSFORMERS. £in. sq. 8: 1.4.5: 1.10: 1, 4/6.

TRANSISTOR CONDENSERS. Electrolytic. 1 x £in. 8, 8, 16 or 30 mfd., 3 or 6 volt. 2/9; .001, .002, .005 .01, .02, or .04, 9d.

TRANSISTOR VARIABLE. Jackson, 365pf., 2-gang, 8/8.

MAINS NEON PANEL INDICATORS. Chrome escutcheon. Red, amber, green or clear. 3/9 42/- doz

COPPER AERIAL WIRE. Ex-U.S.A. 300ft. reels 3/6.

HEAVY DUTY SLIDER. 1 ohm, 12 amp. 6/6.

HEATER TRANSFORMERS. Input 230 volts. Output 6.3 v. 1.5 a., 5/9. 8 amp., 10/6.

CRYSTAL DIODES, G.E.C., 10d. CRYSTAL SET COILS. Repanco dual range, 2/6. Teltron HAX. 3/-, .0005 mfd., variable, 3/10. .0003 mfd. variable 3/10.

BULGIN SIGNAL LAMPS. M.e.s. red, green, white or clear, 1/9.

ALLADIN COIL FORMERS. £in. or £in. with slug, 6d.

ALLADIN COIL FORMERS WITH CANS. £in., 1/-; 2in., 1/3.

EPICYCLIC DRIVES. 5: 1 ratio, 1/3. Cord drives, 1/3.

BRASS £in. COUPLERS 7d.; w/spindle, 9d. Ceramic flexible coupler, 1/6.

LINE CORD. 2 a., 100 ohms/ft., 1/9 yd.; 3 a. 60 ohms/ft. 1/9 yd

CERAMIC CONDENSERS. 500 v wkg. 1 pf. to 5,000 pf. 6d. .01 mfd., 9d.

CARBON RESISTORS. 1/16, 1/4, 1/2 or 1 w. 3d.; 1 w 4d., 2 w. 6d.

VALVE HOLDERS. Octal, 6d. Mazda, 6d. 807, 6d. Ceramic, 1/-; Loctal, 6d. B5A, 9d. B5, 6d. B7G, 6d. W/skirt, 9d. B9A, 9d. W/skirt, 1/-; Anti-microphonic, w/skirt, 1/3. B7G cans, 6d. B9A cans, 8d.

ALUMINIUM CHASSIS

Best quality, 18 swg., four sided, reinforced corners. 6 x 4 x 2 1/2 in., 3/6; 10 x 7 x 2 1/2 in., 5/3; 7 1/2 x 5 1/2 x 2 1/2 in., 4/6; 11 1/2 x 7 1/2 x 2 1/2 in., 6/-; 13 1/2 x 9 x 2 1/2 in., 6/9.

0.0005 mfd., 2-gang, midget, 7/6. Large 3-gang, 6/6. Ditto 4-gang, 7/6. TRIMMERS. Philips beehive, 10 pf. 1/-; 30pf. 10d. Mica, 50 pf. 6d. 2 x 100 pf., 1/-; 2 x 200 pf., 1/-; Ceylon HV, 250 pf., 1/-; Air spaced w/spindle, 50, 100 pf. 1/6. **MIDGET PLUGS.** 1/9. **BELLING 7-PIN P.S. 1/6 pr.** **ACTUAL JONES.** 3-pin 3/6 pr. 12-pin, 4/6 pr. 21-pin, 7/6 pr. **BULGIN** 8-pin mains. P73, 4/6 pr.

ROTARY SWITCHES. Small dia. 2 P. 2 w. 1/6. 3 P. 2 w. 1/6. 4 P. 3 w. 2/6. 3 P. 4 w. 2/6. 2 P. 6 w. 2/6. 1 P. 12 w. 2/6. Large ceramic. 2 P. 6 w. 7/6.

TOGGLE SWITCHES. D/P, on/off, 1/9. D/P on/off, 2/6. 8/P. c/over, 2/3. D/P. c/over, 3/-.

KEY SWITCHES. D/P, c/over, locking, 2/9. Non-locking one side, 2/3.

POTENTIOMETERS. Wirewound. 100 ohms, 300 ohms 1K, 2K, 2.5K, 5K 10K, 50K, 100K, 2/6. Carbon. 1K to 100K, 1/9. 250K to 2 Meg. 2/3. All w/spindle.

FUSE HOLDERS. £in. Open clips. Single, 5d. double, 10d. Fuses, 150 m.a. to 5 amp., 3d.

PAPER CONDENSERS. Tubular, 350 or 500 v., .001 to .1 mfd. 9d., .25 1/- to 1/3.

ELECTROLYTIC CONDENSERS

All new stock		
2,200 v.	1/3	500/50 v. 4/8
8/150 v.	1/-	250 x 250/6 v. 2/6
8/450 v.	1/9	6,000/6 v. 3/6
8/500 v.	2/-	8 x 8/450 v. 3/6
16/450 v.	2/9	8 x 16/450 v. 3/6
16/500 v.	3/3	16 x 16/450 v. 3/6
30/450 v.	3/9	16 x 16/500 v. 4/3
40/450 v.	3/9	16 x 16/500 v. 4/3
10/25 v.	1/-	32 x 32/275 v. 3/6
25/25 v.	1/9	32 x 32/350 v. 4/3
50/25 v.	1/3	32 x 32/450 v. 4/6
50/25 v.	1/-	50 x 30/275 v. 3/9
50/50 v.	1/9	100 x 300/350 v. 7/6
100/25 v.	1/3	32 x 32 x 2/275 v. 3/3
500/12 v.	1/3	50 x 50 x 50/350 v. 5/3

ADMIRALTY REFLEX RE-ENTRANT P.A. LOUDSPEAKERS

Twln units. Impedance 3 ohms. Extremely sensitive and directional. Ideal for all outside work. Complete with 600 ohm line transformer. Price 32/6 each. P/P. 5/-.

P.M. LOUDSPEAKERS, 3 OHM

All new and unused.
Plessey, 2 1/2in., 16/-; R.A. 6in., 17/6;
Plessey, 1 1/2in., 32/6; Goodmans, 3 1/2in.,
17/6; Elac, 4in., 19/6; Rola, 7 x 4in.,
15/6; Elac, 6in., 17/6; Elac 10in.,
27/6; Plessey, 10 x 6in., 27/6.

OUTPUT TRANSFORMERS. 6V6/3 ohm,
4/6. Push-pull 6V6/3 or 15 ohm, 16/6.
Tapped small pentode, 3/9. 3 ratio, mid/igt,
6/-, Push-pull 6V6/15 ohm, 7/6. 465 Kc/5
I.F. Mid/igt, 8/6 pr.

FERRITE RODS, 6in., 1/6.
FERRITE ROD AERIALS. Teletron M/W,
8/9. Repanco dual range 12/6.

REPANCO COIL PACKS. Mid/igt. L.M.S.
without, 36/-.

SUPERHET COILS. Wearite, 3/-. Weymouth, 3/9.
Repanco, 3/3. Osmor, 4/-.

Repanco DRR2. Coil, 4/- Pr. TRF coils, 8/-.

METAL RECTIFIERS. Sentercoil, RM1, 4/3. BM2,
4/6. RM3, 5/6. BM4, 16/6. Contact cooled, 125 v.
80 m/a., 4/3. 250 v. 50 m/a., 7/6. 250 v. 85 m/a.,
9/-, 250 v. 75 m/a. F.W. bridge, 12/6. 250 v. 300 m/a.
15/6. Pencil type, 250 v. 60 m/a., 5/-, 250 v. 80 m/a.,
7/6. 350 v. 60 m/a., 6/-.

INSULATED TERMINALS. Red or black, 1/3.
WANDER PLUGS, 3d. Insulated sockets, 6/d.
TOC 8 MPD. PAPER CONDENSER. 750 volts, 5/6.
Sprague 4 mfd., 600 v., 4/6.

T/V COAXIAL CABLE. 75 ohms. 1/2in. dia., 7/d. yd.,
6/8 12 yds.

BAND IN AERIAL BARGAINS. 3 element, wall
fixing 32/6. Ditto, 6 element 42/6.

BELLING COAX PLUG, 1/3. Socket, 1/2. Joiner,
1/9. Line socket, 2/-. Wall socket, 4/6. Diplexer,
13/-.

REPANCO TRANSISTOR COMPONENTS

Push-pull interstage transformers..... 8/6
Push-pull output transformers..... 8/-
Dual range ferrite slab aerial..... 13/6
315 kc/s I.F. transformers..... 5/-
Combined oscillator/1st I.F..... 11/6

SPEAKER CABINETS. Attractive, polished walnut,
veneer 6in. 16/6. 8in., 21/- GOLD EXPANDING
METAL, 5/- sq. ft.

**25-WAY TAG STRIPS. VOLTAGE SELECTOR
PANELS, 6d.**

PYREX DOME AERIAL INSULATOR, 1/3. 3-link
chain insulator, 6d. Eggs 6d.

JACK PLUG JUMPER LEADS. Fitted with 2 P.O.
plugs, 3/-. Sockets, 9d.

G.P.O. TWIN BELL UNITS. New in boxes, 7/6.

G.P.O. LAMP JACKS, 6d.

12-WAY CONNECTOR STRIPS. Break off type, 2/6.
A.M. 2-way, 4d. 3-way, 6d.

A.M. SWITCHBOXES. Fitted with 3 on/off switches,
1/9.

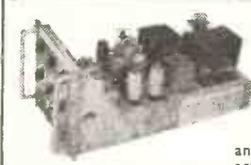
MIDGET H.T. TRANSFORMERS. Input 220/240 v.
Output 220 v., 25 m/a., 6.3 v. 1 amp., 10/6.

SMOOTHING CHOKES. 10H. 40 m/a., 4/6. 15H.
60 m/a., 5/6. 8H. 100 m/a., 8/6. 9H. 100 m/a., 7/6.
5H. 200 m/a., 5/6. 50H. 120 m/a., 15/6. 20H. 120 m/a.,
10/6. 15H. 300 m/a., 10/6. Swinging chokes, 3.6/4.2H.
250 m/a., 10/6. 8/40H. 300 m/a., 10/6.

VALVE BARGAINS

All new and guaranteed.

0A2	8/6	DAP36	9/6
1T4	7/6	EP96	12/6
1R5	8/6	EL54	10/6
1R5	4/6	ECC81	9/-
1N3	10/6	ECC82	9/-
1H6	10/6	ECC83	9/-
1C5	10/6	EZ80	10/6
1A7	12/8	EZ81	10/6
3A5	4/6	EM90	10/6
3A5	10/6	EY91	10/6
3Q4	8/6	ECL80	11/6
3V4	8/6	ECP82	12/6
384	8/6	ECP80	12/6
3Q5	8/6	ECC84	12/6
6U4	8/6	ECL82	12/6
5V4	8/6	EP90	9/6
5Y3	7/3	E737a	10/6
6AG5	3/6	E139	5/6
6AK5	5/6	ECH42	10/6
6H6	1/9	EL41	11/6
6J6	3/6	EP91	9/6
6C4	5/6	EB91	7/6
6J5	4/11	12AH8	10/6
6K8	9/-	PY80	10/6
6V6	7/6	PY82	10/6
6Q7	10/6	PY81	10/6
6SN7	5/11	PK4	13/6
6X5	7/6	PX25	15/6
807	6/-	PCF80	12/6
12A6	7/6	PCF82	12/6
25Z4	9/6	PCC84	12/6
35Z4	9/6	UL41	11/6
DK92	9/6	UY842	10/6
DK96	9/6	UZ5	12/6
DL96	9/6	PI82	10/6
DF96	9/6	VU111	1/9



MODULAR 67

These bargain instruments contain a COMPLETE A.C. MAINS POWER PACK. Input 230 volts 50 cycles. Output 350 volts 120 m/a. and 6.3 volts 5 amps. Choke and condenser smoothed and uses 5Z4 rectifier. (Transformer actually 200 m/a.). Also included in the unit are 11 other valves, 5 SP61, 1 VR116, 2 EB34 and 3 EA50, and many other useful, components, pots, resistors, switches, etc. Size of case 18 x 9 x 7in., which is finished in grey. Supplied brand new.

SPECIAL REDUCED PRICE 39/6 each P/P. 7/6.

50 MICROAMP METERS

2 1/2in. flush mounting meter housed in grey instrument case, complete with a chrome handle. Resistance 800 ohms. Supplied brand new and tested, 59/6 each. P/P. 2/6.

EDDYSTONE POWER PLUGS, S.441B. 200/250

volt A.C. input. Output 300 volts 200 m/a. and 12 volts 3 amps. Double choke and condenser smoothed. Uses 5U4 rectifier. Housed in compact grey metal case. Supplied in perfect condition, 49/6 each. P/P. 7/6.

4 SPEED RECORD CHANGERS

Brand new 1957 model B.S.R. 4 speed automatic record changers. Only 48/12/6 each. P/P. 3/6.
Brand new 1957 model COLLAR RC457 4-speed automatic record changers. Only 48/15/- each. P/P. 3/6.

HEAVY "C" CORE H.T. TRANSFORMERS.

Type 1. Input 230 volts. Output 350/0/360 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. 4 a., 5 v. 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. 5 a., 6.3 v. 1 a., 5 v. 4 a., 75/- each. P/P. 4/6.

Type 3. Input 23 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.

BENDIX COMMAND TRANSMITTERS.

Complete with all valves and crystals. Frequency coverage 2.1 to 3 mc/s. Only 22/6 each. P/P. 2/6.

MARCONI SIGNAL GENERATORS.

Laboratory instruments at a fraction of original cost. Operation of all types, 200-250 volt A.C. Type TF-390G. Frequency coverage 16 to 150 mc/s. Brand new with leads and charts, 425 each. P/P. 4/1. Ditto 4 to 100 mc/s., 422/10/-. Type TF-517G. Frequency coverage 16 to 58 mc/s. and 150 to 300 mc/s. Brand new 435 each. Ditto complete with TF-675 pulse generator, 442/10/- P/P. 4/1.

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 generator. Brand new only 43/19/6 each. P/P. 3/-.

L.T. TRANSFORMER BARGAIN.

Input 200/250 volts. Output 12 volts 5 amps. Only 12/6 each.

AMERICAN GEARED MOTORS



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 7in. x 1 1/2in. Shaft dia. 1/2in. Supplied 19/6 each. brand new only P/P. 3/-.

HOOVER ROTARY TRANSFORMERS.

Latest type, small. 24 volt D.C. input. 210 volts, 120 m/a. output. New 15/6 each. P/P. 1/6.

PARMECO PRESSURE UNITS.

Heavy duty, 3 ohm coil. Not new but all tested, 39/6 each. P/P. 2/6.

TRANSFORMER BARGAIN.

Input 230/250 volts. Output 250/0/250 volts 200 m/a., 6.3 volt 4 amp., 5 volt 2 amp. New, 27/6 each. P/P. 1/6.

6 VOLT VIBRATOR PACKS

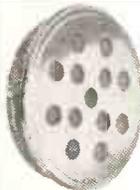
Output 120 volts 30 m/a. Fully smoothed, uses standard Malo'y 4 pin vibrator. Supplied brand new and boxed, 12/6 each. P/P. 2/6.

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. P/P. 1/- all types.



CRYSTAL MICROPHONE INSERTS

Sensitive, ideal for tape recorders, amplifiers, etc., 4/6 each. P/P. 6d.

INSTRUMENT TRANSFORMERS.

Parmeco, Input 230 volts. Output H.T. 195 volts 85 m/a., tapped 130 v. and 65 v. L.T. 6.3 v. 5 amp., 6.3 v. .3 amp. Brand new, 14/6. P/P. 1/6

INSTRUMENT POTENTIOMETERS.

Brand new Colvern type. 100,000 ohms, 10 watts, 3 1/2in. dia. Ideal for bridges, etc., 10/6. Ditto twin gang 5,000 ohms, 10/6. P/P. 1/-.

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/-.

SOUND POWERED BALANCED ARMATURE EARPIECES.

Brand new 3/6 each. P/P. 9d. Brand new sound powered handsets, 19/6 each. P/P. 1/-.

MINIATURE SLOW MOTION DRIVES

Dia. 1 1/2in. Scale 0-100, for 1/2in. spindle. Complete with locking device. Brand new, 7/6. P/P. 1/-. Large type available as above 7/6.

CHEAP MAINS TRANSFORMERS.

Standard replacement type. Pri. 200/250 v. Sec. 250/0/250 v., 80 m/a., 6.3 v. 4 a. tapped 4 v. 5 v. 2 a. Tapped 4 v. Brand new, 18/6. Ditto 350 v. 18/6. P/P. 1/6.

METER BARGAINS

50 microamp 2 1/2in. Pj. M.C. 49/6
100 microamp 2 1/2in. FM. M.C.3 9/6
200 m/amps. 2 1/2in. FM. M.C. 9/6
1 amp. RF. 2 1/2in. Pi.T.C. 5/-
300 volt A.C. 2 1/2in. FM. M.I. 25/-
1.5 amp. A.C./D.C. 2in. FM. M.I. 6/6
500/0/500 microamp 2 1/2in. FM M.C. 25/-
20/0/20 amp. Lucas car type..... 8/6
2 m/a. meter rectifiers, STC..... 5/6

G.W. SMITH & CO (RADIO) LIMITED
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Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2



FOR VALVES— GUARANTEED NEW AND BOXED

OZA	5/6	787	9/-	EL32	6/6	QP21	7/6
IA3	3/6	747	9/6	EL33	14/6	R19	13/6
1A5GT	6/-	774	8/6	EL41	10/6	SP220	3/11
1A7	12/6	75	11/6	EL42	11/6	U10	10/-
1C2	9/6	77	8/-	EL54	11/-	U22	9/-
1H5GT	10/6	80	8/6	EZ80	11/-	U25	15/3
1L	6/6	807	6/9	EM80	11/-	U45	15/-
1LD5	10/6	9D2	2/9	EM81	11/6	U91	12/6
1R5	8/-	9001	5/6	EY51	11/6	UAF42	11/6
1R4	8/-	9002	5/6	EY86	12/-	UB41	9/6
1S5	10/6	9006	5/6	EY91	6/-	UBC41	10/-
1S7	7/6	9003	5/6	EZ40	8/6	UBC42	11/6
1T4	7/6	9004	5/6	EZ90	10/-	UBF80	12/6
2X2	4/6	9006	5/6	EZ90	7/6	UCH42	12/6
2A4	7/-	954	2/-	EL148	2/-	UCH81	12/6
3D6	5/-	955	4/9	GZ32	12/6	UF41	10/-
3Q4	9/6	956	3/6	H30	5/-	UL41	11/-
3Q5	9/6	10F1	12/6	HL33DD	5/-	UL84	12/6
3S4	8/6	12A6	12/6	HN309	12/6	UY41	10/-
3Y4	9/-	12A7	11/6	HN309	13/6	UY85	10/6
4D1	3/-	12A7E	10/6	K4009	9/-	VR51	2/9
4E	8/-	12A7F	9/-	KBC32	8/-	VR53 (EF39)	2/6
5E4GY	9/6	12A7G	9/6	KF35	8/6	VR54 (EB34)	2/6
5U4G	8/-	12AK7	10/-	KL32	11/6	VR55 (EBC33)	7/6
5Y3GT	8/-	12BA6	9/-	KT24	4/6	VR56 (EF36)	6/-
5Y3GT	8/-	12BE6	10/-	KT2	5/-	VR57 (EK32)	6/8
5Z4G	10/6	12BH7	11/6	KT30C	10/-	VR65 (SP61)	3/-
6A7	13/-	12C8	3/-	KT88	7/-	VR65A (SP41)	3/-
6A8G	10/6	12H6	3/-	KTW83	8/6	VR66 (P61)	3/9
6A7	6/6	12J5	4/6	KTZ41	6/-	VR81 (EF50)	4/-
6A65	5/6	12K7	5/6	LP220	5/-	VR81 (SXL)	7/6
6AK5	6/6	12K7	9/-	MH4	7/6	VR82 (EAS6)	1/8
6AK7/6A7	9/-	12K8	13/-	MH41	7/9	VR105 30	8/-
6AL5	6/6	12Q7	9/6	N78	12/6	VR118	4/-
6AM6	9/-	12SC7	2/6	P61	3/9	VR136	6/-
6AQ5	7/6	12SH7	7/6	PE15	3/11	VR137	5/6
6A7B	8/6	12S7	5/6	PEN44	8/-	VR150/30	8/-
6AV6	10/6	12S7	7/9	PEN25	5/-	VR23	6/8
6B4	5/-	12SK7	8/-	PEN46	7/-	VS70	6/6
6B9G	4/-	12SL7	4/-	PEN220A	4/-	VT52 (EL32)	3/-
6BA6	7/6	12S7Q	7/6	PC84	10/-	VT501	5/-
6BE6	8/-	12SE7	8/6	PCF80	11/-	VU39 (MU12/14)	8/9
6B7B	9/-	1457	13/6	PFR30	12/6	VU64 (U12)	9/-
6BR7	11/6	7D2	10/6	PCL83	13/6	VU111	2/6
6BS7	13/-	20D1	13/6	PL81	10/-	W77	8/6
6BW6	8/6	20P3	13/6	PL82	12/-	W729	13/6
6BW7	10/6	20P5	11/6	PL83	10/-	X79	11/6
6C4	7/-	25L6GT	9/9	PP225	12/6	Y83	9/-
6CSGT	6/6	25F5G	9/9	PP225	12/6	Y83	9/-
6C8	5/-	25Z4G	9/-	PY80	10/-	Z309	11/6
6CH8	7/6	25Z5	9/-	PY81	8/-	Z359	11/6
6D6	5/-	25Z6GT	9/6	PY82	8/-	Z759	11/6
6F1	13/6	30F5	12/6	PY83	12/-	Z759	11/6
6F6G	7/6	30FL1	12/6				
6F9M	7/6	30P4	15/6				
6F13	6/6	35L6GT	9/6				
6F23	5/6	35W4	9/6				
6F15	14/-	35Z4GT	8/6				
6G6G	4/6	35Z5	9/6				
6H6	2/6	50C5	11/6				
6J5G	5/6	50L6GT	8/6				
6J6GT	5/6	14B7	3/8				
6J5M	6/6	210DDT	5/6				
6J6	6/-	210VPT	4/6				
6J7G	6/-	A06/PEN	6/6				
6K6GT	7/-	AT74	3/6				
6K7GT	7/-	DAF96	10/6				
6K7B	5/9	DF98	10/6				
6K7M	6/9	DEH73M	9/-				
6K8G	8/9	DK96	10/6				
6K8GT	9/6	DL98	10/6				
6L5G	9/-	DM70	8/6				
6L7	7/6	EABC90	7/6				
6N7	7/-	EAC91	10/-				
6P25	13/6	EAF42	12/6				
6Q7GT	9/-	EB41	9/-				
6SA7GT	8/-	EB41	10/6				
6S7	7/6	EB590	10/6				
6SH7	8/-	ERF80	11/-				
6SK7	8/6	EC91	9/6				
6S7	6/-	ECC84	12/6				
6SL7	8/-	ECC85	10/-				
6SN7	8/-	ECC91	6/6				
6SQ7	9/6	ECC89	14/6				
6U4GT	14/-	EFC82	15/-				
6U5G	8/6	ECH35	11/6				
6U5	8/6	ECH42	10/6				
6U7B	8/6	ECH81	11/-				
6V6G	7/6	ECL80	10/6				
6V6GT	7/6	ECL82	13/6				
6X4	7/6	EF80	10/-				
6X5G	7/6	EF22	8/6				
6X5GT	7/6	EF40	12/6				
6/30L2	12/6	EF41	11/-				
7B7	8/6	EF85	12/6				
7C5	8/6	EF98	12/6				
7C6	8/6	EF98	12/6				
7B7	9/-	EF92	8/6				

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 22in. x 18in. Price £9/9/-.

SENIOR BASS REFLEX CORNER CONSOLE.
Carefully designed to ensure superb quality 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 £11/11/-.

HENLEY-SOLON ELECTRIC SOLDERING IRONS INSTRUMENT MODELS 25 WATTS

Weight 3 1/2 oz. Length 9 in. (excluding flex)
Now available in a wide range of voltages as under:

IRONS	Voltage	List No.	Price
25 watt	12	618	26/-
INSTRUMENT	24	619	26/-
Model fitted with straight bit	50	620	26/-
with 100/110 bit	100/110	621	24/-
	120/130	623	24/-
	200/220	624	24/-
	220/240	625	24/-

ACOS MICROPHONES

MIC. 36 Series
A good quality omni-directional microphone with flat response from 30 to 7,000 c.p.s. MIC. 36-3 Table Model without switch.

MIC. 36-4 Table Model with switch.
MIC. 36-5 Without switch; with adaptor for a floor stand.
MIC. 36-6 With switch and adaptor for a floor stand.

The adaptor incorporates both a 1in. and a 1/2in. 26T.P.I. thread.
Without Switch — £2 3s. 0d.
With switch £3 8s. 0d.

MIC. 36-1 without switch; with adaptor for a floor stand.
A crystal hand or desk microphone designed for '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. The microphone is omni-directional and is housed in an attractive plastic case. Without Switch — £2 10s. 0d.
MIC. 33-2 with switch £2. 15s. 0d.

MIC. 35-1
A general purpose hand microphone of robust construction with substantially flat response from 60 to 5,000 c.p.s. Suitable for use in recording apparatus. Public Address equipment, etc. £1 5s. 0d.
MIC. 35-2
The same as the MIC 35-1 but fitted with a small desk stand. £1 6s. 6d.

METERS

Instrument Meter Moving Coil, ex-Ministry 0-3kV Round Panel mounting.



Brand New 7 1/2 each.
Instrument Meter 0-100 m.A. 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. 16/6 each.

MAINS TRANSFORMERS

3 Way Mounting Type.
MT1
Primary: 200-220-240 v. Secondaries: 250-0-250 v. 80 m.A. 0-6.3 v. 4 amp 0-4 v 2 amp. Both tapped at 4 v. 19/6 each.

MT2
Primary: 200-220-240 v. Secondaries: 350-0-350 v. 80 m.A. 0-6.3 v. 4 amp 0-5 v 2 amp. Both tapped at 4 v. 19/6 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., 19/6 each. Postage and Packing please add 2/- per transformer.

COSMOCORD TYPE MIC.35-1
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. 25/- each

COSMOCORD TYPE MIC.33 (Series)
This microphone will be of particular interest to home recording enthusiasts as well as professional engineers, since the diaphragm microphone insert has a high sensitivity with a pick-up field that may be considered as omni-directional. Substantially flat response from 30 to 7,000 c.p.s.
MIC.33-3. Microphone without switch and with table stand 63/- each
MIC. 36-4. Microphone with switch and table stand 68/- each
MIC. 36-5. Microphone without switch and with floor stand adaptor 63/- each
MIC. 36-6. Microphone with switch and floor stand adaptor 68/- each
*The floor stand adaptor has internal threads of both 1in. and 1/2in. 26 T.P.I. 3/6 each.
TELELECTOR TRANSFORMERS, TYPE T65
Small Mains Transformers suitable for Television Converters, etc.

Specification:
Primary: 230 v. 50 c/s.
Secondary 1. 250 v. 40 m.A.
Secondary 2. 6.3 v. 1.5 a.
Overall Size:
Clamp construction. 3.9in. x 2.4in. x 2in. over windings. Fixed centres: 3.3in.

SENIOR RADIO JACK

Converts a tape recorder or suitable amplifier to a radio receiver with operation on 2 pre-selected MW and 1 LW stations. TA 8 (BSS Jack Plug) or TA 9 (Metric Jack Plug). Price £3 9s. 6d (plus £1 10s. 6d. P.T.).

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. £8/15/-.



COLLARO
Model 3/544. Three speed single player. Automatic stop. fitted with "Studio T" pick-up. Cream finish £6/19/6. Carriage on above units 4/6.



COLLARO
Four speed automatic record change unit. A fully mixed automatic changer with many advanced features. Unit plate 12in. x 13 1/2in. £9/15/-.

WESTINGHOUSE RECTIFIERS

16RC1-1-16-1	9/- each
18RA.1-1-16-1	6/6 each
18RA.1-1-8-1	4/- each
14RA.1-2-3-3	25/- each
14A.86	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

COSMOCORD TYPE MIC.22.
High sensitivity with good fidelity response; substantially flat from 40-6,000 c.p.s.; vibration and shock proof. Not affected by low frequency wind noises.

MIC 22-1 with adaptor for floor stand only 84/- each
MIC 22-2 complete desk unit 84/- each

COSMOCORD TYPE MIC.33-1
A crystal hand 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. The microphone is omni-directional and is housed in an attractive plastic case 50/- each



103, LEEDS TERRACE,
WINTOWN 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/-.
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AUTO-CHANGERS

Our stocks are constantly changing. 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 £13.17.0 **£8.19.6**
LASKY'S PRICE
Post 3/6.

B.S.R. 4-speed with t.o. crystal pick-up. £8/15/-, post 5/-.

SINGLE PLAYERS



Collaro 4/564 4-speed Single Player with Studio T p.u., crystal cartridge and styl. Automatic stop.
LASKY'S PRICE **£7.19.6**
Carr. 3/6.

2 NEW LOW-PRICED SINGLE PLAYER UNITS

B.S.R. TU9, 4-speed motor and latest B.S.R. "ful-fi" pick-up. Post 3/6. **£5.10.0**

COLLARO 4-speed motor and pick-up complete with HGP.59 cartridge. Post 3/6. **£4.19.6**

TRANSCRIPTION TURNTABLES

SPECIAL OFFER of the well-known Collaro 2101, 3-speed, complete with transcription pick-up including P cartridge. **£16.19.6**
Less pick-up, £12/19/6.

COLLARO 4-speed Transcription turntable, 4T200/PX. **£19.10.0**
Less pick-up, £14/18/-.



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 **21/-**
1.5 to 8 Mc/s (double spot—yellow & red)
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.
SPECIAL PRICES FOR 6 AND OVER.

- ★ 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
OC70 or OC71 OC72 OC16
21/- 30/- 60/-

BRIMAR TRANSISTORS
TS1 15/-, TS2 21/-, TS3 24/-.
TP1 or TP2 40/-.
TJ1 30/-, TJ2 35/-, TJ3 40/-.

INTRODUCING LASKY'S TRANSISTORISED SUPERHET FRONT END TUNER

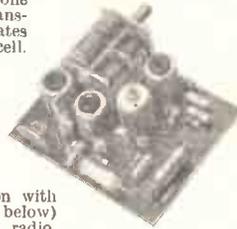
ON PRINTED CIRCUIT

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. Size of printed circuit, 3½in. x 3½in.
CAN BE BUILT FOR £5.12.9

Full details and illustrations post free on request.

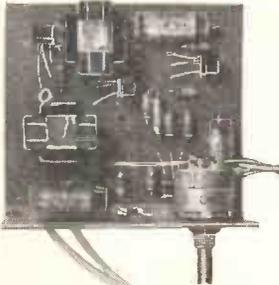
Demonstrations at both addresses.

NOTE.—This Tuner in conjunction with our Transistor Amplifier (see below) makes an excellent Transistorised radio. Cabinets available.



NEW MINIATURE 200 milliwatt TRANSISTOR AMPLIFIER KIT

for construction on a Printed Circuit



All components available separately.

Size: 3¼ x 3½in. Height can be under 1in. 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.

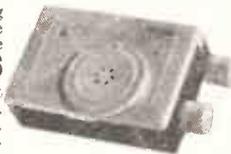
COMPLETE KIT including 4 Transistors, all brand new components, latest T.C.C. miniature condensers, printed circuit and full instructions. **79/6** Post 2/-.

DEMONSTRATIONS AT EITHER OF OUR ADDRESSES

THE TELETRON "COMPANION" POCKET RADIO

3-TRANSISTOR T.R.F. circuit covering and long waves, with balanced armature output. Ferrite aerial. Note small size of case: 4½ x 3 x 1in. **89/6**

Can be built for Full instructions and price list, 6d. post free. All components available separately. Teletron Coil FX25, 15/-, Ardente Trans. D240, D239, 10/- each. Case and Fret, 8/6.



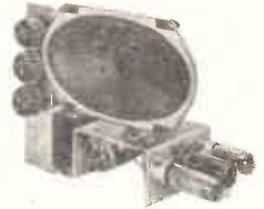
SUB-MIN. TRANSISTOR TRANSFORMERS. **4/6**
45-1 ratio each
Post 1/-.

ALL TRANSISTOR COMPONENTS stocked. Trans, midget, min. and sub-min. Coils, Ferrite Rods, sub-min. Condensers, etc.

LASKY'S RADIO

STOP PRESS BARGAIN

12in. TRUVOX SPEAKERS, 15 ohms, 10 watts. LASKY'S PRICE **45/-**
Post 3/6.



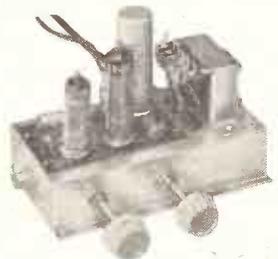
LASKY'S 4-WATT PORTABLE GRAM AMPLIFIER

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 x 4in. 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. 6½ x 3½in. max, height 5in. 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 x 4in. 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

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

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.

WOLSEY BAND III CONVERTERS ALMOST HALF - PRICE !

A high grade Converter covering all Channels and suitable for any set. In attractive cream plastic case. List Price £9/19/6.

LASKY'S PRICE **99/6**

Post 5/-.

Please state Channel required.

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. Post 2/6. DATA BOOK with price list 2/- Note: This tuner uses 4-6AM6 and 2 crystals and can be built for £6/15/-, plus 3/6 post.

JASON "ARGONAUT"

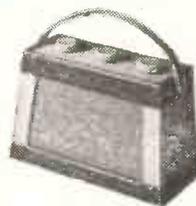
Super-sensitive Tuner for F.M. and medium waves. Complete parcel with power supplies. Post 3/6. **£13.19.6** DATA BOOK 2/- post free. Chassis Assembly 57/9 post 2/6. I.F. and Coil Set 78/- post 1/6. All components available separately.

OTHER F.M. TUNERS

TSL £17/10/-, DULCI £17/10/-, Also Quad, Leak, R.C.A., Rogers, Pamphonic, etc. DULCI H4/T 4-wave AM/FM Tuner, £20/17/-.

BUILD THIS GRAND 4-VALVE SET PORTABLE

The printed circuit supplied makes construction amazingly easy and accurate. You can build it in an hour or so and performance equals ready-built sets costing pounds more!



SEND ONLY £7/7/- plus 3/6 carr. and pkg., for printed circuit, all brand new components and valves, case, circuit diagram, full instructions. Only batteries extra.

SEND ONLY £9/9/- plus 3/6 carr. and pkg. for all above plus specially designed POWER UNIT for 200-250v. A.C. if you wish to make this job as mains/battery set. Circuit diagram and full data 1/6 post free.

Demonstrations at both addresses.

SINGLE-VALVE GRAM AMPLIFIER

Complete with UL41 output valve, metal rectifier, and output transformer. **55/-** Post 3/6.

HI-FI SPECIALISTS !

Selective Demonstrations of all the latest and best Hi-Fi equipment are given at our Tottenham Court Road showrooms. Call and see our large and comprehensive stocks.

PICK - UPS. Garrard, Leak Connoisseur Ortho- phone, B/J., etc., etc. SPEAKERS. Wharfedale, Goodmans, G.E.C., Lowther, Lorenz, etc., etc.

NOTE. We can still supply Goodmans Speakers at pre-increase prices. Why wait and pay more?

AUDIOM 60 £9 2 6 TREBAX £6 4 0
AXIOM 150 Mk. II £10 15 9 AXIOM 22, Mk. II £15 4 6

TRANSCRIPTION TURNTABLES. 3 and 4 speed Garrard, Connoisseur, Collaro Lenco etc.

AMPLIFIERS. Quad, Rogers, Leak, RCA, Pamphonic, Unitelex, W.B., etc.

CABINETS. Wide selection and bargain value in Cabinets and cases to house your speakers and hi-fi equipment.

MULLARD 510 AMPLIFIER KIT WITH T.C.C. PRINTED CIRCUIT



All components for above Amplifier available separately. Price List on request.

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.

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. 38½ 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.

RADIOGRAM CHASSIS BARGAINS

A.M. from **£7/7/0**

A.M./F.M. from **£14/14/0**

PICK-UP BARGAIN "RONETTE" Lightweight Crystal Pick-up with 2 cartridges.

LASKY'S PRICE **45/-** Post 2/6.

ACOS HGP37 p.n. Cartridges, i.p. and standard, complete with styli. List 41/7.

LASKY'S PRICE **18/-** Post 1/-.

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 OFFERS

7in. Plastic, 2/6. Metal 1/6. All other types and sizes of spools in stock.

TAPE DECKS

Collaro "Tape Transcriber," Mk. IV. £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/-.

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/-.
Carr. 5/-.

Lasky's Price **59/6**

MOVING COIL P.M. SPEAKERS
2½in. 17/6. 3in. and 3½in. 19/6
5in. 19/6. 6½in. 17/6. 8in. 21/-
10in. 29/6. 12in. 29/6
6½in. with transformer 21/-
7 x 4in. Elliptical 19/6
10 x 7in. Elliptical 32/6

SPECIAL OFFER OF PLESSEY SPEAKERS
15in. Dual Concentric 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 cross-over unit. List £27/4/6.
LASKY'S PRICE £16.19.6
Carr. 7/6 plus 30/- for wood packing case (returnable).

6-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES
Famous Manufacturer's Surplus. 6-valve 3-wave Superhet. 15-50 m. short. 200-550 m. medium. 1,000-2,000 m. long. Brand new Mullard valves: ECH42, EP41, L63, EB41, 6V6, g.t., EZ40 and finest quality components. Gram., switch, 465 Kcs/L.F. tone control, three-colour dial Overall size 13½ x 5in. height 12½in. Aperture required for dial and controls 11 x 3½in. COMPLETE WITH VALVES, output trans., knobs, etc.
LASKY'S PRICE £10/19/6
Carrriage and packing 7/6 extra.

5-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES
3-wave superhet, 16-50 m. 200-550 m., 1,000-2,000 m.; Brand new Mullard and Mazda valves—6C9, 6F15 6LD20, N108, U107. Overall dim. 13in. long, 6in. deep, 7in. high approx. for A.C. mains 200/250 v.
LASKY'S PRICE 7 GNS.
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 c/s. For outputs up to 6 watts. 2½in. diameter. All post free. 39/6.

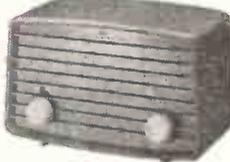
SPEAKER COVERINGS. Large stocks of Tygan and "Somevase" Speaker Coverings. Any size piece cut. Send for samples and prices.

MAKERS' SURPLUS TV COMPONENT BARGAINS

WIDE ANGLE 38 mm.
Line E.H.T. trans., ferrox-cube core, 9-16kV. 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 50/-
Frame Output Transformer 6/6
Scanning Coils, low imp. line and frame 17/6
Frame or line blocking osc. transformer 4/6
Focus Magnets Ferrox-dure 19/6
P.M. Focus Magnets, Iron Cored 19/6
Dooming Focalsies 22/6
300 m/a. Smoothing Chokes 15/-
Electromagnetic focus coil with combined scan coils 25/-

STANDARD 35 m..
Line Output Transformers 6.9 kV E.H.T. and 6.3 v. winding. Ferroxcube 19/6
Scanning coils. Low imp. line and frame 12/6
Ditto by Igranite 14/6
Frame or line blocking oscillator transformer 7/6
Frame output transformer 4/6
Focus Magnets 19/6
Without Vernier 17/6
With Vernier 17/6
Focus Coils, Electro-magnetic 12/6
200 m/a. Smoothing Chokes 10/6

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 8½in. wide, 4½in. deep, 5in. 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, 1/8 post free.
All components available separately.
CABINET only, as illus., 12/6 plus 4/6 post and pkg.

POCKET VOLT TEST METERS

Two ranges D.C., 0-250 v., 0-25 v. Complete with leads in canvas case. 12/6. In leather case, 1/6 extra. Post 2/6.

HIRE PURCHASE TERMS AND CREDIT SALES

available on certain items. Write stating your requirements.



NEW AND PERFECT 16" METAL CONE C.R.T.

Type T901. Note. Not "seconds" but perfect tubes in original cartons. Gives large 11 x 14½ in. picture. Guaranteed by us for 3 months. See our previous adverts in "W. World" or send for details.
Carr. and Insur. 22/6 extra.

LISTED AT **£23.9.10**

LASKY'S PRICE £8.9.6

Masks, Anti-Corona, Bases and Ion Traps available.

FEW ONLY 17in. C.R. TUBES

Rectangular, aluminised or ion trap 0.3 heater. Brand new and unused. 22/6.
Carr. and Insur. 22/6.

CONSTRUCTOR PARCELS



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 6½ x 5½in. deep. **CAN BE BUILT FOR £7/19/6**
Carr. and packing 2/6.

PARCEL No. 2
Contains everything to build a T.R.F. 3-valve set for 200/250 A.C. mains, medium and long waves. Uses 6K7G, 6J7, 6V6 and metal rectifiers. Neat plastic cabinet, walnut or ivory flash, or wood cabinet. Size 12 x 6½ x 5½in. deep. **CAN BE BUILT FOR £5/10/0**
Carrriage and packing 2/6

INSTRUCTION BOOK for either above sets 1/- post free.

CABINETS ONLY, plastic or wood, 17/6. Post 2/6.
All components available separately.

ALL-DRY POWER UNITS

Further purchase enables us to again reduce price

By Decca. Suitable for any battery radio using 1R5 1T4, etc., 674 volts H.T. 14 volts L.T. Mains input 200-250 adjustable. In metal chassis with rubber feet and black plastic cover. Size: 7in. x 5in. x 1½in. Mains lead and on/off switch. Complete with two metal rectifiers ready for use. Listed at £14/15/-.
LASKY'S PRICE 29/6
Post 3/6.

BAND III AERIALS. All types, outdoor or indoor, also Diplexes, Crossover Boxes, Co-axial Plugs, Socket and Cable.



LASKY'S RADIO

MAINS TRANSFORMERS
All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.
MBA/3. 350-0-350 v. 80 mA. 6.3 v. 4 a. 5 v. 2 a. Both filaments tapped at 4 volts. 19/6
MBA/7. 250-0-250 v. 80 mA. 6.3 v. 3 a. 3 v. 2 a. Both filaments tapped at 4 volts. 19/6
AT/3. Auto trans. 0-10-120, 209-230-240 v. 100 watts 19/6
MT/341. 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 1/8 GEX.34 3/8. WG5 3/8.GEX. 54 and OA74 5/-. GD3 3/8. GD4 3/8. CG12E 5/-.

20,000 VALVES IN STOCK

Here are a few examples of brand new surplus and impo. valves:

EB91	7/6	EV41	10/6	EY76	14/6
EB41	7/6	EP80	10/6	EZ40	8/6
EABC80	10/-	EP88	10/6	EZ50	8/6
EP42	10/-	EP88	12/6	PCF82	12/6
EBC11	10/-	EP89	10/-	PCF84	12/6
ECC85	10/-	6V6	8/6	PL81	13/6
ECC84	15/-	6V6	8/6	PL82	10/6
ECC88	9/-	6K7	5/6	PL83	11/6
ECC82	9/-	6Q7	10/6	PY80	10/6
ECC81	9/-	6B7	8/6	PY81	10/6
19A7	8/6	6Z4	9/6	PY82	10/6
19A7	8/6	6AF96	10/-	PY83	10/6
12AX7	9/6	D196	10/-	6AT6	7/6
EB99	10/6	DK96	10/-	6AT7	7/6
ECP82	15/-	DP96	10/-	185	7/6
ECH42	11/6	DM70	9/-	884	9/-
ECH81	11/6	EY51	12/6	1T4	9/-
ECL80	10/6	EC84	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 4075 and CUN 1979.
Open all day Saturday. Early closing Thursday (both addresses)
ALL MAIL ORDERS TO HARROW ROAD PLEASE



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 1/2 in. x 3 in. Price 1/9 each.

RUBBER GROMMETS. Mixed sizes, 6d. doz.

GRID CAPS. 1. Octal Push-on type, 6d. doz. British Screemed type, 3d. each.

ARMOUR PLATED GLASS. Size 1 1/2 in. x 10 1/4 in., rounded corners, 3/6 each.
2 Pin Mains Plug and Socket, 2/6 each.
Pliers Side Cutters, 2/9 pair. Lins Cord, 3 amp., 3 core, 1/9 yard. Line Cord, 2 amp. 3 core, 1/9 yard. Electric Buzzers in Bakelite case. Loud tone, 2/6 each. Epicyclic Friction Drive with Brass Drum. For use with Steel Dial Drive Wire. 1/6 each.

AMERICAN RELAY. 45 ohms Impedance with lead, No. AZ0545, 1/9 each.

IRON LEADS. Black and white flat iron leads, bonded ends, 1/3 each.

POTENTIOMETER PANEL. Four Potentiometers on Panel 60K ohms S.P.S., 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. Waxox choke, max. current 100 mA. D.C. resistance 125 ohms, 6/- each. Westinghouse 1 m/a. Rectifier, wire ends, 9d. each. 6 volt Vibrator Pack, complete with 2 pin Vibrator, 17/3 each. Murphy Richards Type Replacement Iron Elements, 3/9 each.

INDICATOR LAMPS. Swing fixing type 9d. each. "Aerovox" Condenser Clips, 1d. each. Penoil Rectifiers, Type J10, 2/- each. Amplion Volume Controls, 2 meg. S.P.S. 3/6 each. Extension Speaker Volume Controls, 1/3 each. Vibrator Clips (Standard), 5d. each.

NINE-INCH TUBE MASKS. White (Soiled Condition) 4/9 each. Tri-Sol 3-Core Solder. Nett weight 1lb. 16 P.W.G. 60/40 alloy, per carton, 5/6. 0-100 mA. Meter Panel Mounting 7/6 each.

SURPLUS GEAR PARCELS. We have found, from time to time, stocks of components stripped from ex-Government equipment, along with discontinued lines, etc. These are in small quantities and therefore unprofitable to advertise. To make room for new items we offer at less than cost parcels of these components at 10/- each.

JUNCTION BOXES. Type 5X/2234, 20 way, 6 each.

TELETRON transistor superhet coils set of LF and oscillator coils with Ferrite Rod 33/- per set (circuit included).
Long Wave Loading Coil to match 4/6 each.

RECORDING TAPE, 1,200 feet. "Pure-tone," 12/6 each.

NEEDLE CUPS. For Gram. Needles (Bakelite), 1d. each.

CRYSTAL DIODES. Wire Ends, plastic case, 1/- each. Bulgin 7-pin Plug and Socket, 1/6 each. Insulated Coupler, 2in. dia., for standard 1in. spindles, ceramic insulation, 9d. each. Pairs of Instrument Handles, 1/4 in. between centres, 1 1/2 in. back to front, 5/3 pair. Speaker Cones, 6ASP is 8in., cone with tin. cone piece, 4/6 each. 6ASP is 6 1/2 in. cone with tin. 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 ma 6.3 v. 3 amp., 11/6 each. Bulgin Indicator Lamp, single hold fixing for standard MPS bulb, red lens, 3/3 each. Tubular Condenser (Metal Boss) Sprague 4 mfd. 600 v., 4/- each. Sprague Block Condenser, 2 x .1 mfd. 2,000 volts, 3/- each. Paper Block Condenser, 2 mfd. 250 volts, 9d. each. Kettle Elements, 1,000 watts for 200/210 volts or 230/250 volts, 17/6 each. Relay Valve CV271, in Holder, 3/9 each.

BELL TRANSFORMER "CONCORDIA." 3 v., 5 v., 8 v., 1 amp. fused. In bakelite case, 8/6 each.

SELF TAPPING SCREWS (PK). No. 4, 1 in. long, 3/4 doz.

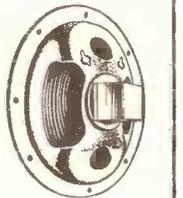
"CLEM" TRAVELLING IRON with ASBESTOS STAND. Size: 4in. x 2in. x 2 1/2 in., including handle, complete with lead and switch to enable it to be used on any voltage between 110 and 250 v. A.R.C. adaptor is fitted on the lead. (Colour as available: Blue, Green, etc.), 21/- each. FUSES: 1, 1 1/4, 2, 3, 5 amp., 1 1/2 in. Standard Cartridge Fuses, 3d. each.

CARRYING CASE. Suitable for use as a projector or recording case, size 15in. x 9 1/2 in. x 1 1/2 in. Internal dimensions: 14in. long, 11 1/2 in. deep, 5 1/2 in. front H.T., 8 1/2 in. rear H.T. With black rexine finish. Weight 8 1/2 lb., 13/6 each. Post and Packing 2/6.

B7G MINIATURE VALVE PIN STRAIGHTENER. This is an American manufactured tool at a price everyone can afford. Complete with plug, 2/6 each.

LOUDSPEAKER UNITS

Make	Type	Size	Price
Elac	Square	3 1/2 in.	19/6 each
Lectrona, Plessey	Round	5 in.	17/6 each
Goodmans, Plessey	Round	6 1/2 in.	18/6 each
Goodmans, R. & A.	Round	8 in.	19/6 each
Plessey, R. & A., Elac	Round	10 in.	25/6 each
Plessey	Round	12 in.	35/- each
Rola	Elliptical	6in. x 4in.	19/6 each
Elac	Elliptical	10in. x 6in.	25/6 each



All the above are PM units with 2 to 3 ohm speech coils.
RTO 12in. heavy duty 20 watts model 15in. ohms 6 1/2 in. Mains Energised Speaker 17 6
Speech Coil 25 5 0
5in. Mains Energised Speaker 1 0 0
All have field coils of approx. 600 ohms.

SPECIAL OFFER
Just a few 8in. units by Goodmans and Lectrona fitted with standard output transformer £1 1 6 each

HEADPHONES—MICROPHONES

EX-GOVERNMENT HEADPHONES AND MICROPHONES	
CLR low resistance type 120 ohms	7/6 pair
Throat Microphones, American surplus. Complete with strap, lead and plug type T30B	3/- set
High Resistance Phones, 4,000 ohms	13/6 pair
High Resistance DLR Phones	16/- pair
Ex.A.P. Microphone. Type 49 with switch	3/6 each



PUBLICATIONS

Please include 4d. postage with single copies.

No. 138—HOW TO MAKE AERIALS FOR T.V. (Bands 1 and 3) and V.H.F. (Band 2).

Data for all Channels. Ten different designs for local and fringe areas. 2/6 each

No. 100—A COMPREHENSIVE VALVE GUIDE, Book No. 1 5/- each

No. 121—A COMPREHENSIVE VALVE GUIDE, Book No. 2 (Characteristics and Base Connections). 5/- each

No. 109—RADIOFOLDER "A" The Master Colour Code Index for Radio and Television 1/6 each

No. 128—PRACTICAL TRANSISTORS & TRANSISTOR CIRCUITS

* How to make your own transistors. * 48 pages 3/6 each

No. 143—A COMPREHENSIVE VALVE GUIDE, Book No. 3

* International Edition * 1,200 valves not previously listed are presented. 5/- each

No. 144—VALVE AND TELEVISION TUBE EQUIVALENTS.

* Receiving * Transmitting * Industrial. 5/- each

No. 140—TELEVISION SERVICING FOR BEGINNERS.

* 40 pages of information 4/6 each

No. 142—A MODERN T.V. CIRCUITS AND FAULT FINDING GUIDE

* Many interesting circuits included. 4/6 each

No. 135—RADIO CONTROLLED MODELS FOR AMATEURS.

* Boats * Aircraft * Circuits, etc. 5/- each.

HIGH QUALITY SOUND REPRODUCTION.

Includes 20 watt amplifier. P.M. Tuner. Pre-Amplifiers, etc. 3/6 ea.

C.R.T. ISOLATION TRANSFORMERS

Type NR20. New "Competition" transformer. Input has one tap which increases output by 25%. Three types available to cover 2, 4 and 6.3 volt CR Tubes.

NR20/A. Input 200/250 volts. Output: 2 volts. NR20/B. Input 200/250 volts. Output 4 volts. NR20/C. Input 200 250 volts. Output 6.3 volts. (All with optional 25% boost).

With tag board primary. Flying lead secondary All types. All 10/6 each.

2 pin Mains Plug and Socket 2/6 each. Pliers Side Cutters 2/9 pair.

LOUDSPEAKER CABINETS.

This attractive walnut finished cabinet is available for 6 1/2 in. or 8 in. speaker units. Metal speaker fret, complete with back and rubber feet.

6 1/2 in. type: Measures 8 1/2 in. x 8 1/2 in. x 4 1/2 in. at base 17/6 each

8 in. type: Measures 10 1/2 in. x 10 1/2 in. x 5 in. at base 21/6 each

5 1/2 in. type: Very similar design. 16/6 each

Postage any type 2/- 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 for your copy now.

MAINS DROPPING RESISTORS

Manufacturers Surplus Types.	
945 ohms Zenith with taps	each 1/-
725 ohms Erie tap at 600 ohms	1/6
650 ohms tap at 375 ohms, 500 ohms, 5 ohms, 30 ohms	2/6
Green Vitreous Mains Dropper 1,328 ohms, 2 taps, Midget type	1/3
Zenith Mains Dropper 910 ohms	2/6
Dubilier Type HY, tapped 200-210 220-230, 240-250 ohms	1/9
Erie Two Section Dropper, 150 ohms and 1,340 ohms, with two taps	1/9
Bulgin Dropper with voltage taps	3/9

REPANCO COILS

TRANSISTOR COILS AND COMPONENTS	
Type OT1 combined 1ST IPT (315 Kc/s) and OSC Coil Medium and Pre-Set Long Wave	11/6
Type TT2 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 TT5 Push Pull Output Transformer	8/-
Type DRX1 High Gain Dual Range Crystal Set Coil	2/6
Type DRR2 Dual Range High Gain Coil	4/-

All are complete with circuits.

TRANSISTORS	
Suitable for audio work yellow and green spot	10/-
red spot	10/-
R.F. for use up to 1.6 mc/s. blue spot ea.	15/-
R.F. for use up to 1.5 mc/s. to 8 mc/s. yellow and red spot	ea. 21/-
JB gang condensers for transistor working "0" gang 1 or 2 each 365 PF swing, aluminium vanes, steel chassis.	
1 gang 7 6 each; 2 gang 11/6 each. JB "00" twin gang condenser 208 PF front section 17/6 PF rear section price 9/6 each.	

CHASSIS

Aluminium Udrilled with Reinforced Corner. Available in the following sizes:

3 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

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: Mazda 30L1 cascade c.t. amp., Mazda, 30C1 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. **£4.10.0**

SPECIAL PURCHASE

THE NEW APEX MARK II BAND III CONVERTOR

8" P.M. Speaker Units with Output Transformer Removed From equipment. **11/6 each**

- 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.
- Size only 5 1/2 in. x 5 1/2 in. x 2 1/4 in.

Retail Price £5/15/- complete

HEATER TRANSFORMERS	
230 v. Input 2 volt .5 amp.	5/3
230 v. Input 2 volt 3.0 amp.	5/6
230 v. Input 4 volt 1.5 amp.	5/3
230 v. Input 4 volt 3.0 amp.	10/-
230 v. Input 5 volt 3.0 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

IMPLOSION GUARDS. For 17in. tube.	
Outside dimensions. 17 1/2 in. x 12 1/2 in.	7/6 each.
Brown/Fawn Escutcheon. Price 7/6 each.	
Post 2/6	

EX-GOVERNMENT HEATER TRANSFORMER.	
Universal Input 2 x 6.3 volt windings at 1 1/2 amps. each.	Price 7/6 each.



Stern's "fidelity" TAPE RECORDER

IT HAS EVERYTHING—EXCEPT A HIGH PRICE

TESTED AND APPROVED AT THE TRUVOX LABORATORIES

IT INCORPORATES: The NEW TRUVOX Mk. IV TAPE DECK together with the "fidelity" MODEL HF/TR2 TAPE AMPLIFIER (both fully described on this page), and a Rola 10×6in. P.M. speaker.

● BEFORE CHOOSING YOUR TAPE RECORDER YOU SHOULD HEAR THIS MODEL—TRULY "Hi-Fi" RECORDINGS ARE OBTAINABLE and it is comparable to much higher-priced Recorders.
Alternatively send S.A.E. for ILLUSTRATED LEAFLET.

PRICE . . . Including CRYSTAL MIKE and 1,200ft. reel of PLASTIC TAPE.

£49.10.0. (OR £3 EXTRA WITH REV. COUNTER.)

(Plus £1/10/- carriage and insurance, of which £1 is refunded on return of Packing Case.)

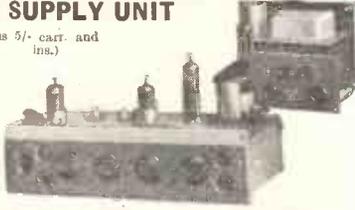
CREDIT SALE: Deposit £12/8/- and 9 monthly payments of £4/10/3.

HIRE PURCHASE: Deposit £24/15/- and 12 monthly payments of £2/5/11.

A COMPLETE KIT OF PARTS TO BUILD The "fidelity" TAPE AMPLIFIER Model HF/TR2 including POWER SUPPLY UNIT

FOR ONLY **£12.0.0** (Plus 5/- cart. and ins.)

This amplifier has been expressly designed to meet the requirements of High Fidelity reproduction. It is based on a new design, completed by the Mullard Technician, and only really high-grade components are incorporated; truly HIGH FIDELITY Recordings are obtainable while "Hi-Fi" reproduction is assured by use of a high-quality Output Transformer by Gibson. It incorporates a "magic eye" Recording level indicator, a two-position equaliser for 3½in and 7½in. speeds, and an effective Tone Control arrangement. Monitoring and Extension Speaker Socket are incorporated and in addition a position is provided to enable it to be used as an independent Amplifier for Gramophone Records or Radio Tuning Unit. Overall size: 11in. x 6in. x 6in. high. Suitable for nearly all makes of Tape Decks. When ordering, please advise make of deck in use.

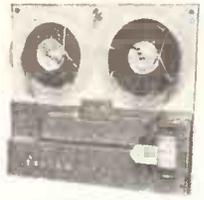


THE ASSEMBLY MANUAL, PRACTICAL DIAGRAMS, etc., are available for 2/9 or send S.A.E. brief details.
WE ALSO SUPPLY THE HF/TR2 ASSEMBLED AND READY FOR USE FOR £16.0.0. (Plus 6/- cart. & ins.). H.P. TERMS: Deposit £8 and 9 monthly payments of £1. CREDIT TERMS: Deposit £4 and 9 monthly payments of £1/9/4.

THE NEW TRUVOX MKIV TAPE DECK

UNDOUBTEDLY ONE OF THE BEST TAPE DECKS ON THE MARKET.

PRICE **£27.6.0** (Plus 10/- cart and ins.)



CREDIT TERMS: Deposit £8/17/- and 9 monthly payments of £2/10/-.

H.P. TERMS: Deposit £13/13/- and 12 monthly payments of £1/5/4.

- SPECIFICATION:—● 3 B.T.H. shaded pole motors with silent friction drive eliminating wow and flutter. ● Push button controls, electrically and mechanically interlocked (patented). ● Patented electric-type push button controlled brake. ● Inching to assist editing; tape loading on the drop-in principle accommodation for reels of 7in. diameter. ● Tracking sense. To British and American standards. ● Playing times: Up to 3 hours with L.P. Tape or 2 hours with Standard Tapes. ● Two tracks side by side, with safety gap. ● Playing time indication by precision revolution counter or large visual type indicator plate, according to choice. Positive Azimuth adjustment of Record/Player Head. ● High Impedance Heads. ● The metal work is Gold Hammered finish. ● Overall size 14½in. x 12½in., 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 £15/9/3 and 12 months of £1/8/3. CREDIT SALE: Deposit £7/12/3 and 9 months of £2/15/10.

STERN'S TAPE PRE-AMPLIFIER AND ERASE UNIT



Provides the "Link" between the HIGH-QUALITY AMPLIFIER and TAPE DECK.

STERN'S MODEL HF/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/- cart. and insurance)

Home Constructors!

YOU CAN BUILD A COMBINED TAPE RECORDER-RADIOGRAM AT HALF THE NORMAL COST.

As will be seen from this advert. there are several combinations with or without a Record Player.

This is a very popular and successful combination and we will supply ALL ITEMS FOR **£79.0.0**

- WE SUGGEST . . .
- (a) The TRUVOX MK IV DECK (with Counter £3.0.0 extra).
 - (b) The HF/TR1P TAPE PRE-AMPLIFIER.
 - (c) The MULLARD 5-10 with "fidelity" Pre-amplifier.
 - (d) STERN'S P.M. TUNER UNIT.
 - (e) COLLARO R.C.456 AUTOCHANGER
 - (f) TAPE and MICROPHONE.

WE MAKE SPECIAL PRICES FOR COMBINED ORDERS WE WILL SUPPLY

- (a) The model HF/TR2 AMPLIFIER and POWER UNIT, both fully assembled, together with the TRUVOX MK IV TAPE DECK for . . . £38 10 0
ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS . . . £35 0 0
- (b) The model HF/TR2 AMPLIFIER and POWER UNIT both fully assembled, together with the TRUVOX TAPE DECK incorporating PRECISION REV COUNTER . . . £41 10 0
ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS . . . £38 0 0
- (c) The model HF/TR2 AMPLIFIER and POWER UNIT, both fully assembled, together with the COLLARO TRANSCRIBTOR . . . £35 0 0
ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS . . . £31 10 0
- (d) The Model HF/TR1P TAPE PRE-AMPLIFIER together with the TRUVOX MK IV TAPE DECK . . . £35 0 0
- (e) ALTERNATIVELY as in (d) above but Truvox Deck incorporating PRECISION REV COUNTER . . . £38 0 0
- (f) The model HF/TR1P TAPE PRE-AMPLIFIER together with the COLLARO TRANSCRIBTOR . . . £31 10 0

PLEASE INCLUDE 12/6 to cover cost of Carriage and Insurance, HIRE PURCHASE and CREDIT SALE TERMS are available on all above (excluding Kits of Parts). Send S.A.E. for details.

NOTE . . . The Collaro Transcrip-tor is in short supply and there may be a delay in delivery. We will however book an order.
The Deck switches of the Transcrip-tor must be "wired-up." We will complete this wiring for use with either the HF/TR2 or the HF/TR1P for an extra charge of £1.0.0.

OTHER TAPE EQUIPMENT

PORTABLE CASE as illustrated above	£5 0 0
ACOS CRYSTAL MICROPHONE	£2 10 0
ROLA 10in. x 6in. P.M. SPEAKER (7in. x 4in. 19/6)	£1 10 0
PLASTIC TAPE of all lengths—L.P. and Standard. (IN STOCK)	
WE WILL SUPPLY ALL ABOVE including a 1,200 ft. reel Plastic Tape for	£9 5 0

Open Monday to Friday 9 a.m.—6 p.m. Saturday 9 a.m.—1 p.m.

STERN RADIO LTD.

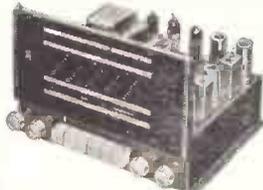
(DEPT 139/W)

109 & 115, FLEET ST., LONDON, E.C.4

Telephone: FLEet St. 5812/3/4

IT'S MUCH BETTER

THE NEW ARMSTRONG P.B. 409 AM/FM RADIOGRAM CHASSIS



PRICE £29.8.0
(Plus 7/6 carr. and ins.)

TERMS: Credit Deposit £7/7/- and 9 monthly payments of £2/14/- . H.P. Dep. £14/1/- and 12 monthly payments of £1/7/3.

BRIEF SPECIFICATION—

A 9 valve line up employing the latest MULLARD preferred-type valves. ● Provides complete coverage of the VHF/FM Transmissions, plus the SHORT, MEDIUM and LONG waves. ● Has Push-Pull output, with negative feedback, for 6 watts Peak output. ● Quick action "Piano Key" Selectors and separate Bass and Treble Controls. ● Has "Magic Eye" Tuning Indicator. ● Dimensions 13in. x 9 1/2in. x 8in. high. Dial size 11 1/2in. x 6 1/2in.

MODERNISE YOUR OLD RADIOGRAM

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-EE PURCHASE TERMS: Deposit £19/10/- and 12 monthly payments of £1/14/4.

IT'S MUCH CHEAPER

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 £8/2/- and 9 monthly payments of £2/4/7. H.P. TERMS: Deposit £12/3/3 and 12 monthly payments of £1/2/7.

BRIEF SPECIFICATION—
● Covers Short, Medium, Long and F.M. Wavebands.
● Employs full A.V.C.
● The Latest 7-valve line-up.
● For 3 or 15 ohm P.M. Speakers.
● "Magic Eye" Tuning Indicator.
● Excellent Tone range up to 4 watts output.
● Internal aerial for local stations.
● Overall size 12in. x 8 1/2in. x 7 1/2in. high.
A Good Quality Chassis and Well Recommended.



THE DULCI MODEL H.3

COMBINED AM/FM RADIOGRAM CHASSIS

This model is very similar to the model H.4 described above but covers 3 WAVEBANDS instead of 4 (omitting the Short Band) and is for 3 ohm Speakers only. Overall size is as for the H.4.

PRICE £20.17.0 (Plus 7/6 carr. and ins.)
CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/19/4. H.P. TERMS: Deposit £10/8/6 and 12 monthly payments of 19/4.

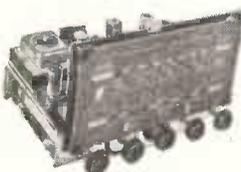
THE FOLLOWING DULCI TUNER UNITS ARE IN STOCK

TUNER H.4T. This model is the "TUNER UNIT VERSION" of the H.4 Radiogram Chassis illustrated and described above. It has the same coverage of A.M. and F.M. Wavebands (4 altogether) and precisely the same in size and appearance, except that it has three Controls only, being: TUNING, WAVECHANGE and Volume On Off, mounted centrally on the chassis. A self-contained Tuner incorporating own Power Supply.

PRICE £20.17.0
(plus 7/6 carr. & ins.)

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/18/4. H.P. TERMS: Deposit £10/8/6 and 12 monthly payments of 19/4.

THE DULCI MODEL H.11



"The Heart of High Fidelity"

A COMBINED AND SELF-POWERED AM/FM TUNER "HI-FI"

CONTROL UNIT

and AUDIO PRE-AMPLIFIER

Incorporating Switching and connections for direct use with TAPE EQUIPMENT.

PRICE £29.3.10
(Plus 7/6 carr. & ins.)

CREDIT TERMS: Deposit £7/6/- and 9 monthly payments of £2/13/6. H.P. TERMS: Deposit £14/12/6 and 12 monthly payments of £1/7/-.

A truly High Fidelity Unit containing the functions of an A.M./F.M. Tuner—Pre-amplifier Tone Control Unit, all on one chassis, designed for use with any High Quality Main Amplifier (i.e., the Mullard 5-10 at £9/10/-, or Williamson, etc.).

BRIEF DESCRIPTION:—

- Covers 4 wavebands being Short—Long—Medium and the V.H.F./P.M. Band.
- Separate Bass and Treble Controls.
- Gram Equalising.
- Magic Eye Tuning.
- Latest BVA 7-valve line-up, plus two matched Diodes.
- Overall size 12in. x 9in. x 7 1/2in. high.

THE DULCI VHF/FM TUNER

A self contained Tuning Unit providing complete F.M. coverage.

PRICE £17.10.0



(Plus 5/- carr. & ins.)

CREDIT TERMS: Deposit £4/7/6. and 9 monthly payments of £1/12/1. H.P. TERMS: Deposit £9/15/- and 11 monthly payments of 17/8.

BRIEF DETAILS:

- (a) Designed to operate with any make of Amplifier and most Radio Receivers.
- (b) Incorporates its own Power Supply.
- (c) Has the highly efficient GERLER INDUCTANCE TUNING HEART.
- (d) A "Magic-Eye" TUNING INDICATOR is incorporated.
- (e) Employs the latest valve line-up—EABC80, ECC85, two EF89's 6 x 4 (Rectifier) and EM80 Indicator.
- (f) A very attractive Dial (size 10 1/2in. wide x 6in. high) is incorporated and the overall size of Chassis is 6in. deep x 9in. wide x 6 1/2in. high.

The T.S.L. V.H.F./F.M. TUNER is also in stock. It is very similar to the above Dulci F.M. Unit both in general appearance and performance.

PRICE—PRECISELY the same as the Dulci V.H.F./F.M. Unit.

THE MODEL A.F.O.—3 Waveband A.M. only RADIOGRAM CHASSIS

PRICE £11.16.4

(plus 7/6 carr. & ins.)

H.P. TERMS: Deposit £5/19/4 and 8 monthly payments of 17/8. This is a standard 5-valve A.C. Mains Superhet Receiver Chassis covering Long Medium—Short Wavebands having Gram and Extension Speaker Sockets. Reproduction from both Radio and Gram is really good and it makes an ideal Chassis for a simple domestic installation. Overall size is 12in. x 7in. x 7 1/2in. high. Really Modern Demonstration Rooms are now available for the convenience of callers.



Stern's "fidelity" F.M. TUNING UNIT

A 5-Valve Tuner incorporating the latest Mullars Permeability Tuned Unit. Price assembled less Power Supply.

£14.10.0

(Plus 7/6 carr. & ins.)

TERMS: (a) H.P. Deposit £7/5/- and 9 monthly payments of 19/4; (b) Credit Deposit £3/12/6 and 9 monthly payments of £1/6/7. Provides "Hi-Fi" reproduction with any make of Amplifier and many Radio Receivers. It incorporates: ● The latest Valve line-up—RCC85, 2 type EF80, 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 allows a selection of foreign stations. **PRICE £18.18.0** (Plus 7/6 carr. and ins.)

TERMS:—(a) H.P. Deposit £9/9/- and 10 monthly payments of £1/1/-; (b) Credit Deposit £4/15/- and 9 monthly payments of £1/14/7. Send S.A.E. if further data required.

STERN'S POWER SUPPLY UNITS

Fully smoothed with all output connections terminated to Connecting Blocks, thereby enabling ease of connecting to a Radio Tuner Unit or Amplifier, etc. (the Compact 5 Amplifiers are immediately connected in this way). Overall size of Units is 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.)

RECORD PLAYERS THE VERY LATEST MODELS ARE IN STOCK

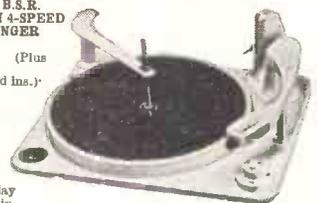
MANY AT REDUCED PRICES !!!
TRANSCRIPTION UNITS—AUTOCHANGERS
SINGLE RECORD PLAYERS

Send S.A.E. for ILLUSTRATED STOCK LIST

CASH ONLY OFFER !!!

This latest B.S.R. MONARCH 4-SPEED AUTOCHANGER

£8.7.6 (Plus 5/- carr. and ins.)



- They play MIXED 7in. 10in. and 12in. records of same speed.
- Minimum baseboard size required 14in. x 12 1/2in. with height above 5 1/2in. and height below baseboard 2 1/2in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

WE ALSO HAVE A FEW ONLY

COLLARO MODEL 456 4-Speed "Mixer" Autochangers. The Units are BRAND NEW and incorporate the STUDIO "O" Pick-up

PRICE £9.10.0 (Plus 5/- carr. and ins.)

FOR CALLERS ONLY

We have in stock various KITS OF PARTS including F.M. Tuners, AM/FM Tuners, Midget Battery Portable and Mains Units, etc., etc. . . We also have the most comprehensive stock of WIRELESS and ELECTRICAL COMPONENTS.

Open Monday to Friday 9 a.m.—6 p.m.
Saturday 9 a.m.—1 p.m.

STERN RADIO LTD.

AMPLIFIERS TUNING UNITS
PRE-AMPLIFIERS FOR THE RADIORECEIVERS
HOME CONSTRUCTOR
— 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.B., Coliari, 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 ULTRA LINEAR OUTPUT TRANSFORMER and the recommended Mullard Valve line-up. All specified Components are supplied and Power Supply is available to drive a Radio Tuner Unit. PRICE OF COMPLETE KIT OF PARTS **£9.10.0** (Plus 5/- carr. & ins.) or alternatively we supply— FULLY ASSEMBLED AND TESTED for **£11.10.0** (Plus 5/- carr. & ins.) THE ASSEMBLY MANUAL containing FULL SPECIFICATION is available for 1/6. It also includes full data on the REMOTE CONTROL UNIT.

STERN'S "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT

"A design for the Music Lover"



This unit can be used with any Main Amplifier. Briefly it has inputs for all types of MICROPHONES, HIGH and LOW GAIN PICK-UPS and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL (b) STEEPCUT FILTER (c) Continuously variable BASS and TREBLE CONTROLS, a variable OUTPUT CONTROL which enables its use with any type of Amplifier and Jack Sockets are incorporated for TAPE RECORDED and TAPE PLAYBACK. Used with the "5-10" the reproduction is comparable to that normally associated only with the very expensive commercially made High Fidelity Amplifiers. PRICE OF COMPLETE KIT OF PARTS **£6.6.0** WE ALSO OFFER IT ASSEMBLED READY FOR USE **£8** (plus 5/- carr. & ins.). THE ASSEMBLY MANUAL contains full specification and is available for 1/6.

THE MULLARD "3-3" QUALITY AMPLIFIER

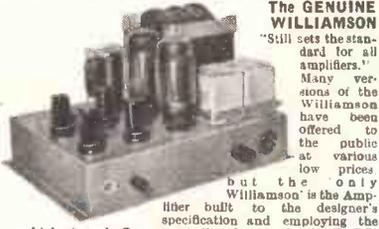


A small Compact Amplifier capable of VERY HIGH QUALITY REPRODUCTION on both RADIO and GRAM. PRICE for Complete KIT OF PARTS... **£6.19.6** (plus 5/- carr. & ins.) Alternatively supplied ASSEMBLED and READY FOR USE **£8.12.6** (plus 5/- carr. & ins.) The complete SPECIFICATION and ASSEMBLY DIAGRAMS are 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 P.M. Tuner and Record Player in a small installation.

SPECIAL PRICE REDUCTIONS FOR PURCHASERS OF A COMPLETE "Hi-Fi" AMPLIFIER WE WILL SUPPLY...

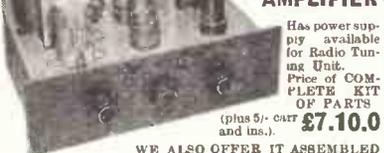
- (a) THE COMPLETE KIT OF PARTS to build both the MULLARD 5-10 and the REMOTE CONTROL UNIT for..... **£11.11.0**
 - (b) THE COMPLETE KIT OF PARTS to build both the MULLARD 5-10 and the "Fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for..... **£15.15.0**
 - ALTERNATIVELY WE WILL SUPPLY ASSEMBLED and FULLY TESTED, as follows—
 - (a) THE MULLARD 5-10 and the REMOTE CONTROL UNIT for..... **£14.0.0**
 CREDIT SALE TERMS. £3.10.0 Deposit and 9 monthly payments of £1.5.8. H.P. TERMS. 27 Deposit and 9 monthly payments of 17/9.
 - (b) THE MULLARD 5-10 and the "Fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for..... **£18.18.0**
 CREDIT SALE TERMS £4.15. Deposit and 9 monthly payments of £1.14.7. H.P. TERMS. £9.9. Deposit and 12 monthly payments of 17/6.
- WHEN ORDERING PLEASE INCLUDE 7/6 to cover cost of Carriage and Insurance.

BRITAINS FINEST "HI-FI" AMPLIFIER



The GENUINE WILLIAMSON "Still sets the standard for all amplifiers." Many versions of the Williamson have been offered to the public at various low prices but the only Williamson is the Amplifier built to the designer's specification and employing the very highest grade Components that he specifies, L.A. PART-RIDGE TRANSFORMERS, CHOKES, etc. It is only in doing this that the exceptionally high standard that has made this Amplifier so famous, particularly in America is obtained. WE HAVE DONE THIS!!! and we offer these KITS OF PARTS, including Partridge and other high grade Components, as follows— (a) to build the MAIN AMPLIFIER ONLY **£14.10.0** (Illustrated above.) (b) To build the TWIN POWER SUPPLY **£13.10.0** (Insufficient space to illustrate this.) (c) COMPLETE KIT to build both above **£27.0.0**

A COMPLETE KIT OF PARTS, STERN'S "HIGH QUALITY" £10 WATT AMPLIFIER



Has power supply available for Radio Tuning Unit. Price of COMPLETE KIT OF PARTS **£7.10.0** (plus 5/- carr. and 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 6V7s in push-pull and incorporating negative feedback. Provides for the use of both 8 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.

THE FOLLOWING HIGH FIDELITY AMPLIFIERS ARE IN STOCK

- STERN'S COMPACT AMPLIFIERS. Expressly developed for very high quality reproduction of Gram Records and particularly FM Transmission. Available in 2 models as follows. COMPACT "5-2". A two-stage high sensitivity amplifier, having separate Bass and Treble Controls. Price **£6.6.0** COMPACT "5-3". A three-stage version of the 5-2 but having an additional stage incorporating negative feedback. Price **£6.16.0** Power supply is obtainable from a small separate unit. Price (additional to above) **£2.10.0** THE DULC MODEL D.F.A.10. A 10 watt Ultra Linear High Fidelity Amplifier with **£19.19.0** separate PREAM-TONE Control Unit THE LEAK MODEL TL10 and "POINTONE" PRE-AMPLIFIER. A universally known Amplifier and now quite accepted as one of the best in **£28.7.0** production. THE ARMSTRONG MODEL A.10 Mk. II. With associate PREAM-TONE CONTROL UNIT, this model is perfectly consistent with Armstrong's very high reputation. **£32.0.0** THE ROGERS "JUNIOR". With associate PREAM-TONE CONTROL UNIT. **£26.0.0**

SPECIAL CASH ONLY OFFER!!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched 6in. P.M. SPEAKER. ALL FOR **£8.7.6** (plus 7/6 carr. & ins.) The Amplifier consists of a 2 Stage design incorporating the modern B.V.A. valves types: ECC83, EL84 plus EZ80 Rectifier and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Maroon and Grey colour Rexine WE ALSO SUPPLY SEPARATELY— (a) The 2-Stage (plus Rectifier) AMPLIFIER... **£4.2.7**



- THE RCA "ORTHOPHONIC". 2-20 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. (b) THE PORTABLE CARRYING CASE **£3.17.6** (c) 6in. P.M. SPEAKER **£18.9.9** Carriage and insurance, 4/- extra. We also have a smaller PORTABLE CASE Idea for Record Players. PRICE ONLY **£3.3** (plus 3/- carr. & ins.). Attractively finished in high grade Rexine and robustly constructed with initial measurements at 13 1/2 x 15 1/2 in. high. It will therefore accommodate all makes of Record Players including Autochangers. An uncut baseboard is also supplied.

DEPT. 109/W
109-115 FLEET ST.
LONDON, E.C.4
 Phone: FLEET Street 5812-3-4.

MULLARD "3-3" QUALITY AMPLIFIER



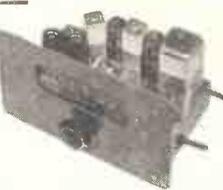
An ideal companion unit to the JASON Tuner. A really first-class 3-valve 3-watt Amplifier giving H.F. quality at a reasonable cost. Mullard's latest circuit. Valve line up: EF88, EL84, EZ80. H/duty mains trans. giving extra HT and LT for Tuner Unit addition.

Variable treble cut 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 sectionalised output transformer to Mullard specification (less speaker) **£8.8.0**

Wired Power C/Pat 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 this modern, highly successful unit, drilled chassis and superior type dial as illustrated. Coils, cans and all quality components, etc. for only 5 gns., post free. Set of 3 spec. EF91 or equiv. valves 30/- post free. Illustrated handbook with full details, 2/-, post free. Free with Kit 48-hr. Alignment Service, 7/6 and 2/- p.&p.

BLICKVAC HIGH PRESSURE & VACUUM IMPREGNATORS



BLICKVAC Impregnators are used by Marconi, Pye, S. Smith & Sons, N.C.B., M.O.S., and many other well-known organisations. A full range of standard models is available — capacities 4 in. by 9 in. to 3 ft. by 3 ft — suitable for Varnish, Wax, Potting Resins, etc. Plants can be designed for special requirements. Blickvac Impregnators are designed to give simplicity in control, outstanding performance and ease in cleaning. A second autoclave can be added at low cost when needed.

BLICKVAC products include:- Epoxy Resin Vacuum Mixing and Casting Plants. Electric Ovens, Vacuum Ovens, Mixing Vessels, Dipping Tanks, etc.

BLICKVAC ENGINEERING LTD.
Bede Trading Estate, Jarrow, Co. Durham. Jarrow 89/7155
96/100 Aldersgate Street, London, E.C.1. Monarch 6256/8

ELECTROLYTICS ALL TYPES NEW STOCK

TUBULAR	CAN TYPES
25/25v. 50/12v. 1/9	8-8/450 v. ... 4/6
60/50 v. 4/500 v. 2/-	8-16/450 v. ... 5/8
100/250 v. ... 1/9	8-16/450 v. ... 5/8
8/450 v. ... 2/3	16-16/450 v. ... 5/6
8/500 v. ... 2/9	18-16/500 v. ... 6/-
8+8/500 v. ... 4/6	18-18-8/350 v. 5/6
16/450 v. ... 5/-	32-32/350 v. 5/6
16/450 v. ... 3/6	32-32/275 v. 4/6
16-16/450 v. ... 6/6	50-50/350 v. 6/6
32/350 v. ... 4/-	60/350 v. ... 6/6
35/500 v. ... 5/-	80-250/275 v. 12/6
32-32/50 v. 5/8	84-120/275 v. 11/6
32+32/450 v. 6/6	100-200/275 v. 12/6
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MIDGET TRANSISTOR TYPES. 2μF, 4μF, 5μF, 6V, 3/6; 6μF, 10μF, 16μF, 3V, 3/6; 32μF 11V, 3/6.

CONDENSERS.—Mica, Silver Mica. All pref. values, 3 pt. to 1,000. pt. 6d. each. Ditto Ceramics 9d. each. Tubulars, 450 v. Hunts and T.C.C. .001 mid-.01 and 1/350 v. 9d. each. .02-1/500 v., 1/- each. 25 Hunts, 1/6. 5 Hunts, 1/9. .001 mid. 5kv. 5/6. .001 mid. 20kv. 9/6.

CLOSE TOLERANCE CONDENSERS S.Mica. 10% Type, 5 pt.—500 pt., each 1/- 600 pt.—5,000 pt. each 1/3. 1% Type 1.5 pt.—50 pt. (Tot. 1 pt.), 1/9; 50 pt.—500 pt. each 1/9; 575 pt.—5,000 pt. each 2/-.

RESISTORS.—Prof. val. 10 ohms 10M ohms.

CARBON	WIRE-WOUND
20% Type, 1 w. 3d.	5 w. } 25 ohms—1/3
1 w. 5d. 1 w. 6d.	10 w. } 10,000 1/6
2 w., 9d.	15 w. } ohms 2/-
10% Type, 1 w. 9d.	5 w. } 15,000— 1/9
5% Type, 1 w. 1/-	10 w. } 33,000
1% Hi-Stab, 1 w. 2/-	10 w. } ohms 2/3

WIRE-WOUND POTS
3w. LAB. COLVERN, etc. Standard Size Pots
2 1/2in. Spindle. High Grade. All Values.
100 ohms to 50 K.
5/6; 100 K. 6/6.
W/W EXT. SPEAKER CONTROL. 10 Ω 3/-

SCOTCH BOY. EMITAPE. etc., 1,200ft. 27/- Long playing, 1,800ft. reels, 40/- Reels only, 3in., 3 1/2, 5in., 3/8, 7in., 4/3.

SENERCEL RECTIFIERS. E.H.T. Type, Fly-Back Voltages, K3/25 2 kV., 5/-; K3/40 3.2 kV., 6/9; K3/45 3.6 kV., 7/3; K3/50 4 kV., 7/5; K3/100 8 kV., 13/6, etc. MAINS TYPES—RM1 125 v. 60 mA., 4/9; RM2 125 v. 100 mA. 5/6; RM3 125 v. 120 mA., 7/6; RM4 250 v. 250 mA. 16/-; RM4B type 270 mA., 17/8. RM5 250 v. 300 mA., 21/-.

SPEAKER FRET.—Expanded Bronze anodised metal. 3 x 8in., 2/3; 12 x 8in., 3/-; 12 x 12in., 4/3; 12 x 16in., 6/-; 24 x 12in., 8/6, etc. Any preferred size cut.

TYGAN FRET (Murphy pattern) 12in. x 12in., 2/-; 12 x 18in., 3/-; 12 x 24in., 4/-, etc.

NEW VALVES ALL BOXED GUARANTEED

1R5, 1T4 7/6	8ABC80 9/6	EZ80 8/6
185, 184 7/6	EB91 6/6	MU14 9/6
384, 3V4 8/-	EDC41 9/6	PCCP4 10/6
5Z4 9/6	ECC83 10/6	PCF80 10/6
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6V6 7/6	ECL80 10/6	PY80 9/6
6X4 7/6	EF41 10/6	PY81 9/6
6X5 7/6	EF90 10/6	PY82 8/6
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DAF96 9/6	EM85 11/3	UCH42 10/6
DF96 9/-	EL41 10/6	UF41 10/-
DK96 9/-	EL51 11/6	UL41 10/6
DL96 9/-	EY51 10/6	UL41 10/6
35L6 10/6	EZ40 8/6	UY41 8/6

SPECIAL PRICE PER SET
1R5, 1T4, 185, 184, or 384, or 3V4 27/6
DK96, DF96, DAF96, DL96 ... 35/-
6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5 35/-

TRANSISTORS. Mfrs. surplus PNP Junction type. Audio Type, 800 kc/s 250 mW. 9/6; R.F. and L.O. Mixer Type, 2.5 Mc/s. 19/6. All tested and guaranteed.

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.

Terms: C.W.O. or C.O.D. Kindly make cheques, P.O.s, etc., payable to T.R.S. Post and Packing up to 7d. 1lb. 1/1, 3lb 1/6, 5lb 2/-, 10lb 2/9. Bargain Lists 3d.

EDDY'S (Nottm.) LTD.

(DEPT. W.W.)
172 ALFRETON ROAD, NOTTINGHAM

THIS MONTH'S SPECIAL OFFERS

RECORDING TAPE. 1,200ft. reels, 9/11 each. Postage etc. 1/- extra.

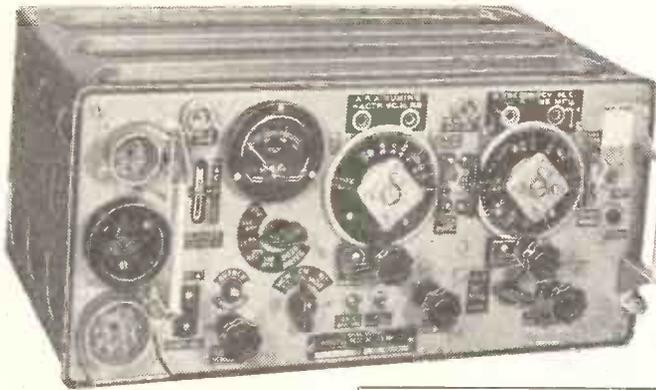
GERMANIUM DIODES. New and guaranteed, 1/- each, Post 3d.

5 inch SPEAKERS. New and guaranteed, 16/11 each. 2/- extra post and packing.

Any parcel insured against damage in transit 6d. EXTRA.	NEW AND GUARANTEED VALVES	All tested before despatch.	Post etc. 6d. per valve. OVER £2 free.				
CY31	12/11	EF86	12/6	IH5G	10/6	6F15	14/-
DM70	7/11	EF89	9/6	IN5G	10/6	6K7G	2/11
DAF96	9/6	EL91	7/11	1R5	7/11	6K8G	8/6
DF96	9/6	EL84	7/11	1S5	7/3	6Q7G	8/3
DK96	9/6	EZ80	8/3	1T4	7/3	6Q7GT	8/11
DL96	9/6	GZ32	12/6	3Q4	9/11	6U4GT	13/11
EB91	6/11	PY80	8/11	3Q5	10/6	6V6GT	5/11
ECC81	8/11	PY81	8/3	354	8/11	10F9	11/6
ECC82	8/11	PY82	8/3	3V4	8/6	25A6G	12/6
ECC83	8/11	U25	13/6	5Z4G	9/6	25Z4G	8/11
ECC84	10/11	UBF80	9/6	5Y3G7	7/6	35W4	8/11
ECC85	9/-	UBF41	8/11	6BA6	6/11	954	1/6
ECH35	9/11	UL41	9/11	6B8G	3/6	955	3/11
ECH81	8/11	UY41	7/11	6B16	7/11	956	2/6
ECL80	8/11	1A7G	13/6	6F1	13/6	958	3/11
EF80	8/3	1C5G	10/6	6J5GT	3/11	VU11	2/6
EY51	11/6						

NO LISTS. TRADE ENQUIRIES INVITED

Best Buy at Britain's



No. 19 MK 2 WIRELESS SETS.

Consists of 2 Transmitter/Receivers and an Intercomm. Amplifier combined. "A" set covers 2-8 Mc/s. (37.5-150 metres), phone and CW. "B" set frequency 235 Mc/s (1.25 metres), phone only. Complete with 15 valves, 6 of 6K7G, 2 of 6K8G, 2 of 6V6G, 1 of 6B8G, 6H6m, E1148, EF50, 807, 500 micro-Amp. check and tuning meter, and instruction booklet and full circuit. Made in U.S.A. Brand new and AIR TESTED. £35/5/0. Carr. 10/-.

DYNAMOTOR POWER SUPPLY UNITS. For 12 v. D.C. operation. Complete with connector to set. Tested 25/- . Carr. 5/- . Send S.A.E. for full details of 19 set equipment.

HR HEADPHONES. Comprised of 2 earpieces of 1,000 ohms, and headband, but less cord. Brand new and tested, 7/6. Post 1/6.

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-11220 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. RMS, 5 v. 1.75 amps., and 5 v. 12.5 amps. 7 x 7 1/2 x 10 1/2 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 4 1/2 x 4 in. high. Upright mounting. Brand new. 32/6. Postage 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 centre 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 ohm, 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 ohm coil. DP C/O (double-contacts). 1 1/2 x 3/8 x 3/8 in. 7/6.

OUTPUT POWER METERS. Ex-W.D. No. 3, Mk. 2 (Windsor 150 A.). Impedance ranges 2.5 to 20,000 ohms in 40 steps. Power ranges 0-5, 50, 500 milliwatts, and 0-5 watts. Also scaled in dB, 3 1/2 in. M/C meter. In oak case, 10 1/2 in. x 8 in. x 5 1/2 in. In good condition. Tested. £15.

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 1 1/2 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.

VIBRATOR PACKS. Input 6 v. D.C. Output approx. 100 v. D.C. at 30 m/Amps., fully smoothed and R.F. filtered. Size 6 1/2 x 5 x 2 in. Fitted with Mallory 629C vibrator. Brand new. Boxed, 12/6.

MOTOR ALTERNATORS. Input 80 volt D.C. at 16 amps. Output 80 volt A.C. 2,000 c/s., at 8 amps. (650 V.A.). Built-in voltage regulator. Brand new. Crated, 79/6. Carriage 15/- .

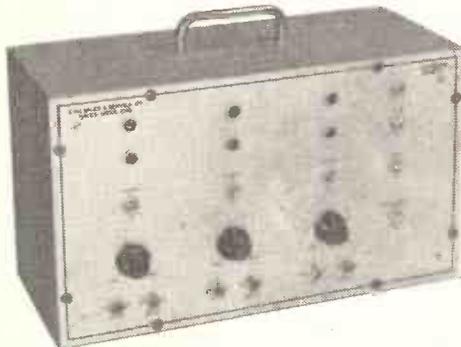
METAL RECTIFIERS. 250 volt, 100 m/A 5/- . 230 volt, 60 m/A 3/6. Many other types.

METER BARGAINS				
RANGE	TYPE	SIZE		PRICE
50 Microamp.	D.C. M/C	2 1/2 in.	Flush circ., scaled 0-100	50/6
100 Microamp.	D.C. M/C	2 1/2 in.	Flush circ., Ex-19 set	39/6
500 Microamp.	D.C. M/C	2 1/2 in.	Flush circular	12/6
500-0-500 Micro-amp.	D.C. M/C	2 1/2 in.	Flush circular, scaled 100-0-100 V.	25/-
1 Milliamp.	D.C. M/C	2 in.	Flush square, Fe/NFe	22/6
150 Milliamp.	D.C. M/C	2 in.	Flush square	7/6
200 Milliamp.	D.C. M/C	2 1/2 in.	Flush circular	10/6
1 Amp. Thermo-couple	2 1/2 in.		Projecting circular	6/9
4 Amp. Thermo-couple	2 in.		Flush square	6/9
30-0-30 Amp.	D.C. M/I	2 in.	Proj. circ., car type	5/-
15 Volts	A.C. M/I	2 1/2 in.	Flush circular	8/6
METER RECTIFIERS. Full wave bridge. Brand new, Salford 1/mA. 6/6. 5 m/A., 6/6. STC 2 m/A., 5/6.				

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 2 1/2 in. panel mounted 300 v. meter reads input and H.T. volts. Double smoothing with paper capacitors. Standard 19 in. rack mounting. **BRAND NEW, £4/19/6.** Carr. 7/6.

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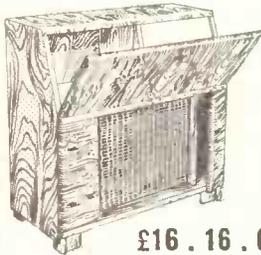
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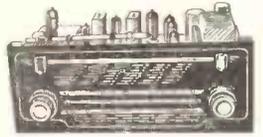
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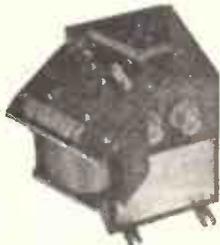
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or Beam position indication system

This comprises a transmitter unit and Indicator which will operate on 12 or 24 v. 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. Price 12/6, plus 2/- p. & p.

3 CM. TEST SET TYPE 205. Brand new. £15, carr. paid.

MAINS POWER UNIT

TYPE 234

(For use with Receiver R1392)

Double Smoothed 200-250 v. 50 c. Input 240 v. 100 mA 6.3 at 6 amps, with Volt Meter reading input and output voltages. Size: 19in. × 10in. × 6½in. Standard Rack Mounting. Price £4/10/- each, plus 10/- carr.



COMPRESSOR AND VACUUM PUMP

(Edwards Type 4). A beautifully constructed pump, coupled with a 24 v. D.C. Motor mounted on rigid steel base, cover and complete with hose coupling Vacuum 10 cm. mercury. Pressure 10 lb. per sq. in. 2.6 cu. ft. per min. Unit in case, size: 16in. × 7in. × 8in. New and boxed £4, plus 10/- postage and packing.

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 v. and 120 v. Unit housed in copper lined wooden case. Size: 15½in. × 13in. × 14½in. In good used condition. £2/10/-, plus 10/- packing and carr.

R.1155 Receiver. In used condition but working order. Price £6/5/-, plus 10/- Pkg. and carr.

12 volt Rotary Transformers. 225 v. 100 mA, size 3½in. dia. × 5½in. long. Price 30/-, plus 3/- p. and p.

ELECTROLYTIC CONDENSERS. 450 v. Wkg. 525 surge. 8 Mfd, 1/9; 16 Mfd, 2/9; 8×8 Mfd, 3/3; 16×16 Mfd, 4/-; 32×32 Mfd, 4/3; 25 Mfd 25 v. wkg., 1/9. All post paid.

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VU.111	2/-	12SH7	2/9	12A6	5/-	6SL7	6/6
VR.54	2/-	6K7.G	3/-	OZ4	5/-	6SN7	6/6
6H6	2/-	6SH7	3/3	6L7	5/6	2D21	7/6
12H6	2/-	VR91	4/-	6CQ6	6/-	6V6m	8/6
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MODULATORS for above, 25/- each. P. & P. 3/-.

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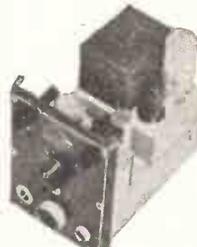
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Includes:—

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Input 110 volts—240 v. Output 345-0-345 at 150 mA, 5 v. at 2 amps and 6.4 v. at 4.5 amps. Fully shrouded, size 5 1/2 x 4 x 4 1/2 in. Brand new, 50/- P. & P. 3/-.

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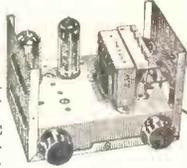
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With cooling Fan. Input 12 v. D.C. Output 300 v. at 90 mA. Completely suppressed. Brand new. 19/- each. Plus P. & P. 3/-.

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SUITABLE ANY T.V. using lower side band NO ALTERATIONS TO SET

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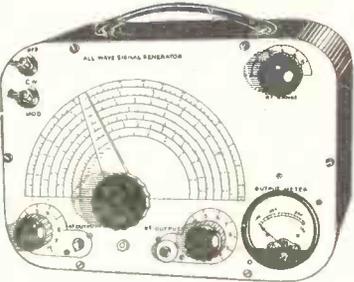
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Coverage 120 Kc/s.-230 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s.-54 Mc/s. Metal case 10 1/2 in. x 8 1/2 in. x 4 1/2 in. Size of scale, 6 1/2 in. x 3 1/2 in. 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated R.F., output continuously variable 100 millivolts, C.W. and mod-switch, variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%.

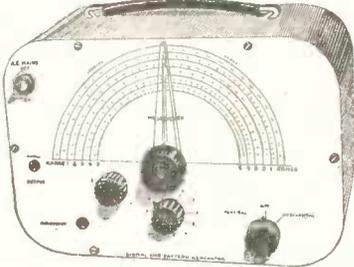
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£4/19/6 or 24/- deposit and 2 monthly payments 25/-. P. & P. 4/6 extra.

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Approx. size 6 1/2 x 2 1/2 incorporating 2 valves, contact-cooled metal rectifier, bass and treble lift controls and double wound mains transformer **39/6** Plus P. & P. 230-250 v.

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Complete in case, grey **19/6** P. & P. 1/6, hammer finish. Point to point wiring diagram 1/-, free with kit.

4 VALVE ALL-DRY SUPERHET PORTABLE KIT

incorporating ferrite rod aerial

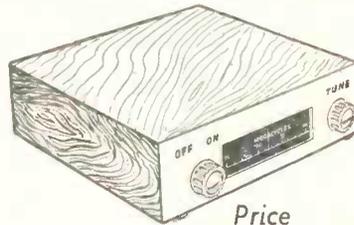
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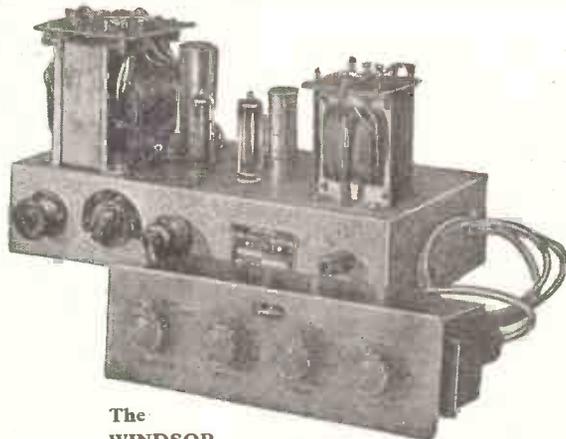
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for ANY SET in ANY AREA

This unit has been widely used since I.T.A. Transmissions began to convert all types of sets, Superhet and T.R.F., to receive on Band III.

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C. & G. KITS

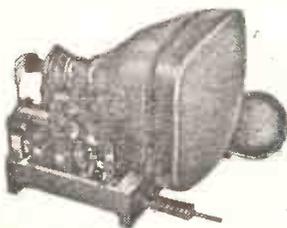
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Complete. Fitted with Bin. P.M. speaker. "W.B." or "Goodmans" of the highest quality. Standard matching to any receiver. 2-5 ohms. Flex and switch included. Unrepeatable at this price. Money-back guarantee if not completely satisfied. Ins., carr. 3/6.

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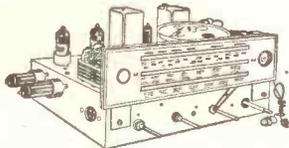
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Stocks cannot last. Ideal for fitting in small cabinet or cupboard door. Let the lady of the house follow that T.V. or radio programme. P. & P. 1/9.

ARGOSY PUSH-PULL RADIOGRAM CHASSIS 139/6.

8 valve, uses 2-EL42, 2-EBF80, ECH81, EBC41, EZ80, EM34. Latest models. 3 wave band and gram. Switched. Over 10 watts output. Full tone range. 4 knob control. Size 12in. x 7½in. x 7½in. Less valves. Ins., carr. 5/6.



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For all I.T.A. and F.M. channels. 3-element type for outdoor or loft, at half their original price. P. & P. 2/6.

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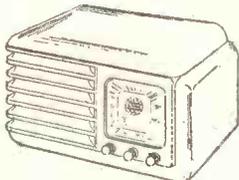
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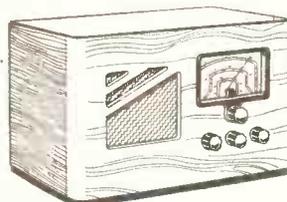
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5 valve, CCH35, EF39, EBC33, CL33, 35Z4 or metal rec., 3 control knobs. Switched for gram. In attractive brown plastic cabinet. 15in. x 7½in. x 9in. Ins., carr. 4/6.

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 ★ 17in. £7/10/-, 14in. £5/10/- ★
 ★ 6 months' full replacement, 6 months' progressive. Made possible by the high quality of our tubes. Ins., carr. 15/6. ★
 ★ **CONVERT YOUR 9" 10", 12" to 14" 15", 16".** ★
 ★ Our pamphlet is FREE and in many cases costs only the tube to give you these giant pictures. ★
 ★ **SPECIAL OFFER.** 14in.-15in.-16in. T.V. ★
 ★ TUBES. £5. Perfect. See them working. ★
 ★ **12" T.V. TUBES £6.** 15/6 Ins., carr. on all ★
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5 valve (octal) s/het 3 w/band receiver. A.C. Gram. P.U. sockets. In wood cabinet 18½in. x 11½in. x 8½in. Ins., carr. 7/6.

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350-0-350 v. 80 m/a., 4 v.-4 v. heaters, 200-250 v. prim. 3/9.
 350-0-350 v. 80 m/a., 12 v.-4 v. heaters, 200-250 v. prim. 2/9.
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1S5	4/9	77	3/9	ECH42	8/9	PEN46	12/-
6AM6	7/9	210LF	3/9	EF41	8/9	PEN220	3/9
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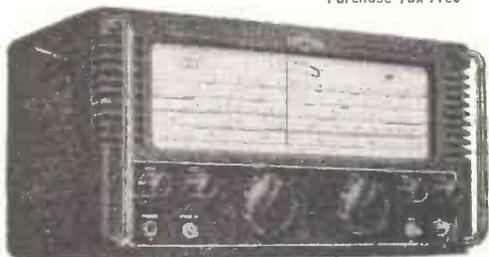
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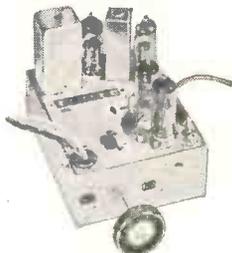
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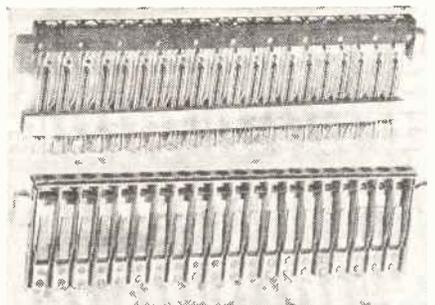
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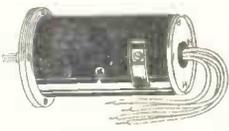
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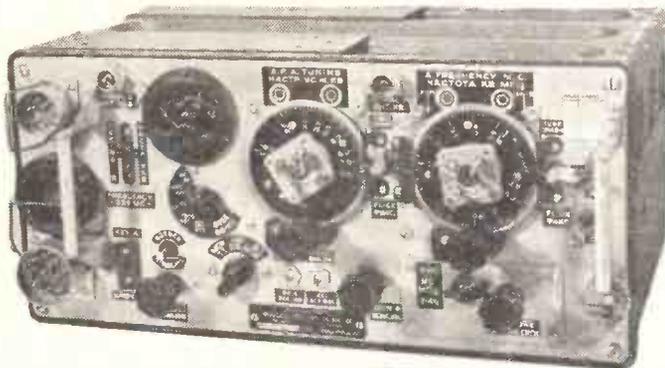
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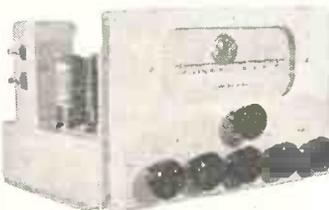
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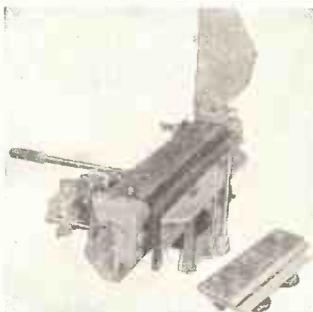
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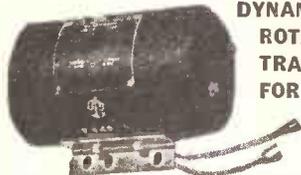
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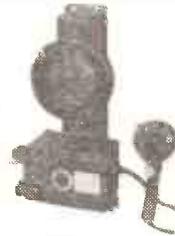
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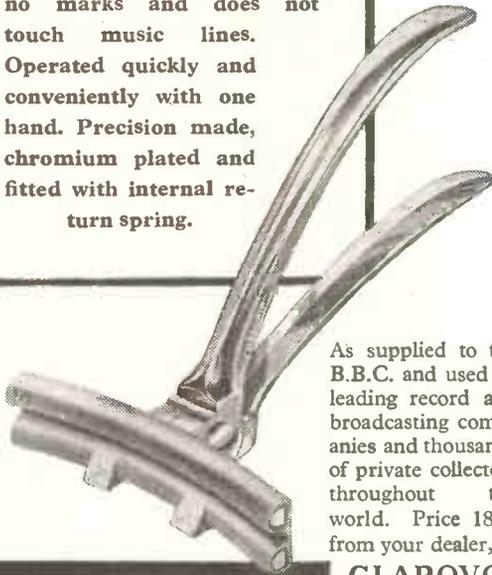
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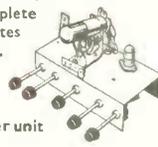
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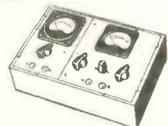
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ASSOCIATED TELEVISION LTD.

invite applications from
TELEVISION ENGINEERS
for appointment as

- (1) ASSISTANT COMMUNICATION ENGINEERS
- (2) JUNIOR COMMUNICATION ENGINEERS

Applicants should have a good knowledge of micro-wave and line transmission techniques and experience in analysing television waveforms.

Apply giving details to:

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JASON SWITCHED F.M. TUNER

KIT



**5 VALVES.
SWITCH-TUNED
FRONT END SUPPLIED
COMPLETE WITH 2 VALVES**

When built, this new Jason F.M. Tuner provides choice of the three B.B.C. programmes at the turn of a switch, with a fourth position for "OFF". The Switch Tuned Front End is supplied wired, tested and aligned, complete with 2 valves and station-indicating plate. Chassis ready punched. In conformity with all Jason F.M. Units, this model is completely stable and offers the highest possible standards of reproduction.

Please send S.A.E. for complete price list.

FROM LEADING STOCKISTS or in case of difficulty
THE JASON MOTOR & ELECTRONIC CO.

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**CONSTRUCTOR'S SWITCH-TUNED
KIT** including assembled Front End
with two valves and all parts as
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SWITCH-TUNED FRONT END with
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JASON POWER PAKE KIT **£2.1.9**

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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.

HOLIDAY ARRANGEMENTS CAN BE MAINTAINED

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 2970Z.

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.

HOLIDAY ARRANGEMENTS CAN BE MAINTAINED

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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 2970A.

THE ENGLISH ELECTRIC
COMPANY LIMITED

GUIDED WEAPONS DIVISION
STEVENAGE

ENGINEERS

CONTROL

ELECTRICAL

ELECTRONIC

ELECTRO-MECHANICAL

A number of engineers (senior or intermediate) in the above categories are required for work in the Engineering Department of our Production Wing. In all cases candidates should have reached H.N.C. or near equivalent standard and should have had industrial experience, preferably of a development nature.

Besides a knowledge of engineering fundamentals, applicants must have an interest in progressing and controlling technical work associated with the problem of getting equipment into production. Such equipment includes that built into missiles as well as test gear and ground equipment.

Adequate salaries will be paid to the right men.

Housing assistance can be made available.

Replies should be sent to Dept. C.P.S., 336/7, Strand, London, W.C.2, quoting Ref. WW1316F.

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for the

"NATIONAL INSTITUTE FOR
RESEARCH IN NUCLEAR SCIENCE"

The UNITED KINGDOM ATOMIC ENERGY AUTHORITY (RESEARCH GROUP) invite applications from PHYSICISTS and ENGINEERS for a number of posts in the project team concerned with the design, construction and commissioning of a seven thousand million ELECTRON VOLT PROTON SYNCHROTRON at HARWELL, Berkshire.

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 Physicists and electrical engineers will be recruited in the Scientific and Experimental Officer Classes. Knowledge of "Particle Accelerators" is not essential, though experience in one of the following fields is desirable:

Electro-magnets or transformers.

Heavy duty electrical machinery, rectifiers and switchgear.

Radio frequency systems especially in the range 1/100 Mc/s.

High Vacuum systems and associated monitoring and control equipment.

Electronics, including control circuits and instruments of all kinds.

ENGINEERING DESIGN, CONSTRUCTION AND MAINTENANCE

Senior posts are available for engineers with proved ability in similar large development projects preferably but not essentially of an electro-mechanical nature. The right experience for other responsible posts will have been obtained by engineers trained in any of the following:

Heavy electrical plant and equipment installations.

Plant and equipment for research and development.

Complex central circuitry.

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Rectifier systems.

Steel works.

SALARIES (Depending upon age, qualifications and experience) Scientific Officer and Engineer Classes—up to £2,080. Experimental Officer Class—up to £1,630.

For further details and an application form, please send a POSTCARD to:
RECRUITMENT (905/45), A.E.R.E., HARWELL, DIDCOT, BERKS.

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 £561 10s. at age 25 rising (subject to a practical test) to £671. The rates are somewhat lower in the Provinces and for those below age 25. Prospects for permanent pensionable posts for those who qualify.

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 £790, Grade II £925, Grade I £1,160.

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)

SENIOR DESIGN DRAUGHTSMEN

and draughtsmen of other grades are invited by the Pye group to apply for positions created by continued expansion in the light engineering industry.

Opportunities are offered to men with sound industrial training and experience in light mechanical or electrical engineering for rewarding work in a wide variety of electronic and electro-mechanical fields, including domestic radio and television.

Applications should be addressed in the first instance to:

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A. V. ROE & CO. LIMITED WEAPONS RESEARCH DIVISION

(GUIDED MISSILES)

WOODFORD, CHESHIRE

have vacancies in their

TRIALS DEPARTMENT

for the following

1 SENIOR ENGINEERS

to be responsible for design and development of instrumentation and monitoring systems.

2 SENIOR ENGINEERS

to develop service test equipment

3 MECHANICAL AND ELECTRONIC TECHNICIANS

to operate in Trials Teams both in U.K. and Australia.

4 TECHNICIANS

for environmental testing.

5 DRAUGHTSMEN

to form part of development teams.

The work is concerned with the development of a guided weapon project and for Post 3 willingness to travel to and from Australia is essential.

QUALIFICATIONS:

Posts 1 & 2 - H.N.C. Standard
Posts 3 - 5 - Preferably O.N.C. Standard.

Previous experience is not necessary providing that initiative is shown and that candidates are willing to work with a minimum of supervision.

The Division is situated within easy access of Manchester and the Derbyshire Hills, and the company provides excellent canteen facilities and a superannuation scheme.

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POSTS 1 & 2

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WEAPONS RESEARCH
A. V. ROE & CO. LIMITED
WOODFORD, CHESHIRE

POSTS 3, 4 & 5

THE PERSONNEL
MANAGER,
A. V. ROE & CO LIMITED,
GREENGATE,
MIDDLETON, M'CHESTER.

Quoting Reference WRD/HWL/R14/W

Progressive and Expanding RESEARCH DEPARTMENT

needs keen, enthusiastic engineers for

TELEVISION AERIALS

An engineer for the development of V.H.F. and U.H.F. aerial systems. Previous experience in this particular subject is not essential but applicants must have a good understanding of the basic principles involved and be prepared to guide a small team.

SUPPRESSION EQUIPMENT

An engineer is required to investigate various problems relating to interference filters and screened compartments for which a knowledge of filter networks is necessary.

Attractive commencing salaries are offered which will be based on experience, qualifications and age in each individual case. A Pension Scheme is in operation and all applications, giving full details of career so far, should be sent to the SECRETARY,

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vacancies exist in the Research Department of a large instrument manufacturing organisation in South-East Essex for graduate physicists or graduate electrical engineers of merit and some years of industrial experience for the investigation of long-term problems associated with Echo Sounding and Non-Destructive Testing.

The work embraces acoustics and electronics and involves the application of the basic physical principles underlying ultrasonics, telecommunications and computers. Some knowledge in these fields would be an advantage.

The initial salary will be in accordance with experience and qualifications within a scale which allows ample scope for future development. A contributory pension scheme is available, and assistance in housing or removal expenses may be given in suitable cases.

Applications, which may be made in strictest confidence, should give full details of qualifications, previous experience, age and salary required, and be addressed to Box No. 1922 c/o "W.W."

R. B. PULLIN & CO. LTD., GREAT WEST ROAD, BRENTFORD MIDDLESEX

invite applications for the following appointments in their progressive and steadily expanding organisation.

(1) CHIEF TEST ENGINEER

to take charge of a department concerned with the production testing of electronic equipment of considerable variety and technical interest. Substantial experience is essential, preferably in a similar capacity, and familiarity with A.I.D. requirements would be an advantage. Technical qualifications to H.N.C. standard or the equivalent are desirable.

(2) SENIOR DEVELOPMENT ENGINEER (ELECTRO-MEDICAL)

to undertake a responsible part in the design of a wide range of Electro-Medical Instruments. An honours degree or the equivalent would be an advantage but is by no means essential.

(3) DEVELOPMENT ENGINEERS (ELECTRONIC)

to be concerned with the design of a variety of SPECIALISED INSTRUMENTS and TELECOMMUNICATIONS EQUIPMENT. Qualifications ranging from O.N.C. to degree standard are acceptable.

For the development posts applicants should have had appreciable previous experience of valve or transistor circuit design preferably (although not necessarily) in one of the above fields.

All appointments are permanent, pensionable and carry attractive salaries; they offer excellent prospects and the opportunity to work on a variety of interesting projects.

Applications will be treated in strict confidence. They should include details of qualifications and experience, an approximate indication of the salary required, and should be addressed to the Superintendent, Electronic Development Division (posts 1 and 3 above), or the Superintendent, Medical Development Division (post 2).

DEVELOPMENT ENGINEER

for Radio and Electrical Manufacturers.

Experienced in the design of radio and associated equipment. High salary for qualified engineer.

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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.

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A number of vacancies, offering good career prospects, exist for:—

Radio Operators — Male

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INSTRUMENT MAKERS with fitting and machine shop experience in light engineering.

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4. Fault-finding in, and maintenance of, electronic apparatus.
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BASIC PAY: £9/2/4d. plus merit pay, assessed at interview and based on ability and experience, as under:—

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SPECIAL RATE: 38/- to 70/-

Opportunities for permanent and pensionable posts.

Five-day week, good working conditions single accommodation available.

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FOR HEADPHONES**
DLR5, DLR2, BA5,
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**RADIO & ELECTRONIC
ENGINEERS . . .**

The MORSE CODE is still, and always will be, the basic Code for individual Signalling, whether on visual or telecommunication circuits.

So add this simple and interesting subject to your qualifications. Apart from the pleasure derived from this extra knowledge, it counts for much when a step up the ladder is under consideration.

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(56W) 52b ABINGDON ROAD, LONDON, W.8
Candler System Co., Denver, Colorado, U.S.A.

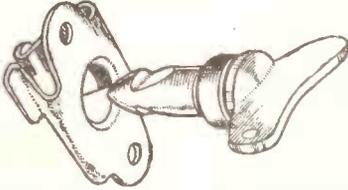
TROUBLE SHOOTERS
ESTERS
RAINEE TESTERS
FOR AM/FM RECEIVERS
GOOD RATES AND
CONDITIONS
APPLY: ACE RADIO LTD.
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TECHNICIAN**
sought as First Assistant to
Head of Workshop in newly established and expanding Research Department. Candidate should have a good practical knowledge of machine tools and research workshop practice. Experience in research or university workshop and/or experience in the wiring and construction of electrical and electronic apparatus an advantage. Age 25-40. Good Salary, plus bonus.
Apply giving details of age, training and experience to:—
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FERRANTI LIMITED, EDINBURGH
are anxious to engage a
TECHNICAL AUTHOR
with at least two years' experience in the electronic field, for the preparation of technical handbooks on radar and fire control systems. A substantial salary will be offered to the successful candidate. Congenial working conditions. Staff superannuation scheme is in operation.
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are required by Pye Limited for development work on equipment for communal T/V aerial systems. Previous experience of development of electronic equipment is essential
Please write in first instance to the Chief Engineer, Pye Limited, Cambridge, quoting 'TVR'.

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SCR 584
RADAR SET AND TRAILER
As new condition—Fully equipped. 10 CM. Search and Track. Ideal for Guided Missile Tracking, Trailer Van, Tools, some Spares, etc.
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Illustrated brochure and other information will gladly be sent on request.
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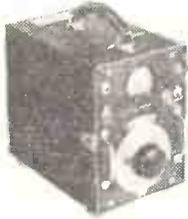
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MAGNETIC RECORDERS
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Progressive positions are open to qualified people of degree standard for work on development and manufacture of special radio valve and microwave devices.
Initial training at 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:—
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MANUFACTURERS OF VALVES for G.E.C.

Z & I AERO SERVICES LTD.

ATTENTION RADIO AMATEURS AND MODEL MAKERS

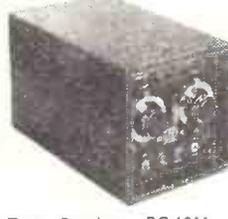
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Frequency Meter (Absorption) BC-906-D, range 150-235 mc/s.



Test Oscillator I-196, portable battery operated; frequency range 150-235 mc/s.



Test Receiver BC-1066, 150 to 235 mc/s, battery operated; contains one valve 1D8GT and two Valves 957.



Range Calibrator BC-949; contains a resonating circuit that can be switched to produce signals from 8 to 81 kc/s. Valves: one each 6SL7GT and 6H6.

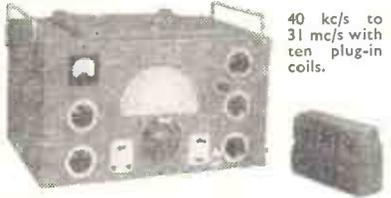


Indicator BC-936; contains a diode rectifier circuit (957) to rectify received pulsed RF signals. The output can be supplied to a C.R. Oscilloscope.

PRICE : £ 5. 10. 0 per set

CARRIAGE : £ 1. 0. 0 extra.

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40 kc/s to 31 mc/s with ten plug-in coils.

PRICE: Aerial Tested, complete with ten coils £12 10 0
Fully overhauled and guaranteed, complete with mains power pack..... £25 0 0
ALSO, for the first time we have available separately coils in sets of ten or individually, at 17/6 each or £6/10/- per set of ten in wooden box.

A.C. MAINS POWER PACKS, for 200/250 v mains. Output 300 v, 200 mA, D.C., 12 v. 3 amp. A.C. These can also be adapted for Eddystone Receivers. Size 7½ in. x 7 in. x 13½ in. Price brand new.....£3

2½ in. CENTRE ZERO PLAIN SCALE 600 MICROAMPS. F.S.D. GALVANOMETERS, projection mounted, plug-in type..... 12/6
2 in. ROUND FLUSH MOUNTED MILLIAMMETER, 1 mA. F.S.D., enclosed in a rectangular steel box 2½ in. square, with 5ft. long lead terminated with 2-pin socket, brand new..... 17/6

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WIRELESS SETS NO. 19 MK. 2, complete with Standard Kits, CANADIAN TYPE C-29 WIRELESS SETS complete with Standard Kits, COLLINS TCS Transmitting and Receiving Installations 1.5 to 12 mc/s. Prices and details on application.

6, 10 AND 12-LINE TELEPHONE SWITCHBOARDS. British and American Field Telephones, and spares.

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R-1294, frequency range 500 to 3,000 mc/s.
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MARCONI "STANDARD" TF144G. 85 kc/s to 25 mc/s..... £85 0 0
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TS-45, "X" Band, combined with Output Power and Frequency Meter £85 0 0

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LM Series, range as above.
TF-643 Marconi Absorption Type, Range 20 to 300 mc/s..... £35 0 0
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Prices and details on application.

BEAT FREQUENCY OSCILLATORS

FURZEHILL No. 1 or equivalent, 0 to 10,000 c/s, mains operated £22 0 0
GENERAL RADIO TYPE 613, 0 to 12,500 c/s, battery operated £25 0 0
MARCONI TF-195E, 0 to 12,000 c/s, mains operated £35 0 0
MARCONI TF-195F, 0 to 12,000 c/s, mains operated £40 0 0
MARCONI TF-195L, 0 to 40,000 c/s, mains operated £65 0 0

MARCONI TYPE TF-428B/1 VALVE VOLT METER, 10 to 150v. in 5 ranges resonant frequency 400 mc/s., brand new, in transit case..... £35 0 0
Service equivalent of the above, overhauled and guaranteed..... £17 0 0

MARCONI TF-340 RECEIVER OUTPUT METER

Meter scale 0 to 50 mW/0 to 17db. 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 and guaranteed £32 10 0

MARCONI TF-338B VARIABLE ATTENUATOR

for Audio Frequencies, range 105 db. Impedance 600 ohms £12 0 0

FOSTER MODEL D PORTABLE THERMOCOUPLE POTENTIAL METER

Range 20/60 mV. Calibrated in °C for Pt/Pt-Rh, Chromel-alumel, and Fe-Con thermocouples. Price complete with standard cell...£32. As above but complete with potential divider...£35.

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Hand Tuned Echo Box, having a frequency range of 3,140 to 3,360 mc/s. Accuracy ± 10 mc/s; Microammeter for measuring relative power and resonance indication. PRICE, each..... £7 10 0

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EVERSHED 1,000 V. 100 megohms SERIES 1 MEGGERS, brand new, complete with Decade Box for Resistance Bridge Measurements... £65 0 0
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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' guarantee. Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

LEWIS RADIO for the right price and best selection. See page 154. [0241]
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 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

HRO Rx's and coils in stock, also AR88, BC343R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053]

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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.

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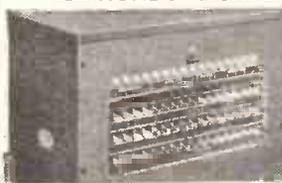


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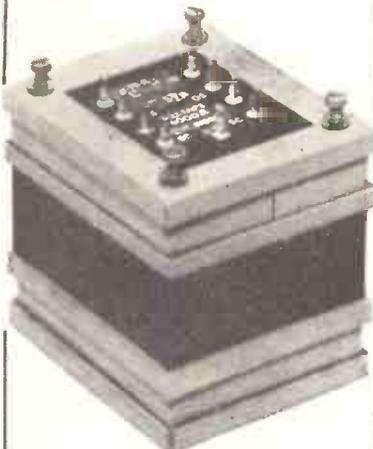
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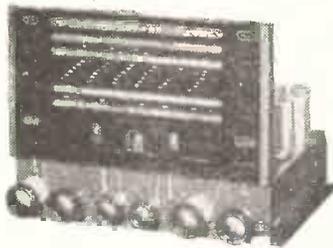
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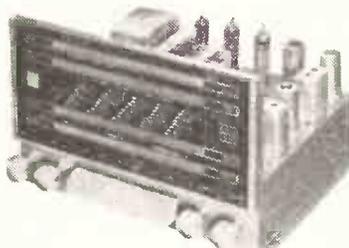
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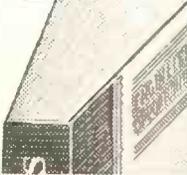
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TELEVISION Development Engineer (Senior) with administrative experience required; capable of carrying out development projects with minimum supervision up to production stage.—Write giving full personal details, Chief Engineer, Rediffusion Television, Ltd., Fullers Way, Chessington, Surrey. [7276]

ELECTRONIC development engineers.—A Midlands manufacturer has vacancies for development engineers for work on domestic TV receivers; should be fully experienced with minimum qualifications of H.N.C.—Those interested should write, giving full particulars of qualifications, to the Personnel Manager, Box 1619. [7359]

GRANADA TV NETWORK, Ltd., invites applications from experienced television lighting engineers for a post in their Manchester studios; applicants should have had considerable experience and show evidence of success in television lighting.—Full details of age, experience and present salary to Personnel Officer, Manchester, 3. [7361]

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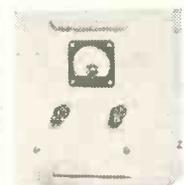
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APPLICANTS should write in the first instance to the Chief Engineer, Cathodeon, Ltd., Church St., Cambridge. [7377]

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TELEVISION Test Engineers.—A Midland manufacturer has a few vacancies for men capable of testing and fault-finding on domestic television receivers; experience of TV circuits and techniques is preferred but ex-service technicians and men of similar background will be considered; 5-day week.—Those interested should write, giving details of career to date, to the Personnel Manager (Ref. T.T.E.), Box 1708. [7367]

TELEVISION Development Engineer.—Vacancy exists in the Wembley area for energetic young engineer with some general experience in the design of television receivers; preferably graduate I.E.E. or Brit.I.R.E., but equivalent qualifications acceptable; pay according to qualifications and experience.—Apply in writing in the first instance to the Chief Engineer, Technical Centre, Radio Rentals, Ltd., Berrisford Ave., Wembley. [7366]

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. [7370]

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ELECTRONIC engineers required for the technical advisory laboratory of design department; the work is varied and interesting, involving practical research into the suitability of all components and materials for inclusion in new designs of receivers, also investigations of oscillator stability, temperature measurements and compensation, etc., of prototype television and radio receivers, meeting special requirements for export equipment, etc. Two vacancies exist—(a) for a senior engineer having H.N.C. or equivalent qualifications and some experience in the above work; and (b) for an assistant engineer having H.N.C. or equivalent qualifications.—WELWYN Garden City is well situated in pleasant countryside within easy reach of London, and applicants from the London area would become eligible for housing.—Applications giving full details of experience, age, qualifications, salary expected, should be forwarded initially to Personnel Department (R.11), Murphy Radio Limited, Welwyn Garden City, Herts. [7360]

TRANSMISSION equipment engineers reqd. for work on carrier telephone and telegraph apparatus contracts at our main works in London; increased activities offer wide scope and prospects for applicants with some experience, civilian or service, in the maintenance and installation of telecommunication equipment; educational qualifications up to Final City & Guilds or H.N.C. standard desirable but not essential; candidates must have completed National Service; where previous industrial background is lacking suitable training will be provided; salaries according to age and experience; liberal staff pension scheme, sports and canteen facilities; give full details to Staff Officer, ref. 744/86, Siemens Edison Swan, Ltd., Woolwich S.E.18. [7377]

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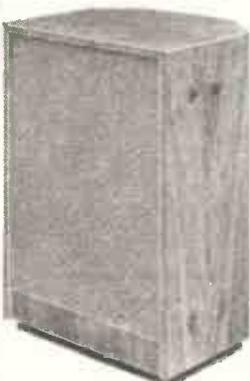
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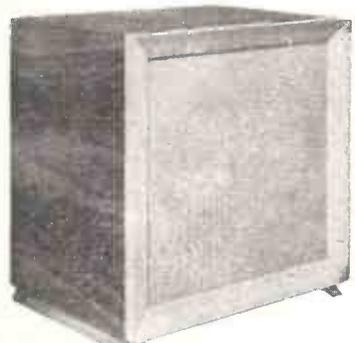
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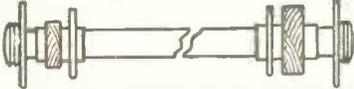
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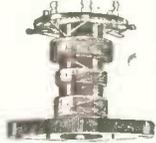
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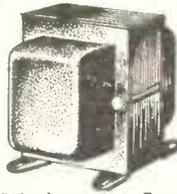
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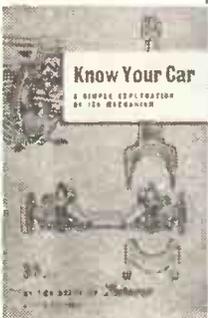
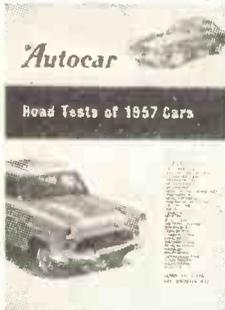
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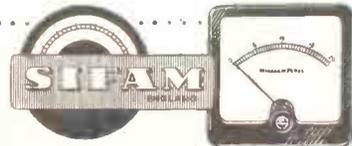
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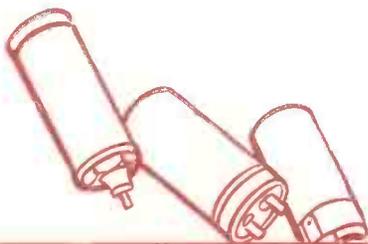
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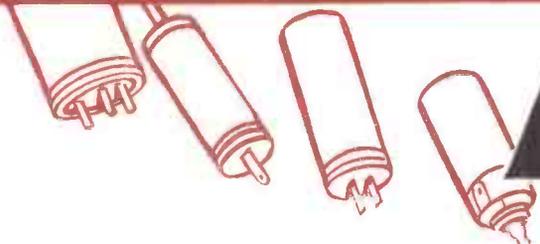
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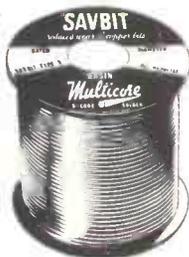
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